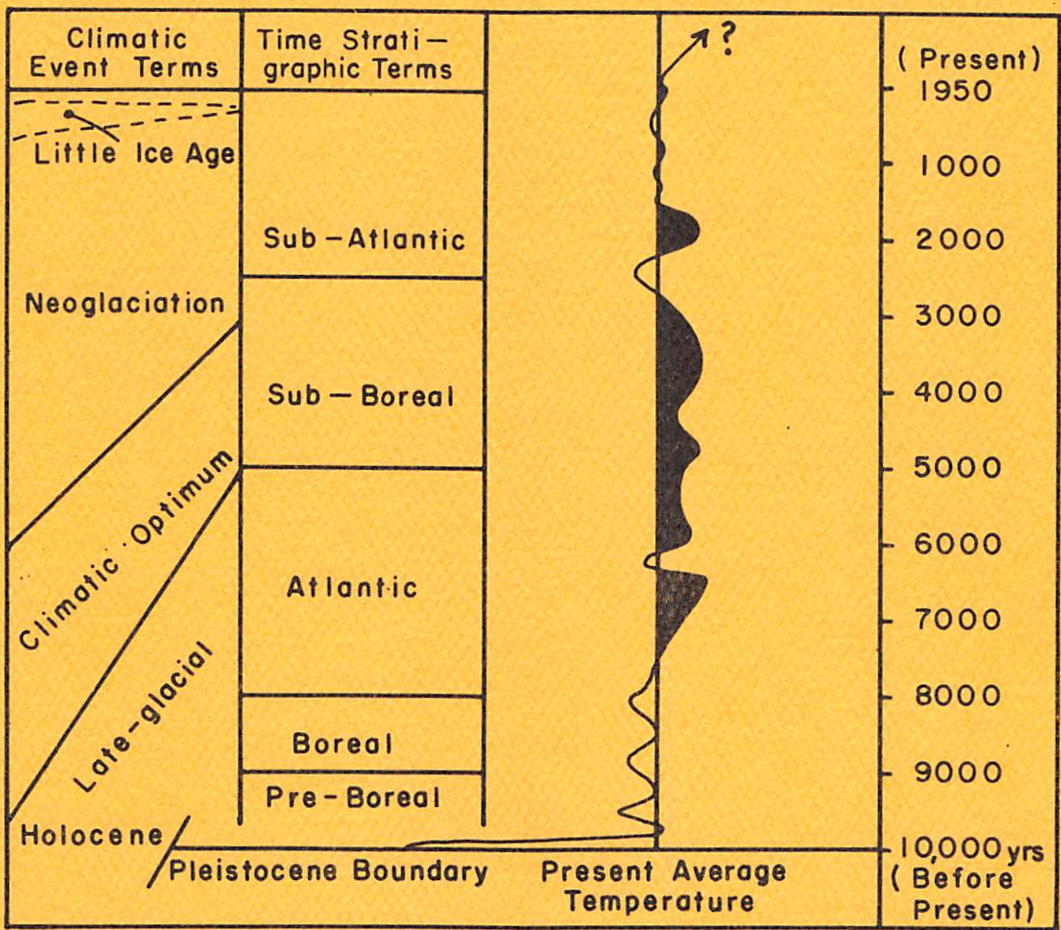
HOLOCENE PALEOCLIMATES: AN ANNOTATED BIBLIOGRAPHY

Volume I: Abstracts

Compiled and edited by Martha Andrews



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VOLUME I

ABSTRACT

Approximately thirteen hundred annotated references to the literature on Holocene paleoclimates, with emphasis on high latitude and high altitude areas, are presented as the result of a project sponsored by the U.S. Department of Energy, Carbon Dioxide Research Division. Covering the past twenty years of research results published worldwide, materials are included from the physical, biological, and earth sciences wherever environmental phenomena sensitive to climatic changes have resulted in proxy records. The references have been divided into fifteen subject categories, based on the primary method of climatic reconstruction. The references are indexed by author, subject category, keywords, time period within the Holocene epoch, geographic area, title, and dating methods; maps are included for reference. The bibliography is preceded by an introduction that details selection and formatting procedures.

FOREWORD

In spite of the increasing availability of computerized bibliographic databases, printed bibliographies in book form are likely to remain, for some time to come, the principal and most practical source of specialized literature information. This annotated bibliography illustrates this point very well. Martha Andrews is to be congratulated for this carefully produced and most thorough Occasional Paper, no. 41 in the INSTAAR series. Knowledge of Arctic and Quaternary literature and considerable library skills have been used to compile this large reference work on Holocene Arctic and Alpine paleoclimates.

The bibliography is intended to provide the background for assessing the potential effects of increasing atmospheric carbon dioxide on the climate at high latitudes and high altitudes. These warming effects, expected to be greater in polar regions than at other latitudes, are also predicted to be commensurate with those believed to have occurred throughout the past ten thousand years, generally agreed to constitute the Holocene epoch. This paper fully meets its primary objective. I suspect, however, that it will have its greatest utility among students of climatic change, whether or not they are interested in the carbon dioxide problem.

Patrick J. Webber, Director
Institute of Arctic and Alpine Research
June 1984

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This project has been supported by the U.S. Department of Energy, Carbon Dioxide Research Division, through contract DE-AC02-81ER60011 with the Regents of the University of Colorado. Michael R. Riches of the Carbon Dioxide Research Division, Office of Basic Energy Sciences, Department of Energy, Washington, D.C. was technical monitor for the project.

The computerized bibliographic file resulting from this project will be merged with the U.S. Department of Energy Carbon Dioxide Information Center's Bibliographic Information System (CDIC/BIS) currently online at Oak Ridge National Laboratory (ORNL). Computerized production of the printed bibliography was performed at this facility. The author wishes to thank Charles R. Weisbin, former Director of the Carbon Dioxide Information Center (CDIC), Michael P. Farrell, present Director, CDIC, and their staff members for many kinds of assistance. Linda J. Allison, former Research Analyst at CDIC, coordinated this effort very effectively, succeeding Helen A. Pfuderer in this capacity. David K. Trubey, Radiation Shielding Information Center (RSIC) at ORNL, converted and transferred the diskette files created at the University of Colorado on a Radio Shack TRS-80 Model III microcomputer to disk storage on the IBM 3033 computers at ORNL. Betty Jacobs, also of CDIC, performed numerous tasks, including running the computer searches. Faye Fletcher and Janet Scott of the ORNL Information Center Complex Computer Services Group were instrumental in preparing the preliminary computer printouts and the final formatted, indexed bibliography for computer printing.

The author wishes to thank the INQUA Paleoclimate Commission, presided over by F.A. Perrott (née Street), for supporting the pilot study that preceded the successful proposal to DOE, for financial support toward the final publication, and especially for supporting the idea of the project.

Special thanks go to Dr. Alan Hecht, formerly of the Climatic Dynamics Division of the U.S. National Science Foundation (current address: National Climate Program, NOAA, Rockville, MD), for his interest in the project and for his very important suggestions concerning funding.

Thanks also go to the several scientists who were kind enough to make suggestions concerning the bibliography, particularly, R.S. Bradley, T. Webb III, W.W. Kellogg, T.D. Hamilton, T.M.L. Wigley, and C.R. Harington.

Several librarians offered very valuable advice: Nita Cooke, Librarian at the Boreal Institute for Northern Studies, University of Alberta, Edmonton, Alberta; Marilyn Stark, Reference Librarian at the Colorado School of Mines, Golden, Colorado; and David Fagerstrom, Science Librarian at the University of Colorado, Boulder.

Thanks also go to several people at the Institute of Arctic and Alpine Research, University of Colorado, including Patrick Webber, Susan Short, and Kathleen Salzberg and especially Vera Markgraf, for providing several records for inclusion and for linguistic assistance; Meg James, for inputting the whole bibliography; and, last but not least, John T. Andrews, for very valuable technical assistance, including writing many, many abstracts and allowing use of his extensive reprint collection.

Finally, thanks go to Keith M. Clayton of Geo Abstracts Ltd. (present address: Regency House, 34 Duke St., Norwich NR3 3AP, England), for allowing use of copyrighted abstracts; to the Arctic Institute of North America for the use of copyrighted abstracts from vols. 14–16 of *Arctic Bibliography*; and to University Microfilms International, Ann Arbor, Michigan, for permission to use several abstracts from Dissertation Abstracts International.

INTRODUCTION

The main objective of this bibliography is to provide the scientific community with a reference source for research on Holocene paleoclimatology, an interdisciplinary field in which publications are widely scattered and thus difficult to access.

> The increasingly visible impact of climatic variability on human affairs lends a sense of urgency to the task of better understanding the workings of the Earth's climatic system. Actual instrumental observations of climate are relatively short, and we must therefore turn to other sources for information about past climates to help develop and test the models that may enable us to predict climatic anomalies such as prolonged droughts or a series of severe winters. (LaMarche 1978, p. 334.)

The data from which past climates may be reconstructed fall into three categories: instrumental, historical, and proxy. Proxy records come from many environmental phenomena sensitive to climate, such as tree rings, ice cores, etc. (See INDEXES, SUBJ CAT. in this Introduction.) This bibliography draws from the literature concerning each of the above three categories but relies most heavily on the research from proxy evidence, notably, glacial geologic and palynologic information.

During recent years, several publications with extensive bibliographies have covered specific aspects of Holocene paleoclimate reconstruction; however, although some of the same references were used, an effort was made not to duplicate the references in these works, which the interested reader should consult independently.

- *Quaternary Paleoclimatology: Methods of Paleoclimatic Reconstruction* (Bradley, in press) is a treatment of methods, with several case studies, and contains a very extensive bibliography.
- *A Bibliography of the Literature on North American Climates of the Past 13,000 Years* (Grayson 1975) is well described by its title; no abstracts are included for the 1398 references.
- *A Review of Paleobotanical Studies Dealing with the Last 20,000 years: Alaska, Canada and Greenland* (Hills and Sangster 1980) deals exclusively with paleobotanic information relating to the areas noted in the title. A reference list of 375 records is tabulated with added information.
- *The Continental Record of Environmental Conditions at 18,000 yr B.P.: An Initial Evaluation* (Peterson et al. 1979) "is a 'state-of-the-art' report in which we have identified the set of paleoclimatic reconstructions of 18,000 yr B.P." (Peterson et al. 1979, p. 68). A 150-page appendix, available separately, tabulates over 1000 references with added information.

During the searches conducted to collect materials for this bibliography, it became apparent that large numbers of papers relating to Holocene paleoclimates are published in certain serials. These are, ranked according to numbers of citations used, as follows: *Arctic and Alpine Research* (90); *Quaternary Research* (62); *Nature* (52); *Canadian Journal of Earth Sciences* (50); *International Association of Scientific Hydrology Publication* (37); *Arctic* (35); *Science* (34); *Geografiska Annaler Series A* (33); *Journal of Glaciology* (32); *Boreas* (30); *Geological Survey of Canada Paper* (27); and *Palaeogeography, Palaeoclimatology, Palaeoecology* (26). The diverse sources of the literature are evident when one considers that these ten serials together supplied only a third of the references included in this bibliography, and that the places of publication of these serials are located in seven countries.

Other noteworthy publication categories are theses (27 Ph.D. and 15 Master's theses are included) and conference proceedings. This last category is perhaps dominated by one classic, *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, A Symposium held at Oulanka and Kevo, October 4–10, 1971* (Vasari et al. 1972), from which sixteen papers are included in this bibliography.

SCOPE OF THE BIBLIOGRAPHY

Papers reporting results of research on high latitude and high altitude areas, believed to be more sensitive than other areas to climatic change from a possible CO_2 buildup in the atmosphere, were the main type chosen for consideration for this bibliography, based on their inclusion of chronological and/or quantitative information. These circumpolar and alpine areas are shown on Maps 1 and 2 in the pocket of Volume II. Some papers pertaining to geographical areas outside of circumpolar and alpine areas have also been included and are also shown on Map 1 (United Kingdom and Ireland, etc.).

Approximately 1300 papers were selected from the literature covering the fields of climatology, geology, biology, archeology, and oceanography to cover all possible sources of proxy climatological information. Only those papers published since 1960 were included, since techniques for detecting climatic changes using proxy records have improved so much during the past twenty years. Technology in the information sciences has also improved vastly during the past twenty years; however, the advent of the commercially available bibliographic databases really dates from the early 1970s, with a few exceptions. It was therefore necessary to search printed indexes in order to retrieve materials published as long ago as 1960. Another reason for using the printed indexes is that some of them are area specific and others have good area indexes, characteristics notably lacking in the computerized databases.

SELECTION OF MATERIALS

The majority of the records in this bibliography were obtained by using printed indexes, library collections (Boreal Institute for Northern Studies, University of Alberta, Edmonton, Alberta; Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado), and the private reprint collection of John T. Andrews at the University of Colorado.

Printed Abstracting and Indexing Services: Secondary Sources

All sources described in this section are referenced fully at the end of this Introduction.

During the first half of the project, the main area of focus was to search printed indexes for materials relevant to the aims of the bibliography. As determined from a pilot study done for the International Quaternary Association (INQUA) [Andrews 1980; 1983 (this paper elaborates in much greater detail than does this Introduction on the methods used for selecting and formatting the materials in this bibliography)], the major printed indexes chosen for searching were the Geo Abstracts bibliographies and the *Arctic Bibliography*, both of which were searched back to 1960, using time terms, subject terms, and geographical area terms as appropriate.

Three sections of the Geo Abstracts bibliographic series were the most useful sources, supplying 231 records. The first of these, *Geomorphological Abstracts*, was succeeded by *Geographical Abstracts A, Geomorphology*, which later became *Geo Abstracts A, Landforms and the Quaternary*. The five-year cumulative indexes were searched, covering the years 1960–1975. The second section of Geo Abstracts used includes *Geographical Abstracts B, Biogeography and Climatology*, later titled *Geo Abstracts B, Climatology and Hydrology*; it was searched via its five-year cumulative indexes covering 1966–1975. The third Geo Abstracts bibliography used was *Ecological Abstracts*, which in 1974 took over the Biogeography component of *Geographical Abstracts B* and expanded it. *Ecological Abstracts* was searched by all of its annual indexes (1974–1979). The Key Word In Context (KWIC) augmented title indexes provided by Geo Abstracts proved very satisfactory. In searching the Geo Abstracts bibliographies, search terms were confined to time and subject terms; items fitting those two categories were then checked for geographic location.

The *Arctic Bibliography* was searched from volumes 10 through 16 (the final volume of the series), covering 1960 through 1972. Some 122 records representative of the arctic areas in all countries surrounding the North Pole, written in many languages, and interdisciplinary in subject field were thus acquired, complete with original abstracts. Since the *Arctic Bibliography* is area specific, search terms indicating the desired time frame and subject fields were used.

In addition to these two major bibliographical services, other printed sources were also very useful: ***Baffin Island Quaternary Environments: An Annotated Bibliography*** (48 citations used); ***Ecology of the Canadian Arctic Archipelago: Selected References***, 1976–1981, vols. 1–9 (48 citations used); ***Antarctic Bibliography*** (37 citations used); and ***Dissertations Abstracts International*** (10 citations used).

Miscellaneous secondary sources, including printouts from the computerized Carbon Dioxide Information Center's Bibliographic Information System and the printed report ORNL/EIS-195 (Chilton et al. 1981), supplied another twenty-one records.

Thus, a total of 517 (39%) of the records included in the present bibliography is from secondary sources and is so acknowledged at the end of each abstract, after the abstractor credit.

An Annotated Bibliography of Quaternary Climatic Changes in Canada, uncorrected draft (Ghanime, unpublished) was useful as a finding source, as were several other sources of a few references each.

Computerized Databases

Selection of databases. Choosing which computerized databases to use included two stages. First, based on the author's experience, including a visit to the Library at the Boreal Institute of Northern Studies, University of Alberta, Edmonton, where some short searches were run on the SPIRES and QL computerized information systems, a dozen databases were chosen for "testing" against DIALINDEX. This database is an index to all of the other databases available through Dialog Information Retrieval Services, vendor for all of the databases used for this project. Second, the twelve chosen databases were combined into three groups representing general scientific subjects: biological/agricultural, marine, and geophysical. For each group, time terms plus a somewhat different selection of subject terms, depending on the scientific discipline, were searched. By running the selected search terms through the selected databases, ten databases were identified as being worthwhile for full-scale searching:

AGRICOLA (Dialog Files 110, 10)
BIOSIS PREVIEWS (Files 55, 5)
COMMONWEALTH AGRICULTURAL BUREAUX ABSTRACTS (File 50)
COMPREHENSIVE DISSERTATION INDEX (File 35)
CONFERENCE PAPERS INDEX (File 77)
GEOARCHIVE (File 58)
GEOREF (File 89)
NTIS (File 6)
OCEANIC ABSTRACTS (File 28)
SCISEARCH (Files 34, 94, 156, 187, 188)

Search strategies. The results of the DIALINDEX search, in addition to being helpful in database selection, were also helpful in formulating the database search strategies. Unfortunately, it was not possible to include an area search term, since these databases are not reliably indexed by area. Even GEOREF, a partial exception to this limitation, is indexed by area using such specific terms that even using a very large number of area terms would not have given adequate returns.

Five different search strategies were used on the several databases, which were combined into five groups: biological/agricultural, oceanographic, general category databases, and geological (two). These searches retrieved items combining any of the time terms with any of the subject terms, using the Boolean operators OR and AND. GEOREF, GEOARCHIVE, and BIOSIS Previews yielded the highest numbers of references. A total of 278 items was retrieved from BIOSIS Previews. GEOARCHIVE was searched specifically using Holocene and Paleoclimatolog?, resulting in 374 retrievals. The Paleoclimatolog? instructs the computer to retrieve all papers indexed to Paleoclimatolog with various endings (-y, -ic, and -ical). The GEOREF search was narrowed down even further, using Holocene and Paleoclimatolog?/DE*. The DE* indicates that retrievals should be limited to papers in which Paleoclimatolog? is the main topic of the paper. Even with such limitations, 1225 items were retrieved from GEOREF. Small numbers of useful references were obtained also from COMPREHENSIVE DISSERTATION INDEX, OCEANIC ABSTRACTS, CAB ABSTRACTS, and NTIS.

Retrievals from these databases, in the form of offline printouts, were used as finding sources only; abstracts from these databases were not used. The computer-retrieved materials were mainly useful for finding materials published in the past ten years (postdating the printed indexes in most cases) and as a source for doublechecking to make sure desired materials were not omitted. Some reasons why the computer searches were not more useful are

1. none of the computerized databases can be searched by area terms successfully;
2. the computer searches produced many duplicates of materials already found in the printed indexes;
3. references to many papers in foreign languages were without English abstracts or notice of an English translation; and
4. the high incidence of duplication among the various databases is a problem without a solution at the moment.

FORMAT OF CITATIONS

Citations in this bibliography are divided into fifteen subject categories or methods of climatic reconstruction. Within these categories, arrangement is by author and publication date. Each citation includes the following information: record number, author, publication date, title, foreign title (if applicable), language (if not English; notation of a second language summary or abstract is also given here), and publication description. Other elements of the citation are

- COMMENT. In this section, notations of anything extra thought to be valuable to the user are entered.
- ABSTRACT. Every record is accompanied by an abstract. The abstractors are all credited in parentheses at the end of the abstract. (Auth) indicates an author abstract; (Auth)(JTA) indicates an author abstract modified by John T. Andrews; (JTA) indicates an abstract written by John T. Andrews. Many abstracts have been quoted from secondary sources and are identified by an author credit if one was given. If none was given, the abstract is identified by its secondary source (see following).
- SEC SOUR. Secondary sources used, such as the *Arctic Bibliography*, are given full credit in this field so the reader may refer to the source if desired.

INDEXES

The annotated records are indexed using the following fields of information:

- SUBJ CAT. Fifteen methods of climatic reconstruction were defined, and the bibliography is arranged by the primary term. Although more than one term was often assigned to a bibliographic record, the citations are sorted by the primary term only. All terms assigned are used as indexing terms. The methods of reconstructing paleoclimates are

  Agricultural—evidence of past farming, crop raising

  Archeologic—evidence of life and culture of ancient people

  Climatologic—instrumental and observational records of climate; computer modeling of climate

  Dendroclimatologic—interpretation of tree-ring records

Geologic—geological evidence not included in the other categories

Geomorphologic—evidence from periglacial process studies and other process studies (fluvial, eolian)

Glacial geologic—evidence from features formed as a result of glacial erosion or deposition or from changes in the position of glaciers

Glaciologic—evidence from existing glaciers, such as ice cores, oxygen isotope ratios, etc.

Historic—evidence from written records

Oceanographic—evidence from changes in the composition of sea water, water temperature, circulation, sea bottom studies, ocean currents

Paleobotanic—evidence from vegetational fossil remains, tree-line movement, etc.

Paleozoologic—evidence from fossil animal remains

Palynologic—evidence from studies of pollen and other spores and their dispersal

Pedologic—evidence from buried soils (paloesols) and other soils

Stratigraphic—evidence from rock strata, varves, ice layers, and other stratified sediments.

- GEOGDESC. After much consideration, the geographic areas covered by this bibliography were divided into approximately seventy-five regions (see Maps 1 and 2 in the pocket of Volume II for delimitation of these regions). The names of these regional divisions are used as terms to form the Geographic Description Index. These maps are polar projections of the Arctic and Antarctic regions at a scale of 1:17,000,000, with an inset on Map 1 to show alpine areas. The regional divisions are based mainly on political boundaries (for ease of reference to larger-scale maps) but include some breakdowns of political divisions into physical areas such as island groups. A few areas were subdivided further based on (1) the supposition that reference to areas as large and diverse as Greenland and Antarctica would not be very useful, and (2) the fact that some areas, such as Alaska and Baffin Island, contain such diverse physical areas and have so many references to them that further breakdown is useful. Reference to the Geographic Description Index reveals a fairly regular distribution of references among the various regions. However, some regions appear to dominate, such as Baffin Island and Alaska in the Arctic and the Rocky Mountains and the Alps in the Alpine.

- TIME. Each bibliographic record is described as to time within the Holocene, using time stratigraphic terms (Early Holocene, Sub-Atlantic, etc.). One descriptor was used for each paper. Climatic event terms such as Neoglaciation and Little Ice Age are used as keywords.

- DAT METH. Methods used by the researchers to provide dates for paleoclimatic reconstructions are entered for each record; any number of the appropriate terms is used, and they form the dating methods index. These terms constitute a controlled vocabulary and include radiocarbon dating, correlations, etc.

- KEYWORDS. The keywords are basically subject terms used to describe the document. These terms provide an index to the printed volume, and will be a main point of access for the online users. (See Acknowledgments.)

An index is also provided to all authors. Important title words are indexed via a permuted title, KWIC index.

BIBLIOGRAPHIES USED AS SOURCES OF MATERIALS FOR THE ANNOTATED BIBLIOGRAPHY OF HOLOCENE PALEOCLIMATES, WITH <SEC SOUR> SYMBOLS ITALICIZED

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Yates, E.M. and Margaret A. Bass, 1972. Geographical Abstracts B - Biogeography Climatology, Cumulative Index 1966–1970. Norwich, England, Geo Abstracts, 954 pp. *GA*

Computerized Databases (Availability Shown)

Carbon Dioxide Information Center's Bibliographic Information System (CDIC/BIS), 1980–present, over 7200 records (Carbon Dioxide Information Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., 37831). Availability information upon request. *CDIC*

QL/ASFA, Aquatic Sciences and Fisheries Abstracts, 1978–present, 98,179 documents (to 1982). QL Systems LTD., 1018 Place de Ville, Tower B, 112 Kent St., Ottawa, Ontario K1P 5P2.

SPIRES/ASTIS, Arctic Science and Technology Information System (Arctic Institute of North America, University of Calgary, Calgary, Alberta). Available online to anyone having an account with the University of Alberta's Computing Services Department. Also available from QL Systems, Ltd., as file ASTIS.

SPIRES/BOREAL, catalogued collection of the Boreal Institute of Northern Studies Library (University of Alberta, Edmonton, Alberta). Available online to anyone having an account with the University of Alberta's Computing Services Department.

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This review which covers Eurasia, North America, Africa and New Zealand, refers mainly to changes which have occurred over the past 2000 years. Altitudinal and longitudinal changes in vegetation distribution include observations and increases in crop production coinciding with periods of warm summers. A section on herbaceous and agricultural crop growth outlines how the history of cereal grain cultivation in Iceland is related to climatic changes and indicates the correlation of poor rice harvests in Japan with periods of excessive cold or moisture. (from Field Crops Abstracts) GA 73B/1241

2. **Bryson, R.A.** 1974. Heyuppskera: An Heuristic Model for Hay Yield in Iceland. *Research Institute Nedri As, Hyeragerdi, Iceland. Bulletin No. 18, 14 pp.*

This paper examines the effect of climate and fertilizer applications on the hay crop of Iceland. The initial assumption was that hay yield is limited by summer warmth. It is calculated that with a mean annual temperature 1.6 degrees Celsius below the average of the 1943-1967 period and with a 5 kg/ha nitrogen application, the calculated yield of hay is 2.9 metric tons per hectare, or about 75% of the 1943-1967 average. The author concludes that the farming economy of Iceland is sensitive to changes in temperature. (JTA)

3. **Malmer, N., L. Lindgren, and S. Persson.** 1978. Vegetational Succession in a South Swedish Deciduous Wood. *Vegetatio 36(1):17-30.*

The wood has been left almost undisturbed during the last 60 yr. Since 1925 the number of vascular plants has diminished by 42%. In the tree layer ULMUS and FRAXINUS have increased since 1918 while FAGUS has remained fairly constant and QUERCUS, the former dominant, has become much less important. In the shrub layer young ULMUS are predominant, while the former dominants CORYLUS and CRATAEGUS have diminished markedly. Analyses show a decrease in both the total number of field layer species recorded and in the number of species per sq.m. ANEMONE RANUNCULOIDES, AEGOPODIUM PODAGRARIA and MERCURIALIS PERENNIS have expanded; ANEMONE NEMOROSA, LAMIUM GALEOBODOLON and GEUM URBANUM have diminished. Increased shading from closer tree canopies, increased litter fall and lower soil surface temperatures are environmental changes since 1935 which may be important for the field and bottom layer species. (Auth) Ecol Abs 79L/0518

4. **Pfister, C.** 1981. An Analysis of the Little Ice Age Climate in Switzerland and It's Consequences for Agricultural Production. *Climate and History, T.M.L. Wigley, M.J. Ingram, and G. Farmer (Eds.). Cambridge University Press, Cambridge, (pp. 214-248), 530 pp.*

A careful search across a number of Swiss archives has yielded an unexpected wealth of documentary information on climate. Based on these data the main spells of heat and cold, wetness and drought can be traced back to the early sixteenth century at the level of individual months. In order to assess the impact of the Little Ice Age (1525-1825) climate upon agricultural production of fluctuations of the major staple foods (grain, wine, dairy products) are considered and compared with documentary climate evidence. It appears that the very poor crops were always the result of extreme meteorological conditions, sometimes far beyond the maxima of the present century. (Auth)

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5. **Aigner, J.S.** 1976. Dating the Early Holocene Maritime Village of Anangula. *Anthropological Papers of the University of Alaska 18-1:51-62.*

Several types of data are examined, among them pedologic, geomorphic, cultural stratigraphic, archeologic, and radiocarbon dating. Based on these data, the author rejects the hypothesis that the duration of occupation of Anangula Island was 1500 years or more (from 8480 + or - 350 B.P. to 6962 + or - 91 B.P., Laughlin, 1975). Rather, the data support a short occupation period (8750-8250 B.P., Black, 1976). This moderate sized, maritime village is the oldest known on the Beringian coasts. (MA)

6. **Aigner, J.S.** 1976. Early Holocene Evidence for the Aleut Maritime Adaptation. *Arctic Anthropology 13(2):32-45.*

Aleutian research provides evidence which demonstrates continuity in material culture and in adaptation from early Holocene to late Aleut sites. There is direct as well as indirect evidence for a true maritime adaptation at least 8500 years ago and reason to believe Aleuts were in the area 2000 to 3000 years earlier, with a similar exploitation pattern. Their maritime adaptation is thus considered that of an Upper Palaeolithic Beringian coastal people. Evidence leads to the rejection of evolutionary models which ascribe maritime adaptations among Bering Sea Mongoloids and other north Asian maritime peoples to either recent borrowings from complex societies or to the late autochthonous evolution of coastal economies from interior economies. (Auth)(JTA)

7. **Arundale, W.H.** 1976. The Archaeology of the Nanook Site: An Explanatory Approach. *Ph.D. Thesis, Michigan State University, East Lansing, MI, 598 pp.*

The Nanook Site (KdDq-9), a prehistoric Dorset site located on the south coast of Baffin Island, N.W.T., Canada, has a number of assets which made it intrinsically interesting to the archaeologist: 1) relatively large sample of artifacts with good preservation of organic materials, 2) the presence of faunal remains, 3) radiocarbon dates which span a period of 500-600 years, and 4) the presence in the immediate vicinity of numerous other Pre-Dorset and Dorset sites to provide context and temporal control. On the basis of radiocarbon dates, the Nanook Site probably was occupied periodically from approximately 2410 B.P. to 1827 B.P., a period of 583 years. While not all researchers agree on the climatic character of this period, it is clear that significant changes in the climatic regime of this part of the Canadaian arctic took place toward the end of this temporal interval. A survey of pertinent evidence from a variety of palaeoclimatic sources, in conjunction with the standing wave model of climatic change derived from the analysis of more recent climatic events, indicates that prior to 1900 B.P. conditions at the Nanook Site were colder and dryer, while after 1900 B.P. they were warmer and wetter. (Portion of author's abstract from Dissertation Abstracts International 37:5906-5907A)(JTA) Ecol Can 1813

8. **Arundale, W.H.** 1981. Radiocarbon Dating in Eastern Arctic Archaeology: A Flexible Approach. *American Antiquity 46(2):244-271.*

Five pages of Carbon 14 dates from the archeological sites in the Eastern Arctic are provided, listing sample materials. Problems with using dates from materials such as marine mammal bones are discussed and suggestions outlined for better understanding of dating sources. The Carbon 14 dates cover the last 5000 years. (JTA)

9. **Baranowski, S., and W. Karlen.** 1976. Remnants of Viking Age Tundra in Spitsbergen and Northern Scandinavia. *Geografiska Annaler 58A(1-2):35-40.*

Fossil tundra fragments consisting chiefly of moss (RHACOMITRIUM LANUGINOSUM, 60%; DICRANUM, 20%) were found in the forefield of Werenskioldbreen. The vegetation formed a cover c. 5 cm thick and occurred between two till layers. The age of the upper part of this layer was dated to 760 + or - 145 years B.P. and the lower part to 1565 + or - 235 B.P. The results indicate that during the Viking Age Spitsbergen and northern Scandinavia experienced a warm period with distinct glacier retraction and well-developed tundra on the glacier forefields. This period was preceded by a marked long- lasting glacier advance and followed by an equally extensive but shorter advance. (Auth) Ecol Abs 77L/2737

10. **Barry, R.G., W.H. Arundale, J.T. Andrews, R.S. Bradley, and H. Nichols.** 1977. Environmental Change and Cultural Change in the Eastern Canadian Arctic during the last 5000 Years. *Arctic and Alpine Research 9(2):193-210.*

Archaeological research suggests that cultural changes in the Canadian Arctic are closely linked to environmental changes. Current knowledge of postglacial climate and marine conditions in the eastern Canadian Arctic–an area demonstrably sensitive to small fluctuations in these conditions–is reviewed in the context of the prehistoric culture sequence. Most of the major cultural events since 4500 B.P. appear to correlate well with the paleoclimatic conditions inferred from environmental data, although specific causal mechanisms cannot be documented. (Auth)(JTA) BafBib 373

11. **Benedict, J.B.** 1973. Prehistoric Man and Climate: the View from Timberline. *IX INQUA Congress, Christchurch, New Zealand, December 2-10, 1973. Abstracts. (pp. 18-19).*

Forty Carbon 14 dates and glacial, periglacial, pedologic and palynological evidence confirms a three-fold Neoglacial sequence in which the most extensive ice advance occurred between 5300 and 4500 B.P. Fig. 1 relates the proxy climatic data and the archeological data from the Indian Peaks area, Colorado Front Range, indicating man's movements in and out of the alpine corresponded to climatic changes. (JTA)

12. **Benedict, J.B.** 1978. Getting Away from it All: A Study of Man, Mountains, and the Two-Drought Altithermal. *Symposium on Colorado Archeology, Plains Anthropological Association, 36th Annual Meeting, Denver, 1978. (pp. 1-11).*

Analysis of 171 charcoal and bone-collagen dates from Altithermal (7500-5000 BP) archeological components in western North America suggests that human population fluctuations during this period were strongly influenced by regional changes in effective moisture. Man's alternate preference for moist and dry environments indicates that the Altithermal "Long Drought" was in reality two severe short droughts (ca. 7000-6500 BP and 6000-5500 BP), separated by an interval of greatly increased effective moisture. The Altithermal was a time of rapid and complex climatic change, leading to human population dislocations on a continental scale. (Auth) (JTA)

13. **Benedict, J.B., and B.L. Olson.** 1973. Origin of the McKean Complex: Evidence from Timberline. *Plains Anthropologist, Journal of the Plains Conference, 18-62 (Pts. 1-2):323-327.*

The Fourth of July valley site (5BL120), a single-component hunting camp at timberline in the Colorado Front Range, was occupied approximately 6000 radiocarbon years ago. Projectile points from the occupation area are typologically intermediate between James Allen and McKean Lanceolate points, and between Pryor

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Stemmed and Duncan points. The age and timberline location of the site, together with the transitional nature of the projectile points, support Husted's (1968) hypothesis that the McKean complex developed from Plano progenitors in high-mountain Altithermal refuge areas. (Auth)

Carbon 14 dates of 5880 + or - 120 and 6045 + or - 120 were obtained from charcoal in hearths excavated from the Fourth of July valley site, Colorado Front Range, which straddles an early Holocene terminal moraine. Indications are that hunters abandoned this site 7500 years BP when water supply became undependable, returned to the area again at 6,000 BP during the Altithermal when precipitation increased, and at the beginning of Neoglaciation 5000 years ago spread down into the plains. (JTA)

14. **Black, R.F.** 1974. Geology and Ancient Aleuts, Amchitka and Umnak Islands, Aleutians. *Arctic Anthropology 11(2):126-140.*

"No glaciers exist on Amchitka today. On Umnak no glacial deposits have been recognized earlier than Late Wisconsinan when an extensive ice sheet covered all but the highest peaks up to about 11,000 years ago. During a Neoglaciation about 3000 years ago several presently restricted alpine glaciers on Umnak Island expanded to the sea. Unconsolidated ash and organic soil sequences began forming roughly 11,000 years ago on both islands; gravity movements are much more pronounced on Amchitka today than on Umnak. Coastal erosion of both islands has been extensive, especially since the sea reached its highest level between 8000 and 3000 years ago. The 8400 year-old archaeologic site of Anangula survived because of protection on the bay side and by the fortuitous inclination seaward of a resistant lava flow which minimized undercutting." (Auth)

The start of Neoglaciation is based on two Carbon 14 dates on organic materials under till. Younger moraines exist near the present glacier margins but have not been dated. (JTA)

15. **Black, R.F.** 1976. Influence of Holocene Climatic Changes on Aleut Expansion into the Aleutian Islands, Alaska. *Anthropological Papers of the University of Alaska 18-1:31-42.*

This paper addresses the influence of climate on the migration of the Aleuts during the Holocene. The evidence and interpretations presented here suggest that climatic change did not play a major role in the migration of the Aleuts during the Holocene - that is after they were first able to enter the islands. The effect of the early and late Holocene glaciations on the Aleuts seems to have been minimal. Without significant changes in their food supply, little incentive to migrate because of climatic changes seems to have existed. (Auth) (JTA)

16. **Campbell, J.M.** 1962. Ancient Alaska and Paleolithic Europe. *Arctic Institute of North America, Technical Paper 11, (pp. 39-54).*

Offers a conditional dating for eight successive pre-Eskimo and Eskimo culture complexes, starting some 8-10 thousand years ago; they are considered intrusive manifestations of different hunting groups rather than a continuous local development. The artifacts of each sequence are described and correlated with co-eval site inventories. Early cultural relationships between the Brooks Range are traced to other Arctic American sites, the Great Plains region, and the paleolithic of Eurasia. The material and cultural remains of 35 sites attributed to the Nunamiut Eskimos are discussed as to origin, antiquity, length of habitation in the Pass region, links with preceding occupants, etc. The artifact typology implies a coastal sea-mammal hunting origin of the inland- montane Nunamiuts. (AB77818) AB77818

17. **Dekin, A.A., Jr.** 1972. Climatic Change and Cultural Change: A Correlative Study from Eastern Arctic Prehistory. *Polar Notes 12:11-31.*

"This paper summarizes available evidence for prehistoric climatic change, hypothesizes a series of climatic fluctuations, and explores the implications of these changes on the human component of the ecosystem." (Auth) Eight tables are used to list evidence, primarily from the published literature, for warmer and colder periods during the last 4500 years of human occupation of the eastern Arctic. Dates on the Stages I-VIII are as follows: 1)warmer prior to 4500 to 3500 B.P.; 2)colder 3500 to ca 3100 B.P.; 3)warmer 3100 to 2700 B.P.; 4) colder 2700 to 2200 B.P.; 5)warmer 2200 to 1500 B.P.; 6) colder 1500 to 1000 B.P.; 7)warmer 1000 to 700 B.P.; and 8)colder 700 to 450 B.P. (JTA)

18. **Dixon, E., Jr., G.D. Sharma, and S.W. Stoker.** 1977. Western Gulf of Alaska Cultural Resource Study. *BLM/MM78/08, Final Report. Volume 1, 221 pp.*

The study is divided into three sections. In section one, the glacial and geological history of the western Gulf of Alaska is reviewed. There is a discussion of submerged sills which may record six individual periods of sea level stability during periods of marine transgression. Included are paleographic maps based on sea level use and bathymetric features. Terrestrial and marine faunal distributions are discussed in section two. Section three reviews the Pleistocene/Holocene prehistory of the study area and the model for archaeological site prediction. Data gaps are identified and a bibliography is included. (NTIS 657136 PB-281 509) NTIS 657136 PB-281 509

19. **Dort, W., Jr., E.J. Zeller, M.D. Turner, and J.E. Vaz.** 1965. Paleotemperatures and Chronology at Archeological Cave Site Revealed by Thermoluminescence. *Science 150(3695):460-461.*

Contrasting values of remnant thermoluminescence of limestone samples from Jaguar Cave, eastcentral Idaho, reveal temperature differences attributable to position within the cave microenvironments. Absence of recorded temperature change during cave-filling by rock and human debris indicates brevity of human occupation, which was near the end of Wisconsin (Pinedale) time. (Auth)

20. **Euler, R.C., G.J. Gumerman, T.N.V. Karlstrom, J.S. Dean, and R.H. Hevly.** 1979. The Colorado Plateaus: Cultural Dynamics and Paleoenvironment. *Science 205(4411):1089-1101.*

Convergent archeological, geological, palynological, dendrochronological, and radiometric data provide a paleoenvironmental record for the American Southwest at a level of detail and time resolution not previously achieved. Many prehistoric cultural and demographic changes on the Colorado Plateaus coincided with environmental fluctuations defined by precisely dated geoclimatic and bioclimatic indicators. These coincidences support the interpretation that socioeconomic changes and population displacements were commonly triggered by environmental stress. (Auth)

21. **Fitzhugh, W.W.** 1977. Population Movement and Culture Change on the Central Labrador Coast. *Annals of the New York Academy of Sciences 288:481-497.*

Figure 4 illustrates a number of inferred climatic schemes from arctic Canada and Greenland and compares them with the

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alternating Eskimo/Indian cultural occupation on the central Labrador coast. Eskimo-type cultures moved into the coastal area during cooler periods although early Pre-Dorset people populated the coast during a "warm" period (4000-3500 BP). Inuit (Eskimo) people spread southward specifically around 2500 BP, 1800 BP, and within the last few centuries A.D. (JTA)

22. **Fitzhugh, W.W.** 1980. Excavations at Rattlers Bight–a Late Maritime Archaic Settlement and Cemetery in Hamilton Inlet, Labrador. *National Geographic Society Research Reports 12, (pp. 223-231).*

Research at Rattlers Bight has included reconstruction of the local environment through the study of fossil pollen, flora, and dietary remains. Pollen analysis (Jordan, 1975) suggests that the area was deglaciated about 9,000 years ago, after which tundra conditions prevailed until the arrival of the spruce forest about 5000 BP. Slight cooling may have occurred after 4000 BP with subsequent minor oscillations until the present. (Auth)

The Rattlers Bight cultural complex on the central Labrador coast represents a settlement of people, perhaps with roots in late Paleo-Indian hunters, dated at 4000-3500 BP (Late Archaic) and based on hunting of marine species. (JTA)

23. **Helskog, K.** 1978. Late Holocene Sea-Level Changes Seen from Prehistoric Settlements. *Norsk Geografisk Tidsskrift 32:111-119.*

Radiocarbon dates from prehistoric human settlements in Varanger, Finnmark, North Norway, are used to examine Holocene relative sea-level changes. The altitudes and the dates of these settlements indicate that the Holocene tide levels reconstructed by Donner, Eronen & Jungner in Norsk geogr. Tidsskr., vol. 31, pp. 103-128, should be at a lower altitude than these authors have suggested. An alternative mean tide line which is, at a maximum, approximately 4 metres lower than indicated by Donner et al., is proposed for this span. (Auth)

24. **Hicks, S.** 1976. Pollen Analysis and Archaeology in Kuusamo, North-East Finland, an Area of Marginal Human Interference. *Institute of British Geographers Transactions 1(3):362-384.*

Prehistory and history of Kuusamo was investigated using pollen analysis. Both relative and pollen influx diagrams for three sites are presented; particular attention is paid to the delimination of "cultural indicators". Pollen evidence is slight but significant; comparison with similar investigations from elsewhere in Finland shows that this is typical for sparse, scattered settlement in a boreal forest environment. (Auth) Ecol Abs 77L/2736

25. **Jacobs, J.D.** 1979. Climate and the Thule Ecumene. *Thule Eskimo Culture: an Anthropological Retrospective, A.P. McCartney (Ed.). National Museums of Canada, National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 88, (pp. 528-535), 586 pp.*

The extent of Thule occupation of the Canadian Arctic is examined in relation to environmental factors in an attempt to determine the environmental limits on human occupation of that region. The extent of the Thule ecumene was delineated by Freeman (1976) showing prehistoric occupation in arctic Canada. Two features are evident from this map: 1) the northern extremities of the arctic archipelago to Ellesmere Island were inhabited during at least part of the Thule period; and 2) within the region as a whole there are areas, coastal and interior, that are known not to have been occupied for any significant time period, if at all. Thule occupation of the High Arctic was relatively brief; it began with the climatic optimum in the middle of the 10th century and ended by the 13th century with the general climatic deterioration in the Canadian Arctic at that time. An example of an extensive coastal area where little evidence of Thule occupation has been found is the eastern and southern coasts of Baffin Island. (Ecol Can 3357)(JTA) Ecol Can 3357

26. **Jacobs, J.D., and G. Sabo, III.** 1978. Environments and Adaptations of the Thule Culture on the Davis Strait Coast of Baffin Island. *Arctic and Alpine Research 10:595-615.*

The eastern coast of Baffin Island is a climatically severe, topographically complex arctic region. Archeaological and historical evidence show that the area was occupied over part, if not all, of the last two millenia by small Eskimo populations. Investigations of the distribution and environments of dwelling sites along a portion of the Davis Strait coast indicate a pattern of site selection which provides the optimum local environment from a demonstrably wide range of alternatives. Site surveys give some indication of the degree of topoclimatic diversity which exists in the region. It is suggested that the observed patterns of site selection and utilization represent a particular local adaptation on the part of Thule culture inhabitants to this climatically stressful region. (Auth)

27. **Jordon, R.** 1975. Pollen Diagrams from Hamilton Inlet, Central Labrador, and Their Environmental Implications for the Northern Maritime Archaic. *Arctic Anthropology 12(2):92-116.*

Palaeoenvironments in Hamilton Inlet, central Labrador, Canada and the environmental implications for the northern Maritime Archaic are discussed. In order to investigate palaeoenvironments, a series of five lake sediment cores was procured and analyzed for fossil pollen. Glacial recession proceeded from east to west beginning c. 90000 B.P. along the present coastline. Western Lake Melville was ice-free c. 6500 B.P. and final wastage of the ice sheet culminated c. 5800 B.P. on the interior plateau. Five pollen zones are evident based on the relative frequency of arboreal pollen, reflecting the process of Holocene revegetation. Inferred cover types were as follows: barren landscape, periglacial tundra, alder thicket, birch-fir woodland and spruce forest. Spruce immigrated between 5800 and 5200 years ago in to central Labrador. Thereafter, only relatively minor fluctuations of the forest-tundra boundary are registered. These changes reflect a mild period between 6500 B.P. and 4000 B.P. The Maritime Archaic were the first people to occupy central Labrador, spreading into this region c. 6000 to 5500 B.P. from the Strait of Belle Isle region with the establishment of forested conditions. Primary economic activity was oriented to the procurement of marine resources, including sea mammals. Interior resources may have been severely limited during the initial period of expansion. The Maritime Archaic disappears from the Labrador coast about 3800 B.P. during a period of climatic deterioration, which may have influenced the distribution, abundance and availablility of marine resources. (Auth)

28. **Laughlin, W.S.** 1974/75. Holocene History of Nikolski Bay, Alaska, and Aleut Evolution. *Folk 16-17:95-115.*

Elevations above mean sea level of critical points on Anangula provide an estimate of the rate of sea level rise. The elevations are 7 m at the wave cut notch marking the upper limit of the marine terrace silhouetting the island, 12 m at the present shoulder of the site, 17 m at the crown of the site, and 22 m at the lower end of the recent village site on the Nikolski Bay side and 22 m at some barabara pits on the Bering Sea side (Laughlin and Marsh, 1954; Laughlin, Harper and Laughlin, 1973). The recent occupation is less than 3,000 years, indicated by the ash stratigraphy, the artifact inventory with faunal assemblage, and a single radiocarbon date of 2115 + or - 120 years B.P. The fact that the lower end of the village site is 22 m, and that the barabara pits on the other side of the island are 22 m suggests that the Aleuts could not maintain permanent occupation at a lower elevation. If the earlier inhabitants of the blade site lived under the same constraint we may assume that the original edge or periphery of the site was at least 22 m above sea level at the beginning of occupation 8700 years ago (8450 years if Libby half-life is used). Recognizing the fact that the tail of Anangula is too low for occupation at present, and that there has been considerable erosion of the periphery of the site on the Nikolski Bay side and even more on the more exposed Bering Sea side, it is possible to suggest that rising sea levels terminated the occupation of the site by encroaching on their shore and drenching the actual site periphery. Thus, the people were forced to leave around 7,600 years ago (7800 B.P. Penn half-life) when the shoulder of the site was some 17-19 meters above sea level. Subsequent to their departure there were two volcanic ashfalls, a minor ash layer (termed Level One) and a major ash layer (ash III). (Auth)(JTA)

29. **Matthews, B.** 1975. Archaeological Sites in the Labrador-Ungava Peninsula: Cultural Origin and Climatic Significance. *Arctic 28(4):245-262.*

Ruins of structures in Arctic Quebec and Labrador were investigated, all apparently less than 1,500 years old and abandoned by their Eskimo inhabitants more than 150 years ago. Similar-sized rectangular foundations at two sites near former sea level probably belong to the Thule culture. That their occupants were in contact with Europeans at one time is suggested by the shapes of the foundations and the presence of carved and nailed. artefacts. From radiocarbon datings of fossilized animal bones, it is concluded that some of the structures were occupied during a mild period 600-700 years ago. Climate and vegetation of that period were reconstructed from pollen analysis and fossil remains. (Auth)

30. **Maxwell, M.S.** 1960. The Movement of Cultures in the Canadian High Arctic. *Anthropologica, n. ser., 2(2):177-189.*

Describes his field work while with the summer 1958 party of Operation Hazen on northern Ellesmere: 33 habitation sites in the Hazen valley and adjacent fiords (mostly temporary camps) were surveyed. A relatively late occupation of the area (marginal to settlements of northwest Greenland) is suggested and its use as a "migration highway" of early cultures rejected. A dispersal route along the warmer shores of Baffin Bay is considered likely. The predominantly late Dorset character of the Lake Hazen finds is noted and 21 major archeological sites on Ellesmere, Devon Island and Greenland are mapped. Past and present climatic trends in the Eastern Arctic are discussed and connected, chronologically, with different cultural expansions through the Arctic. (AB66642) AB66642

31. **Maxwell, M.S.** 1979. The Lake Harbour Region: Ecological Equilibrium in Sea Coast Adaptation. *Thule Eskimo Culture: an Anthropological Retrospective, A.P. McCartney (Ed.). National Museums of Canada, National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper no. 88, (pp. 76-88), 586 pp.*

Evidence from the southeast coast of Baffin Islnd, the region from the southeastern tip of Meta Incognita Peninsula to Amadjuak Bay, suggests that human occupation with relatively stable numbers of people maintained an adaptive equilibrium for four millenia. The distance between these two points is approximately 446 km but complex coastal indentation and adjacent islands amount to a coastal distance of five times this amount. Human ecology in this region has had a long history of equilibrium. This has been in large part due to the moderate but reliable marine mammal populations. (Ecol Can 3452)(JTA) Ecol Can 3452

32. **Maxwell, M.S.** 1980. Dorset Site Variation on the Southeast Coast of Baffin Island. *Arctic 33:505-516.*

The wide variation in Dorset residence structures on the southeast Baffin Island coast may indicate seasonal site differences of greater significance than simple summer/winter differentiation. In this study, a comparison of the cumulative frequencies of seven categories of key lithic artifacts from three Dorset sites in the North Bay area of the southeast coast of Baffin Island (the Morrisson site, the Crystall II site near Frobisher Bay and the Nanook site located 55 m west of the Morrisson site) indicates different sets of tool-making activities. An earlier analysis of relative frequencies of lithic artifacts (Maxwell 1976) had indicated that these differences were not due to cultural change through time. The fact that these differences appear to co-occur with differences in residence structures differentially occupied in winter, spring and summer suggests at least three seasonally differing sets of tool-making activities. Applying the same technique to other Dorset sites in the North Bay region indicates the probability that the Middle and Late Dorset sites located are all summer settlements. This leads to the conclusion that the warming trend of this later period resulted in such increased travel time to the floe edge for hunting that winter settlements were moved to the floe edge of the fast ice. This may also explain the location of Middle and Late Dorset summer settlements after ice breakup deep in protected bays were they would have been closer to the the floe edge. (Ecol Can 3960)(JTA) Ecol Can 3960

33. **McGhee, R.** 1969/70. Speculations on Climatic Change and Thule Culture Development. *Folk 11-12:173-184.*

The time framework for this paper is named and roughly dated climatic episodes established by Bryson and Wendland (1967). Dated archeological sequences suggest changes in hunting techniques which can be speculatively associated with the influence of climatic change on the amount and seasonal distribution of sea ice and the availability of sea mammals. During the Neo-Atlantic (900-1200 A.D.) it is suggested that a decrease in seasonal ice led to expansion of the range of bowhead whales into the western and eastern Canadian Arctic. These animals were followed eastward by Alaskan-based cultures which became the Thule culture of Arctic Canada and Greenland. Between 1200-1550 A.D. evidence suggests that climate deteriorated and local adaptations to climate might have become more pronounced. During the severe climate of the Neo- Boreal (1550-1850 A.D.) more reliance was placed on "breathing hole sealing". Over the last 120 years there has been a general amelioration of climate and a northward expansion of the range of some animals. (JTA)

34. **McGhee, R.** 1972. Climatic Change and the Development of Canadian Arctic Cultural Traditions. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 39-57), 511 pp.*

The archeological evidence presently available from Arctic Canada allows us to make only tentative and generalized statements

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relating to the human responses to past climatic changes. The responses which suggest adaptation to ameliorated climatic conditions, probably as expressed in decreased extent of sea ice and greater availability of food animals, are listed in Figure 2. In comparing these cultural indicators with the Greenland ice core measurements, (Dansgaard et al. 1969), and the position of the forest limit in Keewatin (Nichols 1968), it is apparent that the correlation of culturally indicated warm periods with warm periods as indicated by the other lines of evidence is at best general. A closer correlation appears to exist between the ends of the culturally indicated warm periods and episodes of rapid or extreme cooling as suggested by the other lines of evidence. This is the sort of correlation which might be expected in dealing with human adaptations to Arctic conditions, e.g. population reduction through starvation or abandonment of an area, would have occurred much more rapidly than positive responses to ameliorating conditions involving several decades or even centuries of technological adjustment and population increase. (Auth)

Canadian Arctic prehistory is summarized, and from this the author selects and discusses the major cultural changes which may have been influenced by changes in the physical environment. (MA)

35. **Meldgaard, J.** 1960. Prehistoric Culture Sequences in the Eastern Arctic as Elucidated by Stratified Sites at Igloolik. *Men and Cultures, A.F.C. Wallace (Ed.), Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences, Philadelphia, September 1-9, 1956. University of Pennsylvania Press, Philadelphia, (pp. 588-595), 810 pp.*

Describes excavations on Melville Peninsula and Jens Munk Island in 1954 by the joint Danish National Museum and University of Pennsylvania Expedition. At the Alarnerk site (with 208 house remains), five typologically different Dorset periods are distinguished, the latest 600 + or - 150 years ago from a sample Carbon 14 dating for an antler. At Kapuivik, 48 Dorset houses were found on an 8-23 m. level; stone arrangements and small tent rings on terraces 38-52 m. above sea level, produced stone artifacts closely related to the Sarqaq culture of West Greenland. Carbon 14 date of 3,700 years + or - 300, for antler from a 51 m. terrace, probably represents the earliest Igloolik stage of Sarqaq. A southern origin of Dorset is suggested in preference to a western; western affinities are stressed for the Sarqaq culture. The legendary Tunit are identified as the Dorset people, not the Thule. (AB66669) AB66669

This paper uses an elevational sequence as a surrogate of time. (JTA)

36. **Moe, D., S. Ingrelid, and O. Kjos-Hanssen.** 1978. A Study of Environment and Early Man in the Southern Norwegian Highlands. *Norwegian Archaeological Review 11(2):73-83.*

Thirty-seven Early Mesolithic settlement sites in the southern Norwegian highlands have been radiocarbon-dated. The results indicate that the earliest habitation of the northern parts of the area dates to the middle of the 9th millenium B.P., while the oldest sites of the southern plains are almost 1000 years younger. At ca. 7500 B.P. there was a sudden increase in the number of southern sites. Palynological investigations indicate that the southern plains were partly forested from ca. 8500 to 8000 B.P. In the northern areas the higher relief left large areas unforested. The southern plain forest disappeared during the first half of the 8th millenium B.P. During the forest period, the northern areas were the most favourable for reindeer. It is probable that the deforestation caused a rapid expansion of the reindeer population into the southern plains soon after 8000 B.P. Reindeer was the most important resource for the early highland hunters. Fluctuations of the reindeer population, caused by vegetational changes, seem to explain the uneven distribution of early highland sites. The data available do not give an unambiguous explanation of the apparent lack of sites during the first half of the 7th millennium B.P. A temperature decline, which began at 8000 B.P., combined with a more humid climate caused changes in snowcover. This would affect the winter pastures negatively, and might have caused a reduction of the reindeer population, which in turn also influenced man's interests in the area. However, alternative explanations might also be given. (Auth)

37. **Reeves, B.O.K.** 1975. Early Holocene (ca. 8000 to 5500 B.C.) Prehistoric Land/Resource Utilization Patterns in Waterton Lakes National Park, Alberta. *Arctic and Alpine Research 7(3):237-248.*

Archaeological research in Waterton Lakes National Park, Alberta, between 1967 and 1971 located 12 archaeological sites dating in the interval between ca. 8000 and 5500 B.C. Ten of these were tested and two excavated. The location of these sites is examined in relation to the late glacial-early Holocene environmental sequence, and various present-day variables–climate, physiography, vegetation, and ungulate behavior, and hydroseres which structured the more recent seasonal prehistoric settlement patterns in the Park. The data suggest that a settlement pattern characterized by seasonal use of the various valley areas and resources was established by ca. 6000 B.C. (Auth)

38. **Reeves, B.O.K., and J.F. Dormaar.** 1972. A Partial Holocene Pedological and Archaeological Record from the Southern Alberta Rocky Mountains. *Arctic and Alpine Research 4(4):325-336.*

Salvage excavations at an archaeological site (D1Po-20) located in the Front Range of the Rocky Mountains in southwestern Alberta revealed the presence of a series of living floors, radiocarbon dated at c.4000, 4700 and 6000 B.C., in association with the Ah horizons of a series of buried soils profiles. While archaeological information is minimal, analysis of the buried soils indicates that they formed under a different vegetation cover from that on the site today. The earliest soil, a Degraded Alpine Eutric Brunisol, inferred to have developed under subalpine to alpine vegetation and a cold wet climate, suggests depression of the timberline on the order of 600 m. These climatic characteristics are considered to reflect those of the last valley glaciation (Pinedale IV). The two later buried soils, Orthic Regosols, developed under grassland vegetation reflective of a drier warmer climate, indicating the lower tree line shifted upwards a minimum of 30 m. A return to normal climatic conditions is correlated with the onset of the Neoglacial dated c. 2800 B.C. in the Southern Alberta Rockies. (Authors) GA 73A/0928

39. **Sabo, G., III, and J.D. Jacobs.** 1980. Aspects of Thule Culture Adaptations in Southern Baffin Island. *Arctic 33(3):487-504.*

An archaeological sequence of Neo-Eskimo occupations, based upon excavations of eight Thule winter houses near Lake Harbour, Baffin Island, is outlined, beginning around A.D. 1100 and extending into the present century. Relationships between past climatic events, local environmental characteristics and the organization of Neo-Eskimo subsistence-settlement systems are traced throughout this period of time, based on analysis of artifactual, faunal, and midden deposit data. A rescheduling of procurement systems, coupled with a shift in the emphasis of fall/winter settlement options, is seen in response to climatic/ecological changes,

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commencing after A.D. 1250, which affected the accessibility of bowhead whales, ringed seal, and caribou. It is suggested that flexibility in the organization of domestic units and demographic arrangements was an important cultural mechanism permitting Thule and recent Inuit populations to respond effectively to changes in their biophysical environments. (Auth)

40. **Schledermann, P.** 1974. Thule Eskimo Prehistory of Cumberland Sound, Baffin Island, Canada. *Ph.D. Thesis, University of Calgary, Calgary, Alberta, 289 pp.*

This study has explored the development of the Thule Eskimo culture in Cumberland Sound, Baffin Island, Northwest Territories. Analyses were made of archaeological data obtained from a number of Thule Eskimo winter settlements in the Sound. The time span of the prehistoric Thule Eskimo occupation was divided into three periods: the first major settlement period began about A.D. 1370 and lasted until approximately A.D. 1650; the second period was one of very sporadic occupation, lasting about 100 years until A.D. 1750; the third major settlement period lasted an additional 100 years to about A.D. 1850. Several references are discussed to explain the possible causal relationships between cultural and climatological events. A general summary of three climatic episodes relating to this period in the eastern Arctic are: Period III, A.D. 1850 to A.D. 1550, cooler than the present; Period II, A.D. 1550 to A.D. 1200, a cooling period and deteriorating conditions, close to the present conditions; and Period I, A.D. 1200 to A.D. 800, warmer than the present. The time period 1550 to 1850 was also marked by a further cooling trend, "the little ice age". The period 1600 to 1850 was characterized by prolonged deterioration with cooler summers, decreasing ablation and increasing retention of snow and ice from year to year. The period from 1850 to 1950 showed a general amelioration of climate but the last 20 years have been marked by a cooling trend in Baffin Island (Bradley 1973). (Ecol Can 3545)(JTA) Ecol Can 3545

41. **Schledermann, P.** 1976. The Effect of Climatic/Ecological Changes on the Style of Thule Culture Winter Dwellings. *Arctic and Alpine Research 8(1):37-47.*

The style of Thule culture winter dwellings has changed considerably during the past 1000 years. The early, small, single-family whale-bone structures were replaced by a variety of house forms such as the snow-house complex, quarmat structures, winter tents, and large communal structures. The changing house styles are seen as a cultural response to generalized shifts in climatic and ecological conditions over the last millennium. Climatic changes influence the amount and distribution of sea ice as well as terrestrial precipitation patterns. The reponse of most of the important game species to changing biotopical conditions is discussed in relation to the changing winter settlement patterns of the Thule Eskimos. In general, a correlation does exist between changing winter settlement patterns and fluctuating climatic/ecological periods through time and space. (Auth)

42. **Taylor, J.A.** 1975. The Role of Climatic Factors in Environmental and Cultural Changes in Prehistoric Times. *The Effect of Man on the Landscape: the Highland Zone, Council for British Archaeology Research Report ii, J.G. Evans, S. Linbrey, and H. Cleere (Eds.). (pp. 6-19).*

Reconstructions of climatic changes in Britain since the last major glaciation have neglected the significance of meso- and microclimatic deviations in the Highland zone. Despite the inadequacy of modern meteorological data for the British upland terrain, the paper attempts an extrapolation of the probable scale and timing of climatic oscillations at altitude over the past 12,000 years. It emerges that climate change and culture change may be conceived on two separate but complementary wavelengths: first, the macro-scale framework embracing the millennia presents the backcloth and general chronology, but secondly, the actual changes at ground are governed by short-term periodicities in climate and weather, and a metachronous mosaic of environmental and cultural changes is generated. The paper argues finally that such changes may be fully comprehended only in ecosystematic terms, and locally and regionally rather than zonally or hemispherically. (Auth) GA 75B/3074

43. **Thorson, R.M., and T.D. Hamilton.** 1977. Geology of the Dry Creek Site; a Stratified Early Man Site in Interior Alaska. *Quaternary Research 7(2):149-176.*

The Dry Creek archeologic site contains a stratified record of late Pleistocene human occupation in central Alaska. Four archeologic components occur within a sequence of multiple loess and sand layers which together form a 2 m cap above weathered glacial outwash. The two oldest components appear to be of late Pleistocene age and occur with the bones of extinct game animals. Geologic mapping, stratigraphic correlations, radiocarbon dating, and sediment analyses indicate that the basal loess units formed part of a widespread blanket that was associated with an arctic steppe environment and with stream aggradation during waning phases of the last major glaciation of the Alaskan Range. These basal loess beds contain artifacts for which radiocarbon dates and typologic correlations suggest a time range of perhaps 12,000-9000 yr ago. A long subsequent episode of cultural sterility was associated with waning loess deposition and development of a cryoturbated tundra soil above shallow permafrost. Sand deposition from local source areas predominated during the middle and late Holocene, and buried Subarctic Brown Soils indicate that a forest fringe developed on bluff-edge sand sheets along Dry Creek. The youngest archeologic component, which is associated with the deepest forest soil, indicates intermittent human occupation of the site between about 4700 and 3400 Carbon 14 yr B.P. (Auth)

44. **Van der Hammen, T., and G. Correal Urrego.** 1978. Prehistoric Man on the Sabana de Bogota: Data for an Ecological Prehistory. *Palaeogeography, Palaeoclimatology, Palaeoecology 25(1-2):179-190.*

Recent data on the prehistory, stratigraphy, palynology, archeozoology and paleoecology of the high plain of Bogota (especially from the El Abra and Tequendama rock shelters) are resumed for a first outline of the ecological prehistory of the area. Early man possibly entered in the area before the beginning of the Late Glacial, but anyhow during the Guantiva Interstadial, when rock shelters in the area were used as temporal hunting camps. During the El Abra Stadial (c. 11,000-10,000 B.P.) the high plain was near the forest limit and was covered by a sub-paramo scrub vegetation with areas of open grass paramo. The deer ODOCOILEUS was very abundant in that period and formed the principal source of meat for early man; by that time the people had more stable, or at least seasonal, camps in the rock shelters of the area. Their implements, El Abrain as well as the more elaborate Tequendamian stone artifacts, also indicate that they were more or less specialized hunters. At the beginning of the Holocene the area was forested, and from 10,000 B.P. there is a gradual adaptation to the new circumstances. Besides stone, bone is used for the preparation of artifacts and an increasing abundance of spokeshaves indicates the increasing importance of wood-working. Although deer still forms the principal source of meat, the increasing abundance of bones of small rodents and of snails indicates a gradual increase of "gathering" activities. The relatively dry period between 5000 and 3000 B.P. corresponds to a decrease of human presence in

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the area, but shortly after 2500 B.P. the first signs of agricultural activities are found, associated with a somewhat more humid climate. (Auth)

45. **Wendland, W.M.** 1978. Holocene Man in North America: The Ecological Setting and Climatic Background. *Plains Anthropologist, Journal of the Plains Conference, 23-82(Pt.1): 273-287.*

Patterns of human occupation and vegetation are delineated on maps of North America for one thousand year intervals through the Holocene. The raw data for this review include radiocarbon-dated pollen cores and archaeological information and tree-ring records. Dynamic changes in the Laurentide Ice limits and major ecotones are observed through the middle Holocene, when both features reach essentially post-glacial stability. Significant changes in the vegetation boundaries continue to the present, but the scale of change is much diminished. Early Holocene occupation apparently expanded from Alaska south to California, then east, parallel to the southern boundary of the grasslands, to the Mississippi River and northeastward to the east coast. The absence of occupation in late-Altantic time is noted through much of the Great Plains and continued until about 4,000 B.P. Within the next millennium, evidence of human occupation virtually covered the United States (except for the northwest) and much of coastal Canada. Environmental conditions and occupation over North America are reviewed within the framework of Holocene climatic episodes. (Auth)

46. **Wenzel, G.** 1979. Archaeological Surmise and Ethnohistorical Speculation: An Example from the Barrow Strait Region. *Etudes/Inuit/Studies 3:121-128.*

This article reviews the ecological and ethnographic literature and also uses informant data to suggest an alternative to the view that the arctic archipelago was generally abandoned by Inuit settlement around the onset of the Neo-Boreal climatic episode, about 1550. Based on the evidence presented, it is suggested that parts of the archipelago, especially those areas close to core Inuit areas on the mainland and Baffin Island, remained important resource zones for bands of Inuit who moved into the region for considerable periods of time. (Ecol Can 4099)(JTA) Ecol Can 4099

47. **Wilkinson, P.F., and C.C. Shank.** 1975. Archaeological Observations in North-Central Banks Island. *Arctic Anthropology 12(1):104-112.*

The antiquity of the sites is indicated by the growth of lichens, weathering of muskox skulls, absence of post-contact artifacts, and burial depth of some bones. The abundance and widespread distribution of the sites suggest prolonged prehistoric utilization of north-central Banks Island. The findings are also consistent with exploitation of muskoxen by Pre-Dorset occupants of two sites near Shoran Lake about 3500 B.P. From this investigation the evidence suggests that the distribution, dispersion and behaviour of muskoxen and caribou, and by implication other elements of the Banks Island ecosystem, have been more or less constant over the last 3500 years at least. This is interpreted as ecological continuity–that north-central Banks Island is today comparable in terms of human exploitation to what it was when used by prehistoric Inuit over the past three millenia. Such continuity can be a powerful tool for investigating prehistoric economies in the Arctic. (Ecol Can 1768)(JTA) Ecol Can 1768

48. **Workman, W.B.** 1980. Holocene Peopling of the New World: Implications of the Arctic and Subarctic Data. *Canadian Journal of Anthropology 1(1):129-139.*

While the impact of Asia on later Eskimo cultures cannot be ignored it appears on a balance to have been minor. Little of Asian derivation can be proven to have spread from the Eskimo area to American peoples living further south. In summary, available data lead me to conclude that, with the possible exception of the Arctic Small Tool tradition of 4000 years ago, there is little evidence for significant Holocene population movemnts from Asia to America. While certain ideas of Asiatic derivation did spread at least to Alaskan coastal peoples during the Holocene time their impact on the New World culture history south of the arctic appears to have been quite minimal. (Auth)(JTA)

49. **Wright, G.A., and S.A. Reeve.** 1981?. Prehistoric Resource Procurement and Climatic Change in Northwestern Wyoming. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 423-447), 464 pp.*

The purposes of this paper are threefold: (1) to suggest a methodology for the utilization of archaeological data in paleoclimatic reconstructions, (2) present the evidence for climatic change in northwestern Wyoming over the past 11,000 years and (3) to offer some preliminary remarks concerning the effects of these environmental alterations on prehistoric land use in that region. We conclude that in northwestern Wyoming, environmental change – as evidenced by alterations in treeline elevation and variations in plant community compositions over time – did not disrupt the important root crop habitats that were crucial in the high country adaptation in that region. When cultural change did take place around A.D. 1600, it did not co-occur with major changes in the natural environment. (Auth)(JTA)

50. **Yorga, B.W.D.** 1979. Migration and Adaptation: A Thule Culture Perspective. *Thule Eskimo Culture: An Anthropological Retrospective, A.P. McCartney, (Ed.). National Museums of Canada, National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 88, (pp. 286-291), 586 pp.*

In the last decade the increased availability of paleoclimatic data has resulted in the development of hypotheses attributing the origin and spread of Thule culture to past climatic events. These hypotheses have relied wholly or in part upon the importance of the baleen whale (BALAENA MYSTICETUS) as a primary food resource, and on its susceptibility to climatic shifts. However, archaeological evidence suggests that the emerging Thule economy was capable of efficient exploitation of a wide range of marine and terrestrial resources and did not focus on a single species. The effect of large scale climatic shifts would have been minimized by such a strategy. Ethnographic evidence also suggests that small Thule hunting camps would have had difficulty procuring baleen whales on a regular basis. Other factors such as the increased freedom engendered by flexible, easily modified hunting patterns, dissatisfaction with group leadership in the home village, or simply the desire to travel beyond the known coastline, must also be considered in an explanation of the Thule culture migration. The expansion of the Thule people was almost certainly the consequence of a complex series of events involving cultural as well as ecological variables. (Auth) Ecol Can 3638

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51. **Alexander, T.** 1974. Ominous Changes in the World's Weather. *Fortune 89(2):90-95.*

Warming and cooling trends are due primarily to natural conditions. Carbon dioxide and dust added to the air by man are two additional factors. Iceland illustrates the historical changes in climate. The period from about 1550 to 1890 was a little ice age. This was followed by the warmest period in a thousand years. The cooling trend since 1945 has brought global changes in wind and pressure belts. Drought is a problem south of the Sahara. Monsoon lands face famine due to drought and flood. More temperature extremes and more severe storms occur in temperate lands. This may bring lower crop yields and less food for export. The present cooling trend may be a more common type of climate than the former warming trend of 1890 to 1945. (Forrest McElhoe Jr.) GA 74B/2909

52. **Alt, B.T.** 1983. Synoptic Analogs: A Technique for Studying Climatic Change in the Canadian High Arctic. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 70-107), 343 pp.*

Synoptic climatic patterns are associated with characteristic air masses for the period of observational record with broad glaciological mass balance trends in the High Canadian Arctic. These trends are in turn associated with specific trends in the stable oxygen isotopic record from the Devon Island Ice Cap. The following periods are recognized: 1) 1961-present: lower annual temperatures and higher summer temperatures; 2) Post-1920 melt maximum: estimates of the July temperature (given in Table 3B) are 5.1 deg C compared to a "normal" temperature of 4.1 deg C. The equilibrium line on the ice cap is placed at 1374 m; 3) Little Ice Age: summer temperatures are estimated to have been colder by 0.7 deg C and July temperatures by 1.7 deg C; 4) Medieval warm period (2000-1000 B.P.): temperatures reached their maximum values sooner than estimates from England and China. Temperatures are estimated to have been similar to those of post-1920 A.D. warm period; 5) Post-optimum minimum (3000-2500 B.P.): the oxygen isotope residual curve shows a broad minimum over this interval, with oxygen isotopic values similar to those of the last 50 years; 6) Climatic optimum (5000-4000 B.P.): isotopic values were 2-2.5 ppt more positive than present suggesting temperatures 3 to 4 deg C warmer than present. (JTA)

53. **Andrews, J.T., and R.G. Barry.** 1972. Present and Palaeo-Climatic Influences on the Glacierization and Deglacierization of Cumberland Peninsula, Baffin Island, N.W.T., Canada. *University of Colorado, Institute of Arctic and Alpine Research, Occasional Paper 2, Various pagings.*

The purpose of the research discussed in this report was to attempt an integrated analysis of the past and present climates of the northern Cumberland Peninsula region with specific attention focused on the links between glacier distribution and fluctuations and the climate. The final objective of the research is to attempt to model the paleoclimate of the region during the late Quaternary. (from STAR, N73-24457) GA 74A/1392

54. **Andrews, J.T., R.G. Barry, and L. Drapier.** 1970. An Inventory of the Present and Past Glacierization of Home Bay and Okoa Bay, East Baffin Island, N.W.T., Canada, and Some Climatic and Palaeoclimatic Considerations. *Journal of Glaciology 9(57):337-362.*

An air-photograph inventory of the present glacierization of areas of east Baffin Island adjoining Home Bay and Okoa Bay is described. Ice fields characterize the broad mountain summits of the former, while the latter is an area of cirque glaciers. The extent of glacierization is statistically related to various topographic parameters. It is found that there is a 4:1 ratio between Home Bay and Okoa Bay in the area of ice as a percent of the land area above 600 m a.s.l. Consideration of climatic parameters (snowfall and degree days) and synoptic-climatological results provide no reason for the strong contrast between the two areas. Cool, cloudy summer conditions are associated with easterly flow components that should affect both areas. A possible model for the inception of the mountain ice fields of Home Bay ca. 2000-4000 years ago is outlined and it is suggested that differential lag effects between the ice bodies in the two areas may be responsible for some of the observed difference. The many paradoxical relationships between glacierization, topography and climate in these areas, and the rather negative results, emphasize the dangers of facile palaeoclimatic interpretations. (Auth)(JTA) BafBib 297

55. **Andrews, J.T., and H.F. Diaz.** 1981. Eigenvector Analysis of Reconstructed Holocene July Temperature Departures Over Northern Canada. *Quaternary Research 16:373-389.*

July temperatures for the past 6000 yr at 11 sites in northern Canada have been predicted by transfer-function equations. Normalized departures from the mean of each time series at 250-yr intervals are analyzed by principal component (eigenvector) analysis. An initial analysis included 9 sites and the first three principal components accounted for 85.7% of the variance. Maps of the loadings on the principal components show broad spatial coherence on all three components. Temporal coefficients (principal component scores) illustrate major regional and local midsummer temperature variations. Power spectrum analysis of the significant principal component scores (temperature departures) over the 6000 yr showed that the temporal fluctuations associated with the first three principal components follow a "red noise" spectrum, indicative of strong persistence in the reconstructed climatic records. A peak in power between 2000 and 3000 yr occurs in the variance specturm of the second principal component (significance 10%). (Auth)(JTA)

Above average July temperatues are predicted between 5750 and 2250 BP with the most negative departure occurring 500 BP. The temperature reconstruction from northern Canada matches many aspects of the White Mountains, California timberline record (LaMarche, 1973). (JTA)

56. **Andrews, M., and J.T. Andrews.** 1979. Bibliography of Baffin Island Environments over the Last 1000 Years. *Thule Eskimo Culture: an Anthropological Retrospective, A.P. McCartney (Ed.). National Museums of Canada, National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 88, (pp. 555-569), 586 pp.*

This bibliography of Baffin Island environments is intended to assist in environmental reconstructions of the Thule period on the island, approximately A.D. 1000 to 1700. References are divided into eight subject categories and arrangement within a category is chronological. A total of 112 references are provided in the following subject areas: 1) climatology, sea ice and recent changes of climate - 26 references; 2) glaciology and glacial processes - 22; 3) controls and distribution of present and past ice and snow - 11; 4) lichenometry and radiocarbon dating - 10; 5) glacial geology and chronology - 24; 6) changes of sea level - 9; 7) biotic studies on climatic change

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- 5; and 8) review articles on Holocene climatic chages - 5. (Ecol Can 3195)(JTA) Ecol Can 3195

57. **Aver'yanov, V.G.** 1965. Contribution to the Problem of Climatic Warming in Antarctica. *Soviet Antarctic Expedition 3:42-44.*

A warming trend of about 2 deg C in 30 years and based on data from the Bay of Whales is confirmed by data from Queen Mary Land. It is also confirmed by the temperature within the inland ice-sheet at a depth of 10-12 m which is thought to be the mean annual air temperature 10-15 years before. (K.M. Clayton) GA 66B/205

58. **Ball, T.F.** 1983. Preliminary Analysis of Early Instrumental Records from York Factory and Churchill Factory. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 203-219), 343 pp.*

Monthly mean temperatures are plotted from York Factory and Churchill Factory for the late 18th and 19th centuries. When there are overlapping series the agreement between the two sites is striking. Some important features of the York Factory record are: 1) the period 1775-1779 had below average summer temperatures, whereas the winters were mild and snowy; 2) two periods without records–1783-1795 and 1798-1821 A.D. may be associated with extremely harsh conditions; 3) during the period 1841-1852 summer temperatures were close to the modern average (July 12.6 deg C); and 4) the period 1879-1889 shows a marked amplitude of the seasonal temperature regime. (JTA)

59. **Baranowski, S.** 1975. The Climate of West Spitsbergen in the Light of Material Obtained from Isfjord Radio and Hornsund. *Acta Universitatis Wratislaviensis 251 (Spitsbergen Expeditions I):21-34.*

The author's study discusses the climatic changes which have taken place in West Spitsbergen in recent years in their relation to changes in the climate of this region recorded since the end of the past century. It seems that the wave of a temperature rise and of an intensification of oceanism in the Spitsbergen climate, lasting since the rise of the 1920s, has come to the end with the start of the 1960s; peaks of this wave occurred in 1927/28 and 1953/54. In the course of precipitation during the post-war years at Isfjord Radio, conspicuous is an almost 50% increase in sums of precipitation beginning with 1958. He found a marked conformity in the course of both 5-day and monthly mean air temperatures for both stations; however, Isfjord Radio receives some 30% more precipitation than Hornsund. All in all, the response of the glaciers observed in various parts of Spitsbergen may be ascribed to differences in precipitation rather than to differences in air temperature. (Auth)(JTA)

60. **Baron, W.R.** 1982. The Reconstruction of Eighteenth Century Temperature Records through the Use of Content Analysis. *Climatic Change 4:385-398.*

The reconstruction of a temperature record for eighteenth century eastern Massachusetts is discussed. In addition to instrumental records diaries were analyzed in order to produce temperature indices. Reliability tests demonstrate that the methodology used is capable of replicating results regardless of changes in coders or intraregional variability of language. Validity tests, comparing diary reconstructions with instrumental records for the same period, produced positive results. A compilation of all climate related data shows the decades of the 1720's, 1750's, and 1760's were cool, while the 1770's and 1790's were warm. (Auth)

61. **Barry, R.G.** 1960. The Application of Synoptic Studies in Palaeoclimatology: A Case Study for Labrador-Ungava. *Geografiska Annaler 42(1):36-44.*

This paper examines characteristic airflow pattern types over this region, and their relation to local climatological features. A complex response of regional climatic conditions to changing synoptic situations is demonstrated. Conditions of the winters 1956-57 and 1957-58 are discussed and analyzed; their possible influence on present and Pleistocene glaciation is considered. (AB63285)(JTA) AB63285

62. **Barry, R.G.** 1978. Climatic Fluctuations during the Periods of Historical and Instrumental Record. *Climatic Change and Variability, a Southern Perspective, A.B. Pittock, L.A. Frakes, D. Jenssen, J.A. Peterson and J.W. Zillman (Eds.). Based on a Conference at Monash University, Melbourne, Australia, 7-12 December 1975... Cambridge, Cambridge University Press, (pp. 150-166), 455 pp.*

Climatic changes in the Northern Hemisphere over the last millenium are discussed on the basis of: 1)temperature record from China; 2) prolonged rains in Japan; 3) ring width of bristlecone pine from the White Mountains, California; 4) mean annual temperatures in Iceland; and 5) mean annual temperatures in England. In China the lowest temperature departures occurred about 1150, 1250, and 1340 A.D. whereas in Iceland and England the lowest departures occurred during the 18th and 17th centuries respectively. (JTA)

63. **Barry, R.G.** 1981. The Nature and Origin of Climatic Fluctuations in Northeastern North America. French and German Abstracts. *Geographie physique et Quaternaire 35(1):41-47.*

Features of the atmospheric circulation and climate of northeastern Canada are reviewed. In particular, the role of the upper level trough and its variability are discussed. It is shown that longitudinal displacements of the mean summer trough create anomalies of both air temperature and sea ice conditions in the region of Baffin Island. Climatic anomaly patterns in Labrador-Ungava and Keewatin associated with trough displacements are also summarized. Two examples of the application of such information to paleoclimatological questions are discussed. One concerns the influx of "exotic" tree pollen into Baffin Island and its previously postulated relationship to southerly airflow. It is concluded that pollen peaks cannot yet be reliably used as a paleowind index. The pattern of glacial inception and ice sheet extension during the Last Glacial Maximum is also briefly considered in the light of the available climatic information. Finally, the role of orbital variations affecting the seasonal pattern of solar radiation is discussed with reference to the last glacial cycle. (Auth)

64. **Barry, R.G., R.S. Bradley, and J.D. Jacobs.** 1975. Synoptic Climatological Studies of the Baffin Island Area. *Climate of the Arctic, G. Weller and S.A. Bowling (Eds.), Proceedings of the Twenty-Fourth Alaska Science Conference, August 15-17, 1973. Geophysical Institute, University of Alaska, Fairbanks, Alaska, (pp. 82-90), 436 pp.*

This work began as an exploratory study of the synoptic conditions influencing the climate of Baffin Island, particularly with respect to its glacierization. First, the seasonal climatic characteristics were examined in terms of a classification of the MSL pressure field. Subsequently, the synoptic climatological results have been used as a basis for interpreting present climatic fluctuations and for estimating paleoclimatic conditions. Examination of present and past glacierization of eastern Baffin Island in relation to climate suggests that a decline in summer temperature in the area during the 1960's, and perhaps also the concomitant marked increase in persistence of sea ice in Baffin Bay, is related to a higher frequency of easterly and northeasterly airflow. Apart from the summer cooling, winters in eastern Baffin Island were milder and more snowy in the 1960's. Such anomalies are associated with a westward displacement of the mean 700 mb trough over eastern North America which encourages northward movement of cyclones into Baffin Bay. The evident sensitivity of this area to climatic fluctuations on both short and long time scales makes it a rewarding area for interdisciplinary environmental studies. (Auth)(JTA)

65. **Barry, R.G., D.L. Elliott, and R.G. Crane.** 1981. The Palaeoclimatic Interpretation of Exotic Pollen Peaks in Holocene Records from the Eastern Canadian Arctic: A Discussion. *Review of Palaeobotany and Palynology 33:153-167.*

Processes involved in the transport of "exotic" tree pollen and its deposition in eastern Arctic Canada are reviewed. Synoptic meteorological situations favoring transport northward from the boreal forest are analyzed via boundary-layer trajectory computations. To account for reported exotic pollen peaks in Holocene peat deposits on Baffin Island, the necessary increase in frequency of southerly wind components may be as much as an order of magnitude, which could not be accommodated in the available time interval of pollen release, if sources from all of the Canadian boreal forest are considered. If only Labrador sources are involved, the absolute increase in southerly airflow may be unexceptional. (Auth)(JTA)

The paper includes a figure (Figure 4) which illustrates the typical 5-day trajectories for air originating from south of treeline reaching eastern Baffin Island and the number of such trajectories between April and September, 1975. (JTA)

66. **Berry, M.O.** 1981. Recent Changes in Temperature in Canada, and Comments on Future Climatic Change. *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 19-27), 220 pp.*

The temperature trend for southern Canada shows a warming early in the century followed by cooling beginning in the 1950s. Figures 3 and 4 show, respectively, the change in mean temperature across Canada from 1949-58 to 1959-68, and from 1959-68 to 1969-78. The first period used, 1949-58, corresponds approximately to the decade with the warmest temperature for southern Canada. The cooling trend appears in the 10-year value centred on 1960. In terms of temperature change from 1949-58 to 1959-68 (Figure 3), the cooling was experienced over much of Canada, however magnitude varied considerably from one region to another. Pronounced cooling (arbitrarily defined as >0.5 deg C) occurred in heavily populated southern Ontario, much of Quebec, the Atlantic Provinces and part of the Mackenzie-Great Slave region. Over most of the Arctic Islands, a relatively modest degree of cooling occurred. In contrast to the rest of the country, much of the area extending from southern British Columbia to southern Saskatchewan experienced pronounced warming (>0.5 deg C). Over much of western Canada, the temperature trend reversed in the following period from 1959-68 to 1969-78 (Figure 4). Cooling replaced warming over much of southern British Columbia to southern Saskatchewan. In contrast, a broad swath of warming replaced cooling, from the Mackenzie Delta to northwestern Ontario. Cooling was replaced by little change or some warming in the Lower Great Lakes - Upper Saint Lawrence area, and the Maritimes. Over much of the island of Newfoundland, Labrador, Quebec and the eastern Arctic Islands cooling persisted and intensified. In summary, the eastern half of the country was colder by 1969-78 than in the decade starting in 1949, with the cooling trend in most areas (the Lower Great Lakes, Upper Saint Lawrence and Maritimes being exceptions) intensifying from the second to the last decade of the period (Figure 5). In contrast much of the western half of the country was warmer by the third decade, the main exception being an area of cooling in northern British Columbia and part of the Yukon. (Auth)(JTA)

67. **Bradley, R.S.** 1973. Seasonal Climatic Fluctuations on Baffin Island during the Period of Instrumental Records. *Arctic 26:230-243.*

Temperature and precipitation records for Baffin Island are examined on a seasonal basis for the last 40 to 50 years. Accumulation season temperatures (September to May) during the late 1960s were similar to those which prevailed 30 to 40 years ago. Ablation season temperatures (June, July, August) during the same period were cooler than for at least 30 years. Precipitation variations showed much less spatial coherence, but during the last 10 to 15 years there have been marked increases, mostly during winter months. These increases, accompanied by cooler summers and warmer winters, have led to increased glacierization of the area. The most recent fluctuation of summer temperatures is related to changes in the frequency of synoptic types in the area. Baffin Island is sensitive to small changes in climate which are only revealed by an analysis of temperature and precipition on a seasonal basis. (Auth) BafBib 125

68. **Bradley, R.S.** 1973. Recent Freezing Level Changes and Climatic Deterioration of the Canadian Arctic Archipelago. *Nature 243(5407):398-400.*

An analysis of upper air data for the Canadian Arctic Archipelago indicates that marked changes in the altitude of the freezing level have occurred over the past two decades as a result of changes in the area's atmospheric circulation. A decrease in elevation of the 0 deg C isothermal surface during the summer months can decrease the area of snow and ice affected by melting. Freezing levels have been much lower at all stations in the area (Alert, Clyde, Coppermine, Coral Harbour, Eureka, Frobisher Bay, Inuvik, Isachsen, Mould Bay, Resolute and Sachs Harbour) during the past nine years. Freezing level data indicate that a critical change took place in 1962 to 1964. Significant changes in glaciological response were produced by the freezing level changes. Three examples are given. Previous investigations had noted that the summers of 1962 to 1966 were the coldest sequence of summers since before 1925 for central Ellesmere Island. The equilibrium line on glaciers was lowered to 900 m from a 1,200 m mean for the time 1957 to 1963, equating well with the 300 m drop in freezing level recorded at Alert and Eureka. Similarly, the equilibrium level on the White Glacier, Axel Heiberg Island, dropped 400 m from 1959-60 to 1962-63. Lastly, sea ice surveys in Baffin Bay and Davis Strait showed that a marked change towards more severe ice conditions occurred in 1963. Further reductions in the altitude of freezing level or persistence of these recent conditions will result in increased glacierization throughout the eastern and northern upland area. (Ecol Can 900)(JTA) Ecol Can 900

69. **Bradley, R.S., and R.G. Barry.** 1972. Secular Climatic Fluctuations in Southwestern Colorado. *Monthly Weather Review 101(3):264-270.*

Climatologic

Precipitation and temperature data since records began in southwestern Colorado are analyzed on a seasonal basis. Interstation correlations for recent years indicate that the region responds fairly uniformly to seasonal variations in precipitation, but this was not true earlier this century when precipitation variability was higher. Changes in the dependence of precipitation on elevation are also shown. Annual precipitation totals were low about 1860, 1900, 1930-35 and 1950-55. Mean annual temperatures appear to have fallen from about 1867 to about 1930 when the trend reversed. Overall, the climate of southwestern Colorado in the 1860s appears to have been warmer and at least as dry as current normals. (Auth)

70. **Bradley, R.S., and R.G. Barry.** 1975. Secular Fluctuations of Precipitation in the Rocky Mountain Region. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 215-222), 503 pp.*

By means of seasonal pentad averages and comparisons with records for 1951-1960 A.D. at "analog" stations, changes in precipitation during the latter half of the 19th century are mapped for the western U.S. Although the records are sparse there is broad regional coherence to the trends in precipitation. Table 2 summarizes seasonal decadal precipitation, 1890-1970 A.D., in terms of the 1941-1970 normal. (JTA)

71. **Bradley, R.S., and J.H. England.** 1978. Volcanic Dust Influence on Glacier Mass Balance at High Latitudes. *Nature 271:736-738.*

Evidence is presented that the eruption of Mount Agung (8 deg S, 115 deg E) in March 1963, was responsible for a marked change in the climate of the North American High Arctic and that this change has had a significant impact on glacier mass balance in the region. Mass balance estimates from the Devon Island ice cap show a dramatic shift from negative to positive values before and after 1963 A.D. (Auth)(JTA)

72. **Bradley, R.S., and J.H. England.** 1978. Recent Climatic Fluctuations of the Canadian High Arctic and Their Significance for Glaciology. *Arctic and Alpine Research 10:715-731.*

Various measures of the character of ablation season conditions in the Canadian High Arctic (north of 74 deg N) are discussed based on an analysis of daily climatic data from Alert, Eureka, Isachsen, Resolute, and Thule. Melting degree day totals appear to be the most useful index of "summer warmth". An abrupt change in the summer climate of the region occurred around 1963/64. Various indices indicate a marked decrease in summer temperature after 1963. During the same period, annual precipitation in the north and northwest has increased. Glacier mass balance is strongly controlled by summer climate; in particular, annual melting degree day totals are highly correlated with long-term mass-balance records. This enabled mass balance on the northwest sector of the Devon Islnad ice cap to be reconstructed back to 1947/48. Cumulative mass losses on the Devon Island ice cap from 1947/48 to 1962/63 are estimated to be around 3500 kg/sq m. However, from 1963/64 to 1973/74 a total of <350 kg/sq m have been lost. Significant ice-cap growth is presently limited by low precipitation even when mean summer temperatures are very low; an occasional warm summer may therefore obliterate cumulative mass gains over many years. The post-1963 change in summer climate appears to be related to the massive increase of volcanic dust in the upper atmosphere, primarily due to the eruption of Mt. Agung (March 1963). Subsequent eruptions may have caused the cooler conditions to persist. Volcanic dust affects solar radiation receipts and perhaps also influences the general circulation. If the high volcanic dust levels of the 1960s are responsible for reduced mass losses on High Arctic glaciers and ice caps, it is probable that other periods with high atmospheric dust levels (e.g. 1750 to 1880) had summer temperatures at least as cold as the mid to late 1960s. Conversely, the period of very negative balance on the Devon Island ice cap from 1947 to 1963 was probably typical of the period back to 1920 when the atmosphere was relatively free of volcanic dust. (Auth) Ecol Can 2814

73. **Bradley, R.S., and G.H. Miller.** 1972. Recent Climatic Change and Increased Glacierization in the Eastern Canadian Arctic. *Nature 237(5355):385-387.*

On Baffin Island between 1960 and 1969, the mean temperature of the ablation season (June-August) has decreased by as much as 2.1 deg C, whereas the mean temperature of the accumulation season (September-May) shows an increase of as much as 2.0 deg C. These trends hold for all stations except for these at Cape Dyer and Frobisher Bay, where local conditions explain the anomalies. Winter precipitation shows marked increases but summer records are more variable. The cooling in summer is due to a 29% increase in the frequency of cool easterly to north-easterly flow, and the winter warming is due to an increased frequency of warm southerly winds. Field observations and aerial photo comparisons show that snowbanks decreased in area from 1949 to 1960, whereas all observed snowbanks in the Cumberland Peninsula increased in area from 1960 to 1971. The greatest increase occurred in small snowbanks (10 m diameter) because of their shorter time constant. (Cm 1-8) BafBib 306

74. **Bray, R.G.** 1978. Volcanic Eruptions and Climate during the Past 500 Years. *Climatic Change and Variability, a Southern Perspective, A.B. Pittock, L.A. Frakes, D. Jenssen, J.A. Peterson and J.W. Zillman (Eds.). Based on a Conference at Monash University, Melbourne, Australia, 7-12 December 1975... Cambridge, Cambridge University Press, (pp. 256-262), 455 pp.*

There are significant tendencies for low temperatures and poor grain harvests in higher latitude regions of the Northern Hemisphere to follow volcanic eruptions. It is suggested that many of the glacial advances since 1500 A.D. may have been triggered by reduced ablation seasons associated with the effects of large volcanic eruptions. No cause and effect mechanism is postulated but it is suggested that volcanism may be related to the timing of Holocene glacial advances. (JTA)

75. **Brimblecombe, P.** 1979. Historical Changes in Atmospheric Trace Components. *Colloque International/International Conference, Evolution des Atmospheres Planetaires et Climatologie de la Terre/Evolution of Planetary Atmospheres and Climatology of the Earth, Nice, 16-20 Octobre, 1978. Centre National D'Etudes Spatiales, France, (pp. 533-540), 574 pp.*

Early analyses have not been used frequently in attempts to find changes in the trace composition of the atmosphere. In the case of rainfall analyses records stretch back more than 100 years at some sites, and a long record at Rothamsted in England shows changes in both nitrogen and sulphur levels due to anthropogenic activity. (Auth)

76. **Brinkmann, W.A.R.** 1976. Surface Temperature Trend for the Northern Hemisphere–Updated. *Quaternary Research 6:355-358.*

Climatologic

The surface temperature trend curve for the Northern Hemisphere was extended to include the years 1969 through 1973 following the same procedure used by H.C. Willett, J.M. Mitchell, Jr., and C.H. Reitan. The analysis showed a slight warming of 0.02 deg C between the periods 1965-1969 and 1970-1973, and a significant decrease in the number of negative temperature changes at individual stations (indicating a decrease in the total area experiencing temperature decrease). (Auth)

77. **Brinkmann, W.A.R., and R.G. Barry.** 1972. Palaeoclimatological Aspects of the Synoptic Climatology of Keewatin, Northwest Territories, Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology 11:77-91.*

Mean monthly composite patterns of surface weather anomalies and 700 mbar height anomalies are determined for snowy winters and cool summers in both Keewatin and Labrador-Ungava and also for different positions of the mean 700 mbar trough over eastern Canada. The results indicate that for the selected regimes precipitation anomalies are characteristically of opposite sign in Keewatin and northern Ungava whereas temperature conditions in the two areas are comparable. The implications of the findings are discussed with reference to post-Glacial palynological evidence from Arctic Canada and to the possible conditions favouring inception of glaciation in Keewatin. (Auth)

78. **Broecker, W.S.** 1975. Climatic Change: Are We on the Brink of a Pronounced Global Warming?. *Science 189:460-463.*

If man-made dust is unimportant as a major cause of climatic change, then a strong case can be made that the present cooling trend will, within a decade or so, give way to a pronounced warming induced by carbon dioxide. By analogy with similar events in the past, the natural climatic cooling which, since 1940, has more than compensated for the carbon dioxide effect, will soon bottom out. Once this happens, the exponential rise in the atmospheric carbon dioxide content will tend to become a significant factor and by early in the next century will have driven the mean planetary temperature beyond the limits experienced during the last 1000 years. (Auth)

79. **Brown, J., and J.T. Andrews.** 1982. Influence of Short-Term Climate Fluctuations on Permafrost Terrain. *DOE/EV/10019-2; Carbon Dioxide Effects Research and Assessment Program 013, Environmental and Societal Consequences of a Possible CO2-Induced Climatic Change: Volume 2, Part 3, National Technical Information Service, Springfield, VA, 30 pp.*

This document outlines the evidence for recent historic changes in climate from records in Alaska and Baffin Island and examines evidence for changes in temperature for the mid- and late Holocene from sites in the eastern Canadian Arctic. The paper proceeds to investigate the relationship between permafrost, air temperature, and changes in that temperature. In areas remote from large water bodies, the thickness of permafrost can be approximated by multiplying the negative of the mean annual temperture (deg C) by 30 - 60 m. At Cape Thompson (Alaska) resurvey of ground temperatures indicates a rise in temperature in the last two decades. (JTA)

80. **Bryson, R.A.** 1975. The Lessons of Climatic History. *Environmental Conservation 2:163-170.*

The major portion of this article describes the climatic influence in various parts of the globe that are associated with the increased arctic expansion around 1900 B.C. and again in 1200 A.D. When the Arctic cools, the effect is greatest in northern Canada, the northern Atlantic (Iceland in particular has provided a temperature pattern illustrating the variations of climatic history), and Scandinavia. From A.D. 1600 until the present century, the subarctic had cool temperature and sea-ice expanded. Early in the 1900's, the average temperture of higher latitudes began to rise, particularly in the area of the North Atlantic, and at the same time the Indian monsoons became more reliable. Since 1945, the amelioration of climates ceased and the return to climates similar to the cool period from 1600 to 1900 A.D. has occurred. Several instances are given in support of this statement, including the facts that the average temperature of the northern hemisphere has declined nearly as much as it rose in the early part of this century, the Canadian Arctic has recently experienced severe ice conditions compared to the past few decades, the circumpolar vortex has increased, and monsoons have retreated to give increased droughts in northwest India and northern Africa. Eight figures provide climatological information to illustrate the degree and time of climate change in recent history and over several thousand years as indicated on pollen assemblages. (Ecol Can 1425)(JTA) Ecol Can 1425

81. **Bryson, R.A., D.A. Baerreis, and W.M. Wendland.** 1970. The Character of Late-Glacial and Post-Glacial Climatic Changes. *Pleistocene and Recent Environments of The Central Great Plains, Department of Geology, University of Kansas, Special Publication 3, W.Dort Jr. and J.K. Jones (Eds.). The University Press of Kansas, Lawrence/Manhattan/Wichita, Kansas, (pp. 53-74), 433 pp.*

Computer analysis of world-wide radiocarbon dates for significant climatically related events of the last 10,000 years yields an objective consensus that these events occurred at preferred times. These dates match recent datings of the breaks in the Blytt-Sernander sequence, and are also applicable to North America. The evidence points to a steplike climatic variation and ecological response. There are modern analogues to many of the post-glacial climatic patterns. It is suggested (1) that the Blytt-Sernander terminology be adopted for North America, because the sequence in time is comparable, and (2) that interdisciplinary research efforts might be fruitfully concentrated on the characterization of the climatic episodes, using more sophisticated descriptions than "warm", "dry", "cool", and so forth. (Auth)(JTA)

82. **Bryson, R.A., and B.M. Goodman.** 1980. Volcanic Activity and Climatic Changes. *Science 207:1041-1044.*

Radiocarbon dates of volcanic activity suggest variations that appear to be related to climatic changes. Historical eruption records also show variations on the scale of years to centuries. These records can be combined with simple climatic models to estimate the impact of various volcanic activity levels. From this analysis it appears that climatic prediction in the range of 2 years to many decades requires broad-scale volcanic activity prediction. Statistical analysis of the volcanic record suggests that some predictability is possible. (Auth) ORNL/EIS-195

83. **Bryson, R.A., and F.K. Hare.** 1974. Climates of North America. *World Survey of Climatology, 11. Elsevier Scientific Publishing Company, 420 pp.*

This book contains four chapters, each of which is abstracted separately. Chapter 1, "The climates of North America" by the editors, pp 1-47, 35 figs, 3 tables, 30 refs, provides an introduction to the following three. The climatic pattern is dominated by the cordillera in the west and the broad plains in the middle and east. The mountains obstruct both zonal westerlies and trade winds, the latter allow great meridional excursions of both Arctic and tropical air masses. Using maps of resultant surface streamlines for each month of the year, the pattern of climates is described, and it is noted that the major biotic regions are closely linked with the circulation patterns. Following discussion of seasonal changes and the passage of disturbances, the chapter concludes by looking at climatic change. The standard period in the book is based on 1931-1960, but during the postglacial those climates present today have occupied different positions from time to time. The general sequence of climatic change over the last 1200 years is described, with particular attention to the rapid, although necessarily delayed melting away of the ice from Canada. Finally it is noted that the 19th century may be more typical of the climate to be expected in coming years than the most recent period for which averages are available. (K.M. Clayton) GA 74B/1799

84. **Bryson, R.A., and W.M. Wendland.** 1967. Tentative Climatic Patterns for Some Late Glacial and Postglacial Episodes in Central North America. *Life, Land and Water, W.J. Mayer-Oakes (Ed.), Proceedings of a Conference on Environmental Studies of the Glacial Lake Agassiz Region, University of Manitoba, 1966. University of Manitoba Press, Winnipeg, (pp. 271-298), 414 pp.*

Reconstructs airmass regimes over North America (1) during the late glacial period ca 12,000 B.P. (2) the period 9000-8000 B.P. and (3) 5000-3500 B.P. Using the technique developed by the authors which delineates air mass boundaries and fronts by reference to boundaries of biotic communities, maps are presented for each period showing mean frontal positions and circulatory patterns. During the late glacial period the upper westerlies were strong along 40-45 deg in summer while winters were warmer than present over the U.S. The authors consider it inconceivable that the Arctic Ocean should have been ice-free or even partially open. Changes to Boreal conditions (period 2) were abrupt and the resulting climatic and vegetational patterns are described. At this time subsident Pacific air extended further east than at present, and grasslands were more extensive. Changes to early sub-Boreal time (period 3) and subsequently are outlined. A consistent matching of climatic pattern and biotic evidence can be demonstrated for the past 10,000 yr. This is particularly true of the Boreal forest in the sub-Arctic. (AB94272) AB94272

85. **Budyko, M.I.** 1964. Changes of Climate and Ways of Its Transformation. Izmenenie Klimata i Puti Ego Preobrazovaniia. Russian. *Akademiia nauk SSSR. Inst. geografii. Razvitie i preobrazovanie geografischeskoi sredy, Moskva, (pp. 62-72).*

Reviews in general recent study of heat balance and its effects on climate. Large-scale climatic changes in the past are discussed. Causes of thermal zonality are considered including arctic and antarctic regions. Ice cover in the Arctic and Antarctic appears to be rather a cause than a consequence of low temperature in high latitudes. The annual course of absorbed radiation in the central Arctic is demonstrated on the ice and water surfaces. The human factor in climate changes is also discussed, and some consideration given to a destruction of the ice cover in the Arctic Ocean. (AB94288) AB94288

86. **Budyko, M.I.** 1966. Possibility of Climatic Change by Action on Polar Ice. Vozmozhnost' izmeneniia klimata pri vozdeistvii na poliarnye l'dy. Russian. *Sovremennye problemy klimatologii. Leningrad. Gidrometeorologicheskoe izd-vo:347-357.*

Analyzes the relationship between polar ice masses and arctic climate over long periods of time. The lowering of incident radiation is partially offset by the increased albedo in arctic regions. Temperature-radiation factors are presented in mathematical terms. Data on solar radiation was obtained from the Main Geophysical Observatory (Glavnaia geofizicheskaia observatoriia) and indicates that a sharp decrease in the absorbed radiation of the snow cover lowers the temperature over a wide area. A quantitative discussion of the effect of the thickness of the arctic ice mass and its effect on air temperature is also presented, as are its seasonal effects. Certain trends in present-day arctic climatic conditions appear to correlate with those in late Tertiary-early Quaternary time. (AB94291) AB94291

87. **Budyko, M.I., and K.Ya. Vinnikov.** 1977. Global Warming. *Global Chemical Cycles and Their Alterations by Man, W. Stumm (Ed.), Proceedings of the Dahlem Konferenzen, Berlin, November 15-19, 1976. Abakon Verlagsgesellschaft, Berlin, German Federal Republic, (pp. 189-205), 347 pp.*

This is a review, with 39 references, of climate changes in the last century, the effects on local climates, the components of climate models, the influence of carbon dioxide on air temperature, the errors or uncertainties in various climatic models, and the rising magnitude of anthropogenic as compared with natural effects. Some future scenarios of global warming and global climate are presented and discussed. (HFM) ORNL/EIS-195

88. **Colebrook, J.M.** 1976. Trends in the Climate of the North Atlantic Ocean over the Past Century. *Nature 263:576-577.*

The dominant large scale phenomena determining the climate of the North Atlantic Ocean are the current systems of the Gulf Stream and the North Atlantic Drift as well as the pattern of atmospheric circulation associated with the semi-permanent centers, the Iceland low and the Azores high. Three long time series of data throw some light on the interactions between these ocean-atmosphere systems and indicate the importance of advective processes, as opposed to upwelling, in determining long term variations in the surface temperature of the ocean: (1) Data for sea-surface temperature, based largely on observations from ships, (2) A time series of data for mean sea level at points along the coast of Florida for the period 1902-64 as an index of changes in the strength of flow of the Gulf Stream, (3) A time series of frequencies of tropical cyclones in the Atlantic for 1871-1973. Although there has been a marked drop in temperature in the northeastern Atlantic, it still has some way to go before attaining values similar to those for the 1920s, and there is no evidence from any of the variables that the recent changes are in any way different from those of similar, or even larger magnitude that have occurred over the past hundred years. An approximately 10-yr periodicity in sea-surface temperature variations has been reported for several areas of the North Atlantic as well as for a station in the English Channel from the early 1920s. (Auth)(LJA)(JTA) ORNL/CDIC

89. **Damon, P.E., and S.M. Kunen.** 1976. Global Cooling? No, Southern Hemisphere Warming Trends May Indicate the Onset of the Carbon Dioxide "Greenhouse" Effect. *Science 193(4252):447-453.*

Evidence for global cooling has been based, in large part, on a severe cooling trend at high northern latitutes. This article points out that the Northern Hemishere cooling trend appears to be out of phase with a warming trend at high latitudes in the Southern Hemisphere. The data are scanty. One cannot be sure that these temperature fluctuations are not the result of natural causes. However, it seems most likely that human activity has already significantly perturbed the atmospheric weather system. (Auth)(LJA)(JTA) ORNL/CDIC

90. **Dansgaard, W.** 1969. A Flow Model and a Time Scale for the Ice Core from Camp Century, Greenland. *Journal of Glaciology 8(53):215-223.*

A flow model is described for the Camp Century area in Greenland. The horizontal velocity profile along the core is assumed to be uniform from the surface down to y = 400 m above the bottom. Below this level, the horizontal velocity v(x) is assumed to decrease proportionally to y. Furthermore, at a given y, v(x) is assumed to be proportional to the distance x from the ice divide. The resulting vertical strain-rate under steady-state conditions gives the age of the ice as a function of y. The flow model has explained the measured temperature profile, and the time scale has been verified by comparison between observed stable isotope variations and the past climatic changes (at least 70,000 year back in time) estimated by other methods. (Auth)

91. **Dansgaard, W., S.J. Johnsen, H.B. Clausen, and C.C. Langway, Jr.** 1970. Ice Cores and Paleoclimatology. *Radiocarbon Variations and Absolute Chronology, I.U. Olsson (Ed.), Proceedings of the Twelfth Nobel Symposium, Institute of Physics, Uppsala University, Uppsala, Sweden. John Wiley and Sons, Inc., New York, (pp. 337-351), 652 pp.*

Oxygen-isotope measurements (delta) on a continuous ice core drilled through the entire ice sheet at Camp Century, Greenland, have revealed a climatic record. This record probably spans over more than a hundred thousand years. Estimates of the age of the ice were obtained by considering the ice-flow pattern under simple assumptions. The oxygen-isotope data provide far greater, and more direct, climatological detail than any hitherto applied method. Spectral analysis of the data show climatic oscillations with periods of approximately 400 and 2400 years on the adopted time-scale, probably reflecting solar-activity variations. The independently calculated time-scale agrees essentially with the Carbon 14 scale, judging from the delta-variations left by late-glacial climatic events. Beyond the range of Carbon 14 dating the delta-record suggests agreement with high-sea stands dated by Th 230 and Pa 231. (Auth)

92. **Dansgaard, W., S.J. Johnsen, H.B. Clausen, and C.C. Langway, Jr.** 1971. Climatic Record Revealed by the Camp Century Ice Core. *Late Cenozoic Glacier Ages, K.K. Turekian (Ed.). Yale University Press, New Haven, Conn., (pp. 37-55), 606 pp.*

The Camp Century ice core reveals the climatic history of the Greenland ice-sheet over the past 125,000 years. An ice-core from the southern dome of the Greenland ice-sheet would give more direct information about the conditions that led to buildup and extinction of the large Scandinavian and Laurentide ice sheets. (K.M. Clayton) GA 72A/1826

93. **Dansgaard, W., S.J. Johnsen, J. Moller, and C.C. Langway, Jr.** 1969. One Thousand Centuries of Climatic Record from Camp Century on the Greenland Ice Sheet. *Science 166(3903):377-381.*

A correlation of time with depth has been evaluated for the Camp Century, Greenland, 1390 meter deep ice core. Oxygen isotopes in approximately 1600 samples have been analyzed. Long term variations in the isotopic composition of the ice reflect the climatic changes during the past 100,000 years. Climatic oscillations with periods of 120,940 and 13,000 years are observed. (Auth) GA 70A/1208

94. **Dansgaard, W., S.J. Johnsen, N. Reeh, N. Gundestrup, H.B. Clausen, and C.U. Hammer.** 1975. Climatic Changes, Norsemen and Modern Man. *Nature 255(5503):24-28.*

Oxygen isotope analysis of a new ice core from the crest of the Greenland ice sheet reveals a climatic record of the past 1,420 years. Climatic changes of medium frequencies are in phase with corresponding changes in Iceland and England, while long-term changes at mid Atlantic longitudes are out of phase with Europe and North America. Reconciliation with Norse history suggests a strong climatic impact, and a parallel is drawn to the present critical situation of the human society. (Auth) GA 75B/3072

95. **Dansgaard, W., and A. Weidick.** 1965. Deterioration of Climate in Greenland?. Klimaforvaerring i Gronland?. *Gronland 11:399-405.*

Sea and air temperatures at coastal stations show no new trend as yet, but the general climatic deterioration is expected to affect Greenland eventually. Since 1940 an increasing number of glaciers stopped retreating and some are now advancing. Isotope measurements on the ice sheet by the International Glaciological Expedition in 1959 indicate a fall in the average annual temperature in parts of interior Greenland. These factors imply a deteriorating climate, whether long- or short-term trend is not yet evident. (AB86405) AB86405

96. **Davitaya, F.F.** 1968. Atmospheric Dustiness as a Factor in the Change in the States of Glaciers and Climate. Russian. *Soviet geographers at the 21st International Geographical Congress 1968. Abstracts of Papers. (pp. 46-47).*

The present-day reduction in glaciation is connected with planetary warming-up of the climate in the first half of the 20th century. It is established that with the general warming-up in the high zones of some mountain systems (Caucasus, Pamirs) there is a cooling of the climate, accompanied by simultaneous dehydration of glaciers with an unaltered and even increased amount of atmospheric precipitates. A hypothesis is put forward regarding decrease in albedo of the glaciers due to atmospheric dust settling on their surfaces. Accumulation of dust on the surface of a glacier is confirmed by analysis of firn layers of many years on Mt. Kazbek (Caucasus). (trans. F. Hilton) GA 71A/0603

97. **Diaz, H.F.** 1980. Areally-Weighted Temperature and Precipitation Averages for Alaska, 1931-1977. *Monthly Weather Review 108(6):817-822.*

Areally-weighted time series of temperature and precipitation have been compiled for Alaska for the period 1931-1977. Correlations of the temperature values with those of the contiguous United States indicated that, at both the monthly and seasonal time scales, the temperatures over the eastern two-thirds of the contiguous United States and Alaska are basically out of phase. However, with regard to long-term trends, the temperatures in both Alaska and the lower 48 states exhibit a similar pattern. (Auth) ORNL/CDIC

98. **Diaz, H.F., and J.T. Andrews.** 1982. Analysis of the Spatial Pattern of July Temperature Departures (1943-1972) over Canada and Estimates of the 700 mb Midsummer Circulation during Middle and Late Holocene. *Journal of Climatology 2:251-265.*

The pattern of July temperature variability over Canada north of about 50 deg N for the period 1943-1972 has been analysed by means of principal component analysis. Our objective was to assess the spatial similarities between modern temperature fluctuations at the interannual scale and those derived from paleotemperature records encompassing a period of the last 6000 Carbon 14 years. A comparison of the first four principal components from each data set suggests that contemporary midsummer temperature variations offer a reasonable analogy to Holocene fluctuations on the order of a few centuries. The Keewatin-Baffin Island-Ungava Peninsula region appears to be within the area of maximum temperature response. (Auth)

99. **Diaz, H.F., and R.G. Quayle.** 1980. The Climate of the United States since 1895: Spatial and Temporal Changes. *Monthly Weather Review 108:249-266.*

Time series of temperature and precipitation weighted by area and grouped by season for each of the 48 contiguous United States were analyzed. Within an 83-year period of record (1895-1977) three sub-periods or climatic regimes are identified and the differences in their means and standard deviations plotted and analysed. The statistical significance of the changes in the mean was calculated by using a two-tailed t test; for changes in the standard deviation, the F-ratio test was used. The variation patterns suggest that an east-west mode for changes in both temperature and precipitaion is dominant over the continental United States. Over the past 25 years the average temperature of the United States has decreased approx 1 deg F (0.6 deg C) from the relatively warm interval of the 1920s to the middle 1950s. However, most of this cooling has occurred in the eastern United States. In winter, for example, the southeastern United states cooled approx 3 deg F (1.7 deg C), whereas the Far West actually recorded warmer mean temperatures amounting to approx. 0.5 deg F (0.3 deg C). Increases in precipitation in the past 25 years have favored the eastern United States, as many areas of the western United States experienced diminished precipitation. No systematic relationship could be found between changes in mean termperature and precipitation and corresponding changes in their variance. Among the potential effects of similar climatic fluctuations in the future are increased energy costs for heating and possible water shortages in the western states. (Auth)

100. **Dickson, R.R., H.H. Lamb, S.-A. Malmberg, and J.M. Colebrook.** 1975. Climatic Reversal in Northern North Atlantic. *Nature 256:479-482.*

Over the European arctic and subarctic seas the atmospheric circulation has recently tended towards northerly airflow, with an accompanying climatic deterioration. Since the 1950s direct northerly outbreaks have swept the Norwegian-Greenland Sea with increasing frequency, adding almost every year, particularly in the 1960s, to the severity of the climate in areas as far south as the British Isles. This change has been associated with the establishment over Greenland in the early 1950s of a persistent ridge of pressure anomaly and with its subsequent maintenance and intensification (on average) throughout the late 1950s and 1960s. The effects of this change are discussed. In general, it may be concluded that during the spring months of 1972-74 the Atlantic influx into northern Icelandic waters was stronger than in any year during the period 1965-71 (though remaining slightly weaker than the earlier 1950-60 normal). The polar water component to the north and north-east of Iceland was weaker in the spring 1972-74 than in any year since 1963 and only slightly stronger than in the warm period of earlier years. Thus the "little ice age" observed in northern Icelandic waters in recent years seems to have ended with an amelioration of the marine climate during 1972-74. (It should be stressed, however, that this conclusion is diagnostic rather than prognostic). (Auth) ORNL/CDIC

101. **Dunbar, M.J., and D.H. Thomson.** 1979. West Greenland Salmon and Climatic Change. *Meddelelser om Gronland 202(4):1-19.*

Climatic variations affecting the W. Greenland marine region since the 16h century are reviewed in association with historical records of Atlantic salmon SALMO SALAR. The salmon, very abundant at present during their sea-life in W. Greenland waters, were also abundant around 1600 and 1810. In all three periods the marine climate was cooling, following a warming phase. (from Authors) Ecol Abs 80L/8964

102. **Dzerdzeevskii, B.L.** 1968. Modern Climatology and Ultra-Long Period Predictions (for the Next Climatic Epoch). *Soviet Geographers at the 21st International Geographical Congress 1968. Abstracts of papers. p. 44.*

In the 20th century two circulation and climatic epochs are distinguished with predominance of meridional (first), and zonal (second) circulation, each lasting 25-27 years. At the end of the 2nd epoch, prediction was made for a third epoch. It was to have been more meridional and with very variable weather. The trend of the present weather (climatic regime) confirms this prediction. (trans. F. Hilton) GA 71B/0179

103. **Eddy, J.A.** 1977. Climate and the Changing Sun. *Climatic Change 1(3):173-190.*

Long-term changes in the level of solar activity are found in historical records and in fossil radiocarbon in tree-rings. Typical of these changes are the Maunder Minimum (A.D. 1645-1715), the Sporer Minimum (A.D. 1400-1510), and a Medieval Maximum (c. A.D. 1120-1280). Eighteen such features are identified in the tree ring radiocarbon record of the past 7500 years and compared with a record of world climate. In every case, when long-term solar activity falls, mid-latitude glaciers advance and climate cools; at times of high solar activity glaciers recede and climate warms. We propose that changes in the level of solar activity and in climate may have a common cause: slow changes in the solar constant of about 1% amplitude. (Auth) ORNL/CDIC

104. **Frenzel, B.** 1975. The Distribution Pattern of Holocene Climatic Change in the Northern Hemisphere. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 105-118), 503 pp.*

Twenty-nine records of various kinds (i.e. glaciers, vegetation) are examined for the timing and direction of climatic change. Figure 16 in the paper presents a synthesis of the data and shows fourteen episodes of climatic change for the last 10,000 years. The most significant intervals of climatic change occurred about 8400, 8100, 5000, 3500, 2600, and 1400 B.P. and three times within the last 400 years. The paper also presents a series of fourteen maps that show the location of studies which present evidence for a change in climate (either ameliorating or deteriorating). The maps usually cover an interval of 100 years and are keyed to periods of marked ecological change. (JTA)

105. **Gedeonov, A.D., and E.R. Hope (Translator).** 1969. Eighty-year Cycle of Mean Monthly Air Temperature in the Northern Hemisphere. *Izv. Akad. Nauk SSSR, Geographical Series, 1969(1):85-90; Canada. Defence Research Board, T525R:1-4.*

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Analysis of the temperature departures from the long term January mean are examined by decade from 1881 to 1920 A.D. for the Northern Hemisphere. Two maps are presented which show regional groupings of decadal sign sequences. These suggest a control on temperature by the Rossby waves. The temperature data suggest that there is an 80 year cycle of air temperature variation, whereas the decadal sign sequences indicate that certain sites experienced the same temperature trend but at other sites there was a reverse relationship (one site cooling, the other warming). (JTA)

106. **Gorchakovsky, P.L., and S.G. Shiyatov.** 1978. The Upper Forest Limit in the Mountains of the Boreal Zone of the USSR. *Arctic and Alpine Research 10(2):349-363.*

The high-mountain areas of the Boreal Zone of the USSR may be subdivided, according to the composition of the physiognomic types of the upper forest limit, into three sectors: the western or Atlantic moderately continental sector with oceanic influences, the central or Siberian strongly continental sector, and the eastern or Pacific monsoon sector. On the extreme flanks of this zone, in the western and eastern sectors, the upper forest limit is formed by deciduous summer-green trees (respectively, BETULA TORTUOSA and B. ERMANI). In the central sector, the summer-green coniferous trees (LARIX SIBIRICA, L. SIBIRICA var. SUKACZEWII, L. DAHURICA) form the upper forest limit, but in some southern regions of this sector, where the climate is warmer and more humid, some evergreen coniferous trees (PICEA OBOVATA, PINUS SIBIRICA, ABIES SIBIRICA) reach the upper forest limit. The fluctuations of the upper forest limit as a response to cyclic climatic change are determined through the application of a complex of different methods. These include evaluation of the vitality of trees, of changes in their growth and patterns, and of natural regeneration of high mountain forests. The 60-to-80- and 140-to-160-yr climatic cycles have caused the most important influence on the position of the upper forest limit. A tendency for increase in this upper limit has been observed in most parts of the Boreal Zone during the last few decades. (Auth)

107. **Grichuk, V.P., and G.M. Peterson (Translator).** 1969. An Attempt to Reconstruct Certain Elements of the Climate of the Northern Hemisphere in the Atlantic Period of the Holocene. *M.I. Neishtadt (Ed.), Golotsen. K VIII kongressu INQUA, Paris, 1969. Moscow, Izd-vo Nauka, (41-57); Center for Climatic Research, University of Wisconsin, Madison, Wisconsin, 20 pp.*

This paper briefly presents a method for estimating past (Holocene) climates based on botanical/climatic data. The results are illustrated in three figures which show departures from present conditions at 20 sites for January and July temperatures. Temperature departures along the 35 deg E and 100 deg W meridians show July temperatures above present in high latitudes but below present south of 50-60 deg N at 5500 B.P. (+ or - 200 years). (JTA)

108. **Hamilton, T.D.** 1965. Alaskan Temperature Fluctuations and Trends: Analysis of Recorded Data. *Arctic 18(2):105-117.*

Instrumental records from the state of Alaska and Dawson, Yukon Territory, were examined for regional coherency and long term trends. The majority of stations used in this paper commenced operation between 1901 and 1910 A.D. although others (such as Barrow) did not commence operation until later. Analysis of seven major sites showed a remarkable similarity between their mean annual temperatures with the dominant feature being the peak in temperature in 1940 A.D. A number of additional stations were used to reconstruct a graph of mean annual temperatures between 1875 A.D. and 1960 A.D. A broad rise in temperature is evident between the start of the records and 1940 A.D. after which there is a decline in the mean annual temperature. (JTA)

109. **Hare, F.K.** 1973. On the Climatology of Post-Wisconsin Events in Canada. *Arctic and Alpine Research 5(3, Part 1):169-170.*

The surviving glacial ice of the Northern Hemisphere lies under the eastern limbs of the troughs of the bipolar wave in the circumpolar westerlies. Other distributions such as the forest tundra and the arctic tree line are closely related to the Arctic front, which is also deformed by the bipolar wave. There is some evidence that in the post-Wisconsin warming the phase of these waves was essentially the same as today, and that quite small changes in amplitude are sufficient to account for most climatic variation since that time. (Auth) GA 74A/0129

110. **Hare, F.K., and J.C. Ritchie.** 1972. The Boreal Bioclimates. *Geographical Review 62:333-365.*

This paper presents a climatic analysis of the northern and southern limits of the Boreal Forest. In North America the Forest Tundra/Tundra boundary is closely approximated by the 20 kilolangleys net annual radiation isoline whereas the southern limit of the Boreal Forest parallels the 30 kilolangley isoline. On transects east and west of Hudson Bay the Northern Forest Line and Arctic Tree-line are shown in reference to: annual net radiation, net radiation at temperatures; Thornthwaite potential evaporation; and number of days above 0 deg C. Differences between the two transects exist, for example the number of days with temperatures greater than 0 deg C is 145 at the Arctic Tree-line in Labrador-Ungava but only 120 in western Canada. The paper stresses the importance of the climatic Arctic Front on the position of the Arctic Tree-line. (JTA)

111. **Harley, W.S.** 1980. The Significance of Climatic Change in the Northern Hemisphere 1949-1978. *Monthly Weather Review 108(3):235-248.*

Thirty years of daily 1000-500 mb thickness data from 25-90 degree N latitude at 383 grid points are used to obtain charts of mean temperature change in the lower troposphere between successive 5-year periods from 1949-53 to 1974-78 [1000-50 mb thickness is proportional to the mean (virtual) temperature of the layer]. These charts are then intersected in succession to determine areas of negative or positive trends lasting 25 years or more. A negative trend lasting 25 years is found in four areas and a positive trend in one, while an unbroken negative trend is found in two of the four areas. The layer mean temperature changes between 5-year periods are averaged over all grid points within four latitude belts. Warming is found between the 1954-58 and 1959-63 periods and a stronger cooling between the 1959-63 and 1964-68 periods in all four belts. The analysis also shows that cooling is accompanied by a significant increase in the number of negative layer mean temperature changes at individual grid points (indicating an increase in the total area experiencing temperature decrease). Time series of 5-year, annual and seasonal mean 1000-500 mb thickness values for the areas of cooling or warming are analyzed to determine the characteristics of the trends within each area. Areas containing only one grid point are increased in size to at least 10(E+6) sq km by the inclusion of surrounding grid points to reflect regional rather than merely local influences. A negative trend extending over the 30-year period is found in north Iran in the fall. Five year mean 1000-500 m thickness values over the 30-year period in each area are examined for evidence of climatic change using criteria proposed by Rosini. Evidence of a change to a cooler regime in the lower troposphere is found in East Asia in summer, and in eastern North America in winter. Thirty years of data are found of insufficient length to determine whether the cooling constitutes a climatic change under the given criteria. No evidence of climatic warming is found. (Auth) ORNL/CDIC

112. **Harvey, L.D.D.** 1980. Solar Variability as a Contributing Factor to Holocene Climatic Change. *Progress in Physical Geography 4(4):487-530.*

Several workers have suggested that globally synchronous cold periods occurred during the Holocene Series and furthermore, that the explanation of these cold periods lies in the variability of the sun (for example, Denton and Karlen, 1973). This review evaluates in three ways the hypothesis that solar variability contributed to Holocene climatic change; by compiling global evidence from proxy climatic indicators for the last 7500 years; by critically examining evidence for and against solar variability during the last 7500 years, and finally, by examining possible mechanisms of a solar variability-climate relationship which previously have not been considered in a discussion of Holocene climate. The review closes with a brief discussion of the possible relevance to man of a knowledge of the causes of Holocene climatic change. (Auth)

113. **Hillaire-Marcel, C., S. Occhietti, L. Marchand, and R. Rajewicz.** 1981. Analysis of Recent Climatic Changes in Quebec: Some Preliminary Data. *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 28-47), 220 pp.*

Temperature data since 1840 A.D. are presented for Montreal and Toronto. The coldest year on record in Montreal was 1875 and the warmest 1953. Temperature trends between the two cities are parallel although Montreal is, on average, 2 deg C colder. The coldest decade on record in Montreal was 1880-1890 A.D., a period when water levels in the Great Lakes reached their recorded maximum. (JTA)

114. **Hopkins, D.M.** 2979. Landscape and Climate of Beringia during the Late Pleistocene and Holocene Time. *The First Americans: Origins, Affinities, and Adaptations, W.S. Laughlin and A.B. Harper, (Eds.). Gustav Fischer, New York, Ch. 1, (pp. 15-41).*

The last part of this paper examines the climate of Beringia during the Holocene. The author concludes that climatic changes have been slight within Beringia during the last 10,000 years. There is, however, evidence for an interval of greater summer warmth between 10,000 and 8000 years ago. There is little or no evidence that the limits of spruce and alder fluctuated in reponse to neoglacial cooling although the extent of poplar, aspen and birch trees may have varied in response to climatic change. Climatic change as a process affecting the limit of spruce and alder appears to have been overwhelmed by the process of migration of these species into areas of former shrub-tundra. (JTA)

115. **Hufty, A.** 1981. Some Observations on Recent Climatic Fluctuations in Quebec. Fluctuations climatiques recentes au Quebec. French, English and German Abstracts. *Geographie physique et Quaternaire 35(1):49-55.*

The problem is approached in three separate, but complementary manners centering on a study of temperature regimes in Quebec. These regimes indicate irregular fluctuations around a slight tendency upward, that is most evident in the St. Lawrence lowlands and that peaks around 1950. These variations are in part global and a number of authors, in particular Budyko and Bryson, have tried to account for them by means of energy budget models that indicate the climatic consequences of changes in the amount of dust and CO2 present in the atmosphere, as well as of volcanic eruptions. These climatic theories are becoming better and better known, even outside the scientific community, and there is some indication that the perception of climatic change has increased even more than climate itself. (Auth)

116. **Jacobs, J.D., R.G. Barry, R.S. Bradley, and R.L. Weaver.** 1974. Studies of Climate and Ice Conditions in Eastern Baffin Island, 1971-73. *University of Colorado, Institute of Arctic and Alpine Research, Occasional Paper 9, 77 pp.*

Climatological investigations by the Institue of Arctic and Alpine Research (INSTAAR) in eastern Baffin Island began in 1970. Since 1971 the program has focused particularly on ice conditions in western Davis Strait - Baffin Bay in relation to weather and climate but, in addition, a variety of other related climatic studies have been carried out. These investigations complement the specific field measurements of energy budgets in relation to fast-ice break-up processes. This report is one of a planned series which presents preliminary results of some of these projects and documents data, and information on field activities not appropriate for regular journal publication. (Auth) GA 75B/0241

117. **Jacobs, J.D., and C.Y.Y. Leung.** 1981?. Paleoclimatic Implications of Topoclimatic Diversity in Arctic Canada. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 63-75), 464 pp.*

Field investigations in coastal areas of moderate relief (0 to 600 m.a.s.l.) in Baffin Island have provided the empirical basis for modeling and mapping topoclimates in relative terms. LANDSAT imagery and aerial photographs permit extension of the method to other areas. The topoclimate mapping method uses theoretical solar radiation on slopes and sheltering effects upon prevailing winds to identify areas of relatively favorable microclimates. Good spatial correspondence is found between such maps and vegetation maps derived from LANDSAT imagery. The high degree of spatial variability in microclimate and plant habitat is paralleled by a large temporal variability in regional climate. Associated with the short-term climatic fluctuations are occasional extreme weather events which can have a pronounced impact upon the landscape. Taken together, these observations point to the need for caution in the interpretation of proxy climatic data from widely scattered sites. The reconstruction of past climates and landscapes should proceed on the assumption that the degree of spatial variety observed in the present existed also in the past. (Auth)

118. **Jacobs, J.D., and J.P. Newell.** 1979. Recent-Year-to-Year Variations in Seasonal Temperatures and Sea Ice Conditions in the Eastern Canadian Arctic. *Arctic 32(4):345-354.*

Mean summer and winter temperatures for the 1957-1978 period have been analyzed for four eastern Arctic stations. Standard deviations on the order of 3 deg C in winter and 1 deg C in summer indicate the magnitude of the interannual variations, and these departures are found to be synchronous over the region. Several indices of sea ice severity also show significant year-to-year variations, but these are not spatially coherent. Relationships between climatic

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parameters and sea ice are examined in order to explain these differences. (Auth)

119. **Kalnicky, R.A.** 1974. Climatic Change Since 1950. *Annals Association of American Geographers 64(1):100-112.*

The mean temperature for the Northern Hemisphere had a warming trend from 1890 to 1950 and a cooling trend since 1950. The eastern and central United States had colder temperatures in 1961-1970 than in 1931-1960. The temperature changes were associated with an adjustment of hemispheric circulation from more frequent zonal flow between 1900 and 1950 to more frequent meridional flow since 1950. Regional variations in magnitude and direction of the change were largely related to position in relation to the upper air westerly wave pattern. Time series of individual circulation indices tend to resemble the step function model of climatic change. (Auth) GA 74B/2462

120. **Keen, R.A.** 1977. Response of Baffin Bay Ice Conditions to Changes in Atmospheric Circulation Patterns. *Fourth International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, September 26-30, 1977. Preprint. 9 pp.*

The severity of sea ice conditions within Baffin Bay is determined by summer air temperatures. During cooler summers the prevailing air flow is from the north and is associated with the upper trough being east of its normal position. This trough represents part of a standing wave in the upper westerlies; the eastward displacement appears to be largely in response to an increase in wavelength due to higher west wind speeds in arctic latitudes. (JTA)

121. **Keen, R.A.** 1980. Temperature and Circulation Anomalies in the Eastern Canadian Arctic, Summer 1946-76. *University of Colorado, Institute of Arctic and Alpine Research, Occasional paper 34, 159 pp.*

Four major conclusions are presented: 1) because Baffin Island summer temperatures are well correlated with other records from the Arctic and the extra-tropical Northern Hemisphere, Baffin Island is a significant indicator of larger-scale summer climate conditions; 2) the regional atmospheric circulation near Baffin Island is closely linked to variations in the general circulation of the Northern Hemisphere; 3) ice and snow on, and near Baffin Island, are very sensitive to small changes in summer temperature; and 4) these results are effective over time scales from 2-10 years and may well extend to longer time scales. (JTA)

122. **Kelly, P.M.** 1977. Volcanic Dust Veils and North Atlantic Climatic Change. *Nature 268(5621):616-617.*

The varying level of volcanic activity explains much of the variation in central England temperature (CET) on time scales of 50-3000 yr but certain fluctuations present in CET are not seen in the (dust veil index (DVI). Although the 200-yr periodicity is present in all three records, only central England winter temperatures (CET sub w) contains a linear trend. This trend results from the recovery from the depth of the Little Ice Age which occurred during the second half of the seventeenth century. Neither the magnitude of the DVI, nor the reduction of the south-westerly wind frequencies is sufficient to account for this climatic severity. (Auth)(JTA)

123. **Kirch, R.** 1966. Temperature Conditions in the Arctic during the Last 50 Years. Temperatureverhaltnisse in der Arktis wahrend der letzten 50 Jahre. German, English Summary. *Berlin. Freie Univ. Inst. fur Meteorologie und Geophysik. Meteorologische Abhandlungen 69(3), 102 pp.*

A definitive work on climatic change in the European Arctic and Greenland. The long-term trends at 12 stations are analyzed in detail. Graphs are presented of 10 yr running means of annual and seasonal temp for the various stations and the relevant data are also presented in tabular form. The reliability of the observations is assessed and the sources extensively reviewed, with a bibliography of 29 primary sources. The well marked warming during the first half of the period is discussed. This reached a peak prior to 1930-39 in Greenland, Svalbard, Bjornoya and Jan Mayen and a little later farther east. A decrease in temp has subsequently set in, especially in the USSR section. At Franz Josef Land, a fall of 6 deg C in 10 yr is observable in the winter 10-yr means. (AB96760) AB96760

124. **Krebs, J.S., and R.G. Barry.** 1970. The Arctic Front and the Tundra-Taiga Boundary in Eurasia. *Geographical Review 40(4):548-554.*

The position of the tundra-taiga boundary in Eurasia is compared to the median location of the Arctic Front. The latter was determined from inspection of the 1200GMT synoptic weather maps of the Northern Hemisphere. Fig. 2 shows the median, quartile and decile position of the Arctic Front determined from daily July maps for the period 1952-1956. The near coincidence of the tundra-taiga boundary and the median location of the Arctic Front is striking, especially in the montane areas of the eastern Soviet Union. The association of the vegetation boundary and the climatic boundary still leaves unanswered the precise interaction between the vegetation and the various properties of the atmosphere; such an understanding is important for paleoclimate reconstructions of changes in latitudinal tree line. (JTA)

125. **Kukla, G.J., J.K. Angell, J. Korshover, H. Dronia, M. Hoshiai, J. Namias, M. Rodewald, R. Yamamoto, and T. Iwashima.** 1977. New Data on Climatic Trends. *Nature 270:573-580.*

Indicators of large-scale climate developments show that the oscillatory cooling observed in the past 30 yr in the Northern Hemisphere has not yet reversed. This conclusion was reached by updating our data on the month-to-month, season-to-season, and year-to-year variations of selected zonally averaged meteorological parameters. (Auth)

126. **Kukla, G.J., and J. Gavin.** 1981. Summer Ice and Carbon Dioxide. *Science 214(4520):497-503.*

The extent of Antarctic pack ice in the summer, as charted from satellite imagery, decreased by 2.5 million square kilometers between 1973 and 1980. The U.S. Navy and Russian atlases and whaling and research ship reports from the 1930's indicate that summer ice conditions earlier this century were heavier than the current average. Surface air temperatures along the seasonally shifting belt of melting snow between 55 deg and 80 deg N during spring and summer were higher in 1974 to 1978 than in 1934 to 1938. The observed departures in the two hemispheres qualitatively agree with the predicted impact of an increase in atmospheric carbon dioxide. However, since it is not known to what extent the changes in snow and ice cover and in temperature can be explained by the natural variability of the climate system or by other processes unrelated to carbon dioxide, a cause-and-effect relation cannot yet be established. (Auth)

127. **Kukla, G.J., and H.J. Kukla.** 1974. Increased Surface Albedo in the Northern Hemisphere. *Science 183(4126):709-714.*

Snow and pack-ice cover in the northern hemisphere formed earlier in the year and covered a larger area in the past 3 years than it did 7 years ago, when systematic satellite mapping began. This shift, in all likelihood, has produced a significant change in the hemispheric heat balance. The difference was most pronounced in the fall and was especially large in 1971. The anomalous global weather patterns of 1972 and 1973 may be the result of these developments. This is the main conclusion of our study of secular changes in snow and ice cover in the northern hemisphere. The data are from weekly maps from the National Oceanic and Atmospheric Administration (NOAA) based on photography from meteorological satellites. The charts show snow and ice fields remaining for at least 5 days. (Auth)

The present mean annual snow and ice cover of the Northern Hemisphere is 30 x 10(E+6) km(E+2). In 1971 the mean annual coverage increased by 4 x 10(E+6) km(E+2) or approximately 12%, or one-eighth of the way toward mean annual coverage during a full-scale glaciation! This suggests that short-term climatic fluctuations can be quite drastic. (JTA)

128. **Kutzbach, J.E.** 1974. Year-to-Year Circulation Variability and Some Possible Analogs of Little Ice Age Climates. *Climatic Research Unit Research Publication No. 2; Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the Time of the Last Glacial Maximum about 17,000 Years Ago, Proceedings of an International Conference, Norwich, May 17-22, 1973. Collected Abstracts. Climatic Research Unit, University of East Anglia, Norwich, England, (pp. 101-103), 123 pp.*

Eigenvector analysis of monthly and seasonal sea level pressure maps for the Northern Hemisphere over the last 70 years indicates that the orthogonal components reflect the preferred configuration of the quasi-stationary planetary waves. The climate since the late 1950s resembles, in certain respects, that of the Little Ice Age. From this, it is hypothesized that during the Little Ice Age the Aleutian Low intensified and extended eastwards. (JTA)

129. **Kutzbach, J.E.** 1976. The Nature of Climate and Climatic Variations. *Quaternary Research 6:471-480.*

Space and time scales of climatic variability are reviewed, with emphasis on the Holocene. Regional patterns of climatic variability may be associated with changes in the amplitude and longitude position of the long waves in the westerlies of midlatitudes, and with changes in the intensity and latitude of meridional circulation features such as the Hadley cell. (Auth)(JTA)

130. **Kutzbach, J.E., and R.A. Bryson.** 1974. Variance Spectrum of Holocene Climatic Fluctuations in the North Atlantic Sector. *Journal of Atmospheric Sciences 31(8):1958-1963.*

The general character of the variance spectrum of temperature fluctuations on time scales from 1 to 10,000 years is estimated from a combination of botanical, chemical, historical and instumental records from locations in the North Atlantic sector. Variance spectral density increases with decreasing frequency (increasing period) over the entire frequency domain, reflecting the "thermal inertia" of the ocean and cryosphere portion of the climatic system. This is most pronounced for periods longer than about 30 years. (Auth)

The suggested variance spectrum of temperatures on time scales of 10(E+0) to 10(E+4) years shows an absence of periods between 20 and 2000 years. This is in part attributable to several factors, including reliable dating and the lack of replication in records. Details of the analyses are given in an appendix. (JTA)

131. **Lagercrantz, C.-L.** 1974. Climate, Frozen Ground, and Postglacial Climate Development at Kilpisjarvi, NW Finnish Lapland: Observations Made in 1938-39. Kilpisjarvitraktens klimat; tjale och postglaciala kimatutveckling: observationer gjorda 1938-39. *Terra 86(2):62-67.*

Climatic observations were made during one month in the summer of 1939 and compared with some later years. Through diggings, ocurrences of evidently perennially frozen ground was found. On the basis of two pollen diagrams the postglacial climate development is discussed and found to be in accordance with that known in general about Lapland. (English Summary) GA 74A/2349

132. **Lamb, H.H.** 1962. The Climates of the 11th and 16th Centuries A.D. *Weather 17(12):381-89.*

Summarizes selected papers and discussion at the conference on Northern Hemisphere climates of the 11th and 16th centuries held June 16-24, 1962, at Aspen, Colo. Application of tree-ring study to climatic history was revived by Fritts and Siren who favored the value of such study at the northern forest-limit and the upper timberline. Author's maps showing main depression tracts and trough longitudes "predicted" for the two centuries studied, are reproduced; centered on the North Pole, they show zones of most frequent depressions located over the Greenland Sea and northern Scandinavia generally, except during summers 1550-1600, which was a period of cooling in Alaska and northern Canada. (AB73285) AB73285

133. **Lamb, H.H.** 1963. The Weather, Past and Future. *Meteorological Magazine 92(1094):269-72.*

Describes a trend, since 1937, toward climatic cooling as evidenced by more severe winters in England and extension of the arctic pack ice. Similar periods of deterioration since the mid-16th century are noted, and the situation related to a decline in the prevailing westerlies and an accompanying (possibly resultant) southward trend in the Atlantic depressions. These, with their mild air and storminess had previously restricted sea ice growth. (AB80500) AB80500

134. **Lamb, H.H.** 1966. The Changing Climate. *Methuen, London, 236 pp.*

A collection of papers by one of the leading scholars in the field of climatic changes and trends. Several chapters contain arctic material, and chap 5, p. 140-56, reviews the role of atmosphere and oceans in relation to high-latitude climatic change and the growth of ice sheets on land. Displacements in the mean distribution direction of depression tracks are viewed as highly significant. The problem of identifying eustatic change in sea level is briefly considered, and snow accumulation on Greenland is discussed with map and graphs. A number of theories of ice age development are briefly reviewed. The author considers an Arctic Ocean ice-free on the Atlantic side of the Lomonosov Ridge but frozen on the Alaskan side to offer a possible compromise between the views of Ewing and Donn and Karlstrom. (AB97302) AB97302

135. **Lamb, H.H.** 1973. Whither Climate Now?. *Nature 244(5416):365-397.*

Surface air temperatures averaged over the globe seem to have been falling since the 1940's, at least until 1969. In the Arctic the downturn has been several degrees and remarkably abrupt; in central England temperatures seem to have fallen by about 0.4 deg to return to their level for 1951-1950. The decline in westerly flow over Great Britain that has taken place over the same period is but part of a widespread change in the general atmospheric circulation, with greater amplitude and shorter wavelength in the meandering flow of the upper westerlies, and some expansion of the area of the polar cold cap. The last three years have been something of an exception to this general trend and may have lulled people into a false sense that significant climatic change is not likely. The article ends with a description of the demand for long-range weather prediction, and an account of the present work and future programme of the Climatic Research Unit at Norwich. (K.M. Clayton) GA 74B/1406

136. **Lamb, H.H., R.P.W. Lewis, and A. Woodroffe.** 1966. Atmospheric Circulation and the Main Climatic Variables Between 8000 and 0 B.C.: Meteorological Evidence. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 174-217), 229 pp.*

The evidence of a succession of changed levels of prevailing temperature over the last 10,000 years is examined, with closest attention to the abundant data for England; the probable year-to-year variability of temperature in different epochs is also considered. Derived figures for rainfall, evaporation and excess water to be drained by the rivers in different epochs are presented. In the final section of the paper, surface temperature data for the summers and winters of different epochs since 8000 B.C. are selected from what appear to be the most reliable palaeobiological indicators and used to derive probable patterns of the height interval between the 1,000 and 500 mb pressure levels (roughly equivalent to mean temperature of the lowest 5 km of the atmosphere): from these thermal patterns computation reveals regions of prevalence of either cyclonic or anticyclonic development, and these together with the indicated steering of cyclones and anticyclones by the thermal winds are used to sketch distributions of average surface pressure in each epoch. (Auth)

137. **Le Roy Ladurie, E.** 1965. The Climate of the 11th and 16th Centuries: Series Compared. Le climat des XIe et XVIe siecles: series comparees. *Annales Economies, Societes, Civilisations 5:894-922.*

This paper has significant charts summarizing the climatic pecularities of the individual seasons of the two centuries in question, and representing the synthesis of a collection of data by members of an international conference. Some of the series illustrated are phenological - the flowering of the cherry-blossom at Kyoto indicates spring temperature. Vintages in France indicate especially summer temperature. The dates of freezing in Central Japan and of melting in the eastern Baltic relate especially to winter. Tree-rings in the Rockies reflect rainfall and those in Alaska and Finnish Lapland summer temperature. Prayers for rain in Barcelona reflect drought. Documentary data are marred by the chronological errors of the annalists but they are useful in indicating trends. Famines and grain scarcities are shown. Finally the Egyptian records of High and Low Niles reflect Abyssinian and Equatorial rains respectively. Certain trends clearly revealed by charts are emphasized in the text: the expansion of the European glaciers from 1546-1590 and their culmination 1592-1601; the cold moist European springs c. 1570; the aridity in Catalonia 1530-1550; the drought in the American southwest 1563-1600. In Japan the winters of the period 1560-1680 appear to have been colder than subsequently. Other trends can be readily determined by reference to the charts. (D.J. Schove) GA 66B/207

138. **Mackay, J.R.** 1961. Freeze-Up and Break-Up of the Lower Mackenzie River, Northwest Territories. *Geology of the Arctic, G.O. Raasch (Ed.), Proceedings of the First International Symposium on Arctic Geology, Calgary, Alberta, January 11-13, 1960. University of Toronto Press, Toronto, (pp. 1119-1134), 2 vol.*

Freeze-up and break-up data of varying reliability have been collected for the Mackenzie River and studied with particular reference to the lower course between Fort Good Hope and the Beaufort Sea. Most attention is given to a discussion of Fort Good Hope conditions, but similar results have been obtained for other stations. Variations in dates of freeze-up and break-up have been analysed by standard statistical procedures (t-test, Spearman coefficient of rank correlation, and Kendall coefficient of concordance), using a level of significance of $P = .01$, in order to determine long-term fluctuations in open season from 1876-1955. Cumulated degree days, summed for the site of freeze-up, have proved of no statistical significance in the study of freeze-up in the lower Mackenzie valley. Good correlations are obtained between freeze-up and weighted air temperatures (Rodhe, 1952) when air temperatures are based upon those of estimated flow-travel time of river water issuing from Great Slave Lake. Break-up in the lower Mackenzie valley can be correlated with temperatures in the Fort Simpson area. By using four weighted mean ten-day Fort Simpson temperatures, from April 1 to May 10, estimates can be made of break-up at Fort Good Hope. Reindeer Station break-up can be correlated with Fort Good Hope break-up, which occurs ten to twenty days earlier. Computations involving regression analysis were carried out on a high-speed electronic computer. (Auth)

139. **Manley, G.** 1961. Late and Postglacial Climatic Fluctuations and Their Relationship to Those Shown by the Instrumental Record of the Past 300 Years. *Annals of the New York Academy of Sciences 95:162-172.*

Compares evidence on the smaller climatic fluctuations of recent centuries with that on the larger changes connected with the ice age. Vast accumulation and extension of ice sheets that probably began in Greenland in the Miocene, is the most significant result of large scale climatic change of the ice age period. Recent climatic ameliorations and diminution of the arctic sea ice, are associated with increased meridional transport of warmth into the Arctic Basin, mainly through the atmosphere, but partly by means of ocean surface water. Author concludes that significant climatic fluctuation in the past required "persistence of circulation patterns" over periods up to many decades long; North Atlantic climate has become rather unstable during the past three-four centuries, perhaps because of the changes in the arctic ice; the marked climatic "oscillation" near the north-east Atlantic in 1688-1739 shows no close relation to either vulcanicity or sunspots, suggesting an oceanographic factor as explanation of such short-period changes. (AB73785) AB73785

140. **Manley, G.** 1966. Problems of the Climatic Optimum: The Contribution of Glaciology. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 34-39), 229 pp.*

Records of conspicuous advances of glaciers in historic time, taken from many parts of the world, show a near-synchronous pattern and suggest a common origin in atmospheric behaviour. Caution is needed in drawing deductions from evidence of glacier behaviour because individual glaciers in the same area may well react differently, depending on the morphology of their basin, their size and their exposure to radiation. Glaciological studies have not yet gone far towards answering questions on the timing and dominant location of the Hypsithermal and there is still too little evidence on the rate of melting at different altitudes. (Margaret M. Camina) GA 69A/742

141. **Manley, G.** 1973. Climate in Britain over 10,000 Years. *Man Made the Land, A.R.H. Baker and J.B. Harley (Eds.). David Charles, (pp. 9-21).*

The ice of the last glaciation disappeared about 10,000 years ago and a climatic optimum occurred in about the 4th millennium B.C. While the range of variation in Britain has been quite small, it has lain across temperature values, and of consequent evaporation and rainfall, which have proved critically important. The oscillations of fluctuating length follow no set pattern. During the last 300 years, these changes have been recorded with increasing accuracy by instruments. (John Sheail) GA 74B/1401

142. **Manley, G.** 1974. Central England Temperatures: Monthly Means 1659 to 1973. *Quarterly Journal of the Royal Meteorological Society 100(425):389-405.*

An up-to-date Table is provided of the monthly and seasonal means representative of the air over central England from 1659 onward, incorporating some minor revisions and extensions of the earlier Table (Manley 1953 and 1959). Comments on its construction, and on the prospect of further extension backward in time, are added. (Auth) GA 75B/833

143. **Manley, G.** 1975. Fluctuations of Snowfall and Persistence of Snow Cover in Marginal- Oceanic Climates. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 183-188), 503 pp.*

Graphs are shown of: 1) the rate of increase of snow cover in the British Isles with altitude and latitude; and 2) estimated maximum and minimum duration of snow cover across the British Isles. The author concludes a fall in annual mean temperature of only 1.3 deg C might be enough to reestablish small cirque glaciers in northern Scotland. (JTA)

144. **McGill University. Department of Geography.** 1964. Deepest Permafrost Measurement in North America. *Polarforschung 5(1-2):181-182.*

On July 21 1961, a thermistor cable was installed and kept open with casing to a depth of 2000 feet at Winter Harbour, Melville Island, N.W.T. The cable contains 25 thermistors, each on a separate circuit and spaced at regular intervals. Preliminary measurements, accurate to 0.01 deg C indicate that sub-freezing temperatures extend to 1500 feet. The drilling-fluid temperatures at each depth will not approach their predrilling values for several years. The cable will be left permanently in place and read periodically. A site was selected for the second hole to be drilled further inland at a greater elevation. This hole will be cored throughout the depth to be instrumented. Thermal conductivity measurements on the core will permit a determination of the flow rate of heat from the earth's interior. An analysis of temperatures in the two holes will yield information on recent climatic changes and post-glacial emergence in the northern Canadian Arctic. (B.L. Evans from CRREL Bibliography, 19, 1965) GA 67A/184

145. **McKay, G.A., B.F. Findlay, and H.A. Thompson.** 1970. Climatic Perspective of Tundra Areas. *IUCN Publications New Series No. 16, Productivity and Conservation in Circumpolar Lands, W.A. Fuller and P.G. Kevan (Eds.), Proceedings of a Conference, Edmonton, Alberta, October 15-17, 1969. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland. (pp. 10-33), 344 pp.*

Describes the climatic controls which operate in the Arctic in terms of the climate they produce. Dominative factors are the character of solar energy input, nature of immediate and adjacent surfaces, weather systems and topography. A series of circumpolar charts depict daily total solar radiation for June, percent frequency of cyclonic radiation for June, percent frequency of cyclonic centers and principal storm tracks in Aug. and Feb., air temperatures, annual precipitation, number of snow-covered days, depth of late winter snow cover and winds >11 mps (24 mph) Dec.-Feb. Winter is the favored season for travel when sea ice and land are firm, but extreme cold, driving winds and blowing snow limit human winter activity on the tundra. Storms in all seasons are most severe near the sea coasts. Escape to microclimatic environments is essential to the existence of plants and animals. Disturbance of the delicate balance of such environments can be serious. Removal of tall vegetation results in increased winds and shallower snow cover thus changing the thermal regime near and in the ground. (AB105530) AB105530

146. **Miles, M.K., and P.B. Gildersleeves.** 1978. Volcanic Dust and Changes in Northern Hemisphere Temperature. *Nature 271:735-736.*

Radiation calculations which seemed to demonstrate that changes in the temperature of the Northern Hemisphere on a wide variety of time scales could be attributed to changes in the amount of volcanic dust in the atmosphere have been reported. In this paper the authors put a likely upper limit of 0.2 deg C on the contribution of volcanic dust to the climatic warming between the end of the nineteenth century and the 1940s. (Auth)(JTA)

147. **Mitchell, J.M., Jr.** 1967. Climatic Change. *American Geophysical Union. Transactions 48(2):500-504.*

Reviews American work in paleoclimatology and climatic change during the period 1963-1967, with a select bibliography of 61 items in English. The summary incl studies in Pleistocene chronology, dendro-climatology, general circulation problems, lunar and solar influence, also a brief note on current theories of the causation of glaciation. Successful ice core dating techniques used on the Greenland inland ice are mentioned. (AB98171) AB98171

148. **Morner, N.-A.** 1972. When Will the Present Interglacial End?. *Quaternary Research 2(3):341-349.*

We are now living under interglacial climatic conditions, the Present Interglacial of Flandrian Interglacial Age. It will certainly be followed by the Future Ice Age. The major cold/warm changes seem to have a cyclicity of 10,500 yr. We have been in the second cycle (characterised by cooler climate) after the Last Ice Age for 2200 yr and will continue to be so for another 8,300 yr. By analogy with the conditions during the Last Interglacial it is concluded that this cycle will remain moderately warm. With the end of the third cycle at about 18,800 years A.P. the Present Interglacial will end and the First Future Glacial Cycle Age begin. Further information about the climatic conditions during the "cold" cycle 117,700-107,200 y.a. is necessary, however, before a really well-founded prediction can be made. (Auth) GA 73A/1298

149. **Morner, N.-A.** 1973. Climatic Changes during the Last 35,000 Years as Indicated by Land, Sea and Air Data. *Boreas 2(1):33-53.*

Detailed climatic records from land (glaciation curves, fossil records, etc.), sea (eustatic changes, deep-sea data), and air (Greenland (Oxygen 18 curve) are almost identical for the last 35,000 years. This cannot be a mere coincidence: it indicates that even minor fluctuations are caused by global climatic changes. The various records seem to be easily correlated with each other. The Last Ice Age is characterized by drastic changes between cold and warmer periods. The Present (Flandrian) Interglacial (Holocene Epoch) is also characterized by climatic fluctuations although of minor amplitude. Analysis of peaks and troughs in six Atlantic deep-sea cores gives a climatic sequence identical to the eustatic transgression/regression sequence, indicating the recording of global short-term warm/cold fluctuations. From these fluctuations, the climatic cyclicity was calculated. Two drastically frequency-changing cycles were found, one varying from 230 to 1,000 years and one from 1,000 to 3,500 years. A third cycle of 21,000 years was also established. The transition from the Last Ice Age to the Present Interglacial is marked by three major steps towards interglacial conditions; viz. at 12,700, 10,000 and 9,300 radiocarbon years B.P. The 10,000 boundary has earlier been suggested as the Pleistocene/Holocene boundary. (Auth) GA 73A/1294

150. **Oort, A.H., and V.P. Starr.** 1973. Five-Year Climatic Trend for the Northern Hemisphere. *Geophysical Fluid Dynamics Lab. Report for May 1958-April 1963, United States National Oceanic and Atmospheric Administration, Princeton, N.J., 1973, 5 pp.*

The mean temperature and water vapour content for the atmosphere in the northern hemisphere up to 75 mbar (about 18 km above sea level) has been computed by months from all available daily meteorological soundings during the five year period which started on May 1, 1958. The mode of computing was such as to give the mass averages of the temperature and vapour content. The data are shown in tables and represented graphically. It was found that between May 1958 and April 1963, the mean temperature of the atmosphere in the northern hemisphere fell by about 0.6 deg C. (from U.S. Govt. Reports Announcements, COM-73-50933/3GA) GA 74B/2474

151. **Orvig, S. (Ed.)** 1970. Climates of the Polar Regions. *World Survey of Climatology, 14. Elsevier, New York, NY, 370 pp.*

Three chapters on Greenland, the North Polar Basin and Antarctica, are abstracted separately. In his introduction, the editor notes that the polar areas are particularly susceptible to climatic variation, and that the concept of a 30-year mean climate has little meaning, and almost no predictive value. An energy balance approach is most appropriate in the northern regions, although the existing climatological network is not well adapted for this purpose. On the other hand, it does mean that provided appropriate care is taken, the short records typical of many high latitude stations can be made good use of. Finally it is expected that the rather uniform ground conditions, especially where snow and ice covered will make the observations at a single site representative of a wider area than is usual in other parts of the globe. (K.M. Clayton) GA 74B/1795

152. **Perry, A.H.** 1974. The Downward Trend of Air and Sea Surface Temperatures over the North Atlantic. *Weather 29(12):451-455.*

The expansion of the polar vortex, and the displacement of cyclonic activity over the North Atlantic to lower latitudes have been accompanied by widespread negative sea temperature anomalies. The mean sea surface temperature for the late 1960's at the nine ocean weather ships considered together was nearly 1 deg C lower than in the early 1950's. These anomalies have, in turn, been responsible for producing several seasons of anomalous atmospheric circulation e.g. the summers of 1968 and 1972. The ocean-atmosphere system, however, includes such a complex feedback between the two media that cause and effect are often difficult to separate. (David G. Tout) GA 75B/1920

153. **Petrov, L.S.** 1960. On the Relationship of Recent Fluctuations in the Climate of the Arctic to Atmospheric Circulation and Solar Activity. K voprosu o sviazi sovremennykh kolebanii klimata Arktiki s tsirkuliatsiei atmosfery i solnechnoi aktivnost'iu. *Leningrad. Universitet. Mezhdunarodnyi geofizicheskii god. Sbornik statei i materialov, (pp. 216-23).*

Compares five-yearly temperature fluctuations (1899-1954) with simultaneous changes in other meteorological variables (zonal and meridional circulation, pressure) and solar activity. The climatic trend which began early in the 20th century is found to be related to the secular change in solar activity effecting an intensification of zonal processes of atmospheric circulation and reducing the meridional ones. The process is most pronounced in the Atlantic sector of the Arctic. An 11-year cycle is also present. (AB67414) AB67414

154. **Pinna, M.** 1969. Climatic Changes in the Historical Period and Their Effects on Human Life and Activity. Le variazioni del clima in epoca storica e i loro effetti sulla vite e le attivita umane; un tentativo di sintesi. *Bollettino della Societa Geografica Italiana 106(4-6):188-275.*

The study of palaeoclimatology is an interesting and understudied field; it unites the physical and the humanistic sciences. The various climatic periods of the past 7,000 are examined (the climatic optimum of the post-Ice Age, the cold period of the first millennium B.C., the "hot middle ages" 800-1200, the "Little Ice Age" 1590-1850, and the most recent warm period 1850-1950). It is difficult to tell when this last period ended. Evidence for past climates is often poor, expecially e.g. for the Roman period. Only when more evidence and documentation has been accumulated will it be possible to study objectively the age-old problem of man-climate relationships. (Russell King) GA 71B/0208

155. **Polozova, L.G.** 1963. Climate Fluctuation in North Atlantic Region. Kolebaniia klimata v raione Severnoi Atlantiki. *Akademiia Nauk SSSR. Izvestiia ser geog. no. 2:79-87.*

Analyzes climatic changes in 18 deg - 71 deg N from the air temperature data of 26 stations for 1881-1960 and from the ice conditions of the Barents Sea for 1900-1960. Two areas of the North Atlantic are distinguished: Greenland and the Canada-United States coastal area. The culmination of the climatic warming trend was in the decade 1927-1938 and it was especially evident in the Arctic. Climatic changes in various parts of the Atlantic in ten- and five-year periods are shown in graphs. Effects of Barents Sea ice conditions upon climatic fluctuation are characterized. (AB82169) AB82169

156. **Polozova, L.G.** 1968. Present Day Climate Change and Its Possible Cause. Russian. *Soviet geographers at the 21st International Geographical Congress 1968. Abstracts of papers. Nauka, Moscow, (pp. 47-48).*

In the present century a more significant warming-up of the climate has been found, which has been manifested even in changes in the limits of distribution of flora and fauna at high and moderate latitudes in the northern hemisphere. The warming-up, which has been distributed over a large part of the planet, achieved its greatest intensity in the polar regions of the northern hemisphere in the 30s, after which cooling set in. In Greenland the highest yearly temperatures were found in the 1927-36 decade; the warming up decreased in proportion to the distance from Greenland, and the decade of highest yearly temperatures was displaced to later years. The majority of investigators relate changes in climate with fluctuations in intensity and nature of the circulation of the atmosphere, due to change in level of solar activity. The results of investigating spatio-temporal aspects of such a relation, while confirming its existence, do not explain the distribution of the warm-up. This question is satisfactorily answered by investigating the dynamics of the observed warming-up, in conjunction with known facts about the nature of the action of high energy cosmic particles on the tropospheric circulation, and the distribution of geomagnetic zones. (trans. F. Hilton) GA 71B/0204

157. **Powell, J.M.** 1965. Changes in Amounts of Sunshine in British Columbia, 1901-1960. *Quarterly Journal of the Royal Meteorological Society 91(387):95-98.*

5-year running means and 20-year averages of annual and seasonal sunshine hours for 11 stations in British Columbia having a record of at least 30 years are discussed. In comparison with the period 1921-1940 sunshine hours have been less in all seasons at most stations for the periods 1901-20 and 1941-60. Coastal stations had the greatest change during the summer, but inland stations had the greatest change during the winter. All stations recorded the least change in the spring. (Auth) GA 66B/203

158. **Rakipova, L.R.** 1968. Thermal Factors in Climate Change. Russian. *Soviet geographers at the 21st International Geographical Congress, 1968. Abstracts of papers, Nauka, Moscow, (pp. 48-49).*

The question of artificial and natural changes in climate due to changes in the basic thermal factors is considered. The effect of the arctic ice cover on the zonal distribution of temperature and zonal circulation is evaluated theoretically. The basic climatic characteristics of two extreme regimes are calculated. One of them corresponds to the glacial period, the other to conditions of complete absence of ice in the arctic basin. Next there is considered the effect on climatic changes in amounts of horizontal flows of heat in the ocean, as well as dust contamination of the upper layers of the atmosphere. (trans. F. Hilton) GA 71B/0202

159. **Robock, A.** 1979. The "Little Ice Age": Northern Hemisphere Average Observations and Model Calculations. *Science 206(4425):1402-1404.*

Numerical energy balance climate model calculations of the average surface temperature of the Northern Hemisphere for the past 400 years are compared with a new reconstruction of the past climate. Forcing with volcanic dust produces the best simulation, whereas expressing the solar constant as a function of the envelope of the sunspot number gives very poor results. (Auth)

160. **Rogers, J.C., and H. Van Loon.** 1979. The Seesaw in Winter Temperatures between Greenland and Northern Europe. Part II: Some Oceanic and Atmospheric Effects in Middle and High Latitudes. *Monthly Weather Review 107(5):509-519.*

Description of the seesaw in wintertime climate between Greenland and northern Europe is continued in terms of variations in long waves, frequencies of highs and lows, zonal geostrophic winds, precipitation, sea ice and sea surface temperatures. The monthly variations in four circulation modes are described. Significant spatial correlations exist between the zonal component of the geostrophic wind in the area of the strongest westerlies in the North Atlantic Ocean and the zonal geostrophic wind elsewhere north of the 20 deg N in winter. Long waves 1 and 2 change substantially from one phase of the seesaw to the other at 65 deg N. At 45 deg N only wave 2 changes appreciably between phases. Large, statistically significant anomalies occur during and after seesaw winters in the atmosphere-ocean-ice system of the North Atlantic Ocean and its periphery, as well as in the North Pacific Ocean. Anomalies of sea surface temperature which develop during seesaw winters tend to persist through the subsequent spring and summer. In addition, the seesaw modes are characterized by significantly different ice conditions in Davis Strait, near Newfoundland, and in the Baltic Sea in winter and during the following spring. (Auth)

161. **Rognon, P., and M.A.J. Williams.** 1977. Late Quaternary Climatic Changes in Australia and North Africa: A Preliminary Interpretation. *Palaeogeography, Palaeoclimatology, Palaeoecology 21:285-327.*

Geological and biological data for the period 0-40,000 B.P. suggest that variations in precipitation and evaporation along the temperate and tropical margins of Australia and North Africa are closely related to variations in the position and strength of the subtropical anticyclones. Such changes in the subtropical anticyclones seem related to changes in the position and wave amplitude of the subtropical westerly jet stream. A dynamic interpretation of the inferred palaeoclimates suggests that important additional factors were the distribution of surface temperature anomalies over Siberia and the Sahara at 30,000 B.P.; the location of the North Pacific and the North American surface temperature anomalies at 24,000 B.P.; compression of the westerlies over Tasmania during 20,000-15,000 B.P.; breakdown of the summer monsoon during 17,000-12,000 B.P.; and a possible change in the slope and nature of the Intertropical Convergence during 11,000-7,000 B.P. Major environmental changes associated with the above influences were heavy rainfall, high lake levels, and increased fluvial activity in southern Australia and along both margins of the Sahara between 40,000 and 20,000 B.P.; low lake levels in the Afar at 30,000 B.P.; intertropical aridity and dune-building along the tropical margins of the Sahara and Australia, and desiccation in semi-arid New South Wales during the interval 17,000 to 12,000 B.P.; and very high lake levels and increased precipitation in the Sahel and in northern and southern Australia from 11,000 B.P. to 5,000 B.P. The past and present role of the desert anticyclones in controlling the start and the close of the arid phases is demonstrated, as is the correlation between Southern Hemisphere pressure systems and Saharan rainfall, and between Northern Hemisphere circulation changes and Australian rainfall. The subtropical anticyclones may act as buffers when the thermal balance between the two hemispheres is upset by an excess of surface ice in any one hemisphere, and this influences the climate well beyond the deserts. (Auth)

162. **Sagar, R.B.** 1961. Meteorological and Glaciological Observations on the Gilman Glacier, Northern Ellesmere Island. *Geographical Bulletin 22:13-56.*

Results are given of climatological and glaciological observations taken during the summer of 1961 in the neve area of the Gilman Glacier, northern Ellesmere Island. Long-term records from Alert weather station indicate that the summer season was relatively cool. Gross ablation was about 3 cm water equivalent at 1,660 m above sea level and occurred almost entirely during two brief periods of 88 hours' duration in mid-July. The radiative-energy surplus was estimated to account for more than 85 per cent of the heat used to reduce subsurface cold content and promote melting. Comparison of the 1961 results with those of previous years indicates that an early summer snowfall or a small negative deviation from the present temperature mean, or both, can critically affect the Gilman Glacier economy. (Author) GA 65/388

163. **Salinger, M.J., and J.M. Gunn.** 1975. Recent Climatic Warming around New Zealand. *Nature 256(5516):396-398.*

Extensive records of temperature, rainfall and air pressure for ten New Zealand locations (six urban, two rural, and two small islands) were analyzed in an effort to explain the warming in this area over the past 30 yr. Analysis of the data indicates that the recent warming can be attributed to the southerly migration of the high pressure zone and weaker westerlies over New Zealand. Climatic changes in the New Zealand area do not parallel published curves for the globe. During the past three decades of warming in New Zealand the northern continents have been cooling rapidly. The 5 yr running means of Scott Base, Antarctica show a rise from -21 C in 1960 to -15.9 C in 1969. Orcadas I, at latitude 60 deg 45 min S near South America, similarly has warmed by 0.5 C since 1940. It thus seems that the warming in New Zealand region is common to a wider range in the Southern Hemisphere. (AntB I-15560) AntB I-15560

164. **Savina, S.S., and L.V. Khmelevskaya.** 1968. Fluctuations in Atmospheric Pressure in the Northern Hemisphere in the 20th Century. Russian. *Soviet geographers at the 21st International Geographical Congress 1968. Abstracts of Papers. (pp. 49-50).*

Using B.L. Dzerdzeevskii's typification, a comparative analysis is made of the barometric field of the northern hemisphere of the earth, for 2 extreme decades (1906-1915, and 1931-1940). Real differences in spatial distribution of climatological regions of high and low pressures, as well as in the numbers of cyclones and anticyclones per unit area, are established. The first decade is characterised by a large number of anticyclone centres per unit area, and their distribution over a larger area, and the second decade is characterised by a smaller number of precipitations and a smaller area over which they were distributed. From comparison of cyclonic and anticyclonic regions (climatologically) in the Atlantic and Pacific sectors, it follows that in 1931-40 the Azores region was 10 deg in latitude to the north-west, relative to its average position 1906-1915. In the Pacific sector, the spatial position of the Hawaiian anticyclone is found to be the more stable one, and there are basic differences shown in its intensity. The values of the mean 24 hour pressure gradient, calculated for 1 deg of latitude in the 55-35 deg latitude north band, change for the periods of action of the elementary circulating mechanisms over the decades mentioned; they are greater in the 2nd decade than in the first. The results obtained can be of interest for investigating fluctuations in climate in the 20th century, and for prediction. (trans. F. Hilton) GA 71B/0203

165. **Schaupweinberg, W.** 1973. On the Sequence of Normal, Warm and Cold Years and Seasons Respectively in Badgastein. *Salzburg. Universitat. Geographisches Institut. Arbeiten, Band 3:101-109.*

The author was able to evaluate meteorological and climatological data observed in the world famous spa Badgastein (Salzburg, Austria) covering a period of 107 years. The analysis of this material of unusual scope according to a specific temperature code has led to new insights with regard to the succession of normal, warm and cold years and/or seasons. With the help of numerous tables the author has examined whether and to what extent climatic periodicities or even lows of recurrence can be discerned. Apart from this, the immediate goal of the study, various comparisons allow a better comprehension of the difficulties encountered in choosing an appropriate sample period within the larger time span. Thus, the influence of the climatic pendulum during the last three decades is clearly evident. (English summary) GA 74B/0957

166. **Sellers, W.D.** 1964. The Energy Balance of the Atmosphere and Climatic Change. *Journal of Applied Meteorology 3(3):337-339.*

Presents recent figures on the annual energy balance of the atmosphere, tabulated by 10 deg zones of latitude for each of five components, viz: absorption of solar radiation, emission and absorption of infrared radiation, transfer of sensible heat by conduction and convection, net horizontal advection of heat to or from neighboring air columns, and the phase change of atmospheric water substance. Main implication of analysis of the table is that the climate of the polar and sub-polar regions is largely governed by equatorial conditions, e.g., a decrease in mean tropical precipitation records do not substantiate this conclusion, since the 1.5 deg C rise in temperature since 1880 poleward of 60 deg N has not been accompanied by any apparent change in tropical precipitation. The close interrelationship of the various energy balance components makes it difficult to determine the effect of climatic change from one region to another. (AB91558) AB91558

167. **Selsing, L., and E. Wishman.** 1978. An Approach to the Understanding of the Summer Climate 7000-6000 B.P. in Ryfylke, Southwest Norway. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 145-149), 259 pp.*

Archeological and paleobotanical evidence and recent climatic data are used to interpret paleoclimate, on the assumption that a certain mean temperature for June-September (10.4 deg C) characterizes the mean pine forest limit which was 200 m higher than present at 7000-6000 B.P. Assuming the present environmental lapse rate of 0-55 deg C/100 m applied then, the temperature during the years 7000-6000 B.P. was 1.1 deg higher than present. This differene is attributed to favorable circulation patterns occurring more frequently than at present. (JTA)

168. **Shackleton, N.J.** 1969. World May Freeze in New Ice Age Very Soon. *Geographical Magazine 41(9):705-706.*

The present interglacial period has already lasted about 11, 000 years and was at its warmest some 5000 years ago. Many of the hypotheses put forward to explain climatic changes appear to suggest that the next ice age is 10,000 or more years away. The author's research implies that such hypotheses are ill-founded and there is no basis for predicting affirmatively or negatively a serious climatic deterioration even during our own lifetimes. The determination of palaeotemperatures by oxygen isotope ratio in the shells of foraminifera as a promising technique, and the Milankovic hypothesis on periodic changes in world climate are discussed. (from Antarctic Bibliography) GA 71A/1345

169. **Smith, C.G.** 1969. Winters at Oxford since 1815. *Weather 24(1):23-26.*

Analysis of mean winter temperatures, number of days with snow or sleet and the number of days with snow cover as recorded at Radcliffe Observatory, Oxford, shows the existence of a cyclic trend with period of about 60 years. (W.A.R. Brinkmann) GA 71B/0211

170. **Sorenson, C.J.** 1977. Reconstructed Holocene Bioclimates. *Annals Association of American Geographers 67(2):214-222.*

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Paleopodzols and frost wedge polygons in and near the forest/tundra ecotone indicate that Holocene fluctuation of the forest border has varied from 280 km (170 mi) north to a minimum of 50 km (30 mi) south of the modern forest border in southwest Keewatin. The 320 km (200 mi) wide range for Keewatin appears to decrease systematically northwestward across Mackenzie and northeastward across Labrador. Significant forest/tundra border displacements occurred at least six times during the postglacial period in reponse to relatively conservative changes in the incidence of Arctic and Pacific derived air masses. (Auth)

171. **Sorkina, A.I.** 1963. The Main Features of Atmospheric Circulation in the Northern Part of the Pacific Ocean and Changes in the Circulation Regime during the Last Half Century. Osnovnye cherty atmosfernoi tsirkuliatsii nad severnoi chast'iu Tikhogo okeana i izmeneniia v rezhime tsirkuliatsii za poslednie polveka. Russian. *Okeanologiia 3(3):378-383.*

Analyzes circulation from synoptic charts of 1891-1939 and 1954-1959. Synoptic processes are characterized for each season of the year, with attention to the Gulf of Alaska, Kamchatka areas among others. The main features of climate have been a warming trend and an increased activity of cyclones. These changes are of planetary character. (AB83184) AB83184

172. **Sorkina, A.I.** 1975. Variations in the Atmospheric Circulation Regime over the Oceans in the Northern Hemisphere during Recent Decades. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 159-166), 503 pp.*

Analysis of synoptic charts for the Northern Hemisphere (1899-1969 A.D.) indicates a pronounced feature has been the strengthening of the circulation, especially during the winter season. Tables are given of ice extent off Iceland (1880-1939 A.D.) and in the Sea of Okhotsk (1942-1958 A.D.), both of which show a decrease in sea ice cover during the period of record. (JTA)

173. **Stuiver, M.** 1971. Evidence for the Variation of Atmospheric Carbon 14 Content in the Late Quaternary. *Late Cenozoic Glacial Ages, K.K. Turekian (Ed.). Yale University Press, New Haven, Conn., (pp. 57-70), 606 pp.*

The evidence is reviewed for late Quaternary Carbon 14 variations obtained from tree rings, historically dated samples, varves, lake sedimentation rates, chronological distribution of Carbon 14 dates, and time reversals. Excellent agreement is found for the various methods over the past 7500 calendar years. New data for the Lake of the Clouds varve chronology disagree with the Swedish varve chronology for the interval of 7500-10,000 years B.P. The end of the Laschamp magnetic polarity event is tentatively dated at 20, 000 years B.P. (Author) GA 72A/1618

174. **Svenonius, B., and E. Olausson.** 1977. Solar Activity and Weather Conditions in Sweden for the Period 1756-1975. *Journal of Interdisciplinary Cycle Research 8(3-4):222-225.*

This paper discusses the Stockholm series of temperature measurements over a span of 220 years (1756-1975 A.D.). The series gives mean monthly temperatures in degrees Celsius accurate to one decimal place. The authors conclude that an analysis of the data, based on 4 steps of 55 years each, indicates that winters have become milder whereas there has been no appreciable change in summer temperature. These temperature records are compared to the Zurich sunspot records which have an 11.2 yr average period between consecutive maxima. (JTA)

175. **Terasmae, J.** 1961. Notes on Late-Quaternary Climatic Changes in Canada. *Annals of the New York Academy of Sciences 95:658-675.*

Reviews the various sources of paleoclimatic information on Canada, under meteorology, glacial geology, oceanography, paleontology, botany, soils, and palynology. Edaphic, genetic, and geologic factors are suggested for consideration in reaching paleoclimatologic conclusions. Palynological studies in Northern Ontario and Quebec indicate a possible recurrence of glaciation with a 5 deg - 10 deg F fall in mean summer temperatures. More paleoclimatologic information may be found in the Canadian Arctic than hitherto expected. Unusual atmospheric circulation may contribute to the small ice caps on Baffin, Devon, and Ellesmere Islands; presence of unglaciated areas is not completely explained. Time equivalence of late-Quaternary climatic changes is the basic requirement for all correlations using palynological and paleontologic evidence. Migration rates for plants and animals constitute a factor important in paleoclimatology. (AB76102) AB76102

176. **Thomas, M.K.** 1974. Canada's Climates are Changing More Rapidly. *Canadian Geographical Journal 88(5):32-39.*

With five identifiable climatic provinces and considerable daily fluctuation longer term variations are difficult to establish. Statistical analysis of data for up to 10 years is usually sufficient to illustrate fluctuations. Likely mechanisms for causing climatic change are discussed as are methods of detecting post-Pleistocene climatic variations. Fluctuations since the mid-19th century are described together with spatial variations but prediction with accuracy is viewed as unlikely. (D.A. Lewis) GA 75B/0435

177. **Thompson, E.M.** 1979. 911 Years of Microparticle Deposition at the South Pole: A Climatic Interpretation. *Ph.D. Thesis, Ohio State University, Columbus, OH, 200 pp.*

A detailed analysis is presented of the particles in a 101 m core from Amundsen-Scott Station, which contains approximately a one thousand year record of atmospheric particle concentrations over the East Antarctic plateau. The work is organized in 8 chapters: 1)an introduction; 2)the physical and meteorological characteristics of the central Antarctic plateau; 3)the climatic history of the earth, with emphasis on the Little Ice Age; 4)the basic properties of the tropospheric and stratospheric particles; 5)a technical description of the entire microparticle analysis procedure; 6)details of the method used to construct the time scale for the 101 m core; 7)interpretation of the microparticle data; and 8)conclusions and future research. Supplementary tables and scanning electron microscope micrographs are presented in appendixes. (AntB I-22990) AntB I-22990

178. **Tollneer, H.** 1966. On Climatic Variation in the East Alpine High Mountains Since 1887 and Its Effects. Uber Klimaschwankungen im ostalpinen Hochgebirge seit 1887 und ihre Auswirkungen in der Natur. *Zeitschrift fur Meteorologie 17(9-12):367-334.*

In the snow region of the eastern Alps remarkable variations of a number of meteorological elements occurred during the past 80 years. Glacier formation - partly retreat of the tongues, partly stationary conditions, partly slight advances - was highly influenced by the thermal behaviour of the warm season. Discharge conditions of the High Alps water courses are strongly affected by the character of the summer of the upper regions. (Auth) GA 68B/1040

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179. **Tucker, G.B.** 1975. Climate: Is Australia's Changing. *Search 6(8):323-328.*

Data from Australian stations and a number of Antarctic coastal stations do not reflect the findings for the northern hemisphere, of a general increase of 0.6 deg C in surface temperatures from 1880 to 1940 and a decrease of 0.4 deg C since then; indeed, during the seven year period 1967-73 a large part of the continent experienced an increase in excess of 1 deg C. The wet years of 1973 and 1974 deviate markedly from the general trend to lower annual precipitation over much of central Australia for the previous 60 years; secular variation, particularly along the eastern seaboard, may however indicate important climatic mechanisms. (Auth mod.) AntB I-5994

180. **U.S. Committee for the Global Atmospheric Research Program** 1975. Survey of Past Climates. *Understanding Climatic Change. National Academy of Sciences, Washington, D.C., Appendix A, (pp. 127-195).*

The nature of paleoclimatic evidence and the methods of climate reconstruction are discussed in this appendix. A discussion of regularities in climatic series, illustrated by a composite variance spectrum of temperature on time-scales of 10 to 10(E+3) years is presented. A chronology of global climate is then presented, broken down into: The Period of Instrumental Record; The Last 1000 Years; The Last 5000 years; The Last 25,000 Years; etc. Examples of climatic series for each of these periods are presented graphically. Geographic patterns of climatic change are mapped and graphed, and the climatic record is summarized, and some inferences drawn for the future. A six page bibliography is included. (JTA)

181. **Van den Dool, H.M., H.J. Krijnen, and C.J.E. Schuurmans.** 1978. Average Winter Temperatures at De Bilt (The Netherlands):1634-1977. *Climatic Change 1:319-330.*

A very long series of average winter temperatures in the Netherlands is presented. The series is based on direct observations (1735-1977) and administrative data concerning Dutch canals (1634-1734). The sources and the reliability of the data are discussed. Some characteristics of the series are shown. (Auth)

182. **Van Loon, H., and J.C. Rogers.** 1978. The Seesaw in Winter Temperatures between Greenland and Northern Europe. Part I: General Description. *Monthly Weather Review 106:296-310.*

We have investigated the well-known tendency for winter temperatures to be low over northern Europe when they are high over Greenland and the Canadian Arctic, and conversely. Well-defined pressure anomalies over most of the Northern Hemisphere are associated with this regional seesaw in temperature, and these pressure anomalies are so distributed that the pressure in the region of the Icelandic low is negatively correlated with the pressure over the North Pacific Ocean and over the area south of 50 deg N in the North Atlantic Ocean, Mediterranean and Middle East, but positively correlated with pressure over the Rocky Mountains. The composite patterns of pressure anomalies in the seesaw are almost identical to the first eigenvector in the monthly mean pressure, but the standard deviations of pressure anomalies in seasaw months are as large as the standard deviations of montly means in general. Since 1840 the seesaw, as defined by temperatures in Scandinavia and Greenland, occurred in more than 40% of the winter months and the occurrences are seemingly not randomly distributed in time as one anomaly pattern would be more frequent than the other for several decades. For this reason the circulation anomalies in the seesaw come to play an important part in deciding the level of regional mean temperatures in winter and thus in deciding the long-term temperature trends. These regional temperature trends are then closely associated with changes in frequency of atmospheric circulation types, and it is therefore unlikely that the trends are caused directly by changes in insolation or in atmospheric constituents and aerosols. (Auth)

183. **Veryard, R.G.** 1962. The Changing Climate. *Discovery 23(1):8-15.*

Discusses climatic fluctuations; evidence of past changes, causes, current changes, possible results. Effects on the Arctic are noted of warmer periods during the Climatic Optimum circa. 3,000 B.C., the Secondary Climatic Optimum of 800-1200 A.D. and from 1850 to 1940; influence of the colder periods around 500 B.C. and the Little Ice Age of 1500-1800 A.D. is also considered. The earth is about two-thirds along the way to a period of maximum interglacial warmth. An apparent trend since 1940 towards a moderately cooler climate in high and middle latitudes is probably transitory to be followed by continued warming in the next decade. (AB76380) AB76380

184. **Vibe, C.** 1967. Arctic Animals in Relation to Climatic Fluctuations. *Meddelelser om Gronland 170(5):1-227.*

A study of the East Greenland Ice in Davis Strait makes it possible to recognize three main drift-ice stages which play an important role for climate and ecology in all Greenland. A) The drift-ice stagnation stage (approx. 1810-60). The East Greenland Ice does not advance far north into Davis Strait where the Canadian Current has a dominating influence. The climate of northern West Greenland is relatively cold, dry and stable. B) The drift-ice pulsation stage (approx. 1860-1910). The ice of the Arctic Ocean drifts into the Atlantic in larger amounts than before. The East Greenland Current and the East Greenland Ice advance far north into Davis Strait either early or late in summer. The populations of sea mammals and sea birds decrease in central West Greenland. The climate becomes relatively unstable and wet. C) The drift-ice melting stage (approx. 1910-1960?). The East Greenland Ice decreases in Davis Strait where the Irminger Current has a dominating influence on climate and production. The poplulations of sea mammals and sea birds increase in northern West Greenland and in East Greenland. The Reindeer population of West Greenland has ample summer grazing, but the winter pastures are often covered by snow and ice–and the population stagnates in all West Greenland, except for the short dry period of 1910-20. (Auth)(JTA)

185. **Wahl, E.W., and R.A. Bryson.** 1975. Recent Changes in Atlantic Surface Temperatures. *Nature 254(5495):45-46.*

Analysis of sea surface temperatures for the period 1951-1972AD (Rhodewald, 1973) are examined against sea surface reconstructions for the ocean at 18,000BP and for estimated Little Ice Age sea surface temperatures. The analysis suggests that during the Little Ice Age the sea surface temperatures were about one-sixth of the way toward full glacial conditions. The analysis also indicates that by 1972 AD the surface temperature of the North Atlantic had returned to approximately Little Ice Age conditions. (JTA)

186. **Wendland, W.M., and R.A. Bryson.** 1974. Dating Climatic Episodes of the Holocene. *Quaternary Research 4:9-24.*

Over 800 Carbon 14 dates associatied with pollen maxima and minima, sea level maxima and minima, and top and bottom surfaces of peat beds were simultaneously analyzed to identify times of globally synchronous environmental discontinuities. Some 3700 Carbon 14 dates associated with 155 cultural continua of the world were collectively analyzed to identify worldwide synchroneities in appearance and termination of the cultures. Significant globally synchronous discontinuities were identified in each independent analysis. The dates of environmental and cultural discontinuities are rather similar, particularly during the recent half of the Holocene. The fact that the cultural discontinuities mostly follow rather closely those of the paleobotanical record suggests that there has been a distinct climatic impact on the cultural history of man. (Auth)(JTA)

Significant dates of environmental change (Table 3) are used to date breaks in the Blytt-Sernander nomenclature as follows: 1) Pre-Boreal/Late-Glacial 10,030 BP; 2) Boreal/Pre-Boreal 9,300 BP; 3) Atlantic/Boreal 8490 BP; 4) Sub-Boreal/Atlantic 5060 BP; and 5) Sub-Atlantic/Sub-Boreal 2760 BP. Division of the last 2760 years is suggested at 1680 and 850 BP. (JTA)

187. **Williams, J.** 1980. Anomalies in Temperature and Rainfall during Warm Arctic Seasons as a Guide to the Formulation of Climate Scenarios. *Climatic Change 2:249-266.*

Recently much concern has been expressed regarding the impact of an increased atmospheric CO2 concentration on climate. Unfortunately, present understanding and models of the climate system are not good enough for reliable prediction of such impacts. This paper presents an analysis of recent climate data in order to illustrate the nature of regional temperature and rainfall changes in different seasons and to provide some guidance with regard to points which might be borne in mind when scenarios of future climate (especially those taking into account human impacts) are being formulated. Since it is believed that an increased atmospheric CO2 concentration will cause a warming and models and data suggest that the Arctic is more sensitive to climatic change than other latitudes, anomalies associated with warm Arctic seasons have been studied. The regional temperature, precipitation and pressure anomalies in the northern hemisphere for the 10 warmest Arctic winters and 10 warmest Arctic summers during the last 70 years have been investigated. Even when the Arctic area is warm, there are circulation changes such that large coherent anomalies occur elsewhere, with some regions warming and some cooling. The 10 warmest Arctic winters were characterised by larger amplitude anomalies, in the Arctic and elsewhere, than the 10 warmest summers, illustrating the difference in response between seasons. The precipitation differences for the 10 warmest Arctic winters and summers show for North America large coherent areas of increase or decrease, which again differ according to season. However, in winter the differences are not statistically significant, while the differences in two areas are significant in summer. (Auth)

188. **Williams, J., and H. Van Loon.** 1978. Trends of Winter Temperature in the Southern Hemisphere. *Climatic Change and Variability, a Southern Perspective, A.B. Pittock, L.A. Frakes, D. Jenssen, J.A. Peterson and J.W. Zillman (Eds.). Based on a Conference at Monash University, Melbourne, Australia, 7-12 December 1975... Cambridge, Cambridge University Press, (pp. 191-194), 455 pp.*

For McMurdo and the South African National Antarctic Expedition station the winter (June-July-August) temperature trends for 1955-1969 A.D. are opposite with rates of + 0.25 deg C/yr and -0.26 deg C/yr respectively. Over the Southern Hemisphere as a whole temperatures for the same period are increasing over much of South America and parts of Australia and Antarctica. Temperatures are on average decreasing over New Zealand, most of Antarctica, and the islands north of Australia. (JTA)

189. **Williams, L.D.** 1975. The Variation of Corrie Elevation and Equilibrium Line Altitude with Aspect in Eastern Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 7(2):169-181.*

It has been common practice to estimate ice-age climates by calculating the difference in temperature, at an assumed lapse rate, between the elevation of the present snowline and that represted by the lowest corries (cirques) in a region. Such a procedure not only ignores many other factors which may affect corrie glacierization, but is actually incorrect, because the change in snowline for a given temperature change does not depend only on lapse rate. This study suggests that variation of equilibrium line altitude (ELA) with aspect provides a climatic "signature" supplementary to that of lowest ELA. A method of computing heat and water balances on glaciers from climatic data is described and tested against observations on Baffin Island glaciers. This model is used to estimate ELA as a function of aspect in the Okoa Bay area of Baffin Island, using 1963 to 1972 climatic data, and then for two contrasting climates which have been suggested for early and late stages in the last glaciation. The results are compared with distributions of corrie glaciers and ice-free corries in the area. (Auth)

190. **Williams, L.D.** 1978. Ice-Sheet Initiation and Climatic Influences of Expanded Snow Cover in Arctic Canada. *Quaternary Research 10:141-149.*

It has been suggested that the Laurentide Ice Sheet originated with extensive perennial snow cover, and that the snow cover affected climate so as to aid ice-sheet development. In this study, a large increase in extent of October 1st snow cover in the Canadian Arctic from 1967-70 to 1971-75 is compared to changes in October means of other climate variables. Over the area of snow-cover expansion, mean surface air temperature decreased by up to 3 deg C, mean 500-mbar height was lowered by over 60 m, and precipitation was increased by up to a factor of two. These effects, if applied to the entire summer, together with the temperature change computed by Shaw and Donn for a Northern Hemisphere summer isolation minimum (the Milankovich effect), can account for glacierization of the Central Canadian Arctic. (Auth) Ecol Can 3624

191. **Wilson, A.T., C.H. Hendy, T.R. Healy, J.W. Gumbley, A.B. Field, and C.P. Reynolds.** 1974. Dry Valley Lake Sediments: A Record of Cenozoic Climatic Events. *Antarctic Journal of the United States 9(4):134-135.*

The bathymetry and sediments of both lobes of Lake Bonney were studied with special emphasis on the east lobe which contains a record of past climates of this region. Several cores were taken from both lobes with a specially built corer capable of coring up to at least 3 m in soft sediment in depths of water up to 100 m. A deposit of halite at least 0.3 m thick and occupying an area of 1.1 sq km was found to underlie the east lobe of Lake Bonney. The work indicates that the high level, about 210 m above Lake Bonney, is indeed a lake and not a sea level, that it is about 6,000 yr old, and that the lake dropped from this level rapidly. Lake Bonney, having remained stable for a considerable period, now is rising rapidly. (AntB-E-14329) AntB E-14329

192. **Wilson, C.V.** 1983. Part II–Little Ice Age on Eastern Hudson Bay; Summers at Great Whale, Fort George, Eastmain, 1814-1821. *Canadian Climate Centre Report No. 83-9, Atmospheric Environment Service, Downsview, Ontario, 145 pp. + appendix.*

The wealth of weather information contained in the Hudson's Bay Company archives, 1814-1821, provides the opportunity to

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study the summer climate along the east coast of the Bay during a critical decade in the Little Ice Age. These years also include the eruption of Mt. Tambora in April 1815, and span the second of a double cycle of low sunspot number – the lowest since the Maunder minimum. It was a period of wide variability between the seasons. There is evidence that the summers of 1816, 1817 were not only colder than those on modern rcord, but were exceptionally severe even for the period. Those for 1818 and 1820 were milder and considered very favourable, suggesting that the average expectation was lower than the modern normal. In general, the historical seasons differed from the modern in the colder springs and autumns, and more frequent spring and autumn snowfall. From autumn 1815 through April 1818, this coast experienced arctic conditions; in the consecutive summers 1816, 1817, the arctic boundary (after Koppen) lay close to Eastmain. The mean daily temperature at Great Whale in July 1816 was nearly 6 deg C below the 1941-70 normal, and at Fort George in 1817, a -5 deg C anomaly was sustained through the season. Bay ice in 1816, 1817, remained longer than in any year on modern record, and 1816 provides a marginal case for the carry-over from one season to the next. With its summer snowfall, 1816 also provides a marginal case for a residual snowcover on the east side of Hudson Bay. This summer also had an unusually high frequency of northerly winds. (Auth)(JTA)

193. **Wilson, C.V.** 1983. Some Aspects of the Calibration of Early Canadian Temperature Records in the Hudson's Bay Company Archives: A Case Study for the Summer Season, Eastern Hudson/James Bay, 1814 to 1821. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 144-202), 343 pp.*

There is evidence that the temperature observations for Whale River, Big River, and Eastmain from 1814 to 1821 A.D. were taken with care, and that with appropriate adjustments these records can be compared to recent instrumental observations. Such a comparison indicates that 1814-1821 A.D. was generally cooler than recent (1960-1972) and the summers of 1816 and 1817 were colder than any on modern record. (JTA)

194. **Woetmann, N.** 1978. Variation of Climate, as Indicated by Extended Temperature Records from Denmark, the Faroes and Greenland (Including a Short Review of Sun–Weather Relationships). *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 212-222), 259 pp.*

The records used in this study consist of mean monthly temperatures computed on the basis of three daily, equally spaced temperature measurements from: Copenhagen (Denmark), Jutland (Denmark), the Faroe Islands (1873-1971 A.D.), and Godhab (West Greenland) for the period 1875-1974 A.D. Graphs are shown of seasonal (3 month) averages. Minimum temperatures in the northeast North Atlantic (the Faroes) occurred about 1930 A.D., but in West Greenland the minimum was reached about 1900 A.D. Pronounced seasonal differences in temperature trends are evident between the station records. Analysis of the root mean square of the moving monthly averages shows little variation for the Faroes and much larger trends for Denmark and West Greenland, where variability has decreased from 6.2 deg to 5.2 deg C. (JTA)

195. **Wollin, G., G.J. Kukla, D.B. Ericson, W.B.F. Ryan, and J. Wollin.** 1973. Magnetic Intensity and Climatic Changes 1925-1970. *Nature 242(5392):34-37.*

The results are reported of correlations between short period changes in magnetism and climte, based on indirect instrumental observations. Total intensity curves based on annual means are correlated with 10 yr means of air temperature at the nearest weather stations. The intensity is decreasing at observatories in Mexico, Canada and the United States while the climate is getting warmer. At observatories in Greenland, Scotland, Sweden and Egypt the intensity is increasing whereas the climate is getting colder. Observations suggest that the trends in intensity from most of the magnetic observatories in the world with records over at least 30 yr correlate negatively with the 10 yr means of air temperature. The authors conclude that a close relationship links changes of the Earth's magnetic field and climate. This may be a direct cause and effect relationship but the possibility that both the Earth's magnetic field and climate show parallel reactions to the processes in the Sun cannot be excluded. (Margaret A. Bass) GA 74B/0401

196. **Wood, P.H.** 1977. Interpretations of Climatic Change in Arctic North America during the Last 20,000 Years. *Thesis, Ecole des Hautes Etudes en Sciences Sociales, 204 pp.*

The literature is surveyed for evidence of climatic change over the past 20,000 years. Surveys are included for northern Alaska; Arctic Canada: the mainland; and Arctic Canada: the Arctic Archipelago. Critical radiocarbon dates from these regions are listed in a series of tables. Fig. 28b summarizes the data in the form of diagrams that show "warming" and "cooling" at 14 sites over the last 16,000 years. The interval of maximum warmth is variously dated as starting nearly 11,000 years ago to as late as 6000 B.P. Major cooling is recorded at many sites between 4000 and 3000 B.P. An extensive bibliography is included. (JTA)

Dendroclimatologic

197. **Beschel, R.E., and C.P. Egan.** 1966. Geobotanical Investigation of a 16th Century Moraine on the Bucher Glacier, Juneau Icefield, Alaska. *Sixteenth Alaskan Science Conference, E.G. Viereck (Ed.), Proceedings of Conference, Juneau, August 29 - September 1, 1965. American Association for the Advancement of Science, Alaskan Division, College, Alaska, (pp. 114-115), 321 pp.*

In connection with the 1965 Juneau Icefield Research Program an examination was made of two main end moraines of the Bucher Glacier, with the objectives of (a) establishing a minimum dendrochronological date, and (b) making a reconnaissance lichenometrical study. These moraines are located in a south-trending valley on the western flank of the Juneau Icefield at ca. Lat. 58 deg 52 min N; Long. 134 deg 31 min E. Crustose lichens growing on the outer (older) moraine provisionally indicate a growth period of 300 to 350 years. Slightly larger lichens are present outside of this moraine. A dendrochronological date was obtained from the lowest of several trunk discs sawed from a large mountain hemlock Tsuga mortensiana, growing on the crest of the outermost moraine. Allowing time for establishment of the seedling, and growth to the disc height, the date of formation of this moraine is considered to be near or slightly prior to 1600 A.D. (Auth)(JTA)

198. **Blasing, T.J., and H.C. Fritts.** 1975. Past Climate of Alaska and Northwestern Canada as Reconstructed from Tree Rings. *Climate of the Arctic, G. Weller and S.A. Bowling (Eds.), Proceedings of the Twenty-Fourth Alaska Science Conference, August 15-17, 1973. Geophysical Institute, University of Alaska, Fairbanks, Alaska, (pp. 48-58), 436 pp.*

Spatial anomaly patterns of sea-level pressures over North America, the North Pacific, and eastern Asia in the 20th century can be statistically calibrated with spatial anomaly pattern of tree growth in semi-arid western North America. Growth anomalies prior to 1900 were substituted into the calibration equations to reconstruct past circulation features for the 18th and 19th centuries. The success of the reconstructions for the Arctic was tested against climatic data where possible and against the variations in growth of Arctic trees which respond to variations in climate. Ten different types of tree-growth anomaly pattern were identified in the Arctic between 1800 and 1939. Climatic conditions inferred from the growth anomalies of Arctic trees were compared to circulation anomalies over the arctic as reconstructed from the arid-site trees to the south. Both of these sources of information were used to infer climatic conditions for the period 1800-1939. Tentative inferences are presented as to climatic conditions for each of five regions in Alaska and northwestern Canada in hope that they may be tested against other lines of evidence. (Auth)

199. **Blasing, T.J., and H.C. Fritts.** 1976. Reconstructing Past Climatic Anomalies in the North Pacific and Western North America from Tree-Ring Data. *Quaternary Research 6:563-579.*

Winter climatic anomalies in the North Pacific sector and western North America are statistically calibrated with tree-ring data in western North America and reconstructed back to A.D. 1700. The results are verified using climatic data from the last half of the 19th century, which is prior to the calibration period. Climatic conditions reconstructed for the 18th and 19th century winters are then summarized and compared with the 20th century record. (Auth)

200. **Bray, J.R., and G.J. Struik.** 1963. Forest Growth and Glacial Chronology in Eastern British Columbia, Canada. *Canadian Journal of Botany 41:1245-1271.*

Recent activity of Yoho Glacier was determined by botanical and geological dating techniques and from published accounts. Tree growth in four forests adjacent to the end moraine was measured by increment borings of 200 PICEA ENGELMANNII. Drawings of the increment cores were made in the field, to avoid differential shrinkage with storage. From these drawings, tree growth was calculated in trunk basal area per decade. Corroborating data from three trees indicated that maximum advance of the Yoho Glacier was in 1844. Ice recession increased from 8 m/yr in the mid 1800's to 59 m/yr in 1951-1960 with the greatest rate of increase after 1900. Recession in 1961-1962 was rapid (121 m/yr) because of the warm summer of 1961 and topographic conditions. Total recession 1844-1962 was 2.4 km (ca. 40% of the distance to the Wapta Icefield). Tree ecesis periods for six surfaces of known age ranged from 20 to 43 years (mean 28). The influence of Yoho Glacier in decreasing forest growth was mainly limited to less than 5 meters of the ice margin except in the decade of maxiumum advance when the influence extended to 30 m. There was no statistical difference in relative trunk growth toward or away from the glacier. Total tree growth was higher from 1581 to 1680, 1761 to 1790, 1851 to 1870, and 1901-1960 with lower growth intervening. Total growth was positively related to world temperature and sunspot activity and negatively related to world precipitation and glacial activity. Records of glacial activity in Alberta, British Columbia, Washington, and Oregon from 1580 to 1960 showed that two intervals, 1711 to 1724 and 1835 to 1849, contained over one-half of the glacial advances. These intervals followed the two lowest periods of solar activity (1645-1715; 1798-1833) since 1610. Periods of high solar activity showed glacial retreat or stagnation. These results support the solar radiation climatic hypothesis. Resumes of forest growth, glacial activity, climatic regime, and solar activity for 1580-1960 and 800-1950 gave further evidence of a close relation between solar activity and climate. The use of solar activity data in predicting climatic trends and glacial activity was discussed. (Auth) ORNL/EIS-195

201. **Clague, J.J., L.A. Jozsa, and M.L. Parker.** 1982. Dendrochronological Dating of Glacier-Dammed Lakes: An Example from Yukon Territory, Canada. *Arctic and Alpine Research 14(4):301-310.*

The chronology of prehistoric, glacier-dammed lakes can be established, in many cases, through the use of dendrochronological techniques. Driftwood deposited at the margins of a glacier-dammed lake can be precisely dated, and the history of the lake thereby deduced, by matching the annual ring patterns in the driftwood with those of nearby old living trees. Dating is facilitated by X-ray densitometric analysis, whereby digital data on ring width and intraring density variations are obtained from X-ray images of wood. Dendrochronology is not subject to the severe limitations on precision inherent in radiocarbon and other absolute dating techniques. It is the preferred method for dating recent geologic and other events where exact ages are required and where appropriate fossil material (i.e., reasonably well preserved wood with sensitive annual ring patterns) is available. Dendrochronological techniques were applied to Neoglacial Lake Alsek, a former glacier-dammed lake in southwestern Yukon Territory with a complex history of filling and emptying. Lake Alsek forms whenever Lowell Glacier, a large surging glacier in the St. Elias Mountains, advances across Alsek Valley and blocks Alsek River. Dendro-dating of driftwood, combined with sparse historical and other data, indicate that Lake Alsek last extended beyond the front of the St. Elias Mountains to the vicinity of Haines Junction between A.D. 1848 and 1891, probably in the early 1850s. (Auth)

202. **Cropper, J.P.** 1982. Climate Reconstructions (1801 to 1938) Inferred from Tree-Ring Width Chronologies of the North American Arctic. *Arctic and Alpine Research 14(3):223-241.*

A spatial grid of 56 tree-ring width chronologies from Alaska and northwestern Canada, for the period 1801 to 1938, are reduced using principal components analysis. The principal component weights are calibrated, via multiple regression, against coefficients representing seasonal spatial anomaly patterns of sea-level pressure over the North Pacific sector of the Northern Hemisphere, for the period 1900 to 1938. The quality of the chosen regression models is determined by statistically testing the models against independent data. The testing data are a temperature reconstruction for Fairbanks and pressure anomaly coefficients derived from western North American tree-ring width chronologies. Climate conditions inferred from the reconstructed pressure- type coefficients are an anomalous strengthening of the summer North Pacific High in the period 1830 to 1850 and associated anomalously low summer temperatures at Fairbanks. Almost normal summer pressures during the first 15 yr of the 19th century would cause average Fairbanks summer temperatures such as occurred in the early 20th century (1920 to 1938). (Auth)

203. **Cropper, J.P., and H.C. Fritts.** 1981. Tree-Ring Width Chronologies from the North American Arctic. *Arctic and Alpine Research 13(3):245-260.*

A literature search and an inspection of the Laboratory of Tree-Ring Research, University of Arizona, files reveal that over 100 tree-ring chronologies exist for the arctic region of North America. The indices for five unpublished chronologies are presented, and the various characteristics of 94 selected dendroclimatic chronologies are summarized. The autocorrelations, standard deviations, and mean sensitivities of the arctic chronologies are comparable to those for chronologies from eastern North America. However, the average autocorrelation is higher, and the average standard deviation and mean sensitivity are lower than those for chronologies from western North America. Because of limited replication and chronology length, many of the arctic chronologies are of limited value for climatic analysis compared to those from lower latitudes. Nevertheless, some climatic analysis is possible from these data, and with additional collections, more replication, and the use of modern techniques, the North American Arctic offers considerable dendroclimatic potential. (Auth)

204. **Fritts, H.C.** 1978. Tree Rings, a Record of Seasonal Variations in Past Climate. *Naturwissenschaften 65:48-56.*

The width and other characteristics of the growth layers in trees provide valuable information on past variations in climate. Not only can past climate be deduced from past growth, but computers can be used to calibrate the tree growth with climate and to obtain quantitative estimates or reconstructions of the climatic variables in the past from the measurements of ring widths. Some of the biological and physical phenomena that influence the climatic records are described, and the unique opportunities provided by tree-ring analysis of climate are summarized. (Auth)(JTA)

Figure 5 illustrates a 300 yr record from Fort Chimo, northern Quebec, showing that low tree ring indexes (cool springs and summers) prevailed between 1810 and 1870 A.D. Maps of the western USA show areas of wide rings (moist and cool climate) and narrow tree rings (dry and warm climate) for different periods between 1521 and 1785 A.D. (JTA)

205. **Garfinkel, H.L., and L.B. Brubaker.** 1980. Modern Climate-Tree-Growth Relationships and Climatic Reconstruction in Sub-Arctic Alaska. *Nature 286(5776):872-874.*

Statistical comparisons between tree-ring width sequences and climatic records provide a means of identifying climatic limitations on tree growth and allow the reconstruction of past climates. This information is especially important in the North American sub-Arctic where climate growth relationships are poorly understood and instrumental weather records are very short, typically less than 75 yr. Dendroclimatic reconstructions before 1900 are essential for estimating a realistic range of high latitude climatic variation, because twentieth century climate is now thought to be somewhat anomalous. While some dendroclimatic studies have been carried out in the sub-Arctic, none has made full use of current multivariate statistical techniques. This study, as part of a multidisciplinary investigation of treeline fluctuations in the Brooks Range of Alaska, uses ring-width sequences of white spruce (PICEA GLAUCA (Moench) Voss) to define climatic limitations on radial growth at treeline and to reconstruct past climatic variables for Fairbanks, Alaska. Multiple regression techniques were used to analyze climate-growth relationships and the results suggest important modifications to the theory that growth at treeline is limited primarily by summer temperature. For example, we have found that radial growth is directly related to summer and autumn temperature and precipitation during certain months, but inversely related to winter-spring temperature. The same ring-width sequences were used to reconstruct average May-July temperature at Fairbanks, Alaska, for the period 1829-1930. This reconstruction, which more than doubles the length of the existing climatic record, was verified by statistically comparing it to independent instrumental data. It indicates that the Fairbanks area has been warmer in the twentieth century than in the nineteenth century during these months. As the longest annual record of temperature from northern Alaska, this reconstruction provides quantitative evidence for a climatic warming similar to that occurring throughout large portions of the Northern Hemisphere during the past 100 yr. (Auth) ORNL/CDIC

206. **Haugen, R.K.** 1967. Tree Ring Indices: A Circumpolar Comparison. *Science 158:773-775.*

A graphic and statistical comparision of major trends in tree ring indices representative of interior Alaska, northern Urals, northern Scandinavia, and Labrador indicates a highly significant correlation for most 50-year intervals between 1650 and the present. This is suggestive of similarities in trends of summer temperature on a circumpolar scale. (Auth)

207. **Heusser, C.J., and M.G. Marcus.** 1964. Historical Variations of Lemon Creek Glacier, Alaska, and their Relationship to the Climatic Record. *Journal of Glaciology 5(37):77-86.*

The Lemon Creek glacier of Alaska has shown a net deficit of 10.32 x 10(E+6) m(E+3) during the period 1953-1958. Trim lines and moraines give evidence of former advance and dating has been done by dendrochronology. A peat deposit, dated at 10,300 + or - 600 years B.P., shows that the glacier has not advanced as much 3.75 m beyond its recent maximum for about 10,000 years. The recent maximum was reached in the mid-eighteenth century, and recession since then has been 2.5 km, with the slowest retreat from 1769-1891 and 1902-1929, and most rapid between 1891 and 1902. Variations since the early twentieth century can be related to variations of temperature, but changes in precipitation must also be considered and their effect varies with changes in temperature. Advances in neighbouring glaciers have been fixed between about 1090 and 2790 B.P. by Carbon 14 dating. Juneau glaciers, however, do not show evidence of advance in the Hypsithermal (8000-3500 B.P.) as do some Alaskan glaciers. Local crustal activity may account for some of the variations in advance in different areas, e.g. the Fairweather Range in one area has risen 46 m in the last 3000 years. (C.A.M. King) GA 64/398

208. **Jacoby, G.C.** 1981. Past Temperature Variations Inferred from a 400-Year Tree Ring Chronology from Yukon Territory, Canada. *Arctic and Alpine Research 13(4):409-418.*

A time series of ring-width indices from 27 cores of 13 white spruce trees (PICEA GLAUCA (Moench) Voss) from Yukon Territory shows growth response to summer temperatures and other climatic variables. The correlations with various temperature parameters are high enough that past temperature information can be inferred for the last 400 yr. The highest simple correlation is between tree growth and total degree days above 10 deg C for June and July. A substantial moisture stress in the trees towards the end of the growing season is also indicated. The chronology shows effects of the "Little Ice Age," of the subsequent Northern Hemisphere warming, and of a recent cooling trend. A second time-series of the first amplitude from a principal component analysis of the ring widths yields a better climatic signal than the time series of ring-width indices. These and other temperature-sensitive trees from near the northern tree line are being used in conjunction with improved analytical techniques to reconstruct temperature parameters for high latitude areas. (Auth)

209. **Jacoby, G.C., and L.D. Ulan.** 1981. Review of Dendroclimatology in the Forest-Tundra Ecotone of Alaska and Canada. *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 97-128), 220 pp.*

Studies indicate that both temperature and moisture information are recorded in the rings of subarctic trees, especially in response to summer conditions. Effects of the Little Ice Age and recent warming are both shown in the records from several sites. Tree-ring width indices for two sites in the Yukon and Alaska show the lowest indices occurred around 1700 A.D. with maximum growth recorded between 1940-1950 A.D. Other substantial troughs in tree ring growth occurred ca. 1625 and 1850 A.D. (JTA)

210. **Kay, P.A.** 1976. Post-Glacial History of Vegetation and Climate in the Forest-Tundra Transition Zone Dubawnt Lake Region, Northwest Territories, Canada. *Ph.D. Thesis, University of Wisconsin - Madison, 154 pp.*

This study reconstructs vegetation and climate of the Holocene for the forest-tundra transition zone in northern Canada. Four sites on a transect from the forest limit to tundra in the Dubawnt River basin were sampled for pollen and dendrochronological data. The distribution of trees is largely determined by climate. The forest limit corresponds to the mean summer position of the arctic front. Pollen and soil studies by other workers have indicated several episodes of forest limit movement during the Holocene. Principal components analysis of surface pollen data indicate that forest sites can be differentiated from tundra sites by a component that has positive loadings of BETULA and Ericaceae and negative loadings of PICEA and PINUS. Calculation of component scores for the four cores facilitates interpretation and comparison of the pollen data. At Dubawnt Lake, the period c. 5800-3700 B.P. was one of boreal forest. A rapid transition to tundra vegetation occurred at 3745 + or - 60 B.P. (WIS-852), and tundra vegetation has predominated since then. Little change in either the extent or the composition of the tundra and forest occurred since c. 3700 B.P. Climatic reconstruction is achieved by multivariate statistical techniques. Transfer functions were constructed by step-wise regression of principal components of pollen and climate data, and by canonical correlation. The different models consistently indicate an abrupt drop in July temperatures of 3-5 deg C at 3745 + or - 60 B.P. Temperatures prior to c. 3700 B.P. were about 1-2 deg C above modern values, whereas temperatures since c. 3700 B.P. have been within + or - 1 deg C of modern values. A depression of temperature of only about 1-2 deg C was sufficient to move the forest limit southward some 150 km. Fire accelerated the change in vegetation. Tree-cores from PICEA MARIANA in stands at the forest limit and in forest outliers were studied for climatological information. Trees at the forest limit exhibit larger mean ring widths and lesser sensitivity than do trees in the outliers. The amount of variance in ring widths explained by climate is greater for trees at the forest limit than for trees in outliers. It is suggested that site factors in the outliers mitigate the impact of climatic stress. The results are consistent with the hypothesis of a frontally-determined forest limit. The lack of a long climatic record precluded climatic reconstruction from the ring series. (Auth) Dissertation Abstracts International 38(1):119-B, Order No. 77-8793

211. **Kuivinen, K.C., and M.P. Lawson.** 1982. Dendroclimatic Analysis of Birch in South Greenland. *Arctic and Alpine Research 14(3):243-250.*

Dendrochronological research in Greenland has met with only qualified success in the last two decades, and no dendroclimatic interpretations have resulted from these initial efforts. During the summer of 1978, field work was conducted on stands of birch (BETULA PUBESCENS) in a uniquely fertile and isolated valley, Qinguadalen (60 deg 16 min N, 40 deg 30 min W). Although the birch suffer considerable geomorphic stress, conventional dendroclimatic procedures revealed significant growth response to climate. Trees generally exhibit contorted or near-horizontal stems, producing asymmetrry in the pith-to-bark dimensions, and frequently develop heart-rot. Of the 35 trees sampled, the oldest datable stem was 143 yr old. A growth response function derived from multivariate analysis of the chronology and 35 yr of climatic (principle component) data from Ivigtut relates 38% of the chronology variance to climate and a total of 60% to climate plus prior growth. Although the Qinguadalen birch chronology is relatively short, it does contain considerable information concerning the relationship between climatic variables and tree growth for the region. (Auth)

212. **LaMarche, V.C., Jr.** 1973. Holocene Climatic Variations Inferred from Treeline Fluctuations in the White Mountains, California. *Quaternary Research 3(4):632-660.*

Remains of dead bristlecone pine (PINUS LONGAEVA Bailey) are found at altitudes up to 150 m above present treeline in the White Mountains. Standing snags and remnants in two study areas were mapped and sampled for dating by tree-ring and radiocarbon methods. The oldest remnants represent trees established more than 7400 y.a. Experimental and empirical evidence indicates that the position of the treeline is closely related to warm season temperatures about 3.5 deg F higher than those of the past few hundred years. However, the record is incomplete, relative warmth may have been maintained until at least 1500 B.C. Cooler and wetter conditions are indicated for the period 1500 B.C.-500 B.C followed by a period of cool but drier climate. A major treeline decline occurred between about A.D.1100 and A.D.1500, probably reflecting onset of cold and dry conditions. High reproduction rates and establishment of scattered seedlings at high altitudes within the past 100 yr represents an incipient treeline advance, which reflected a general climatic warming beginning in the mid-19th century that has lasted until recent decades in the western United States. This evidence for climatic variation is broadly consistent with the record of Neoglacial advances in the North American Cordillera, and supports Antev's concept of a warm "altithermal age" in the Great Basin. (Auth) GA 74B/2472

213. **LaMarche, V.C., Jr.** 1974. Paleoclimatic Inferences from Long Tree-Ring Records. *Science 183(4129):1043-1048.*

Tree-ring data contribute to a better understanding of the nature of past climatic variations. Annual ring records several thousand years long can be constructed for a few areas, but interpretation of them requires the development of new approaches. For example, a single record of average ring width in the upper tree line environment provides a guide to past temperature fluctuations. However, comparison of this record with another, that of the arid lower forest border, from the same area permits characterisation of associated precipitation and temperature anomalies that may, in turn, be linked to features of the general circulation. Other approaches that promise to be very fruitful include study of the variation of ring-width statistics through time, investigation of the physical and chemical properties of wood, and combined multivariate analysis of data for a variety of palaeoclimatic indicators. (Auth) GA 74B/2477

214. **LaMarche, V.C., Jr.** 1977. Dendrochronological and Paleoecological Evidence for Holocene Climatic Fluctuations in the White Mountains, California. *Dendrochronologie und Postglaziale Klimaschwankungen in Europa, B. Frenzel (Ed.). Erdwissenschaftliche Forschung 13, (pp. 151-155).*

The major climatic event of the past 6000 years was a change from generally warm to cooler and probably moister conditions between 1300 B.C. and 1100 B.C. This is shown by changes in average ring widths in trees near both distributional limits and by a decline in the level of upper treeline. The preceding period, from 4000 B.C. to 1300 B.C., although warmer and drier than the subsequent millennia, was punctuated by a brief cool-wet episode between 3100 and 2800 B.C. The period from 2800 to 1300 B.C. was warm and moderately dry. Upper treeline may have risen early in this period. From 1100 to 200 B.C., the White Mountains were cool and moist. A warming between 200 B.C. and A.D. 300 was followed by renewed cooling, reaching a minimum in about A.D. 900. A very abrupt temperature rise followed, culminating about A.D. 1200. This was followed by an extended cool period, during which upper treeline again declined, reproduction ceased near upper treeline, and ring-width growth was suppressed at high altitudes. Warmer conditions have characterized the period since about 1850. Tree-growth rates have increased, and the upper treeline has been advancing. (Auth)

215. **LaMarche, V.C., Jr.** 1978. Tree-Ring Evidence of Past Climatic Variability. *Nature 276(5686):334-338.*

The increasingly visible impact of climatic variability on human affairs lends a sense of urgency to the task of better understanding the workings of the Earth's climatic system. Actual instrumental observations of climate are relatively short, and we must therefore turn to other sources of information about past climates to help develop and test the models that may enable us to predict climatic anomalies such as prolonged droughts or a series of severe winters. Tree-rings are one of the best sources of climatic proxy information. They can provide long, accurately dated, year-by-year records at many points around the globe, and bridge the gap between recent instrumental or historical data and the longer but more generalised geological records. Variations in the width of annual rings reflect the influence of climatic factors that limit the biological processes governing ring formation within a tree. Study of reconstructions of long records of a variety of climatic and related variables, such as temperature, precipitation, stream runoff and barometric pressure over periods of several hundred to several thousand years strongly suggests that the climate of the past century or so is not representive of the conditions that have frequently prevailed over longer periods. Proxy records are thus a great help in our efforts to anticipate or predict future climate, which may be significantly different from the recent climatic past. (Auth)

216. **LaMarche, V.C., Jr., C.W. Ferguson, and W.B. Woolfenden.** 1974. Holocene Climatic Correlations in Western United States: Tree-Ring and Glacial Evidence. *Abstracts, Third Biennial Meeting, American Quaternary Association, Madison, Wisconsin 1974, (p. 77), 132 pp.*

Synchroneity in the timing of advances and retreats of mountain glaciers in widely separated regions should not be assumed a priori. Although episodes of glacier expansion at about 5300, 2800, and 300 years ago have been recognized and independently dated in several parts of the world, glaciers in some areas may not have followed this general pattern. Such apparent regional anomalies should be carefully investigated because of their potential importance in understanding the nature of past climatic variations. (Auth)(JTA)

217. **LaMarche, V.C., Jr., and H.C. Fritts.** 1971. Tree Rings, Glacial Advance and Climate in the Alps. *Zeitschrift fur Gletscherkunde und Glazialgeologie 7(1-2):125-131.*

Ring-width variations in stone pine near upper treeline in the Alps show a high negative correlation with the percentage of advancing glaciers in Austria and Switzerland. The relationship is due to the similarity of climatic models for tree growth and the glacial mass budget. Tree-ring fluctuations during the period 1800-1899, prior to the compilation of glacial statistics show good agreement with historical glacial advances and periods of low summer temperatures, especially around 1820-1955. Tree-ring studies could assist in reconstructing the glacial and climatic history of the Alps, possibly for a period of 1,000 years or more. (Auth) GA 74A/0179

218. **LaMarche, V.C., Jr., and H.A. Mooney.** 1972. Recent Climatic Change and Development of the Bristlecone Pine (P. LONGAEVA Bailey) Krummholz Zone, Mt. Washington, Nevada. *Arctic and Alpine Research 4(1):61-72.*

Wood remnants above the present upper tree line are the basis for reconstruction of past changes in tree form and distribution. Living bristlecone pines (PINUS LONGAEVA Bailey) on Mt. Washington, in the Snake Range of east-central Nevada, show progressive gradation in form from tall, erect trees in the upper forest zone to dwarfed, prostrate krummholz at the highest elevations. A similar gradient existed from 4,000 to at least 2,000 radiocarbon years ago, but the boundaries between vegetational zones based on tree stature were at least 100 m higher than today. The altitude of the krummholz zone is probably controlled by environmental factors affecting hardiness of the tree foliage. The downward shift of the krummholz zone since late Altithermal time can be attributed either to a decrease in summer temperature, an increase in summer precipitation, or both. The krummholz forms of bristlecone pine do not appear to be genetically distinct from the erect trees growing at lower elevations. (Auth)

219. **LaMarche, V.C., Jr., and C.W. Stockton.** 1974. Chronologies from Temperature-Sensitive Bristlecone Pines at Upper Treeline in Western United States. *Tree-Ring Bulletin 34:21-45.*

Ring-width variation in trees at upper treeline in the high mountains of temperate latitudes is a potentially important indicator of past climatic variations, especially temperature variations. Bristlecone pines (PINUS LOGAEVA D.K. Bailey and P. ARISTATA Engelm.) were sampled at nine sites in western United States. Plotted annual ring-width indices are given for chronologies that range in length from 532 years in New Mexico, 1409 years in Colorado, and 1239 years in Nevada to 1501 years in eastern California. Possibilities for increasing the length of these chronologies by incorporating tree-ring data from logs and remnants are good in several of these areas, and a 5405-year upper treeline chronology has been developed in California. Ring-width departures from the long-term mean during the past 500 years were calculated from upper treeline data for 30-year subperiods. The departures are in the same direction over the whole region during many of these subperiods, indicating that climate, rather than local ecological factors, is responsible for the ring-width variations. Comparison of tree-growth fluctuations with meteorological observations at selected stations shows that a general warming trend between the periods 1901-1930 and 1931-1960 is reflected by an upward trend in tree growth. However, low rates of tree growth during an earlier warm period (1850-1869) may be due to a lag in the response of ring-width growth to climatic changes at upper treeline. (Auth)(JTA)

220. **Libby L.M., and L.J. Pandolfi.** 1977. Climate Periods in Tree, Ice and Tides. *Nature 266:415-417.*

Ten climate periods found in stable isotope ratios of oxygen and hydrogen, measured in 1,800 yr of Japanese cedar rings, agree with climate periods found in 800 yr of Greenland ice and with periods computed from the tidal stresses of the Sun-Moon-Earth system, and with periods found in the Carbon 14 record of the bristlecone pine sequence of southern California. The Greenland oxygen ratios have previously been found to have opposite phase to the Carbon 14 ratios of the bristlecones, and we have found also an opposite phase between oxygen and hydrogen ratios in the Japanese cedar on the one hand and Carbon 14 in bristlecones on the other hand. (Auth)

The ten periods identified in these records range between 50 and 300 years. (JTA)

221. **Maksimov, Ye.V., and N.M. Maksimova.** 1971. Dendrochronological Aspects of Intrasecular Variations of Mountain Glaciers. Russian. *Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva 103(6):517-530.*

Traces of intrasecular variations of present terminal glacier moraines are morphologically fairly distinct. Dendrochronology can help greatly in determining the intrasecular stages of glaciation. Dendrochronological studies in the mountains of Tien-Shan have revealed the existence of 11-year, 23-year, secular, and multisecular rhythms. Only multisecular and intrasecular (23-year) rhythms play a glaciomorphological role. The warmest period in the last 300-400 years was the beginning of the 18th century and the coldest (maximum of the Fernau stage) was between 1780 and 1860. There are significant differences in rhythmic manifestations in the Tien-Shan and the Urals; there is no complete similarity in the chronological plan of the same rhythms, there are extra rhythms in the Urals and the secular rhythms there are displaced with respect to the rhythms in the Tien-Shan. Investigations show that the sequence of climatic events in the Urals most likely repeats that in the Tien-Shan, but more gradually and somewhat later. An attempt is made to correlate rhythmic manifestations in the Tien-Shan and the Urals. (from Soviet Hydrology) GA 74A/1100

222. **Matthews, J.A.** 1977. Glacier and Climatic Fluctuations Inferred from Tree-Growth Variations over the Last 250 Years, Central Southern Norway. *Boreas 6:1-24.*

A PINUS SYLVESTRIS (Scots pine) tree-growth series from near the tree-line in upper Gudbrandsdalen, southern Norway (Slastad 1957) is analysed, and possible relationships to glacier and climatic fluctuations are explored. The series is smoothed by harmonic analysis, and calibrated using a variety of independently derived glaciological, geomorphological, and climatological data from Storbreen (Jotunheimen), the Storbreen gletschervorfeld, and Dombas meteorological station. The curves are then used to make inferences about the number, date, magnitude, and duration of glacier fluctuations and summer temperature fluctuations from 1700 A.D. to 1950 A.D. At least 10 major oscillations in the tree-growth data, reflecting fluctuations in summer temperatures of amplitude 1.0 deg C to 3.0 deg C, are believed to be indicative of glacier fluctuations. Periods of reduced tree-growth are a response to cool phases and indicate glacier advances after a lag of about 4 years. These short-term oscillations are superimposed on a general trend of glacier retreat and a long-term warming of 1.0 deg C indicated by a glacier equilibrium-line displacement of 140 m to 145 m since 1750 A.D. Problems and prospects for development of dendroglaciological and dendroclimatological techniques are discussed. (Auth)

223. **Mikola, P.U.** 1962. Temperature and Tree Growth near the Northern Timber Line. *Tree Growth, T.T. Koslowski (Ed.). Ronald Press Co., New York, NY, (pp. 265-274), 442 pp.*

Reviews studies of annual and long-term variations of tree growth in Finland. Correlations were found between annual radial growth of Scots pine (PINUS SILVESTRIS) and the mean July temperature and of Norway spruce (PICEA ABIES) and the June temperature. Radial growth of both species is also influenced by temperatures of the preceding summer, and the annual height growth of Scots pine is determined (mostly) by this factor. The length of the pine needles, however, depends mainly on temperatures during their growth. A sharp retreat of the Finnish timber line in 1902-1911, was followed by northward advance during warmer temperatures until the late 1930's. (AB74001) AB74001

224. **Parker, M.L., P.A. Bramhall, and S.G. Johnson.** 1983. Tree-Ring Dating of Driftwood from Raised Beaches on the Hudson Bay Coast. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 220-272), 343 pp.*

Using living trees and cross-dated driftwood a tree ring chronology is established from 1656-1972 A.D. for Churchill River and Owl River, west of Hudson Bay. Comparison of ring width and maximum wood density with climatic parameters from the Churchill weather station indicate reasonable correlations between climatic and tree ring parameters. The data are presented as an extensive appendix. (JTA)

Dendroclimatologic

225. **Parker, M.L., L.A. Jozsa, S.G. Johnson, and P.A. Bramhall.** 1981. Dendrochronological Studies on the Coasts of James Bay and Hudson Bay (Parts 1 and 2). *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 129-188), 220 pp.*

Dendrochronological data from Cri Lake, about 4 km northeast of Great Whale River, Quebec, is documented for a series that extends back to 1700 A.D. Detrended ring-width indices show that the minimum period of tree growth occurred between 1825-1850 A.D. with the maximum ring-width index peaking ca. 1810 A.D. Other maxima occurred about 1730 and 1960 A.D. Extensive tables of data are appended. (JTA)

226. **Payette, S.** 1976. Ecological Succession of White Spruce Forests and Climatic Fluctuations, Poste-de-la-Baleine, New Quebec. Succession ecologique des forets d'epinette blanche et fluctuations climatiques, Poste-de-la-Baleine, Nouveau-Quebec. *Canadian Journal of Botany 54(12):1394-1402.*

The stand structures of three PICEA GLAUCA climax forests of the hemiarctic zone in New Quebec are described. The forests have a similar structural pattern, characterized by important and irregular variations in the number of individuals per age, diameter and height classes. These variations are synchronic and suggest that the climate strongly influences the forest regeneration. The discontinuous trend in the curves may possibly be related to changes in seed production and seedling establishment. Synchronism between the 300-yr dendrochronological curve and the stand age-structure is apparent. The hollow parts of the age curves are related to unfavorable climatic periods and the peaks to favorable ones. These climatic fluctuations are probably responsible for either a decrease or an increase in white spruce seed production important to hemiarctic forest regeneration. The writer suggests a theoretical age-structure curve for climax forests in the maritime forest-tundra near Poste-de-la-Baleine, New Quebec. (English summary) Ecol Abs 77L/2167

227. **Payette, S.** 1980. Great Ice Floods of the Leaf River, New Quebec; a Dendrochronological Analysis. Les Grandes Crues Glacielles de la Riviere aux Feuilles (Nouveau-Quebec): Une Analyse Dendrochronologique. French, English Summary. *Naturaliste Canadien 107(4):215-225.*

Tamarack (LARIX LARICINA (DuRoi) K. Koch) and black spruce (PICEA MARIANA (Mill.) BSP) populations located in the Leaf River floodplain (Nouveau- Quebec) are affected by ice-floods. A dendrochronological analysis of 150 trees presenting ice-scars has provided the dates of major ice-floods along the mid-section of this river since 1850. The registered ice-floods occurred with an 11-year mean interval during the 19th century (tentatively) and with a 10-year mean interval during the 20th century. The presence of many ice-scars on the same stem allowed an evaluation of the importance of the 1934 and 1979 ice-floods. Both these floods had about the same amplitude, and reached at least 4 meters above the summer lowest water-level; these two catastrophic floods strongly disturbed the vegetation and soils of the floodplain. Available climatic and hydrological data suggest that major ice-floods occur mainly during cold periods characterized by a mean annual temperature below the general trend, and abundant snow precipitation, and an early sometimes rainy spring; low temperatures in the months and even the year preceeding ice-floods might have amplified them, especially in areas like the Leaf River where permafrost favors runoff during snowmelt. Data on ice-flood frequency and ice-flood amplitude obtained from dendrochronological analysis may be valuable for river management and for ecological studies of fluvial system dynamics. (Auth)

228. **Pilcher, J.R.** 1974. Tree-Ring Research in Ireland. *Tree-Ring Bulletin 33:1-5.*

In spite of a climate with no great extremes, tree ring patterns in Irish oak and pine timbers show good cross-dating and have proved suitable for analysis. The wet climate has caused the preservation of large amounts of timber in bogs and lakes from all periods from at least 8000 years ago. This timber provides the potential for building a long tree-ring chronology for dating archaeological sites, for calibration of the radiocarbon time-scale (Valuable for comparison with the bristlecone pine chronology obtained from a different climate) and for studies of the history of bog woodlands. (from British Archaeological Abstracts) GA 75B/3073

229. **Rothlisberger, F., P. Haas, H. Holzhauser, W. Keller, W. Bircher, and F. Renner.** 1980. Holocene Climatic Fluctuations - Radiocarbon Dating of Fossil Soils (fAh) and Woods from Moraines and Glaciers in the Alps. *Geographica Helvetica 35(5-Special issue/numero special):21-52.*

The present paper on glacial and climatic fluctuations in the Valais (Switzerland) constitutes an intermediate report on the investigations currently being made under the direction of Professor Gerhard Furrer of the Geographical Institute of the University of Zurich. Radiocarbon dates of fossil woods and soils give information about the glacial states of the last 12,000 years. A dendrochronological curve for larches of the Gotthard massif and the Valais exists for the period 3900 to 2600 B.P. For the first time, an attempt has been made to relate a climatological interpretation of this 1300 years' tree ring chronology to the oscillations of glaciers. (Auth)(JTA)

230. **Sandon, F.** 1974. A Millenium of West European Climate - a Cu-Sum Look at Dendroclimatology. *Weather 29(5):162-166.*

An analysis was carried out of Hollstein's (1965) record of tree-ring widths of dated oak beams from West Germany for the period A.D. 822-1964 in terms of the accumulated sum of differences from the period mean of 1.21 mm. It was found that there was not a close connection between the features of the climate of this period as outlined by Ladurie, Lamb and Gill and those evidenced for the tree-growing climate of West Germany. The Cu-Sum analysis indicates considerable variation in the year-by-year conditions and even in those of quarter centuries, a long-term decrease in the conditions from about A.D. 1100 onwards and evidence of three cycles each of roughly 300 years' duration of gradually decreasing intensity. (David G. Tout) GA 74B/2464

231. **Schove, D.J.** 1978. Tree Ring and Varve Scales Combined, c. 13500 B.C. to A.D. 1977. *Palaeogeography, Palaeoclimatology, Palaeoecology 25(3):209-234.*

Varve chronologies are of several kinds but glacial varves respond to summer temperature and fluvial varves to summer rainfall. Tree-ring chronologies near the timberline respond to summer temperature, but European oak chronologies respond to summer rainfall. Certain global features of the weather of the summer season, notably the Biennial Index, are therefore parameters that can be used for cross-dating both varves and tree-rings in different continents. Characteristic curves for different parameters in the Late Glacial (Zones Ia, Ib and II) and in the past thousand years are presented. A moisture curve is given for the North European Plain (200 B.C.-A.D. 1100). A conversion chart for tree-rings and radiocarbon dates is extended back into the Late Glacial on the tentative assumption that the radiocarbon error was about 950 years at the beginning of the Holocene (III/IV), i.e. that 10300 B.P. should be 11250 B.P. or 9300 B.C. Supplementary sources of information useful in obtaining approximate dates include: (a) palaeomagnetism; (b) tephrochronology and X-ray analysis; (c) cycle analysis; (d) climatic peculiarities associated with specific radiocrbon centuries; (e) X-ray analysis of specific varves; and (f) new methods of varve analysis. The varve series used for the Late Glacial, if the author's cross-dating between North America and Scandinavia is acceptable, constitute a floating chronology of about 4000 years. Given approximate Carbon 14 dates for any long series of varves or tree-rings in one part of the world, it is now possible to obtain cross-dating with any other long series in another part of the world, and it will be easy to replace the tentative "950-year" error by a precise figure determined from a combined varve and tree-ring scale extending back from present day to (say) the zero of Sauramo's scale for varves in Finland. In the meantime the "950" is mnemonically convenient, as this would make the year of the B.C. scale one thousand less than the year on the b.p. scale. (Auth)

232. **Schweingruber, F.H., O.U. Braeker, and E. Schaer.** 1979. Dendroclimatic Studies in Great Britain and in the Alps. *Colloque International/International Conference, Evolution des Atmospheres Planetaires et Climatologie de la Terre/Evolution of Planetary Atmospheres and Climatology of the Earth, Nice, 16-20 Octobre, 1978. Centre National D'Etudes Spatiales, France, (pp. 369-372), 574 pp.*

On the basis of the cell wall density measurements of the latewood (maximum density) of various conifers from cool-humid sites it is possible to draw direct conclusions about the summer temperatures. The average annual figures are very consistent in the entire Alpine region. A slight similarity can also be said to exist between this area and England, Scotland, and Southern Sweden. The Alpine density fluctuations are similar to those in the Northern Appalachian Mountains. Two 700-year-long chronologies were developed on the basis of overlapping tree-ring sequences in the Alps. (Auth)

233. **Siren, G.** 1961. On the History and Climate of Forests in Northern Lapland during Historical Time. Taka-Lapin metsien historiasta ja ilmastosta historiallisena aikana. Finnish, English Summary. *Lapin tutkimusseura. Vuosikirja, v.2, pp. 29-47.*

Examines annual rings and other phenomena as evidence of temperature trends in Finnish Lapland from 5000 B.C. to the present. A 900 + or - 50 year periodicity is found, with temperature now in an upward trend from its last low in the 17th century. This trend should be utilized for forest development by modern methods. Forests in former times far beyond the present tree limit are indicated by burnt-out areas. (AB75674) AB75674

234. **Stockton, C.W., and D.M. Meko.** 1975. A Long-Term History of Drought Occurrence in Western United States as Inferred from Tree Rings. *Weatherwise 1975:244-249.*

Although many factors complicate the relationship between moisture conditions and ring width, widespread droughts or wet periods lasting for several years can be reconstructed from tree ring records. Tree rings indicate: (1) that the mid-1930's drought in the western United States was unsurpassed in magnitude by any drought in the previous two centuries, and (2) that the years 1907-1916 constituted the wettest decade since A.D. 1700. With a greater margin of error, tree rings suggest that the driest single year since A.D. 1700 was 1934. (Auth) ORNL/EIS-195

235. **Svenonius, B., and E. Olausson.** 1978. Ring Widths of Trees, Solar Activity and Weather Conditions in Sweden in the Period 1756-1975. *Geologiska Foreningens i Stockholm Forhandlingar 100:95-100.*

A comparison of the ring widths of various Swedish trees with temperature is found to show positive correlations with coefficients at about 0.3. The yearly precipitation in Sweden seems to be sufficient for the growth of trees, and a comparison of ring widths and precipitation shows nearly zero values of the correlation coefficient. The solar activity and temperature have been compared with observable relations. Finally, a comparison of the tree rings with solar activity shows that broad rings in general correspond to large sunspot numbers, but, at least apparently, the opposite effect has also been recorded–a warning against drawing too rapid conclusions. (Auth)

236. **Zoltai, S.C.** 1975. Tree Ring Record of Soil Movements on Permafrost. *Arctic and Alpine Research 7(4):331-340.*

Trees growing on severely cyroturbed soils on permafrost terrain produce reaction wood in response to tilting of trees by ground heave movements. A total of 157 tree disks taken from 59 different earth hummocks show multiple tilting and recovery. The direction of tilt is generally away from the center of active hummocks. The chronology of ground heave movements as recorded by reaction wood shows brief periods of high activity and quiescence in the last 160 years. Such periods can be matched in two areas 450 km apart, but occur two years earlier in the north than in the south. Above-average levels of activity are indicated for the period 1847 to 1943, and low levels of activity during the last two decades. There are indications that high levels of activity are related to higher than normal fall temperatures and precipitation. (Auth)

Geologic

237. **Bartsch-Winkler, S., A.T. Ovenshine, and R. Kachadoorian.** 1983. Holocene History of the Estuarine Area Surrounding Portage, Alaska as Recorded in a 93 m Core. *Canadian Journal of Earth Sciences 20:802-828.*

A 93 m core obtained at Portage, Alaska records four prograding cycles of estuarine deposition for the past 8230 + or - 100 years. Analyses of texture, mineralogy, paleontology, and sedimentary structures enable definition of eight lithologic units. Mineralogic studies show that past and present sedimentation at Portage has been largely mud and sand from the Susitna River on the northwest side of Cook Inlet. Six radiocarbon dates from concentrated organic debris in the core and on the surface enable determination of sedimentation rates for four intervals and show rates to be higher and to vary more at depth than rates nearer the surface. (Auth)(JTA)

238. **Benedict, J.B.** 1979. Fossil Ice-Wedge Polygons in the Colorado Front Range: Origin and Significance. *Geological Society of America Bulletin, Part I, 90:173-180.*

Polygonal patterned ground in a tundra valley near Sawtooth Peak, Boulder County, Colorado, is unique in the Front Range because of its large size and its resemblance to fossil ice-wedge polygons. The polygons occur in a terminal moraine of latest Pinedale age (about 15,000 to 10,000 B.P.), at an altitude of 3,390 m. They range from 10 to 25 m in diameter and are outlined by shallow, vegetated troughs that show no surface indication of sorting. The polygonal ground pattern is attributed to thermal contraction cracking and ice-wedge formation during a late Pinedale or early Holocene cold interval in which permafrost existed at least 350 m below its present lower altitudinal limit. Frost-sorted rubble accumulated in troughs above the melting ice wedges; evidence of sorting, however, is concealed by humus-rich loessal or slope-wash sediments that bury the stones and fill interstices between them to form wedges of silty material as deep as 1.0 m. Organic matter in the humus-rich silt is believed to have eroded from an Altithermal A1 horizon during early Neoglaciation; radiocarbon dates of 5750 + or - 110 and 5765 + or - B.P. apply to formation of the Altithermal soil and are maximum ages for its erosion and redeposition, but they have no bearing on the time of patterned ground formation. Stones in the polygon borders have experienced no important frost sorting since the close of the Triple Lakes stade of Neoglaciation, which ended prior to 2855 + or - 90 B.P. in the Sawtooth valley. (Auth)

239. **Black, R.F.** 1966. Late Pleistocene to Recent History of Bering Sea–Alaska Coast and Man. *Arctic Anthropology 3(2):7-22.*

Outlines the geologic history of the region: depression and rise of the Bering platform, changes in shore lines and sea levels, climatic fluctuations, glacial advances and retreats, volcanic activity, etc. Conditions during the Late Pleistocene presented no prohibitive impediments to man's penetration from Siberia to Alaska. (AB94657) AB94657

240. **Black, R.F.** 1974. Late Quaternary Sea Level Changes, Umnak Island, Aleutians–Their Effects on Ancient Aleuts and Their Causes. *Quaternary Research 4:264-281.*

Late-Quaternary sea level changes in the eastern Aleutian Islands are of paramount importance in the reconstruction of the migrations and environment of the ancient Aleuts. A radiocarbon-dated ash stratigraphy provides the chronology into which geomorphic events can be fitted. These provide evidence for the sea level changes. Deployment of beach material and coastal configuration intimate that sea level was about 2-3 m above the present level about 8250 radiocarbon yr B.P. Beach deposits suggest that sea level remained high until about 3000 radiocarbon y.a. when it gradually dropped to its present position. It is concluded that the ancient Aleuts that settled Anangula about 8400 y.a. used boats; all major passes in the eastern Aleutians were flooded, and did not have winter ice. Those ancient Aleuts did not have available the major year-round food resources of the present strandflats as they were cut during the high sea level stand 8250-3000 yr B.P. The ancient Aleuts must have been marine oriented, for land-based food resources would have been limited. The cause of relative sea level changes on Umnak Island is considered indeterminate with present data. Eustatic, glacial isostatic, water isostatic, tectonic, and volcanic causes are considered the main possible controls in combinations such that a basic eustatic sea level curve and likely a glacial-water isostatic curve must be common to any solution. Representative solutions are given to illustrate some of the problems. (Auth)

241. **Clague, J.J., J.R. Harper, R.J. Hebda, and D.E. Howes.** 1982. Late Quaternary Sea Levels and Crustal Movements, Coastal British Columbia. *Canadian Journal of Earth Sciences 19(3):597-618.*

Late Quaternary sea-level fluctuations on the British Columbia coast have been established from studies of terrestrial and marine sediments and landforms. These studies indicate that the sea-level history of mainland British Columbia and eastern Vancouver Island is very different from that of the Queen Charlotte Islands and western Vancouver Island. Specifically, in the former areas, there was a rapid rise of submerged coastal lowlands between about 13, 000 and 10,000 years ago. Emergence culminated about 6000-9000 years ago, depending on the locality, when the sea, relative to the land, was 12 m or more lower than at present in some areas. During middle and late Holocene time, relative sea level rose on the mainland coast and at least locally on eastern Vancouver Island, resulting in inundation of coastal archaeological sites and low-lying terrestrial vegetation. Tidal records and precise leveling suggest ongoing submergence of at least part of this region. In contrast, shorelines on the Queen Charlotte Islands were below present from before 13,700 years ago until approximately 9500-10,000 years ago. A transgression at the close of the Pleistocene climaxed about 7500-8500 years ago when relative sea level probably was about 15 m above present in most areas. Most of the emergence that followed apparently occurred in the last 5000-6000 years. There has been a similar pattern of emergence on the west coast of Vancouver Island during late Holocene time. The above patterns of late Quaternary sea-level change are attributed to complex isostatic response to downwasting and retreat of the late Wisconsin Cordilleran Ice Sheet, to transfers of water from melting ice sheets to oceans and to plate interactions on the British Columbia continental margin. Late Pleistocene and early Holocene crustal movement were dominantly isostatic. Although the recent regression on the outer coast likely is due, at least in part, to tectonic uplift, some late Holocene sea-level change in this area and elsewhere on the British Columbia coast may be either eustatic in nature or a residual isostatic response to deglaciation, which occurred thousands of years earlier. (Auth)

242. **Craig, B.G.** 1959. Pingo in the Thelon Valley, Northwest Territories; Radiocarbon Age and Historical Significance of the Contained Organic Material. *Geological Society of America Bulletin 70(4):509-510.*

Suggests on the basis of organic material in this pingo (64 deg 19 min N., 102 deg 41 min W.), that the deglaciation occurred more than 5500 years ago between Great Slave Lake and Hudson Bay and that the Keewatin Ice Divide had disappeared or shrunken sufficiently by that time to allow drainage of the proglacial lake that occupied the Thelon valley. The organic material, of radiocarbon age 5500 + or - 250 years, and largely Ceratophyllum demersum L., indicates a climate warmer than the present one and a habitat on a broad flood plain in which silting occurred periodically, indicated also by the layered structure of the silt composing the pingo. The silt and organic material probably were deposited during normal flow of the Thelon River subsequent to deglaciation and marine submergence of the area. Neither the pingo nor the silt composing it show indication of having been glaciated. Organic materials of similar radiocarbon age from Back River and Rankin Inlet have been reported overlain by later glacial deposits; it is suggested that these deposits were not necessarily later nor glacial. (AB57472) AB57472

243. **Curry, R.R.** 1969. Holocene Climatic and Glacial History of the Central Sierra Nevada, California. *Geological Society of America Special Paper 123:1-47.*

Climatic data for the Sierra Nevada are compared with the range of climatic conditions that are inferred to have occurred during the last 10,000 years. A model of paleoclimatic fluctuations based chiefly upon variation in mean seasonal snowfall is derived. From a model based upon fluctuations in mean snowfall of less that 50 percent of the mean snowfall during the standard climatic normal period (1931-1960) a chronology of climatic fluctuations for the last 10,000 years is proposed. This chronology is based upon paleoclimatic data derived from study of geologic deposits dated by radiocarbon and lichenometry, variation in tree rings, changes in timberline position, vegetational age classes, and direct and indirect historical records. At least four major periods of increased mean snowfall and cooler, cloudier summers during the last 10,000 years resulted in four periods of multiple glacial advance in the Sierra Nevada. These occurred between 6000 and 7000 years ago, between 2000 and 2600 years ago, around 1000 years ago, and between 650 years ago and the present. The latest major period of net accumulation and advance in all cirques that are presently occupied by residual glaciers occurred between 1880 and 1908 with a peak from 1895 to 1897. The fluctuations from glacial to interglacial climate that are presently known to have occurred during the last 8000 years can be fully explained by a climatic model in which the extremes of mean precipitation for the 96 years of historical record are greater than the range of long-term means for that climatic parameter. (Auth) GA 70A/539

244. **David, P.P.** 1981. Stabilized Dune Ridges in Northern Saskatchewan. *Canadian Journal of Earth Sciences 18:286-310.*

The dunes and the associated eolian features were all formed by southeasterly paleowinds of uniform direction. The dune ridges developed primarily parabolic dunes of simple and composite types through the process of dune elongation. At the same time, exposed rock surfaces were abraded by the wind and loess was deposited downwind from the developing dune fields. The southeasterly direction of the paleowinds, which is almost directly opposite to the direction of the present-day winds affecting dunes in the Lake Athabasca area, was due to adiabatic air masses coming off the ice sheet from the east and affected eolian activity in quite a large region in northern Saskatchewan and Alberta. The somewhat cool and sufficently dry adiabatic winds checked the vegetation on the dunes and in the areas around them. The development of the dune ridges came to an end when a sudden climatic change evoked the rapid stabilization of the dunes by vegetation but not before most of the ridges became partly deformed by southwesterly crosswinds resulting from the same climatic change. The period of eolian activity is estimated from the age of the local ice frontal positions to have been between 10,000 and 8800 years B.P. Only one other region is known from North America, namely, the St. Lawrence Lowland in the East, where analogous eolian environment prevailed in the zone peripheral to the the continental ice sheet and produced comparable eolian features. (Auth) (JTA)

245. **Dibner, V.D.** 1965. Formation History of the Late Pleistocene and Holocene Deposits of Franz Joseph Land. Istoriia formirovaniia pozdnepleistotsenovykh i golotsenovykh otlozhenii Zemli Frantsa-Iosifa. Russian, English Summary. *Leningrad, N.-issl. inst. geologii Arktiki. Trudy 143:300-318.*

Describes and distinguishes the following stratigraphic horizons of Quaternary deposits and their fauna: Pleistocene glaciation, deposits of marine terraces of upper and lower complexes, present glacial and aqueo-glacial deposits as well as alluvial, lacustrine and eolian deposits. Paleogeography of Franz Joseph Land is characterized, three radiocarbon age determinations are given. Two stages of relief formation and glaciation in the Late Pleistocene and Holocene are described. (AB86521) AB86521

246. **Digerfeldt, G.** 1975. Post-Glacial Water-Level Changes in Lake Vaxjosjon, Central Southern Sweden. *Geologiska Foreningens i Stockholm Forhandlingar 97:167-173.*

A series of four layers of sandy gyttja found in Lake Vaxjosjon is described. The deposition of the Sandy layers is connected with lowerings of the water-level. One layer deposited around the boundary between the Pre-Boreal period and Early-Boreal periods, and another during the later part of the Early Sub-Boreal period indicate the two major water-level lowerings in Post-Glacial time. The other two layers, which probably represent minor fluctuations, are deposited around the boundary between the Early and Late Atlantic periods and during the Early Sub-Atlantic period respectively. (Auth)

247. **Fairbridge, R.W.** 1983. The Pleistocene–Holocene Boundary. *Quaternary Science Reviews 1:215-244.*

In 1969, the INQUA Holocene and Shorelines Commissions, after worldwide studies, recommended to the Paris Congress that the ideal Holocene boundary stratotype would be found in S.W. Sweden, in the region of Goteborg. Holocene boundary problems are recognized as partly global, partly local, but here only the global questions will be addressed. First is the question of total glacier ice and melting, by ca. 10,000 B.P., and the adjustment rates of hydro-isostasy and glacio-isostasy. Revised estimates are needed. Both deep-sea and shelf stratigraphy suggest a fluctuating transgression beginning about 17,000 B.P., marked notably by a eustatic drop during the Younger Dryas of ca. -10 m to about -40 m below present MSL, that was followed by rapid transgression during the Preboreal stage. (Auth)(JTA)

248. **Fleming, C.A., D.C. Mildenhall, and N.T. Moar.** 1976. Quaternary Sediments and Plant Microfossils from Enderby Island, Auckland Islands. *Journal of the Royal Society of New Zealand 6(4):433-458.*

At Enderby Island, a deposit of till, here named the Enderby Formation, locally separated into upper and lower members by lenses of laminated lake siltstone, overlies a sequence of flat-lying basalt flows, perhaps benched by the sea during an interglacial perod of high sea level. Except on the coast these deposits are blanketed by zonal peat, 3 m thick, which contains the record of post-glacial vegetation. The formation is described and its age, history, glacial and post-glacial vegetation and climatic history are discussed. The laminated siltstone and a clast of siltstone from the upper till contain pollen and spores indicating a cold climate vegetation of dominant Compositae with associated herbs, grass, sedge and scrub (COPROSMA, DRACOPHYLLUM, and MYRSINE) but lacking METROSIDEROS and other trees of the present Auckland Island vegetation. Four zones in the peat can be defined from pollen analysis. The METROSIDEROS phase in Zone 3 (reflecting a warm interval from ca 6000 to 3000 yr B.P.) and available Carbon 14 dates allow other Auckland Island pollen spectra to be correlated and dated, and the sequence of wind-transported exotic pollen confirms correlation with South Island post-glacial vegetation sequences. (AntB E-19065) AntB E-19065

249. **Funder, S.** 1971. Observations on the Quaternary Geology of the Rodefjord Region, Scoresby Sund, East Greenland. *Gronlands Geologiske Undersogelse Rapport 37, (pp. 51-55).*

This progress report of fieldwork in the southwestern part of the Scoresby Sund region notes positive glacial erosion features to 1500 m altitudes and negative features in Fohn fiord to depths of 1000 m. Calving glaciers occupy all fiord heads. Glacial and marine deposits have been mapped and the chronology supported by Carbon 14 datings of lacustrine deposits and marine bivalve shells. Three main groups of glacial stages are summarized. During the Milne Land Stages, fiords were occupied by ice streams and shorelines open at 90-120 m elevation. Moraines and kame terraces, 500-800 m in elevation, are possibly related to these stages. Their age is tentatively set at 10,000 yr. The younger Rodefjord Stages are dominated by extensive systems of kame terraces and deltas, the oldest of which is related to a shoreline 60 m above sea level. A younger stage is dated to 7140 + or - 130 yr B.P., and the last stage to shoreline features at 6650 + or - 125 yr B.P. Glaciers were then at or behind their present positions. Fossil finds from marine deposits have dates of 6840 + or - 125 to 6450 + or - 120 yr B.P.; others date from postglacial warm period. In the Post-Rodefjord Stages the glaciers advanced. (AB103553) AB103553

250. **Funder, S.** 1971. Carbon 14 Dates from the Scoresby Sund Region, 1971, *Gronlands Geologiske Undersogelse Rapport 37, (pp. 57-59).*

Presents data on eight samples of postglacial lake mud and marine bivalve shells collected in 1969 and 1970. Pollen from lower lake deposits incl BETULA NANA pollen dating to 8580 + or - 140 yr before 1950 and SALIX pollen to 2290 + or - 140 yr before 1950. Four identified marine shells represent marine features at elevations below 50 m. (AB103551) AB103551

251. **Hendy, C.H., A.T. Wilson, K.B. Popplewell, and D.A. House.** 1977. Dating of Geochemical Events in Lake Bonney, Antarctica, and Their Relation to Glacial and Climate Changes. *New Zealand Journal of Geology and Geophysics 20(6):1103-1122.*

Measurements of major ion concentrations, Oxygen delta 18 and Carbon 14 content of the waters of Lake Bonney, have enabled a reinterpretation of the geochemical events which have taken place in the lake and enabled the age of some of these events to be estimated. The sequence appears to have been: 1) flooding of the Bonney basin with sea water about 100,000-300,000 years ago, some time after the last occupation of the lower Taylor Valley by the Taylor Glacier; 2) evaporation of the West Lobe to near dryness prior to 15, 000 years B.P.; 3) penetration of the Bonney basin by meltwaters from the Taylor Glacier, and reflooding of the West Lobe by meltwaters derived in part from the glacier about 15,000 years ago; 4) reflooding of the East Lobe by meltwaters from the Taylor Glacier, as long ago as 5,000 years B.P., as a result of the glacier reaching a maximum extension close to its present position; 5) evaporation of the East Lobe to a depth of 19 m, perhaps as a result of a temporary retreat of the Taylor Glacier, producing a convecting, ice-free lobe saturated in sodium chloride; and 6) reflooding of the East Lobe by meltwaters from the Taylor Glacier overflowing the West as a result of a re-advance of the glacier or a decrease in the aridity of the climate. The reflooding began not less than 250 years ago. The Taylor Glacier is currently advancing and occupying part of the West Lobe. (Auth) AntB E-20757

252. **Hume, J.D.** 1965. Sea-Level Changes during the Last 2000 Years at Point Barrow, Alaska. *Science 150:1165-66.*

Geologic studies of old Pt Barrow beach ridges in 1964 disclosed a fossil log and other driftwood; Carbon 14 dating indicates eustatic rises of sea level A.D. 265-500 and A.D. 1000-1100, forming raised beaches. After the first rise, sea level dropped about two m below the present level, permitting the establishment about 500 A.D. of the Eskimo settlement of Birnirk, which was flooded by the second rise. Present sea level is about 0.6-1.0 m below the high-water levels, and Birnirk is partly flooded. (AB87955) AB87955

253. **Koutaniemi, L.** 1979. Late-Glacial and Post-Glacial Development of the Valleys of the Oulanka River Basin, Northeastern Finland. *Fennia 157(1):13-73.*

The majority of the glaciofluvial material was deposited proglacially around 9300-9500 B.P. Initially the valleys themselves were flooded by water most probably having a direct outlet into the White Sea. The subsequent infilling of the valleys up to the prevailing water level then led to the accumulation of supra-aquatic valley-train deposits on top of the subaquatic delta formation. The valley-train delta assumed more or less its present form immediately upon deposition in the lower reaches of the river valleys, but further upstream the final relief only emerged some centuries later, with the melting of the buried dead ice. The major role in the postglacial changes in relief is attributed to fluvial processes, regulated by isostatic land uplift. Downcutting was most rapid in the early post-glacial period, declining later with the decreasing rate of land uplift. The dominant modern process is lateral erosion, although this is now restricted to only the lower reaches of the Oulanka river, where the meanders of the river are migrating downstream at varying speeds. (Auth)(JTA)

254. **Koutaniemi, L.** 1979. Outline of the Development of Relief in the Oulanka River Valley, North-Eastern Finland. *Palaeohydrology of the Temperate Zone, Y. Vasari, M. Saarnisto and M. Seppala (Eds.), Proceedings of Working Session of Commission on Holocene—INQUA (EuroSiberian Subcommission). Hailuoto-Oulanka-Kevo, August 28-September 6, 1978. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 82, Geologica No. 3, (pp. 29-38), 176 pp.*

The basic relief features of the Oulanka river valley originate pre-glacially as the weakness zone in the bedrock became eroded by flowing water. Considerable overdeepening probably then occurred during the last glaciation, and thick layers of glaciofluvial drift were deposited on the valley floor as the ice retreated, first as sub-aquatic delta horizons and later as a supra-aquatic valley-train formation superimposed on this. Since isostatic land uplift proceeded more rapidly in the upper reaches of the river, the river gradient steepened, the base level of erosion fell and downcutting of the river bed into the glaciofluvial sediments began. This downcutting was most pronounced in the immediate post-glacial period, declining thereafter with the reduction in tilting due to land uplift. The predominant process currently shaping the relief is lateral erosion, which has been going on together with downcutting since late-glacial times. This is causing the meanders in the lower river to advance downstream at varying speeds, the most rapid being likely to progress one wavelength in the next 350 years, although for the majority this would take at least 1000 years. (Auth)

255. **Locke, W.W., III** 1979. Etching of Hornblende Grains in Arctic Soils: An Indicator of Relative Age and Paleoclimate. *Quaternary Research 11:197-212.*

The inferred climate of northern Cumberland Peninsula, Baffin Island, N.W.T., Canada preceding, during, and following the last (Foxe) glaciation, is indicated by the degree of etching of hornblende grains in soil profiles of various ages as follows: pre-Foxe - warm/wet; early to middle Foxe - mild/moist; middle to late Foxe - cold/arid; Hypsithermal - mild/moist; neoglacial - cool/dry. The variation in the rate of etching is believed to be caused by a variation in the amount of available moisture, which is in turn a function of the climate. Therefore, if the ages of a series of soils can be estimated, the climate between episodes of deposition can be inferred. Alternatively, if the climate can be estimated (e.g., by pollen analysis) and the approximate rate of etching can be determined, it should be possible to date a soil profile on the basis of the etching. For Cumberland Peninsula, Baffin Island, N.W.T., Canada, this technique allows a climatic reconstruction as follows: (1) a warm wet period preceded the last glaciation; (2) a mild moist period occurred between ca. 100, 000 and 60,000 yr B.P.; (3) extreme aridity and/or cold prevailed between ca. 60,000 and 8,000 yr B.P.; (4) a mild moist climate returned between ca. 8000 and 3200 yr B.P.; and (5) cool dry conditions occurred between ca. 3200 yr B.P. and the present. Part of the climatic reconstruction is corroborated by etching in cryoturbated soils. Comparisons with stable soils indicate that the surface soils began to form ca. 4000 yr B.P. on previously frost-stirred terrain. The data are concordant with the onset of cool dry conditions as determined above. (Auth)(JTA) Ecol Can 3404

256. **Lowdon, J.A., and W. Blake, Jr.** 1976. Geological Survey of Canada Radiocarbon Dates XVI. *Geological Survey of Canada Paper 76-7, 21 pp.*

The Geological Survey of Canada publishes, usually on an annual basis, a list and description of radiocarbon dated sites throughout Canada. The list is organized by Province or Territory. Each site is described in full. The information consists of latitude and longitude, elevation, stratigraphy and nature of the sample and enclosing sediment, the Carbon 14 age of the sample and a comment on the significance of the date. Many of the samples in each date list are on materials of Holocene age and dated materials include: shell, whalebone, driftwood, peat, lake sediment, seaweed, skin and other materials. The date lists are an invaluable source of information on Holocene events within Canada. (JTA)

257. **Mack, G.H., and L.J. Suttner.** 1977. Paleoclimate Interpretation from a Petrographic Comparison of Holocene Sands and the Fountain Formation (Pennsylvanian)in the Colorado Front Range. *Journal of Sedimentary Petrology 47(1):89-100.*

In at least four areas of the Colorado Front Range remarkable similarity exists in the detrital quartz populations in the Fountain Formation and Holocene sand from modern day streams draining Precambrian crystalline rocks and located close to the Fountain outcrops. Near Colorado Springs and Boulder both the Fountain and Holocene quartz populations were derived principally from granitic source rocks; in the vicinity of Loveland and Golden metamorphic rocks provided most of the quartz. Because both the Fountain sandstone and Holocene sand in these four areas came from common parent rocks and accumulated under similar conditions, plots of frequency percent resistant framework grains as a function of size for the two deposits can be used to compare Pennsylvanian and Holocene climates for the east flank of the Front Range following the approach of Young et al. (1975). In all four areas such comparisons suggest that the Fountain was deposited in a climate substantially more humid than that which has existed during the Holocene. A humid climate is consistent with the inferred near equatorial, southern hemisphere location of the Ancestral Rocky Mountains during the Permian and Pennsylvanian. An orographic effect would have been produced as warm, moist southeasterly trade winds, blowing off the mid-continent sea, ascended the Ancestral Rockies. Precipitation would have been concentrated on the east flank, but more arid conditions would have prevailed in western Colorado on the opposite flank. (Auth)

258. **Madole, R.F.** 1972. Neoglacial Facies in the Colorado Front Range. *Arctic and Alpine Research 4(2):119-130.*

A variety of surficial deposits related to three intervals of Neoglaciation occur in valley heads above timberline in the Colorado Front Range. These deposits may be treated as facies, each representing a distinct and separate depositional environment. Frost-riving and rockfall produce detritus over a broad area, but depending upon the environment, it becomes part of either talus, a lobate rock glacier, a tongue-shaped rock glacier, or moraine. No two facies develop simultaneously in the same place. Oscillation of climate causes horizontal shifting and overlapping of facies just as does marine transgression and regression. Thus, geologic and in part climatic history can be inferred from vertical sections, or altitudinal succession can be used as a guide to stratigraphic succession. Differences in topoclimate strongly influence the distribution pattern of the facies as well as some of their sedimentary characteristics. Consequently, these diverse surficial deposits become indicators of topoclimate and microenvironment, past and present. (Auth)

259. **McCulloch, D.S.** 1967. Quaternary Geology of the Alaskan Shore of Chukchi Sea. *Bering Land Bridge, D.M. Hopkins (Ed.). Stanford University Press, Stanford, CA, (pp. 91-120), 495 pp.*

Presents a history of the Pleistocene and Recent based on the literature and on own examination of the sediments and collection of marine molluscs in the three widely separated areas of Kotzebue Sound, Selawik Lake and Kivalina. Six Pleistocene marine transgressions, two major glacial advances, and two important postglacial warm intervals are recorded by unconsolidated marine sediments exposed along this coast. A summary of the Quaternary geology events is presented in a table. (AB97728) AB97728

260. **Mercer, J.H.** 1972. The Lower Boundary of the Holocene. *Quaternary Research 2(1):15-24.*

A decision appears imminent to define the lower boundary of the Holocene formally in terms of the European sequence, as comprising all or part of the interval between the end of the Bolling Interstade and the end of the Younger Dryas Stade (ca. 12,100-10, 350 Carbon 14 years B.P.) However, a lower boundary in this position can define the base of a European provincial stage only (the Flandrian). The interval contains no boundary suitable for global use, because temperature trends in many parts of the north polar and north temperate regions, including Europe, were then distorted by vast masses of melting ice inherited form Full-Glacial times. The last unquestionably worldwide major climatic event before the Hypsithermal Interval was the sharp cooling that has been inferred from glacier advances culminating about 14,500-14,000 Carbon 14 years B.P. and consequently the horizon at the transition from cooling to warming at the end of this episode should be defined as the base of the Holocene. (Auth) GA 73A/0202

261. **Miller, C.D.** 1973. Chronology of Neoglacial Deposits in the Northern Sawatch Range, Colorado. *Arctic and Alpine Research 5(4):385-400.*

Lichenometry and geological evidence permit establishment of a chronology of rock glacier development during Neoglaciation in the northern Sawatch Range. Portions of rock glaciers were assigned approximate absolute ages based on maximum thallus diameters of RHIZOCARPON GEOGRAPHICUM, LECANORA THOMSONII, and LECIDEA ATROBRUNNEA. Values for the total percentages of lichen cover also aided in separating younger from older deposits. Although lichen growth-rate curves could not be constructed for the study area, a growth-rate curve for RHIZOCARPON GEOGRAPHICUM developed in 1967 by Benedict for the Colorado Front Range, appears to be useful for dating rock surfaces in the northern Sawatch Range. Available data indicate that rock glacier development in four cirques was nearly synchronous during the last several thousand years. An early period of rock glacier develoment, here termed Temple Lake I, began more than 4,000 years ago and lasted for an unknown length of time. Temple Lake II deposits began to form between 3,750 and 3,500 years B.P. and continued to accumulate until about 2,500 years ago. Audubon rock glaciers began forming about 1,900 years B.P. and continued to develop until 1,000 to 900 years ago. Relative sizes of Temple Lake and Audubon rock glaciers indicate that processes and conditions favoring rock glacier formation during the Temple Lake stade were more intense and/or lasted longer than during the Audubon stade. The Gannett Peak stade of Neoglaciation is represented in the study area only by talus. This study supports earlier conclusions that Neoglaciation in the Rocky Mountains was characterized by three main intervals of glacier advance and/or rock glacier movement. The glacial record, however, is incomplete in the study area because no evidence was found of glacier or rock stade activity during the Gannett Peak stade. (Auth)

262. **Morner, N.-A.** 1980. A 10,700 Years' Paleotemperature Record from Gotland and Pleistocene/Holocene Boundary Events in Sweden. *Boreas 9:283-287.*

Lacustrine carbonate (Chara lime) from the Island of Gotland provides an excellent paleotemperature record for the last 10,700 years. From arctic conditions during the Younger Dryas Stadial, the temperature rapidly rose to the present level, which was reached at about 9000-9250 B.P. A Holocene climatic optimum is clearly recorded. It ended with a drastic deterioration at about 2500 B.P. at the Subboreal/Subatlantic transition. The Subatlantic temperatures are significantly lower than those of the climatic optimum. The Holocene of Sweden seems to have started with a tremendous earthquake linked to extensive faulting (explaining the inconsistencies in the sea level records and the "drainage of the Baltic Ice Lake"), a distinct peak in the non-dipole geomagnetic field (explaining the intensity peak at this level in cores from different environments) and regional disturbances of the sedimentation (explaining the "drainage varve" character of the varve - 1073 in the Swedish Time Scale). (Auth)

263. **Orombelli, T., and S.C. Porter.** 1983. Lichen Growth Curves for the Southern Flank of the Mont Blanc Massif, Western Italian Alps. *Arctic and Alpine Research 15(2):193-200.*

Growth curves spanning the last two and a half centuries have been constructed for RHIZOCARPON GEOGRAPHICUM s.l. and ASPICILIA CINEREA, two ubiquitous lichen species that grow on granitic substrates on the south side of the Mont Blanc massif. Ages derived from arithmetic and semilogarithmic plots of control data are nearly accordant over the past 275 yr, but beyond that point derived ages are increasingly discordant. The curves are suitable for dating granitic substrates of unknown age within upper Val d'Aosta between altitudes of approximately 1100 and 2000 m. Outside these geographic and altitudinal ranges the growth curves may not be applicable, as suggested by published growth curves for other parts of the Italian Alps. (Auth)

264. **Perkins, J.A., and J.D. Sims.** 1983. Correlation of Alaskan Varve Thickness with Climatic Parameters, and Use in Paleoclimatic Reconstruction. *Quaternary Research 20:308-321.*

The thickness of varves in the sediments of Skilak Lake, Alaska, are correlated with the mean annual temperature ($r = 0.574$), inversely correlated with the mean annual cumulative snowfall ($r = -0.794$), and not correlated with the mean annual precipitation ($r = 0.202$) of the southern Alaska climatological division for the years 1907-1934 A.D. Varve thickness in Skilak Lake is sensitive to annual temperature and snowfall because Skilak Glacier, the dominant source of sediment for Skilak Lake, is sensitive to these climatic parameters. Trends of varve thickness are well correlated with trends of mean annual cumulative snowfall (mean $r = -0.902$) of the southern Alaska climatological division with trends of mean annual temperature of the southern (mean $r = 0.831$) and northern (mean $r = 0.786$) Alaska climatological divisions. Trends of varve thickness also correlate with trends of annual temperature in Seattle and North Head, Washington (mean $r = 0.632$ and 0.850, respectively). Comparisons of trends of varve thickness with trends of annual temperature in California, Oregon and Washington suggest no widespread regional correlation. Trends of annual snowfall in the southern Alaska climatological division and trends of annual temperature in the southern and northern Alaska climatological divisions are reconstructed for the years 1700-1906 A.D. Climatic reconstructions on the basis of varve thickness in Skilak Lake utilize equations derived from the regression of series of smoothed climatological data on series of smoothed varve thickness. Reconstruction of trends of mean annual cumulative snowfall in the southern Alaska climatological division suggests that snowfall during the 1700s and 1800s was much greater than that during the early and mid-1900s. The periods 1770-1790 and 1890-1906 show marked decreases in the mean annual snowfall. Reconstructed trends of the annual temperatures during the 1700s and 1800s were lower than those of the early and mid-1900s. Two periods of relatively high annual temperatures coincide with the periods of low annual snowfall thus determined. (Auth)

265. **Porter, S.C.** 1964. Antiquity of Man at Anaktuvuk Pass, Alaska. *American Antiquity 29(4):493-96.*

Correlates geologic and archeologic data in support of a max age limit of about 7,000 yr for the oldest cultural material. The sites lie behind a terminal moraine of the latest ice advance 8,000 to 9,000 yr ago of the Itkillik glaciation. Radiocarbon analyses indicate deglaciated habitable areas near the present drainage divide some 7200 yr ago; prior to that time, the valley floor was largely buried under stagnant ice. (AB90942) AB90942

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266. **Reheis, M.J.** 1974. Source, Transportation, and Deposition of Debris on Arapaho Glacier, Front Range, Colorado. *M.Sc. Thesis, University of Colorado, Boulder, CO, 71 pp.*

Lichenometry was used to date the moraine complex fronting the Arapaho Glacier. Ages were derived using Benedict's (1968) lichen growth curve. Six groups of moraines were identified and dated. Age estimates were as follows: Group 1 = 0-70 years; Group 2 = 85 years; Group 3 = 90 years; Group 4 = 100 years; Group 5 = 115 years; and Group 6 = 1000 years. (JTA)

267. **Terasmae, J.** 1972. The Pleistocene-Holocene Boundary in the Canadian Context. *International Geological Congress, Twenty-fourth Session, Montreal, 1972. Section 12, Quaternary Geology, (pp. 120-125), 226 pp.*

At the 1969 meeting in Paris the INQUA Subcommission for the Study of the Holocene recommended that the Pleistocene-Holocene boundary be defined in terms of a significant climatic change and a type section (international stratotype) where evidence (geological, biological and other) for this change would be available for examination. The age of this boundary was proposed to be 10,000 radiocarbon years before present. About 10,000 years ago, a substantial part of Canada was still covered by the residual mass of the continental ice sheet. This report draws attention to some of the problems that are related to the establishment of the Pleistocene-Holocene boundary in Canada, and some of the criteria that could be used for defining this boundary. In the Canadian context, the Holocene should not be equated with such commonly used terms as Postglacial and Recent. It is recommended that the term Holocene be adopted as defined by the INQUA Commission, to avoid unnecessary confusion. This requires acceptance of the fact that some continental ice did not melt until 2,000 or 3,000 years after the beginning of the Holocene in Canada. International agreement of this usage of the term Holocene is deemed more important than local or regional convenience which may oppose placing the Pleistocene-Holocene boundary as defined by the INQUA Commission. (Auth)

268. **Whitney, J.W.** 1980. Climatic Influence on Alluvial Deposition, Northwest Colorado. *U.S. Geological Survey Professional Paper 1175, (p. 223-224).*

The late Wisconsin-age gravel fill of the White River has acted as a stable base level for its tributary streams for the duration of the Holocene. Drilling in the deposits of the lower tributary valleys indicates that the White River fill acted like a dam, creating shallow lakes that deposited fine clayey silt during the early Holocene time. Valley aggradation seems to have been interrupted only briefly by small periods of arroyo cutting until about 1,100 to 1,150 yr B.P. At that time, the character of sedimentation changed from basin-wide aggradation of sandy silt deposits to an environment characterized by the prograding of coarse alluvial deposits from valley walls and smaller streams over the finer grained deposits of the main White River tributaries. Pollen analysis suggests that there was not a significant botanical change at this time. This indicates that there was little change in total precipitation and yearly temperature averages but it is possible that the precipitation changed to a regime characterized by a greater number of summer convective thunderstorms, resulting in greater localized runoff. This environment, with small changes toward greater aridity occurring in the 13th century, has persisted to the present day. Teeth and bones of modern day cattle are common in many of the entrenched fills of the tributaries of the White River, suggesting a close relationship between land use by man and historical arroyo cutting in this drainage basin. (Auth) (JTA)

269. **Zinderen Bakker, E.M. van, and M.J.A. Werger.** 1974. Environment, Vegetation and Phytogeography of the High-Altitude Bogs of Lesotho. *Vegetatio 29(1):27-50.*

The geological and climatological setting of the high-altitude bogs occurring in the river heads of the Lesotho mountains is shortly described. The high summer rainfall and the diurnal climate are characteristic for this region. The daily "frost-thaw" regime at ground level causes up-freezing, small polygons, terracettes and the formation of thufur in the bogs. The bogs have originated in postglacial times around the springs or from small alpine lakes. During the last glacial period, temperatures in the alpine region were too low for the growth of bog vegetation. The bogs are of great significance for the regular flow of clear water and for grazing. They are in the process of being eroded through animal trampling, and measures for protection are being proposed. (from Authors) Ecol Abs 75L/0231

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270. **Badyukov, D.D., and P.A. Kaplin.** 1979. Sea Level Changes Along the USSR Far Eastern and Arctic Coasts Over the Last 15,000 Years. Izmeneniya Urovnya na Poberezh'yakh Dal'Nevostochnykh i Arkticheskikh vorej SSSR za Poslednie 15,000 Let. *Okeanologiya (Oceanology) 4:674-679.*

In the end of the recent glaciation the level of the USSR seas as well as that of the World Ocean was in a regressive state at the present depths of 90-120 m. The transgression developed rapidly but with intervals during which coastal lines and lagoon complexes were formed. Some of these formations were dated by Carbon 14 which permits reconstruction of the sea level during the different periods. During late Pleistocene and Holocene the Far Eastern and Arctic Seas developed, on the whole, synchronously with the World Ocean coasts, though complicated regional tectonic movements of the continental margin caused changes in the general pattern of the Flandrian transgression in many areas. (QL/ASFA) QL/ASFA

271. **Barnett, D.M.** 1967. Development Landforms and Chronology of Generator Lake, Baffin Island, N.W.T. *Geographical Bulletin 9(3):169-188.*

The development of Generator Lake is traced from its beginnings as a proglacial lake ponding against the regional watershed to a lake with an area of some 120 km (E+2) still dammed by part of the Barnes Ice Cap after a 26-km retreat of the ice margin. A critical review of lichenometry indicates that caution is necessary when applying this useful dating technique close to the size limit of a species. A provisional chronology covering the last 1,500 years is proposed, extending from establishment of the higher lake between 1,500 to 1,100 years ago to its draining between 950 and 750 years ago. (Auth)(JTA) GA 69A/151

272. **Barnett, D.M.** 1977. Glacial Geomorphology in a Sub-Polar Proglacial Lake Basin: A Process-Response Model. *Ph.D. Thesis, University of Western Ontario, London, Ontario, 62 pp.*

At the margin of the Barnes Ice Cap in Baffin Island a sub-polar glacial regime prevails adjacent to proglacial Generator Lake. Fluctuations of both ice margin and lake level provide an excellent opportunity to assess the influence of sub-polar ice on geomorphic processes. Interpretation of paleoenvironments would be enhanced with an appreciation of responses (landforms) which may be diagnostic of sub-polar ice influence. This study develops such a process-response model for the Generator Lake basin. The four elements - process, geometry, response and time are integrated as a qualitative model of circular form symbolizing the lake basin. A radiocarbon chronology of 4000 to 4500 years is based on 11 dates from detrital organic matter derived from deltaic sediments and supercedes a tentative lichen chronology. The lengthened chronology is still compatible with regional deglaciation chronology. Relative dating by lichenometry is still adequate. Fluvial and lacustrine processes are highly sensitive to small changes of mean summer temperatures, with geomorphologically active and inactive summers recorded. Asymmetry of intensity of these processes is attributable to the Barnes Ice Cap, and the efficacy of lacustrine processes on pebble morphology greatly exceeds that of frost shattering. Current processes are of similar magnitude to those of the past 4000 years. Derived process rates from a raised delta sequence are compatible with present fluvial conditions. (Dissertation Abstracts International 38B:4132-4133 (1978))(JTA) Ecol Can 3209

273. **Bednarski, J.M.** 1979. Holocene Glacial and Periglacial Environments in the Whistlers Creek Valley, Jasper National Park. *M.Sc. Thesis, University of Alberta, Edmonton, Alberta, Canada, 152 pp.*

Geomorphological events in the Whistlers Creek Valley, Jasper National Park, are dated by lichenometry and by relative dating methods. Rock glacier and ice glacier deposits are present in the upper valley, and deposits from both sources cross-cut each other. Pre-Little Ice Age deposits exist but are poorly dated. Both rock glacier deposits indicate a period of increased activity 250-180 B.P. Termination of the Little Ice Age is dated at between 1885 and 1925 A.D. (65-25 B.P.). (JTA)

274. **Benedict, J.B.** 1966. Radiocarbon Dates from a Stone-Banked Terrace in the Colorado Rocky Mountains, U.S.A. *Geografiska Annaler 48A(1):24-31.*

Despite uncertainties introduced in correcting for the age of the A horizon at time of burial, a picture of climatic change has emerged that is reasonably consistent with other evidence. The terrace originated 3,000-2,500 years ago, during late Temple Lake time. Two periods of rapid downslope movement occurred, each during the latter part of a minor glacial episode, and each reflecting an interval in which the soil was saturated, but snow-free, at the beginning of the fall freeze-up. Optimum conditions for rapid movement probably occurred as the terraces first emerged from perennial snowbanks that covered this slope during glacial maxima. (Auth)(JTA)

275. **Benedict, J.B.** 1970. Downslope Soil Movement in a Colorado Alpine Region: Rates, Processes, and Climatic Significance. *Arctic and Alpine Research 2(3):165-226.*

Soil-movement rates, processes, and land-forms were studied above timberline in the east slope of the Colorado Front Range. At least two generations of turf-banked lobes and terraces occur in the Niwot Ridge area. Terraces with gentle, subdued fronts and patterned treads date from the late Pleistocene, and were used as camping and butchering areas by prehistoric man as long ago as 7,650 + or - 190 radiocarbon years. Most bear an altithermal soil: five dates for the soil range from 5,800 + or - 125 to 5,300 + or - 130 BP. Lobes and terraces with overhanging fronts and unpatterned treads postdate the Altithermal interval: radiocarbon and stratigraphic evidence suggest that they formed late in the Temple Lake Stade of Neoglaciation. A series of radiocarbon dates from the buried A horizon in one stone-banked terrace suggests that its front has advanced at an average rate of 0.34 cm/yr during the past 2,470 + or - 110 radiocarbon years. Movement was slow during the Temple Lake-Arikaree interstade (2,650 to 1,850 BP), a time of soil formation and intense cavernous weathering, and during the Arikaree glacial maximum, when lichen measurements show that the slope was covered with an insulating blanket of perennial snow. Disappearance of the snowbank led to an eight-fold increase in the rate of terrace advance between about 1,150 and 1,050 BP. (Auth)(JTA)

Figure 57 summarizes late Quaternary climatic fluctuations in the Colorado Front Range alpine region. (JTA)

276. **Blake, W., Jr.** 1973. Age of Pumice Beaches, Eastern Arctic Canada. *Geological Survey of Canada Paper 73-1B, (pp. 141-142).*

Dating of pumice collected from several sites around western Jones Sound on Ellesmere and Devon Islands, found in close proximity with driftwood which was also dated, confirmed that the pumice is approximately 5,000 years old. Samples of wood collected more than 0.5 m below the level of the pumice are less than 5,000 years old (conventional radiocarbon years) and samples collected above the pumice level are more than 5,000 years old. The driftwood was identified as PICEA or LARIX sp. At Cape Tanfield, Baffin Island,

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a charred piece of fat, possibly seal fat, was dated as 4,690 + or - 360 years old. (Ecol Can 892) BafBib 280

277. **Bowler, J.M., G.S. Hope, J.N. Jennings, G. Singh, and D. Walker.** 1976. Late Quaternary Climates of Australia and New Guinea. *Quaternary Research 6:359-394.*

In the last 10,000 years climate has been relatively stable although there are some indications that temperature and rainfall were marginally higher than now between 8000 to 5000 B.P. Since then, lake levels have oscillated; a brief, limited resumption of periglacial activity took place in the Snowy Mountains and there were small glacier advances in New Guinea. (Auth)(JTA)

278. **Brown, J.** 1965. Radiocarbon Dating, Barrow, Alaska. *Arctic 18(1):36-48.*

This report lists in tabular form the radiocarbon dates of 28 samples of organic materials taken from the Barrow peninsula and spit (Pleistocene Gubik formation); 26 consist of peat, driftwood, etc., and two are artifacts. From these a detailed geomorphic and cryopedological chronology of the area is attempted. The highly polygonized tundra areas are judged to be less than 8300 years old. Much of the older peat has been reworked. The artifacts are from the second millenium A.D. A correction is made in Arctic 18(2):122. (AB85896) AB85896

279. **Brown, J., and P.V. Sellmann.** 1966. Radiocarbon Dating of Coastal Peat, Barrow, Alaska. *Science 153:299-300.*

A buried, frozen section of peat from the Barrow spit at sea level gave radiocarbon dates between 700 and 2600 B.C.; they predate formation of the northern extension of the spit. A continuous frozen peat section extends to 1.5 m below sea level; it is composed of freshwater vegetation. Radiocarbon dates of upper, middle and basal parts of a core are 2650 + or - 160, 2860 + or - 140, and 4570 + or - 130 yr B.P. It is unlikely that sea level was higher than the proposed pond during the development of the peat section. Drowning and subsequent burial of the peat occurred as the result of either encroachment of the ocean by inland erosion or a rising sea level. Rapid changes of level have been postulated for the formation of the compound ridged spit. There is no doubt that sea level at Barrow has been within several meters of that existing now, since 700 B.C. Further evidence suggests a low sea level 4500-4000 B.C. (AB94239) AB94239

280. **Carrara, P.E., and J.T. Andrews.** 1973. Problems and Application of Lichenometry to Geomorphic Studies, San Juan Mountains, Colorado. *Arctic and Alpine Research 5(4):373-384.*

The use of lichenometry for dating neoglacial deposits in the San Juan Mountains of southwestern Colorado encounters several difficulties, primarily (1) the lack of a locally-derived growth curve for RHIZOCARPON GEOGRAPHICUM, (2) the small size and susceptibility to weathering of volcanic tuffs, andesites, and other rock debris, which limit the size of maximum-diameter lichen thalli, and (3) the fact that many deposits in the high basins above timberline (>3500, a.s.l.) are older than the effective range of lichenometry. Lichens found on tombstones in cemeteries of local mining towns in the San Juan Mountains are used to construct initial growth curves for R. GEOGRAPHICUM, LECANORA THOMSONII, LECIDEA ATROBRUNNEA, XANTHORIA ELEGANS, and PARMELIA spp. The results indicate respective growth rates of 30, 146, 150, 150, and 330 mm for the first 100 years. Lichen measurements and weathering data for three rock glaciers and one block-stream suggest a general age increase from the source area to the snout. One Carbon 14 date on spruce fragments beneath the blockstream and another on a dead, in situ tree on a rock glacier snout are probably 250 years old. These dates are then similar with that of 280 + or - 80 B.P. on wood buried beneath peat at 3,700 m a.s.l. Frequency histograms of lichen diameters from moraines, rock glaciers, protalus ramparts, and talus do not show a three-part Neoglacial sequence, and many of the rock glaciers are considered to be composed of material dating from the late Pinedale time. (Auth)

281. **Carroll, T.** 1974. Relative Age Dating Techniques and a Late Quaternary Chronology, Arikaree Cirque, Colorado. *Geology 2(7):321-325.*

Late Quaternary deposits in Arikaree Cirque are re-examined, using eight relative age dating methods including lichenometry. If snowkill of lichens is unrecognized, an erroneously young age may be assigned to Neoglacial deposits if only lichenometric methods are employed. The data were entered into two clustering programs, which were used to group sample sites according to age. The results of this study differ from those of Benedict in two ways: 1) no deposits of unequivocal Audubon age are believed to exist in Arikaree Cirque–those deposits previously thought to be Audubon age have an Audubon lichen cover because of snowkill of the original lichen cover sometime after deposition; and 2) deposits originally mapped as Temple Lake are thought to include both pre- altithermal (Pinedale) and post-altithermal (early Neoglacial) deposits. (Auth) GA 74A/1903

282. **Carson, C.E.** 1968. Radiocarbon Dating of Lacustrine Strands in Arctic Alaska. *Arctic 21(1):12-26.*

Reports on 1958-1964 studies of lacustrine processes and basin sequences in the Point Barrow region. Lakes developed in the ice-rich late Pleistocene Gubik Formation are surrounded by two to four exposed and revegetated wave-cut shelves which suggest regional correlative cycles of piracy due to minor shifts in climate and eustatic level. Shelves exposed when lakes are intersected by tundra streams and drained, require 10-20 yr for revegetation in the present climate. Radiocarbon dates of samples from abandoned strands show the majority to be less than 3500 years old. The postglacial transgressive- regressive lacustrine cycle is described and diagrammed. The lacustrine maximum transgression probably occurred near the end of the hypsithermal (3500-4000 B.P.) and the onset of the post-hypsithermal cooling phase was synchronous with the initial period of draining. More systematic investigation is required however, before clear time correlation of geomorphic surfaces and events can be established. (AB102776) AB102776

283. **Church, M.** 1978. Palaeohydrological Reconstructions from a Holocene Valley Fill. *Canadian Society of Petroleum Geologists Memoir 5:743-772.*

At the head of Ekalugad Fjord, eastern Baffin Island, outwash deposits preserve a 6,000 year history of Holocene fluvial activity. Four depositional phases occurred: 1) deposits of sublateral drainage under glacial ice prior to 6,000 years B.P. (referred to as Tl); 2) major outwash deposits in front of retreating ice before 4,300 years B.P. (T2) followed by an erosional interval; 3) aggradation correlated with Neoglacial events at 2,500 years + or - B.P. (T3) followed by an erosional interval; 4) aggradation associated with recent Neoglacial activity (300 to 100 years B.P.) (T4). The T2 sediments are mainly foreset deltaic beds, deposited into the sea. Beds vary from cobbles with little matrix to fine, laminated sands. About 2,000 beds, comprising 30% of the total thickness, were sampled to determine grain size. These results form the basis for palaeoflow calculations using tractive force theory. The assumptions underlying the calculations are critically examined and several alternative calculations are made. The relative frequency distribution of the high flows is presented: discharges were about 10 times larger than present-day ones, with a maximum of about 300 cu m/s, against an observed maximum of 200 cu m/s. Present knowledge of sediment transport mechanics constrains palaeohydrological reconstructions from sediment textural information to be at best an order-of-magnitude exercise. (Auth) BafBib 99

284. **Compton, P.A.** 1964. Recent Changes of Sea-Level Along the Northeast Coast of Brodeur Peninsula, Baffin Island, N.W.T., Canada. *Arctic 17(4):279-285.*

Describes a geomorphic investigation of raised marine depositional features. Two sets were identified; a younger up to 375 ft. above sea level is referred to the Recent isostatic emergence of the area; the older and higher set are considered evidence of either an older emergence or earlier deglaciation. Investigation of Eskimo Spit (map) showed uplift to be continuing or to have ceased only recently. (AB86287) BafBib 285

285. **Corte, A.E.** 1980. Glaciers and Glaciolithic systems of the Central Andes. *International Association of Scientific Hydrology Publication 126:11-24.*

A study of debris-covered glaciers and rock glaciers has been made within the context of the glacier inventory of the Mendoza River basin, Argentina. There is a relationship between precipitation amounts and types of glacier activity. Covered ice is observed to be distributed in four altitudinal facies: thermokarst, structural debris, inactive rock glacier and fossil ice rock glacier. Debris cover varies from a few centimetres to many metres at lower altitudes. The sequence of four facies is explained as the result of four warm and cold phases of the Holocene. (Auth)

286. **Danilov, I.D.** 1980. The Hypothesis of a Late Wurm Arctic Ice Sheet. *Polar Geography and Geology 4(1):15-20.*

On the basis of geomorphological and geological data as well as radiocarbon dates, the author rebuts the hypothesis of the existence during the Late Pleistocene and Early Holocene of an extensive ice sheet on the Barents and Kara shelves and the adjacent northern lowlands. (Auth)

287. **Dowdeswell, J.A.** 1982. Relative Dating of Late Quaternary Deposits Using Cluster and Discriminant Analysis, Audubon Cirque, Mt. Audubon, Colorado Front Range. *Boreas 11:151-161.*

Holocene and Late Quaternary talus, lobate rock glaciers, and moraines within Audubon Cirque, Colorado Front Range, were assigned relative ages using the following age dependent criteria: fresh-weathered ratio, pitting, weathering rind development, angularity, and surface oxidation of boulders, together with lichen cover and largest lichen diameter. Tentative correlation with other Colorado Late Quaternary sequences suggests that unit C is of Gannett Peak age (100-300 years B.P.), unit R of Audubon age (950-1850 years B.P.), unit E of Early Neoglacial age (3000-5000 years B.P.), and unit V of Late Pinedale age (about 10,000 years B.P.). Correlation is problematic due to differences in operational definitions of relative dating parameters between workers, and because climatic and lithologic variations between areas may confound the data. (Auth)(JTA)

288. **Dyke, A.S.** 1977. Quaternary Geomorphology, Glacial Chronology, and Climatic and Sea-Level History of Southwestern Cumberland Peninsula, Baffin Island, Northwest Territories, Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 207 pp.*

The stratigraphies of a large number of Holocene terrestrial sections and 41 radiocarbon dates on organic material from them, along with data on glacier fluctuations, permit the following reconstruction of paleoclimate: a) The early Holocene was warm. Outlet glaciers of the Penny Ice Cap receded rapidly back to or behind their present margins by 6800 B.P., while the Laurentide margin receded more slowly, leaving the head of Cumberland Sound about 5600 B.P. b) The oldest accumulation of eolian sand commenced about 4460 B.P., which probably records the onset of a cold and/or dry interval. c) Growth of peat around 2500 B.P. indicates warm and/or wet conditions. d) Burial of soils by eolian sand about 2100 B.P. indicates cold and/or dry conditions, and cirque glaciers probably advanced about that time. e) Between about 1800 and 1000 B.P. peats accumulated and soils were buried by proglacial outwash, due to flooding by meltwater streams. Cirque glaciers had retreated from their moraines by 1650 B.P. f) Burial of soils by eoloian sand about 900 B.P. indicates cold and/or dry conditions, and cirque glaciers probably readvanced about that time. g) Growth of peat and burial of a soil by proglacial outwash about 600 B.P. indicates warm and/or wet conditions. Cirque glaciers had retreated from their moraines by about 780 B.P. h) Expansion of a snow bank, accumulation of eolian sand and growth of an ice wedge indicate cold and/or dry conditions between 400 and 100 B.P., and cirque glaciers advanced then. i) The last 30 to 100 years have been warm, causing recession of most cirque glaciers from their latest Neoglacial moraines. (Auth)(JTA)

289. **Dyke, A.S.** 1978. Qualitative Rates of Frost Heaving in Gneissic Bedrock on Southeastern Baffin Island, District of Franklin. *Geological Survey of Canada Paper 78-1A, (pp. 501-502).*

The ages and weathering properties of morphostratigraphic units progressively distant from the western edge of the Penny Ice Cap north of the head of Cumberland Sound are given the following qualitative granite gneiss weathering rates: weathering zone - A1 (500 yr duration) Partial surface oxidation; A2 (4,000 to 5,000 yr) Complete surface oxidation; A3 (8,000 to 9,000 yr) Minor surface crystal removal indicated by destruction of striae and polish; minor disruption by frost heaving. (Auth)(JTA) Ecol Can 2848

290. **Fairbridge, R.W., and C. Hillaire-Marcel.** 1977. An 8,000-Yr Palaeoclimatic Record of the "Double-Hale" 45-Yr Solar Cycle. *Nature 268(5619):413-416.*

A series of isostatically-emerged Holocene beach ridges on the east side of Hudson Bay have been precisely surveyed and dated back to 8,300 B.P. They number 185 and show a nearly uniform rhythm of about 45 yr correlated here with the "Double-Hale" solar magnetic cycle. (Time is in sidereal yr.) Longer correlations are suggested with eustatic sea-level curve and with planetary conjunction cycles. The coupling mechanism with terrestrial meteorological behaviour is believed to be by means of stratospheric generation of polar cirrus cloud and low-latitude ozone, affecting the planetary albedo. (Auth)

291. **Fredskild, B.** 1977. The Development of the Greenland Lakes since the Last Glaciation. *Folia Limnologica Scandinavia 17:101-106.*

Greenland lake cores covering the period from deglaciation to present show a similar progression of sediment types. Till occurs in the base of the cores and is followed by finely laminated clay gyttja. The laminae consist of fine vegetable material and clayey-sand layers. This reflects inwash of sediments during a period of plant colonization of bare slopes. After a period of time, estimated at 200 years or so, the sediment changes rather suddenly into a fine detrital gyttja. Sediment thickness in lakes that have been cored varies between 1.5 and 2.5 m. Sedimentation rates in the lakes were often high during the initial stages of sedimentation (4-10 cm/100 yr); thereafter a fairly constant rate was maintained to the present averaging 1-3 cm/100 yr. The modal sedimentation rate during the Holocene is 2.5 - 3.0 cm/100 yr. (JTA)

292. **French, H.M.** 1976. Pingo Investigations, Banks Island, District of Franklin. *Geological Survey of Canada Paper 76-1A, (pp. 235-238).*

Investigation was made of groups of pingo-like mounds at three locations on Banks Island along the central Bernard River and the upper Sachs River. At the third location, pingos previously described by Pissart (1975) have been Carbon 14 dated by willow fragments enclosed within sediments overlying the ice core and from willow fragments found in windblown sand on the terrace on which the pingos are located. The pingos of Thomsen River and Able Creek localities developed in the time period 4990 years B.P. and 3640 years B.P. (Ecol Can 1925)(JTA) Ecol Can 1925

293. **Govorukha, L.S., L.M. Zauer, and A.S. Zelenko.** 1965. Paleogeographic Reconstruction of the Holocene on Franz Joseph Land through Investigation of Lacustrine Deposits. Paleogeografischeskaia rekonstruktsii golotsena Zemli Frantsa-Iosifa na osnovanii izucheniia ozernykh otlozhenii. Russian, English Summary. *Leningrad, N.-issl. inst. geologii Arktiki. Trudy 143:319-26.*

Reports results of the 1957-1962 study of lacustrine deposits in 13 lakes of the archipelago. Thermal regime and chemical composition of the waters, morphology of lake basins, and geologic structure of the shores were investigated, with attention mostly to Kosmicheskoye Lake on Kheysa Island. Diatom algae assemblages are analyzed. Periods of sedimentation and stages of evolution of the lagoon lakes for the last 8000 yr are determined. (AB87482) AB87482

294. **Hamilton, T.D.** 1981. Episodic Holocene Alluviation in the Central Brooks Range: Chronology, Correlations, and Climatic Implications. *U.S. Geological Survey Circular 823-B, The United States Geological Survey in Alaska: Accomplishments during 1979, N.R.D. Albert and T. Hudson (Eds.), (pp. B21-B24).*

A figure is presented which shows 42 radiocarbon dates from seven areas of the central Brooks Range. The dates bracket the interval between 6000 B.P. and the present. The radiocarbon dates are associated with two major environmental changes: alluviation of valleys (many glacially fed) and the soil/peat formation. Alluviation was most marked between 3000 and 2000 B.P. (possibly starting about 4000 B.P.); between 1400 and 800 B.P.; and between 500 and 100 B.P. The intervals of valley alluviation correspond to lichenometrically dated glacial advances in the Brooks Range. (JTA)

295. **Hamilton, T.D., T.A. Ager, and S.W. Robinson.** 1983. Late Holocene Ice Wedges Near Fairbanks, Alaska, U.S.A.: Environmental Setting and History of Growth. *Arctic and Alpine Research 15(2):157-168.*

Test trenches excavated into muskeg near Fairbanks in 1969 exposed a polygonal network of active ice wedges. The wedges occur in peat that has accumulated since about 3500 yr B.P. and have grown episodically as the permafrost table fluctuated in response to fires, other local site conditions and perhaps regional climatic changes. Radiocarbon dates suggest one or two episodes of ice-wedge growth between about 3500 and 2000 yr B.P. as woody peat accumulated at the site. Subsequent wedge truncation evidently followed a fire that charred the peat. Younger peat exhibits facies changes between sedge-rich components that filled troughs over the ice wedges and woody bryophytic deposits that formed beyond the troughs. A final episode of wedge development took place within the past few hundred years. Pollen data from the site indicate that boreal forest was present throughout the past 6000 yr, but that it underwent a gradual transition from a predominantly deciduous to a spruce dominated assemblage. This change may reflect either local site conditions or a more general climatic shift to cooler, moister summers in late Holocene time. The history of ice wedge growth shows that wedges can form and grow to more than 1 m apparent width under mean annual temperatures that probably are close to those of the Fairbanks area today (-3.5 deg C) and under vegetation cover similar to that of the interior Alaskan boreal forest. The commonly held belief that ice wedges develop only below mean annual air temperatures of -6 to -8 deg C in the zone of continuous permafrost is invalid. (Auth)

296. **Harrison, D.A.** 1966. Recent Fluctuations of the Snout of a Glacier at McBeth Fiord, Baffin Island, N.W.T. *Geographical Bulletin 8(1):48-58.*

Recent fluctuations of the snout of "Siward Glacier," McBeth Fiord, Baffin Island, are described. A chronology of the retreat phases of the glacier margin and an associated series of ice-dammed lakes is established by application of techniques in air-photograph interpretation, geomorphology, dendrochronology, lichenometry and radiocarbon dating. Results derived from the different techniques show a good measure of correspondence, except for lichenometry, where local variations in microclimate are probably responsible for large anomalies in lichen growth rates. (Auth) BafBib 379

297. **Hillaire-Marcel, C., and R.W. Fairbridge.** 1978. Isostasy and Eustasy of Hudson Bay. *Geology 6:117-122.*

In the eastern Hudson Bay area, a "staircase" of 185 Holocene strandlines provides a continuous record of emergence from about 8,000 yr B.P. (sidereal) to the present. Ages were obtained from corrected radiocarbon analyses of shells and from application of a newly discovered 45 yr cycle in beach building that is presumed to be related to the "double Hale" solar cycle. Thus, we deduced a record of climatic storminess. The mean curve of emergence confirms Andrews's model of glacio-isotatic uplift. Analysis of the residuals in the emergence curve can be transformed to an approximate eustatic curve, which shows some degree of coincidence with other sea-level curves derived from low latitudes as well as with several climatic indicators. The strandline analysis appears to be a powerful new tool for Holocene climate analysis and prediction. (Auth)

298. **Hurni, H., and P. Stahli.** 1982. Simen Mountains–Ethiopia, Vol. II: Climate and the Dynamics of Altitudinal Belts from the Last Cold Period to the Present Day. Hochgebirge von Semien–Athiopien, Vol. II: Klima and Dynamik der Hohenstufung von der letsten Kaltzeit bis zur Gegenwart. German, English Summary. *Geographica Bernensia G13, 196 pp.; Beiheft zum Jarhbuch der Geographischen Gesellschaft von Bern 7, 196 pp.*

During the late Wurm the lower limit of glaciation and periglaciation extended about 800 m lower than present, implying a climate 7 deg C colder and with less rainfall and runoff. In the early Holocene there was at first a period of natural intensive erosion followed by the formation of andosols, commonly about 70 cm thick.

Geomorphologic

Soil erosion has increased over the last 2000 years due to agricultural practices. (JTA)

299. **Jonsson, S.** 1983. On the Geomorphology and Past Glaciation of Storoya, Svalbard. *Geografiska Annaler 65A(1-2):1-17.*

Storoya is a 50 sq km large island in northeastern Svalbard. Its southern half is covered by a cold-based ice-cap, while the remaining part (22 sq km) is non-glacierized. Most of the latter area is covered with regolith. The marine limit was found at 66 m a.s.l. Above this elevation the regolith has a non-washed character but still contains rounded boulders of the same type as below the marine limit. As many of these rounded boulders are made of metamorphic or red magmatic rocks found on Nordaustlandet, while the bedrock of Storoya is gabbro and quartz diorite, the regolith is considered to be old beach material transported as till to the island. Here and there bedrock crops up through the regolith. These rock exposures lack all glacial structure, wherefore the glacier that deposited the till on Storoya must have been cold-based. In analogy with present-day conditions on Austfonna-Sorfonna a warm-based interior of the glacier must have existed on Nordaustlandet. Eight samples of driftwood have been collected. The highest sample was taken from 53 m a.s.l. Extrapolation of the curve to the marine limit shows that deglaciation of Storoya started around 10,000 years B.P. on the northeastern tip of the main hill. The preceeding advance of a partly warm-based glacier from Nordaustlandet is suggested to have taken place during the Younger Dryas. During the Holocene epoch Storoyjokulen must have had a smaller area than at present at least between 7200 and 3200 years B.P. and most probably also between 1000 and 7200 years B.P. (Auth)

300. **Kaplina, T.N., and A.V. Lozhkin.** 1980. Age of Alass Deposits of the Maritime Lowland of Yakutia. *International Geology Review 22(4):470-476.*

A series of radiocarbon dates from alass (thermokarst) deposits indicate the major portion of the depressions in the Maritime Lowlands of Yakutia formed prior to the pre-Boreal cooling, possibly between 12,000 and 11,000 years ago. Throughout the Holocene the alasses were the sites of lacustrine and paludal sedimentation. Evidence is noted for "extremely intense warming" during the Boreal period. (JTA)

301. **Klimek, K.** 1980. Geomorphological Evidence of Holocene Climatic Changes in Northern Mongolia. *Geographia Polonica 43:101-110.*

This paper provides a paleoclimatic interpretation of the results of both geomorphological and sedimentological research made in Northern Mongolia during three summers, 1976-1978. The areas of study were in the major valleys of the Selenga-Orkhon mountains of intermediate height. The climatic cooling some 5000 a B.P. (= the AT/SB transition), which has been recorded from west Europe (vide Starkel 1977), from the Russian Plain and Siberia (Ravskiy 1972), brought about clearly wetter conditions on the northern, mountainous border of Central Asia. This humid phase lasted for some 3000 years and favoured the formation of younger ravines. These relic landforms survived without much modification because of arid conditions now prevailing in this part of Asia. (Auth) (JTA)

302. **Lachenbruch, A.H., G.W. Greene, and B.V. Marshall.** 1966. Permafrost and the Geothermal Regimes. *Environment of the Cape Thompson region, Alaska, N.J. Wilmovsky and J.N. Wolfe (Eds.). United States Atomic Energy Commission, Division of Technical Information, Oak Ridge, TN, (pp. 149-163), 1250 pp.*

Analysis of temperatures to a depth of 1200 ft beneath Ogotoruk Valley reveals that present earth temperatures at depth are strongly influenced by an extinct climate and by an ancient shoreline position. An active climatic change that has been in progress throughout the past century has increased the mean annual ground-surface temperature on the order of 2 deg C. If the present climate persists, the inland permafrost thickness eventually will be reduced from about 1170 to about 850 ft. Earth-temperature anomalies near the shoreline indicate a rapid encroachment of the Chukchi Sea several thousand years ago and imply that permafrost extends under the margin of the sea to a maximum distance of about 100 yards at a depth of 200 or 300 ft. Preliminary results indicate that local heat flow from the interior of the earth is close to world-wide average. (Auth)

303. **Lasca, N.P.** 1966. Postglacial Delevelling in Skeldal, Northeast Greenland. *Arctic 19(4):349-53.*

Skeldal is a northeast-trending valley in the Mesters Vig district, on the southwest shore of Kong Oscars Fjord, about 70 km from the fiord's entrance, in the northeast corner of Scoresby Land. Thirteen radiocarbon dates of shell material which were used to establish a rate of emergence in Skeldal, indicate that the valley was partially open to the sea by ca 8500 B.P. Early emergence (8000-7000 B.P.) was approximately 3 m/century. Emergence is related almost entirely to adjustment due to glacial unloading. (AB97353) AB97353

304. **Mackay, J.R.** 1975. The Stability of Permafrost and Recent Climatic Change in the Mackenzie Valley, N.W.T. *Geological Survey of Canada Paper 75-1B, (pp. 173-176).*

There seems to be the good probability that mean annual ground temperatures in the Mackenzie Valley increased by as much as 3 deg C from the late 1800s to the 1940s, with possibly a 1 deg C decrease since then. If this change did occur, then the southern boundary of continuous permafrost one hundred years ago may have been as far south as Fort Norman, N.W.T. The warming, with a northward shift in "permafrost conditions" likely was accompanied by partial to complete disappearance of permafrost in many areas of the upper Mackenzie Valley to give some of the extensive nonpermafrost areas of today. Expected warming changes should be recognizable in: relict permafrost at depth; young thermokarst lakes; thermal erosion; thickening of the active layer; truncation of some ice-wedge tops and increasing inactivity; mass movements; cryoturbation features; and so forth. A cooling trend should be shown by: new growth of permafrost in the upper Mackenzie Valley; thinning of the active layer; growth of aggradation ice at the top of permafrost; rejuvenation of inactive ice wedges; and so forth. Irrespective of any climatic change in the past century, there is excellent evidence from thaw unconformities, deep root penetration into permafrost, buried organic material in permafrost, and fossil, truncated, and rejuvenated ice wedges along the western arctic coast to show that permafrost shifts, exceeding that of the last 100 years, have occurred before. (Auth)(JTA)

305. **Mackay, J.R.** 1976. Ice Wedges as Indicators of Recent Climatic Change, Western Arctic Coast. *Geological Survey of Canada Paper 76-1A, (pp. 233-234).*

The case for a post-1950 climatic cooling trend is well documented for many areas. Burns (1973) has shown that in the lower Mackenzie Valley, January air temperatures decreased about 4 deg C from 1950 to 1970 and July temperatures were little changed.

Geomorphologic

Thus mean annual air temperatures probably declined about 2 deg C. Ground temperatures would be expected to parallel, in a general way, those of air temperatures although other factors (e.g. snow cover) play a major role. In any event since present mean annual ground temperatures along the western Arctic coast are in the -8 deg C to -10 deg C range, a 2 deg C cooling trend should result in active layer thinning and upward permafrost aggradation. The rejuvenated ice wedges provide field evidence for a period of recent climatic cooling, a thinning of the active layer, and upward permafrost aggradation. As many of the secondary and tertiary wedges were split by fresh 1975 ice veinlets, the wedges obviously are growing. Ice wedges without secondary wedges appeared to be, with very few exceptions, inactive, because single ice veinlets extending downwards into the wedge tops could rarely be found. (Auth)(JTA)

306. **Pewe, T.L., R.E. Church, and M.J. Andresen.** 1969. Origin and Paleoclimatic Significance of Large-Scale Patterned Ground in the Donnelly Dome Area, Alaska. *Geological Society of America Special Paper 103:1-87.*

Large-scale patterned ground in the Donnelly Dome area of central Alaska consists of polygons 25 to 46 m in diameter bounded by shallow troughs 1 to 2 m wide that form the sides of the polygons. The troughs are underlain by wedge-shaped masses of sediments that extend downward 2 to 3 m. Texture of the sediments of the wedges is distinct from that of the poorly stratified glacial-outwash gravel that the wedges transect. Sediments of the wedge vary texturally along the strike and vertically within a given wedge. The coarsest material in the wedge is about 75 mm in diameter, which is the same size as the coarsest material in the outwash. The fine material in the wedges is silt, the same as that which blankets the area. The patterned ground of the Donelly Dome area originated during Wisconsin time, when the mean annual air temperature was at least 3 deg C colder than now. A polygonal network of large-scale thermal-contraction cracks formed in the gravel during the winters, and ice wedges grew in the permafrost. With the warming of the climate in post-Wisconsin time most of the perennially frozen gravel thawed and the ice wedges melted. The voids created by the melting of ice wedges were filled with sediment that was washed from the surface or collapsed from the thawed sides of the voids. The troughs bounding the polygons are now, however, no longer underlain with ice wedges but with ice-wedge pseudomorphs ("fossil ice wedges"). (Auth)

307. **Pewe, T.L., and R.G. Updike.** 1970. Guidebook to the Geology of the San Francisco Peaks Arizona. *Plateau, the Quarterly of the Museum of Northern Arizona, 43(2):45-100.*

Boulder streams and protalus ramparts are common in the cirques of the San Francisco Peaks and postdate the disappearance of Wisconsin ice. Two Holocene protalus ramparts can be delimited on the basis of soil development and extent of vegetation. Although no dates on these two periglacial events are available the authors suggest that they date from the last 4000 years (neoglacial time). (JTA)

308. **Pheasant, D.R., and J.T. Andrews.** 1972. The Quaternary History of Northern Cumberland Peninsula, Baffin Island, N.W.T. Part VIII: Chronology of Narpaing and Quajon Fiords during the Past 120,000 Years. *International Geological Congress, Twenty-fourth Session, Montreal, 1972. Section 12, Quaternary Geology, (pp. 81-88), 226 pp.*

The Quaternary chronology of the Narpaing and Quajon fiords is based on the delimitation of three weathering zones in the coastal highlands, the regional patterns of moraines and raised marine features, and Carbon 14, uranium series and amino-acid dates. The boundary between weathering zones I and II is the upper limit of continental glaciation. Weathering zone II is characterized by strongly weathered till and lateral moraines and is associated with a glacio-marine delta amino-acid dated greater than or equal to 100, 000 B.P. Weathering zone III consists of a relatively unweathered till and contains three distinct morphological units. These units were formed during early mid and late stades of the last glaciation, which began 100,000 to 140,000 B.P. A relatively warm interstadial 58,000 to 78,000 B.P. has been recognized. The early Wisconsin glaciation was the most extensive and the late Wisconsin glaciation was least extensive in this area. Fiord heads were finally deglaciated about 6,000 B.P. The latest phase of mountain glaciation began <5,000 years ago and is marked by ice-cored moraines. (Auth) BafBib 462

309. **Pissart, A.** 1977. Eolian Deposits and Processes on Banks Island, Northwest Territories, Canada. Depots et phenomenes eoliens sur l'ile de Banks, Territoires du Nord-Ouest, Canada. *Canadian Journal of Earth Sciences 14:2462-2480.*

Two radiocarbon age determinations from two different sites along Thomsen River show that the deposition of eolian sands began 3790 + or - 90 years B.P. (GSC-2119) and 3460 + or - 80 years B.P. (GSC-2124). Ages of 5800 + or - 180 years B.P. (GSC-2419) were obtained respectively for the start of eolian sedimentation along Bernard River and on the outwash surface situated southeast of Sachs Harbour. The hypothesis that the initiation of eolian activity around 4000 years ago may have been the result of a drier and cooler climate on Banks Island is put forward. (Auth)(JTA)

310. **Salvigsen, O.** 1978. Holocene Emergence and Finds of Pumice, Whalebones, and Driftwood at Svartknausflya, Nordaustlandet. *Norsk Polarinstitutt Arbok 1977:217-228.*

Marine features are found up to about 120 m above sea level, and levels up to 70 m are dated here. Datings of twenty driftwood samples and three whalebones give an emergence curve starting at 9,500 years B.P. The rate of emergence was high from 9,500 to 7,500 B.P. and low in the period 7,500-5,000 B.P. Uplift has been insignificant during the last 1,500 years. The only pumice level found is dated to about 4,500 B.P. Driftwood logs and whalebones are common up to 50 m above sea level and are also found scattered at higher levels. Embedded logs give reliable rates of the beaches in which they are found, although one well preserved log found 90 m above sea level has given an infinite Carbon 14 age. (Auth)

311. **Seppala, M.** 1979. Recent Palsa Studies in Finland. *Palaeohydrology of the Temperate Zone, Y. Vasari, M. Saarnisto and M. Seppala (Eds.), Proceedings of Working Session of Commission on Holocene--INQUA (Eurosiberian Subcommission), Hailuoto-Oulanka-Kevo, August 28-September 6, 1978. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 82, Geologica No. 3, (pp. 81-87), 176 pp.*

The aim of this report is to give a general view of the palsa studies made in Finland during the last few years. This paper includes discussion about the geographical distribution, morphology, development, stratigraphy and age of palsas, which are geomorphological phenomena typically occurring in the discontinuous permafrost zone. (Auth)

312. **Servant, M., J.-C. Fontes, J. Argollo, and J.-F. Saliege.** 1981. Variations of the Regime and Nature of Precipitation

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during the Past 15 Millenia in the Bolivian Andes. Variations du regime et de la nature des precipitations au cours des 15 derniers millenaires dans les Andes de Bolivie. French, English summary. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie II 292(17):1209-1212.*

Geomorphology and fluvial sedimentology indicate oscillations of climatic regimen during the Upper Quaternary in the Bolivian Andes area. Coarse deposits and active erosion are correlated with tropical summer rains. Organic silty deposits and weak erosion are correlated with more equally distributed precipitations during the year. The climatic regime fluctuated with a periodicity of about 2,000-3,000 years. (Auth)

313. **Sollid, J.L., and L. Sorbel.** 1974. Palsa Bogs at Haugtjornin, Dovrefjell, South Norway. *Norsk Geografisk Tidsskrift 28:53-60.*

Palsa bogs are described from an area at Haugtjornin, Dovrefjell (62 deg 21 min N, 9 deg 45 min E). This locality is the southernmost reported occurrence of palsa bogs in Fennoscandia, see Fig. 1. The palsa bogs are in a degenerating stage. Morphology and erosional processes of different types of palsas are discussed. Melting of permafrost by water contact seems to be the most important erosional factor. Further studies are planned. (Auth)

314. **Starkel, L.** 1966. Post-Glacial Climate and the Moulding of European Relief. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 15-33), 229 pp.*

This paper is based on geomorphological and other studies testifying to the differentiated evolution of European relief in the Holocene. Changes in climatic zones and belts are related to both the floral zones and the morphogenetic regions. The analysis of forms and processes permits the reconstruction of changes of relief in the Holocene. Conversely, geomorphological data can provide the evidence for changes of climate. The climate of the pre-Boreal and Boreal periods was warmer, with retreat of glaciers, though rather dry and there was reduced fluvial activity. The Atlantic period had higher rainfall, warm winters and a mean annual temperature about 2 deg higher than that of today. Fluvial deposits are consistent with periods of heavy rain. The climate of the sub-Boreal period was warm but with great variations in humidity. At the beginning of the sub-Atlantic period there was a marked cooling. Fluvial sediments and glacier advances bear witness to frosty and snowy winters and heavy rains during the cool summers. Thus geomorphological data are of value for the recognition of climatic changes and can be applied as one of the criteria, especially over large areas. The general changes in humidity and temperature in a particular climate zone are reflected in the changes in the intensity of processes which are recorded by land forms and sediments. (Auth) GA 67A/1280

315. **Starkel, L.** 1977. Last Glacial and Holocene Fluvial Chronology in the Carpathian Valleys. *Studia Geomorphologica Carpatho-Balcanica XI:35-51.*

Figure 1 illustrates a series of climatic reconstructions for the region of the Carpathian rivers, Poland. Temperatures of the warmest month have declined an estimated 1-2 deg C since a climatic optimum during the Atlantic period. This trend is also associated with a period of river incision during the last few centuries. (JTA)

316. **Street, F.A.** 1977. Deglaciation and Marine Paleoclimates, Schuchert Dal, Scoresby Sund, East Greenland. *Arctic and Alpine Research 9(4):421-426.*

Three new Carbon 14 dates on molluscs from Schuchert Dal, East Greenland, ranging from 8570 to 8670 B.P., date the maximum marine invasion of Schuchert Dal after the glacial advance of the Milne Land Stadial, which terminated around 9900 B.P. The faunas contain the earliest known occurrence of CHLAMYS ISLANDICA, an indicator of the hypsithermal incursion of warmer waters into Scoresby Sund. Carbon 14 dates previously obtained for this species range from 7870 to 5680 B.P. (uncorrected ages). The initial rapid rate of isostatic rebound in the valley (4.8 m 100 yr(E-1)) is typical of Greenland uplift curves. Formation of open system pingos on the lower slopes occurred after 8580 B.P. (Auth)

317. **Trench, N.R.** 1978. The Geomorphology and Paleoenvironmental History of the Lake City Landslide Complex, Southwest Colorado. *M.A. Thesis, University of Colorado, Boulder, CO, 149 pp.*

Pollen and stratigraphic analyses of sediments formed in the Thompson Lake depression suggest that rapid lake formation followed the initial sealing of the lake bottom soon after basin creation. An early local SALIX-dominated vegetation was succeeded by an increase in Cyperaceae and other lake-marginal flora. A basal date of 680 + or - 130 B.P. (USGS-311) gives a probable close minimum age for landslide occurrence. Pollen analysis of the flood deposit indicates an increase in the elevation of vegetion zones, part-way up the sequence, probably due to the onset of Little Ice Age conditions (less than 310 B.P.). Analysis of the local modern pollen rain demonstrates smaller PICEA/PINUS ratios at high altitudes than elsewhere in the San Juan Mountains (Maher, 1961). This may be due to the preponderance of an aspen vegetation on the disturbed slide terrain. Radiocarbon dating of organic sediments ponded by sliding reveals phases of major landslide activity at about 8600, 1770 and 700 B.P. Lineations (observed in aerial photographs) crossing the debris flow tongues of the Hay and Larsen Landslides suggest reactivation of underlying blocks, possibly at about 700 B.P. Also, the occurrence of Slumgullion Earthflow (1) at about this time infers the possibility of a regional event. Debris flow activity associated with some sliding, and the temporal pattern of sliding itself, suggest that individual events dated in this study may be related to high groundwater conditions prevailing during early postglacial times, and during the period of climatic deterioration after about 2500 B.P. (Auth)(JTA)

318. **Volkov, I.A.** 1972. Late Glacial and Early Holocene Times Climatic Fluctuations in the South of the Western Siberian Plain. *International Geology Review 14(10):1044-1050.*

The new data presented refer to structures of Late Glacial and Early Holocene sediments in the Kondinian flat, on the Lower Irtysh and elsewhere in the territory. Information on buried soils and peat bogs is likewise presented, together with a biostratigraphic characterisation of the sediments. A plan of the climatic fluctuations is developed by analysis of geological and geomorphological evidence, indicative of abrupt changes in denudation and sedimentation in southern parts of Western Siberia. It is proved that the optimum climate was drier and warmer at the end of the Pleistocene and beginning of the Holocene than at the onset of the waterlogging, about 8.4 thousand years ago. (AGI Abstract) GA 73A/1004

319. **Vorren, K.-D., and B. Vorren.** 1975. The Problem of Dating a Palsa. Two Attempts Involving Pollen Diagrams, Determination of Moss Subfossils, and Carbon 14 Datings. *Astarte 8:73-81.*

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Age determination of a palsa implies localizing and dating of the uppermost hydrophilous peat layer of the uneroded palsa crest. The hydrological conditions which prevailed during the formation of the peat can best be judged by examination of macro-subfossils, especially mosses. A preliminary local and regional biostratigraphy of the eastern Ovre Dividal National Park, Norway, 600 m a.s.l., has been established. A Carbon 14 dating of palsa at Peerajarvi, Finland, suggests a maximum age of 1010 Carbon 14 years. Another palsa situated in the southeastern part of the Ovre Dividal area is, according to a Carbon 14 dating and the accumulation rate of peat, assumed to have formed during a short period some time between A.D. 1410 and 1710. (Auth)

320. **Weide, D.L.** 1974. Postglacial Geomorphology and Environments of the Warner Valley - Hart Mountain Area, Oregon. *Ph.D. Thesis, University of California, Los Angeles, CA, 311 pp.*

Two methods of reconstructing postglacial changes in precipitation, runoff, and evaporation in the Great Basin yield acceptable results when applied to the Warner Valley, southeastern Oregon. Application of the Snyder-Langbein model, originally designed for Spring Valley, eastern Nevada, and the Leopold model, based on a study of Lake Estancia, New Mexico, suggest that during the last 13 to 17 thousand years, the time since pluvial Lake Warner occupied the last high stand, mean annual evaporation has increased from 37 inches to 45 inches. At the same time mean annual precipitation has declined from 18 inches to 15 inches. Deposits of Mazama pumice recovered from a continuous section of marsh sediments indicate that the pluvial lake had vanished by at least 6,600 B.P. The equilibrium between annual runoff and evaporation is expressed in the distance from south to north water will penetrate the Warner lakes closed basin. In general, climatic conditions have favored a persistent lacustrine-marsh environment in the basin during the last 8 to 9 thousand years. While short term cycles of drought or excessive runoff affect the areal extent of the marsh-lake system, at no time since the final disappearance of pluvial Lake Warner have the contributing streams gone completely dry. This pattern may be seen at numerous other localities in the Great Basin where well developed marshlands, mountain streams, and springs are prominent hydrologic factors. Their persistence through time may prove critical in man's occupance of the Great Basin since the close of late glacial pluvial conditions. (Auth)(JTA) Dissertation Abstracts International 36(1):142-B, Order No. 75-14,071

321. **Worsley, P., and C. Harris.** 1974. Evidence for Neoglacial Solifluction at Okstindan, North Norway. *Arctic 27(2):128-144.*

A section excavated through two adjacent turf-banked solifluction lobes has revealed buried soils beneath each solifluction sheet. Five radiocarbon dates are reported from the buried soils and these reveal evidence of soil movement which probably extends over nearly 3,000 years until the present. The initiation of the movement appears to be linked to the late Sub-Boreal climatic deterioration and Neoglacial glacier expansion which induced the development of a late-lying snow patch at the study site. The first period of movement appears to have been faster than that during the later phase. It is suggested that this reduced rate is associated with a decrease in slope angle and to increased distance from the late-lying snow band at the head of the slope, rather than to a less severe climate environment. (Auth)

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322. **Aksu, A.E., and D.J.W. Piper.** 1979. Baffin Bay in the Past 100,000 yr. *Geology 7:245-248.*

Upper Quaternary sediments in Baffin Bay are predominanty debris flows and turbidites derived from ice-rafted sediments on the continental slope. Individual lithofacies can be correlated across hundreds of kilometres. Two ash horizons provide useful stratigraphic markers. Peaks in foraminiferal abundance indicate that two main penetrations of subarctic water occurred in Baffin Bay during the past 100,000 yr. One penetration occurred about 70,000 to 40, 000 yr B.P. and another at 9,000 to 6,000 yr B.P. Both were accompanied by distribution of ice-rafted carbonate sediment over a wide area of Baffin Bay and the eastern Canadian continental margin. (Auth) BafBib 332

323. **Alley, N.F.** 1980. Holocene and Latest Pleistocene Glaciations in the Shuswap Highland, British Columbia: Discussion. *Canadian Journal of Earth Sciences 17:797-798.*

The Harper Creek Moraine is radiocarbon dated at older than 7985 + or - 125 B.P. and it is suggested the moraine is younger than 11,000 years old. The Dunn Peak Moraine is bracketed by radiocarbon dates and is considered to have been deposited between 7985 + or - 125 and 4320 + or - 95 years B.P. (JTA)

324. **Allison, I., and P. Kruss.** 1977. Estimation of Recent Climate Change in Irian Jaya by Numerical Modeling of its Tropical Glaciers. *Arctic and Alpine Research 9(1):49-60.*

An attempt to estimate climatic change from the retreat of small mountain glaciers is made for the tropical Carstensz Glacier and Meren Glacier in Irian Jaya, Indonesia. The results show that the present day equilibrium line altitude needs to be lowered by 96 m for the Carstensz Glacier to reach a steady state length equivalent to the actual Neoglacial extent, and that the observed retreat rate of the glacier can be well matched by increasing the equilibrium line altitude at a rate of about 80 m/century. The model matches known surface profiles of the glacier at various times and the measured surface velocities as well as the terminus retreat rate. The increase of the equilibrium line altitude at a rate of 80 m/century can be considered, in a first approximation, to be due to an air temperature warming rate of 0.6 deg C/century. There can be no unique solution to the relationship between glacier net balance change and climatic change, but evidence from other sources of a general warming in tropical zones of 0.4 to 0.6 deg C for the last century supports the conclusion that the glacier retreat is due to increasing temperature. (Auth)(JTA)

325. **Andersen, J.L., and J.L. Sollid.** 1971. Glacial Chronology and Glacial Geomorphology in the Marginal Zones of the Glaciers, Midtdalsbreen and Nigardsbreen, South Norway. *Norsk Geografisk Tidsskrift 25:1-38.*

Lichenometry was employed to determine the outer limits of glacier marginal zones and to date moraine ridges. (Auth)(JTA)

A lichen growth curve is reconstructed from calibration based on moraines of known age. These moraines are dated at 1750, 1875, 1899, 1909, and 1930 A.D. (JTA)

326. **Andrews, J.T.** 1963. End Moraines and Late-Glacial Chronology in the Northern Nain-Okak Section of the Labrador Coast. *Geografiska Annaler 45(2/3):158-171.*

This paper reports a reconnaissance field study in a hitherto unexamined area, particularly on a series of complex massive end moraines in the Tasiuyak Bay–Umiakovik Lake Trough approximately 57 deg 10 min N. 62 deg 10 min W. They are taken to represent a major glacial phase, referred to as the Tasiuyak phase. A chronology is suggested for the development of the various end moraines. Tentative dates for nearby phases indicate that the advances and recessions (described in the report) occurred at the end of the last glaciation. (AB77032)(JTA) AB77032

327. **Andrews, J.T.** 1965. Glacial Geomorphological Studies on North-Central Baffin Island, N.W.T. *Ph.D. Thesis, University of Nottingham, Nottingham, U.K., 3 vol.*

This paper discusses: (1) the physical milieu, and the aims and methods of research; (2) systematic studies, including till fabric of cross- valley moraines, surface boulder orientations around the northwest margin of the Barnes Icecap, and application of lichenometry to glacial geomorphology; and (3) glacial chronology, beginning with the Flitaway Interglacial at 40,000 B.P., followed by the Foxe Glaciation, and the Steensby Interstadial marine transgression, is described. Land uplift is still continuing. The recent history of the Barnes Icecap and Lewis Glacier is given. A final section contains conclusions and appendixes of the petrologic techniques. (GeoRef 65-03080-N) BafBib 228

328. **Andrews, J.T.** 1966. Pattern of Coastal Uplift and Deglacierization: West Baffin Island, N.W.T. *Geographical Bulletin 8(2):174-193.*

The marine limit in the Grant-Suttie Bay/Isortoq Fiord area is a major strandline formed in association with the Isortoq Phase moraines and established, according to radiocarbon dating, less than 7,000 years ago. Subsequent offshore updoming resulted in an upward tilt of the area toward S 35 deg W at the rate of 1.0 metre/km. A lower strandline at about 20 metres above sea level was formed less than 4,000 years ago. Uplift of the west coast of Baffin Island has been slow compared to adjacent glacial dispersal zones. It is suggested that this relates in part to the dampening effect of the Baffin Island ice cap which was of major proportions during the initial rebound period. Rates of uplift are compared from both sides of Foxe Basin and found to differ. (Auth) BafBib 272

329. **Andrews, J.T.** 1967. Late-Pleistocene History of the Isortoq Valley North-Central Baffin Island, Canada. *Melanges de Geographie Physique, Humaine, Economique, Appliquee, offerts a M. Omer Tulippe. Vol. I, Geographie Physique et Geographie Humaine, Jose A. Sporck (Ed.). Editions J. Duculot, S.A., Gembloux, (pp. 118-133).*

Within the last 8,000 years 7 glacial substages are recoginized of which the first, the Cockburn-McAlpine, occurred outside the field area and marks the perimeter of an ice cap with a 1,000 km radius. Rapid disintegration of the ice resulted in an open Foxe Basin about 6,700 years ago. From that time to the present the western margin of the Baffin Island Ice Cap retreated slowly but at least six distinct readvances are recognized within the Isotorq Valley. This history contrasts with other evidence from arctic Canada which indicates more favourable conditions in the period of 5,000 to 7,000 years ago. (Auth)(JTA)

330. **Andrews, J.T.** 1968. Postglacial Rebound in Arctic Canada, Similarity and Prediction of Uplift Curves. *Canadian Journal of Earth Sciences 5(1):39-47.*

Uplift curves, constructed from data for 21 locations in close vertical proximity to the local marine limit, indicate a similar proportional response through time. At these sites the marine limit is assumed to be synchronous with deglaciation and the age of their marine shells to date the formation of the marine limit. The time/altitude relationship can thus be expressed as a percent of uplift within a specific time period. A graph of the results is a smoothly decelerating curve. A formula approximating the curves is given, as are tables and a figure so that uplift curves can be predicted on the basis of elevation of the marine limit and date of site deglaciation. Velocities derived from uplift curves allow the calculation of residual uplift. For a sector of Hudson Bay the figure is 100 m. (AB101816) BafBib 274

331. **Andrews, J.T.** 1968. Pattern and Cause of Variability of Postglacial Uplift and Rate of Uplift in Arctic Canada. *Journal of Geology 76(4):404-425.*

Discusses results of analyses of sites in arctic Canada exclusive of the Queen Elizabeth Islands, where elevation and age of marine limits are known. They indicate that the marked variability of postglacial uplift and rate of uplift is explicable in terms of distance from the former ice margin (a measure of ice thickness) and date of deglaciation. Trend surfaces for postglacial uplift in the last 6000 yr and the present rate are given. Mathematical models are developed that indicate the effect of different rates of glacial retreat on postglacial uplift, elevation of the marine limit and strandline deformation. (AB101814) BafBib 271

332. **Andrews, J.T.** 1969. Importance of the Radiocarbon Standard Deviation in Determining Relative Sea Levels and Glacial Chronology from East Baffin Island. *Arctic 22(1):13-24.*

This paper deals with the problem of error in estimating relative sea levels and glacial chronology in a small area where radiocarbon dates provide some chronological control, but where the precision of radiometric technique does not allow a clear-cut chronology to be developed on that basis alone. Results indicate that glaciers lingered in the east and central Baffin Island valleys from 5700 to at least 4350 B.P. (AB101812)(JTA) AB101812

333. **Andrews, J.T.** 1969. Shoreline Relation Diagram: Physical Basis and Use for Predicting Age of Relative Sea Levels (Evidence from Arctic Canada). *Arctic and Alpine Research 1(1):67-68.*

A shoreline diagram for Arctic Canada is constructed from the equation of the form of postglacial uplift. This operation in itself indicates that the shoreline relation diagram represents a valid concept. The diagram is then used to predict the age and elevation of marine limits, glacial lake strandlines, and lower relative sea levels. A comparison of predicted and observed values suggests that the shoreline relation diagram presented in the paper functions efficiently as a chronological forecaster that can complement and extend late-glacial and postglacial chronologies. The workings of the diagram are such that a few selected radiocarbon dates can be used to establish an extensive and detailed chronology. (Auth) BafBib 278

334. **Andrews, J.T.** 1970. Differential Crustal Recovery and Glacial Chronology (6,700 to 0 B.P.), West Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 2(2):115-134.*

Five strandlines are associated with stillstands of the western margin of the residual Baffin Island ice cap. Each strandline is dated by reference to a radiocarbon-controlled emergence curve. Correlative geologic-climatic phases along the western margin of the late-glacial Barnes Ice Cap are indicated by the moraine evidence. The Isortoq Phase is dated about 6,700 B.P. It was succeeded by a period of retreat with limited halts. Another major glacial phase, the Flint, occurred about 5,000 B.P., and is correlative with the growth of the Ellesmere ice shelf and glacier readvance in other parts of the world. Younger prominent moraines are > 1,700, 700 and 250 years old. (Auth)

335. **Andrews, J.T.** 1970. Present and Postglacial Rates of Uplift for Glaciated Northern and Eastern North America Derived from Post-Glacial Uplift Curves. *Canadian Journal of Earth Sciences 7(2, Part 2):703-715.*

Average rates of postglacial uplift reach a maximum value of nearly 4 m 100y(E-1) over southeastern Hudson Bay, and another high cell, with rates of about 2.5 m 100y(E-1) lies between Bathurst Inlet and Southampton Island. Current rates of uplift are underestimated if exponential curves are fitted solely to dated raised marine deposits without considering the amount of future recovery. Rates of rebound are, instead, derived from A/t where A is uplift in the first 1000 y since deglaciation, and t is time since deglaciation. For the northwest margin of the former ice sheet coefficients of determination for rate of uplift, at specific times, as a function of distance are greater than or equal to 0.934. Maps of rates of uplift for northern and eastern North America are presented for 8000 y B.P., 6000 y B.P. and the present day. They reveal the existence of three uplift centers and show that rates of uplift declined from a maximum of 10 to 12 m 100y(E-1), immediately following deglaciation, to a current maximum of about 1.3 m 100y(E-1). Agreement is satisfactory when calculated rates of uplift are compared with those derived from geological observations, radiocarbon dates, and from water-level records. A final map shows isochrones on the uplift rate of about 1 m 100y(E-1). The rate dropped to this value about 10,000 y ago on the outer northwest and southeast coasts, whereas the value might not be reached for another 2000 y in southeastern Hudson Bay. (Auth) BafBib 276

336. **Andrews, J.T.** 1970. A Geomorphological Study of Post Glacial Uplift with Particular Reference to Arctic Canada. *Institute of British Geographers Special Publication 2, London, Institute of British Geographers, 156 pp.*

This monograph synthesises recent research on glacio isostatic recovery in the Canadian arctic, with particular reference to the geological and geomorphological evidence, and provides a series of arguments for reconstructing and post-glacial uplift, emergence and crustal deformation for areas varying in size from local to continental. (Gsg 1-5) BafBib 265

337. **Andrews, J.T.** 1973. The Wisconsin Laurentide Ice Sheet: Dispersal Centers, Problems of Rates of Retreat, and Climatic Implications. *Arctic and Alpine Research 5(3, Part 1):185-199.*

Isochrone maps on the late Wisconsin deglaciation of the Laurentide ice sheet enable estimates to be made of changes in the volume and area of the ice sheet. The average marginal recession between 12,000 and 7,000 B.P. is estimated as 260 m year (E-1) and varies little between the northwest and southern margins. The northeastern margin retreated at 20 m year (E-1) and the overall tendency was for the Laurentide ice sheet to migrate toward Baffin Island. (Auth)(JTA) BafBib 427

338. **Andrews, J.T.** 1975. Support for a Stable Late Wisconsin Ice Margin (14,000 to 9,000 B.P.): A Test Based on Glacial Rebound. *Geology 3:617-620.*

Three alternative hypotheses for the timing and rate of deglaciation in the outer fiords and coasts of the eastern Canadian Arctic are tested by a computer program that provides information on the amount and form of crustal deflection according to a two-layer geophysical model. The three alternative hypotheses are (1) a glacial advance that started about 20,000 B.P. and reached a maximum at the outer coast at 18,000 B.P. and a slow glacial retreat that began at 14,000 B.P., (2) a glacial advance about 20,000 B.P. with the gla-

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cial margin stabilized along the Cockburn moraines near the fiord heads from 15,000 to 8000 B.P., and (3) a glacial advance to the coast from 20,000 to 19,000 B.P. with the glacial margin stabilized until 9000 B.P. and then a rapid glacial retreat to the fiord heads. The derived-deflection and relative sea-level curves, for a position equivalent to the outer coast of Baffin Island, indicate that the results from hypotheses 1 and 3 are incompatible with the observed distribution of raised Holocene and late Pleistocene marine sediments and their associated Carbon 14 dates. In contrast, the curve for relative sea level from hypothesis 2 explains significant elements of the distribution of radiocarbon dates and suggests that a marine transgression affected the outer coast until about 8500 B.P. The marine transgression was not caused by the peak in eustatic sea level but by the glacio-isostatic depression of the coast maintained by the stable mass of the northeastern sector of the Laurentide Ice Sheet. (Auth) BafBib 279

339. **Andrews, J.T.** 1982. Holocene Glacier Variations in the Eastern Canadian Arctic: A Review. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 9-14), 47 pp.*

Three main glaciological situations existed during the Holocene: 1) advances and retreats of local cirque glaciers; 2) fluctuations of the margins of local ice caps and outlet glaciers; and 3) variations in the marginal position of a Foxe Basin/Baffin Island/Labrador continental ice sheet. Some comments on the glacial fluctuations are: i) in several areas there is evidence that local neoglaciation moraine sequences record glacial expansions as extensive as any recorded for the last 40ka or more; ii) in Cape Dyer/Merchants Bay researchers have traced the transition from mode i) (above) to another situation where earliest Holocene/latest Pleistocene moraines extend several kilometers from the neoglacial moraines; iii) radiocarbon-dated marine shells in sediments associated with glacier termini indicate that over much of the region regional deglaciation commenced between 9 and 8ka; however, in Frobisher Bay a major advance of the ice down this sound is recorded by glacial sediments and in marine cores and dates between 11 and 10ka; iv) glacial retreat during the Kangilo Chron (Substage)(5-8ka) was remarkably slow despite the fact that many glaciers terminated in the sea; v) Neoglaciation is recorded in the response of local ice caps, valley and cirque glaciers; ten to eleven discrete events have been recognized; in most areas the advances of the last 450 to 100 yr have been the most extensive of this phase. (Auth)

340. **Andrews, J.T., and D.M. Barnett.** 1979. Holocene (Neoglacial) Moraine and Proglacial Lake Chronology, Barnes Ice Cap, Canada. *Boreas 8:339-356.*

Lichen diameters and radiocarbon dates from the western and southern margins of the Barnes Ice Cap yield a growth curve similar to that from southeastern Baffin Island. As a consequence, the moraine chronology of the northern and western Barnes Ice Cap needs revision as does the chronology of the large proglacial lakes that existed north of the present Barnes Ice Cap. The revised chronology indicates that moraines were formed along the western margin of the Barnes Ice Cap during the following intervals: (1) less than 100 years ago; (2) 400-500 B.P.; (3) ca. 750 B.P.; (4) ca. 1000 B.P.; (5) ca. 1600 B.P.; (6) ca. 2100 B.P.; and (7) 2800 to 3100 B.P. As the western margin of the Barnes Ice Cap retreated, punctuated by stillstands and readvances, the northern margin of the Barnes Ice Cap lay athwart a series of westerly draining valleys, and a complex of proglacial lakes were dammed between the ice margin and the height of land. This sequence is traced by means of well-developed shorelines, lacustrine deltas, and spillways: specific lake levels are dated by lichenometry. Comparison of specific data from Swedish Lappland and Baffin Island shows substantial agreement. Although Neoglacial records may be globally synchronous, the case for a 2500 year return interval is suggested for the period between 0 and 3000 B.P. (Auth)(JTA) BafBib 368

341. **Andrews, J.T., J.T. Buckley, and J.H. England.** 1970. Late-Glacial Chronology and Glacio-Isostatic Recovery, Home Bay, East Baffin Island, Canada. *Geological Society of America Bulletin 81:1123-1148.*

Fossiliferous raised marine deposits occur around Home Bay, east Baffin Island, Northwest Territory. We developed a late-glacial chronology on the bases of 32 radiocarbon dates and morphostratigraphic evidence. Retreat of the fiord glaciers was relatively rapid (average 27 m yr (E-1)) between 10,000 and about 8000 B.P. Evidence for a major readvance of the glaciers about 8000 years ago includes moraines overlying marine clay, elevation of associated raised delta deposits relative to local marine limits, and a prominent and extensive moraine, the Ekalugad Moraine (new name). Related radiocarbon dates are similar in age to the Cockburn Moraine of Arctic Canada. Another moraine, dated about 6800 B.P., is of similar age to the Isortoq Moraine of west Baffin Island. Valley glaciers from the main interior ice sheets were still descending to near sea level only 4500 to 4000 years ago. Disappearance of the interior ice sheet west of Home Bay apparently coincided with, or at least preceded, the growth of the local mountain ice caps. (Auth)(JTA) BafBib 393

342. **Andrews, J.T., P.T. Davis, and C. Wright.** 1976. Little Ice Age Permanent Snowcover in the Eastern Canadian Arctic: Extent Mapped from LANDSAT-1 Satellite Imagery. *Geografiska Annaler 58A(1-2):71-81.*

Extensive areas of the eastern Canadian Arctic are light grey/white on both conventional black and white air photography and on multi-spectral LANDSAT-1 satellite imagery. These areas stand out in marked contrast to the darker toned surrounding terrain. Field investigations indicate that the light grey areas possess few lichens or plants; in contrast, their margins abut terrain with a mature lichen cover. Areas within the lichen trimlines are interpreted as the sites of former permanent snowbeds and snowfields. Radiometric and lichenometric dates indicate that the episode of permanent snowfields occurred about 500 to 300 years ago with retreat starting between 300 and 70 years ago. A comparison of Little Ice Age glaciation levels with those based on the present distribution of permanent ice/snow bodies indicates that during the Little Ice Age the regional snowline fell between 100 and 400 m; thus extensive areas of the upland plateaus of Baffin Island above 600 m were mantled by a thin but extensive permanent snowcover. This study serves to provide a realistic model for the inception of a North American ice sheet. (Auth)(JTA) BafBib 371

343. **Andrews, J.T., and R.E. Dugdale.** 1971. Quaternary History of Northern Cumberland Peninsula, Baffin Island, N.W.T.: Part V: Factors Affecting Corrie Glacierization in Okoa Bay. *Quaternary Research 1(4):532-551.*

Corries in Okoa Bay contain glaciers, ice patches or are empty. Each of 165 corries is described by 17 variables that describe shape, location and geometry and also have some relationship to the glaciological conditions in each basin. Residual elevations from a linear trend surface on corrie lip altitudes indicate that empty corries lie, on average, only 200 m below those currently ice-filled, thus the area is extremely sensitive to the effects of climatic change. The 200-m lowering of local snowline implied by the corrie lip data is equivalent to a 1.2 deg C temperature decrease–this is the same as estimates based on changes in the earth's orbital parameters for this latitude. It is suggested that glacierization of much of Baffin Island is possible with a lowering of snowline by 200 m, this could then trigger other areas such as Labrador and Keewatin. (Auth)(JTA)

344. **Andrews, J.T., and G. Falconer.** 1969. Late Glacial and Post-Glacial History and Emergence of the Ottawa Islands, Hudson Bay, Northwest Territories; Evidence on the Deglaciation of Hudson Bay. *Canadian Journal of Earth Sciences 6(5):1263-1276.*

Study of striations in Precambrian metavolcanic bedrock of Gilmour and Perley Islands in northeastern Hudson Bay suggests that the earliest recorded glacial movement was toward the northeast. With deglaciation of the Hudson Strait and central Hudson Bay, the ice movement shifted in an anti-clockwise direction, the final movement being toward the west-southwest. Deglaciation of the islands occurred 7610-7250 yr ago. The marine limit is 158 m above sea level. Deltaic deposits below are in sets that correlate with glacial advances in Labrador-Ungava and Baffin Island and with palynological results from Keewatin. Climatically induced processes are inferred rather than a balance in eustatic-isostatic movements. Postglacial uplift and emergence curves are based on Carbon 14 dates on marine shells. Uplift rates were approx 0.06 m/yr (E-1) at 6500 yr B.P.; the present rate is approx 0.008 m/yr (E-1). With deglaciation of Hudson Bay, the ice sheet split along the submarine deep that trends southward between Mansel and Coats Islands toward the southwest coast of the Bay. (AB101813) AB101813

345. **Andrews, J.T., S. Funder, C. Hjort, and J. Imbrie.** 1974. Comparison of the Glacial Chronology of Eastern Baffin Island, East Greenland, and the Camp Century Accumulation. *Geology 2(7):355-358.*

Independently derived glacial chronologies from eastern Baffin Island, Canadian Arctic, and from East Greenland show essentially similar glaciologic trends that are notably different from the reponse of the southern margins of the Laurentide and Fennoscandia Ice Sheets. The critical aspects of both chronologies and the related extent of the ice sheets are: 1) an early and maximum glacial stade, during the early phase of the last glaciation, reaching its peak about 100,000 to 75,000 years ago; 2) an interstadial about 70,000 B.P.; 3) an ice advance peaking about 45,000 yr ago; 4) an interval about 40,000 to 11,000 yr ago of restricted ice extent; ; and 5) a late glacial stadial between 11,000 and 8,000 B.P. This record shows basic agreement with a chronology of snow accumulation at the Camp Century ice core site based on a revised chronostratigraphic interpretation. Fluctuations in sea level between 120,000 and 70,000 B.P. may well be related to glacierization of high arctic land masses under conditions of heavy snowfall. The subsequent reduction of accumulation in these high arctic areas then leads to a reduction of ice volume with a dry, cold interstadial correlative in time with the "classical" Wisconsin ice advance along the southern margins. The late glacial advance of both eastern Baffin Island and East Greenland, which extended into Holocene time, represents a brief return to high accumulation rates as the global circulation changed from a glacial to an interglacial mode. (Authors) GA 74A/1846

346. **Andrews, J.T., and J.D. Ives.** 1972. Late- and Postglacial Events (10,000 B.P.) in the Eastern Canadian Arctic with Particular Reference to the Cockburn Moraines and Break-up of the Laurentide Ice Sheet. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 149-176), 511 pp.*

The Cockburn Moraines (morpho-stratigraphic term) of the Canadian Arctic are discussed in terms of their climatic implications at two levels: the first is their place in the late-glacial chronology of eastern Baffin Island, N.W.T.; the second is their relationship on the regional scale to the final disintegration of the Laurentide Ice Sheet and the Cochrane readvance, south of James Bay. In eastern Baffin Island an analysis of 144 radiocarbon dates from coastal sites indicates a marked peak in the number of dates between 8,500 and 7,500 B.P. and a complete absence of any dates between 10,500 and 24,000 B.P. It is now certain that several areas on the outermost coast of eastern Baffin Island were not covered by late-Wisconsin fiord glaciers, so that the absence of Carbon 14 dates in this interval is unusual. In some fiords, dates of deglaciation obtained from marine shells associated with local marine limits do not vary significantly from the fiord head to the mid-fiord areas and this suggests that in places the marine limits of ca. 8,000 B.P. were formed during an extensive transgression that is tentatively related to a readvance of the fiord glaciers during Cockburn time. In certain areas the Cockburn Moraines may even mark the greatest extent of late-Wisconsin ice. It is believed that the readvance is associated with increased precipitation during a general warming phase. (Auth)(JTA) BafBib 392

347. **Andrews, J.T., and J.D. Ives.** 1978. "Cockburn" Nomenclature and the Late Quaternary History of the Eastern Canadian Arctic. *Arctic and Alpine Research 10(3):617-633.*

A system of end and lateral moraines, extending from near Frobisher, Baffin Island, to the west of the Penny Ice Cap, and roughly parallel to the fiord heads of the northeast coast to Bernier Bay, was identified in the 1960s and given the name "Cockburn end-moraine system." Since then the name "Cockburn" has been used in conjunction with several distinct types of stratigraphic units and landform assemblages. The three main uses are (1) Cockburn end-moraine system, Cockburn moraines, Cockburn Moraine, which are all morphostratigraphic units; (2) Cockburn Stade, which is a geologic-climate unit; and (3) Cockburn Glacial Phase, which was originally defined as occurring between 8000 and 9000 radiocarbon years ago, and which is, therefore, a chronostratigraphic unit. Thus there is an ambiguity in present usage that has developed over the last 15 yr as knowledge of the glacial morphology and stratigraphy of the eastern Canadian Arctic has expanded. In this paper an attempt is made to reduce this ambiguity by preparing new definitions. (Auth) BafBib 389

348. **Andrews, J.T., R. McGhee, and L. McKenzie-Pollack.** 1971. Comparisons of Elevations of Archaeological Sites and Calculated Sea Levels in Arctic Canada. *Arctic 24:210-228.*

Based on a study of postglacial uplift in the Canadian Arctic it has been proposed that relative emergence can be estimated if the age and elevation of late glacial marine limits are known. This suggestion is used to construct 5 maps showing the amounts of relative sea level emergence since 4,000, 3,200, 2,400, 1,600 and 800 B.P. The archaeological sequence of coastal arctic Canada has been artifically divided into 5 corresponding 800 year periods. Eighty four archeological sites are examined; 71 of these appear to have been located with reference to contemporaneous sea level. The mean elevation of the 71 sites is only 5.2 m above the interpolated sea level for each period; the Spearman rank correlation between site elevations and interpolated sea level is 0.82. The maps can therefore be used to delimit area of search for cultural remains of specific ages in archeological reconnaissance, but the relationship is not sufficiently close to allow the construction of a detailed chronological sequence using elevation data alone. (Auth) BafBib 261

349. **Andrews, J.T., A. Mears, G.H. Miller, and D.R. Pheasant.** 1972. Holocene Late Glacial Maximum and Marine Transgression in the Eastern Canadian Arctic. *Nature Physical Science 239(96):147-149.*

This paper surveys the frequency distribution of 185 Carbon 14 dates from Baffin Island. There is a complete absence of dates between 20,000 and 10,500 B.P. This was not a period of widespread glaciation. A period of glacial readvance (the Cockburn Stade) occurred 7800 to 8400 B.P. and coincided with a marine transgression: it represents the late Wisconsin maximum in the area. The transgression, which is also seen in Europe, is correlated with the catastrophic disintegration of the Laurentide Ice Sheet over a few hundred Carbon 14 years. Strandlines from Europe and the Canadian Arctic are listed and thought: 1) to be synchronous and thus to have time-stratigraphic significance; 2) to reflect climatic changes during the Holocene. As far as ice cover is concerned, it is thought that most glacial chronologies are controlled by temperature, and that areas such as Baffin Island are controlled by precipitation and so do not correlate neatly with glacial sequences elsewhere. The decrease in volume of ice over eastern Baffin Island over the last 100, 000 years is related to a decrease in temperature and precipitation and the development of the main Laurentide centres to the southwest. (K.M. Clayton) GA 73A/0633

350. **Andrews, J.T., and G.H. Miller.** 1976. Quaternary Glacial Chronology of the Eastern Canadian Arctic: A Review and a Contribution on Amino Acid Dating of Quaternary Molluscs from the Clyde Cliffs. *Quaternary Stratigraphy of North America, W.C. Mahaney (Ed). Dowden, Hutchinson and Ross, Inc., Stroudsburg, Penn., (pp. 1-32), 512 pp.*

The eastern Canadian Arctic represents both a sensitive and stable area located along the northeastern margin of the Laurentide Ice Sheet. Isochrones on deglaciation show the Laurentide Ice Sheet retreating in general to the northeast so that the last major residual ice mass lay over Baffin Island by 6700 B.P. In contrast, extensive lichen-free areas on the interior plateaux testify to a major permanent snowcover during the Little Ice Age. The Quaternary stratigraphy and glacial chronology is based on a number of different approaches including relative weathering, depth of soil formation, Carbon 14 and U-series ages and amino acid diagenesis. Excellent but complex stratigraphy is exposed along many of the outer forelands of eastern Baffin Island. These sections vary between 10 and 50 m in height and show a sequence of glacial tills, glaciomarine units and terrestrial organic peats and mucks. (Auth)(JTA) BafBib 425

351. **Andrews, J.T., and G.H. Miller.** 1979. Climatic Change over the Last 1000 Years, Baffin Island, N.W.T. *Thule Eskimo Culture: an Anthropological Retrospective, A.P. McCartney (Ed.). National Museums of Canada, National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 88, (pp. 541-554), 586 pp.*

Problems faced in establishing a geologic-climatic stratigraphy for Baffin Island over the last 1000 years are discussed in this paper. Many of these problems are associated with dating deposits and the interpretation of the "climate" part of the record. In addition, a summary of the available glacial chronology is presented in brief form, as well as new data on preliminary July temperature and summer precipitation reconstructions. The geological evidence, when combined with glaciological data, indicates that the present-day environment of the eastern Canadian Arctic is atypical of the last 1000 years. During this millennium, conditions such as prevail today may have occurred only about one-third of the time. For the remaining two-thirds of the time, our reconstructions suggest that summer temperatures were lower than the "warm" period of the 1940's and 1950's. (Auth)

Fig. 1 shows various proxy records for climatic change including two possible mass balance models for glacial variations, Carbon 14 dates on mosses buried by snow/ice, and fluctuations in the isotope and ice content of the Devon Island ice core. Fig. 2 shows temperature and precipitation reconstructions based on pollen data and on the ages of buried peats and soils. (JTA)

352. **Andrews, J.T., and K. Tyler.** 1977. The Observed Postglacial Recovery of Quebec and Nouveau-Quebec Since 12, 000 B.P. *Geographie physique et Quaternaire 31(3-4):389-400.*

Radiocarbon dated relative sea levels, the tilts of proglacial lake shorelines and raised marine shorelines, the directions of the tilt of these features, and postglacial delevelling are used to construct six isobase maps showing relative sea level movements over the last 12,000, 10,000, 8000, 4000, and 2000 years. No map has more than 30 control points and usually there are only 12 "good" points controlling the isobase patterns. Each map shows a relationship of the isobases to the current ice sheet extent. Along the southern margin of the Laurentide Ice Sheet, the maximum postglacial emergence has been quite uniform with the 240 to 200 m isobase always close to the ice margin. Along the northeastern margin of the ice sheet, the postglacial emergence at the retreating ice edge was closer to 100 m. Equidistant diagrams are drawn along the planes southeast from southern Hudson Bay and eastward from Southampton Island. If these diagrams are compared on a Shoreline Relation diagram, the two profiles appear similar and compare moderately well with a theoretical SR Diagram published in 1969. The isobases show a major uplift center located around the area of James Bay and southern Hudson Bay where a maximum emergence of nearly 300 m occurred in the last 7500 years. High marine limits southwest of Ungava Bay need to be dated because if they date close to 8000 B.P. as we suggest, then more emergence is suggested for the region southwest of Ungava Bay than we currently allow for. (Auth) BafBib 270

353. **Andrews, J.T., and P.J. Webber.** 1969. Lichenometry to Evaluate Changes in Glacial Mass Budgets: as Illustrated from North-Central Baffin Island, N.W.T. *Arctic and Alpine Research 1(3):181-194.*

Direct measurement of the growth of ALECTORIA MINUSCULA over 4.3 growing seasons enables a further assessment to be made on the value of lichenometry around the Barnes Ice Cap. Detailed lichen sampling in two formerly glacierized valleys allows isophyses to be drawn for specific diameters of A. MINUSCULA. The gradients of the isophyses are similar to those of lateral glacial features. These reconstructions define ice margins from about 1650 A.D. to the present time and enable glacier changes in length, area, and volume to be estimated for the Lewis and Pintail glaciers. Local differences in the trend of area or volume loss are explained by differences in deglacial history. Specific ablation for the expanded Lewis Glacier below the 500 m ice contour averaged about 1.5 m ice equivalent per year, a value not dissimilar to those determined on the present glacier of about 1.3 m ice equivalent. Sampling over extended distances on substrates of similar age around the Barnes Ice Cap indicates comparable maximum lichen diameters are present. The value of lichenometry in arctic areas is reaffirmed. (Auth) BafBib 370

354. **Anonymous** 1966. The Present and "Historic" Glaciation of Kamchatka. Sovremennoe i "istoriceskoe" oledenenija Kamcatki. *Izv. Akad. Nauk., ser. Geogr. (Moskva), 3:70-78.*

The exact geomorphologic investigations in Kamchatka in 1959-1963 show the true extent of Holocene glaciation, the result of which are the present glaciers. Number and size of the present glaciers are given and compared with the values of Ivankov (1958) and Vinogradov (1965). A map shows their position. The peninsula has more than 290 glaciers of more than 0.1 km (E+2) and covering a total of 487.5 km (E+2). The present glaciation is characterized and compared to the Holocene glaciation. The influence of volcanic action is discussed. (translated from Ref. Geographie (Leipzig), 1966, 2161) GA 67A/963

355. **Baranowski, S.** 1977. The Subpolar Glaciers of Spitsbergen Seen Against the Climate of this Region. *Acta Universitatis Wratislaviensis 410:1-93.*

In Spitsbergen the Holocene can be divided into six periods of glacier response: 1) 11,000 to 7000 B.P.–decrease of glacier volume; 2) 7000 to 3500 B.P.–climatic optimum and glaciers reduced in size but stable; 3) 3500 to 2000 B.P.–advance of glaciers and increase in their mass; 4) 2000-750 B.P.– retreat of the glaciers; 5) 750 to 100 B.P.–advance of the glaciers; and 6) the last 100 years–recession of the glaciers and small decrease in mass. Graphs are presented showing changes in glacier elevations for the last several decades. (JTA)

356. **Barnett, D.M., and G. Holdsworth.** 1974. Origin, Morphology, and Chronology of Sublacustrine Moraines, Generator Lake, Baffin Island, Northwest Territories, Canada. *Canadian Journal of Earth Sciences 11(3):380-408.*

Locations of eleven Carbon 14 samples, obtained from organics washed into deltaic sediments, are shown on a map (Figure 5). A chronology for ice retreat is delimited for the last 4500 years. (JTA)

357. **Beget, J.E.** 1981. Early Holocene Glacier Advance in the North Cascade Range Washington. *Geology 9:409-413.*

Moraines and glacial drift of the White Chuck advance were deposited in early Holocene time in cirques near Glacier Peak, Washington. These sediments overlie Glacier Peak tephra, including layers G.N.F.C.M.T. and B which were erupted between about 12, 500 and 11,250 yr. B.P. White Chuck drift is overlain by Mazama tephra layer O, deposited about 6,700 yr. B.P. Charcoal collected from till deposited during the White Chuck advance is about 8,300 to 8,400 radiocarbon years old, indicating that the glacial advance that deposited the till occurred about this time and that a previously unrecognized period of cooling and/or increased precipitation of sufficient intensity to produce glacial advances comparable to or greater than those of the recent Little Ice Age occurred in early Holocene time in the North Cascade Range. (Auth)(JTA)

358. **Beget, J.E.** 1983. Radiocarbon Dated Evidence of Worldwide Early Holocene Climate Change. *Geology 11:389-393.*

Radiocarbon dated glacial deposits from several different areas of the world indicate that alpine glaciers and ice caps in parts of both the Northern and Southern Hemispheres expanded in response to climatic change in Early Holocene time. These data suggest that a worldwide episode of cooler climate similar in scope to the more recent Neoglaciation occurred ca 8,500-7,500 yr B.P. (Auth)

359. **Bellair, N.** 1967. Climatic Variations during the Last Millenium at the Kerguelen Islands. Variations Climatiques durant le Dernier Millenaire aux Iles Kerguelen. French. *Comptes Rendus Hebdomadaires des Seances de l'Academie des sciences, Serie D, 264(17):2085-2088.*

On the N tip of Grande Terre, Kerguelen a raised beach 4 m above MSL believed to be about 5500 B.P. representing the climatic optimum, is capped by a peat deposit 1.5 m thick, which was analyzed for sediments, pollen, and absolute age. Carbon 14 dating showed 800 yr at a level 30 cm above the peat base. From this, 100 yr was estimated for the bottom of the deposit which is also the top level of a Flandrian transgression. At 50 cm above the peat base there is a gravel layer estimated above 600 yr marking a milder stage, followed by more peat characterstic of Heard I., and finally evidence of present warm-up after 1750 A.D. (AntB I-9126) AntB I-9126

360. **Bellair, P.** 1966. Problems of the Quaternary in the French Sub-Antarctic. Problemes du Quaternaire dans les Iles Subantarctiques Francaises. *Quaternaria 8:259-261.*

Subantarctic islands of Indian Ocean have been under the climatic influence of the Antarctic ice sheet since the beginning of Quaternary times. Volcanism is still active in these islands, but there are not permanent volcanoes. Marine terraces are rare, except the 4 m level, which probably corresponds to the climatic optimum 5,500 B.P. Frontal moraines of the last glaciation are under the sea. The glaciation has never developed a wide ice cap all over Kerguelen Islands, which are too small for a thick mass of ice. (Auth) (JTA) GA 68A/785

361. **Bellair, P.** 1971. Deglaciation, Glacio-Eustatism, Isostasy: the Seas of the Canadian Post-Glacial. Deglaciation, Glacio-Eustatisme, Isotasie: Les Mers du Post-Glaciaire Canadien. *Bulletin de l'Association francaise pour l'etude du Quaternaire 2:51-55.*

The deglaciation of Europe and North America were strongly out of phase due to the more southerly extent of the North American ice sheet and its slower rate of melting. Latitude for latitude, North America is colder than Europe. On the premise that the pas de Calais opened in 9000 B.P. and sea-level rose to zero in the Climatic Optimum, the ice over Hudson's Bay is calculated to be about 3 km thick still at the earlier date (explaining the Cochrane Stage, which is absent in Europe). Moreover, the Antarctic ice must have been melting at an even slower rate, losing only 3% by volume between 6500 B.P. and 5000 B.P. (John Thornes) GA 72A/1213

362. **Belopukhova, E.B.** 1963. Features of Permafrost Development in the Northwest of Western Siberia in the Late Holocene. K Voprosu ob Osobennostiakh Razvitiia Mnogoletnmerzlykh Porod na Severo-zapade Zapadnoi Siberi v Pozdnem Golotsene. Russian. *Akademiia nauk SSSR. Inst. Merzlotovedeniia. Mnogoletnemerzlye Gornye ... (pp. 218-224).*

Some data on cryogenic and postcryogenic phenomena in the Poluy-Nadym interfluve in Recent time are reported. An unseparated sandy loam-clayey stratum of alluvial, alluvial-lacustrine, and deluvial deposits formed from the middle of the upper Pleistocene to the present is analyzed. Thermokarst processes, thawing of

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ice veins in peat bogs, formation of polygonal relief, etc. are analyzed. Development of thermokarst is concluded to have been more intense in the late Holocene than at present. This and other signs indicate a warming of the climate or increase of its continentality. An increase in the thawing of permafrost in the 5-8th centuries A.D. is also considered. (Auth) AB77367

363. **Benedict, J.B.** 1967. Recent Glacial History of an Alpine Area in the Colorado Front Range, U.S.A. I. Establishing a Lichen-Growth Curve. *Journal of Glaciology 6(48):817-832.*

A lichen growth curve for the Front Range, Indian Peaks region 70 km northwest of Denver, Colorado. RHIZOCARPON GEOGRAPHICUM was found to be the best lichen. It could be used to date features up to 3000 years old. Its ecology is discussed in terms of rock type, abrasion, shading, temperature, moisture, stability of substrate and length of growing season. Lichen growth rates can be established using historically dated surfaces or Carbon 14 dates. Twenty-four historically dated surfaces were used up to 69 years old. Mudflows, dated by Carbon 14 were also used. Observations were also made on Indian walls 970 years old, which suggest that lichens now between 40 and 47 mm across started to grow at that time. Ground moraine had a date of 510 B.C. with 94 mm lichens. Average growth of R. GEOGRAPHICUM in this area is 3.3 mm/100 years and is slow by world standards due to lack of moisture. The largest thallus measured was 220 mm and 6000 years old. (C.A.M. King) GA 68A/780

364. **Benedict, J.B.** 1968. Recent Glacial History of an Alpine Area in the Colorado Front Range, U.S.A., II. Dating the Glacial Deposits. *Journal of Glaciology 7(49):77-87.*

Cirques in the Colorado Front Range were studied to obtain a chronology of the recent ice advance. The climate is cold, dry and windy and present glaciers are small. Dating was done mainly by lichenometry. Fifty moraines were sampled. Three phases of moraine formation were established, some producing dual or triple moraines. The youngest are the Gannett Peak moraines dated between 1650 and 1850 A.D. Then the Arikaree moraines come next, of which the earliest and largest ice extent reached a maximum in 250 A.D., a second stage occurred about 550 A.D. and a third advance reached a maximum in 950 A.D. The Temple Lake moraines are more subdued and they occur between 0.1 and 0.3 km from the present glaciers. The youngest of these was deposited in about 900 B.C., while the glaciation started about 2500 B.C. Alluviation of the high plains occurs during the later stages of mountain glaciation, as the climate becomes warmer and drier. (C.A.M. King) GA 68A/1124

365. **Benedict, J.B.** 1973. Chronology of Cirque Glaciation, Colorado Front Range. *Quaternary Research 3(4):584-599.*

Moraines and rock glaciers in Front Range cirques record at least four, and possibly five intervals of Holocene glacier expansion. The earliest and most extensive was the Satanta Peak advance, which deposited multiple terminal moraines near present timberline shortly before 9915 + or - 165 B.P. By 9200 + or - 135 B.P., timberline had risen to at least its modern elevation; by 8460 + or - 140 yr B.P., patterned ground on Satanta Peak moraines had become inactive. Although a minor ice advance may have occurred just prior to 7900 + or - 130 B.P., there is no evidence that glaciers or perennial snowbanks survived in the Front Range, during the "Altithermal" maximum (c 7500-6000 B.P.), or during a subsequent interval of alpine soil formation (c 6000-5000 B.P.). Glaciers were larger durng the Triple Lakes advance (5000-3000 B.P.) than at any other time during Neoglaciation. Minimum ages of 4485 + or - 100 B.P., 3865 + or - 100 B.P. and c 3150 B.P. apply to a threefold sequence of Triple Lakes deposits in Arapaho Cirque. After an important interval of soil formation and cavernous weathering, glaciers and rock glaciers of the Audubon advance (1850-950 B.P.) reoccupied many cirques and perennial snow banks blanketed much of the area above present timberline; although the general Audubon snow cover had begun to melt from valley floors by 1505 + or - 95 B.P., expanded snowbanks lingered on tundra ridge crests until 1150-1050 B.P., and glaciers persisted in sheltered cirques until at least 955 + or - 95 B.P. Following a minor interval of ice retreat, glaciers of the Arapaho Peak advance (300-100 B.P.) deposited multiple moraines in favourably oriented cirques. (Auth)(JTA) GA 74A/1490

366. **Bergstrom, E.** 1973. The History of the Pre-Recent Local Glaciation in the Scandinavian Mountains. Den Prerecenta Lokalglaciationens Utbredningshistoria Inom Skanderna. Swedish, English Summary. *Naturgeografiska Institutionen, Forskningsrapport 16, 214 pp.*

Table 1 presents data on the timing of local mountain glacier fluctuations. Glacial moraines are present in several areas during the Pre-Boreal and one example is noted within the Boreal as well as another site within the Atlantic period. Most glaciers expanded during the Sub-Atlantic. Dating these events is based on the position of moraines in relation to raised marine shorelines and lichenometry. (JTA)

367. **Binns, R.E.** 1972. Flandrian Strandline Chronology for the British Isles and Correlation of some European Postglacial Strandlines. *Nature 235:206-210.*

"Strandline correlations, derived from a study of the distribution and origin of drift pumice found on certain European and Arctic postglacial strandlines, are presented. ...an intimate connexion exists between strandlines and climate variations. The culmination of a transgression and of a shoreline construction phase should approximately coincide with the culmination of a climatic optimum." (Auth)

Table 3 summarizes chronology data presented in the text. Correlation between episodes of shoreline formation in Fennoscandia and Svalbard and Great Britain are discussed. The strandlines were apparently constructed during the following periods (B.P.): 7000-6700, 6450-6200, 5700-5500, 5000-4700, 4400-4300 (minor), 4100-3900, 3700-3500, 3200-3000, and 2500-2400 B.P. The latest date is associated with a marked climatic deterioration. (JTA)

368. **Bird, J.B.** 1970. The Final Phase of the Pleistocene Ice Sheet North of Hudson Bay. *Acta Geographica Lodziensia 24:75-87.*

Evidence from physical setting, marine transgression, Carbon 14 shell dates, stratigraphy, and landforms supports earlier views that the Pleistocene ice sheet left residual caps on Southampton Island in northern Hudson Bay. At least four may have melted within four or five centuries; the largest, 7,000 yr. B.P., may have had a perimeter close to the present 200 m contour in the uplands. The ice margin seems to have retreated principally from south and west; how long remnants lasted in the northeast part of the island is not known. Cirques here appear to have been occupied by ice in postglacial times. (from Abstracts N. American Geology)(JTA) GA 72A/0672

369. **Black, R.F.** 1976. Late-Quaternary Glacial Events, Aleutian Islands, Alaska. *IUGS—International Geological Correlation Program, Project 73-1-24, Report No. 3, On the session in Bellingham, Washington, USA, September 1975;*

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Quaternary Glaciations in the Northern Hemisphere, D.J. Easterbrook and V. Sibrava (Eds.), (pp. 285-301).

This note emphasizes the striking uniformity of timing of deglaciation of ice caps that covered many Aleutian Islands up to about 11,000 radiocarbon years ago. A Neoglacial advance and retreat of alpine glaciers occurred about 3,000 years B.P. Other intervening fluctuations of alpine glaciers are apparently less uniform from island to island. Much still remains to be learned about fluctuations of the alpine glaciers and also about many internal inconsistencies in the Carbon 14 dates. Futhermore, considerable difficulty has been experienced in separating glacial deposits from lahars (Crandall, 1971). (Auth)(JTA)

370. **Black, R.F.** 1981?. Late Quaternary Climatic Changes in the Aleutian Islands, Alaska. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 47-62), 464 pp.*

A radiocarbon-dated, soil-tephra sequence documents the major events: 1) ice-cap deglaciation 12,000-10,000 B.P.; 2) major alpine glacier advances in the general intervals 7500-5500 and 3500-2000 B.P.; and 3) a Hypsithermal Interval peaking about 5500-3500 B.P. Summers are and have been shorter, cooler, and wetter in the western Aleutians than in the eastern, in part a consequence of a more continental one and an outpouring of cold Arctic air from Siberia. The major changes of climate in the Aleutian Islands are accompanied by major changes in the intensity and position of the Aleutian Islands. That low is controlled in part by the temperature of the north Pacific Ocean waters vs. the colder Bering Sea. The dominant westerlies are intensified in winter, especially with Arctic air, and probably were throughout the years of the glacial advances. Marked changes in the climate of the Aleutians are accompanied or followed by changes in the climate elsewhere. (Auth)

371. **Blake, W., Jr.** 1963. Notes on Glacial Geology, Northeastern District of Mackenzie. *Geological Survey of Canada Paper 63-28, 12 pp.*

This report describes glacial features and evidence of marine submergence in a 55,000-square mile area 65 deg-19 deg N. 102 deg-112 deg W. centered about Bathurst Inlet, from 1962 Operation Bathurst data, air-photo interpretation, and ground traverses. Former shorelines are well developed about 100 ft. above the present level of Contwoyto Lake. Evidence of marine submergence 700-750 ft. above sea-level is noted near Bathurst Inlet. Radiocarbon dates for marine shells are summarized; they suggest the highest beaches 10,200 yrs. B.P., the end moraine near MacAlpine Lake 8,200 yrs. B.P., and the rate of land uplift presumably less than 1.5 ft./100 yrs. at present. (AB77510)(JTA) AB77510

372. **Blake, W., Jr.** 1966. End Moraines and Deglaciation Chronology in Northern Canada, with Special Reference to Southern Baffin Island. *Geological Survey of Canada Paper 66-26, 31 pp.*

Reports first accurate mapping of a 325 mile long end moraine system, crossing Frobisher Bay. Another end moraine crossing Foxe Peninsula is thought to correlate with it. Carbon 14 dates indicate that some segments of the Frobisher Bay system were forming about 8,200 B.P. and continued to form for several hundred years. (AB94066) AB94066

373. **Blake, W., Jr.** 1970. Studies of Glacial History in Arctic Canada. I. Pumice, Radiocarbon Dates, and Differential Postglacial Uplift in Eastern Queen Elizabeth Islands. *Canadian Journal of Earth Sciences 7(2,Part 2):634-664.*

Dark brown pumice has been discovered recently on raised beaches of Ellesmere and Devon Islands, and in archeological sites on Baffin Island. It is similar in appearance and chemical composition to pumice associated with raised marine features throughout northern Europe, especially along the coasts of Norway and Spitsbergen. The source area for the pumice is uncertain, but Iceland is a good possibility. Radiocarbon dates on driftwood and whale bones imbedded in beaches at the "pumice level", as well as at higher and lower elevations, indicate that the pumice arrived approximately 5000 years ago. (AUTH)(JTA)

Radiocarbon dates are presented on three tables. The data suggest that there was considerable seasonal open water in northern polar areas about 5000 years ago. (JTA)

374. **Blake, W., Jr.** 1972. Climatic Implications of Radiocarbon Dated Driftwood in the Queen Elizabeth Islands, Arctic Canada. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 77-104), 511 pp.*

Numerous radiocarbon dates show that by 10,000 years ago the disintegration of the Innuitian Ice Sheet was well underway in the western part of the Queen Elizabeth Islands, although a lobe of the Laurentide Ice Sheet still impinged on the south coast of Melville Island at that time. By 8,000 years ago all of the inter-island channels were open, with the possible exception of the northern part of Nares Strait between Ellesmere Island and Greenland. The oldest driftwood logs discovered, from widely separated parts of the archipelago, are between 8,500 and 8,000 years old. Driftwood 6,500 to 4,500 years old is especially abundant, indicating that at least as much open water as at present, and probably more, existed during that interval. The marked decrease in the abundance of driftwood between approximately 4,500 and 500 years B.P. is attributed to the onset of more severe sea ice conditions, an event which coincided with the development of ice shelves, especially along the north coast of Ellesmere Island, but perhaps elsewhere in the archipelago as well. (Auth)

Thirty-two Carbon 14 dates are listed in three tables. (JTA)

375. **Blake, W., Jr.** 1974. Periglacial Features and Landscape Evolution, Central Bathurst Island, District of Franklin. *Geological Survey of Canada Paper 74-1B, (pp. 235-244).*

This paper describes the periglacial features which occur along the low, central valley across Bathurst Island named Polar Bear Pass. From the radiocarbon age determinations, a time framework is now available for the periglacial landforms of this area. Several hundred years were required for Polar Bear Pass to become free of glacial ice following the deglaciation of the hilltop areas. From marine molluscs dated at 8,440 + or - 150 yr, it is possible to determine when Polar Bear Pass became an arm of the sea. Marine submergence occurred to 150 ft (46 m). With isostatic rebound, modern features such as the beach ridges were created at successively lower elevations. Current height of Polar Bear Pass is 100 ft (30 m) above sea level. It is believed that this valley persisted as an arm of the sea for nearly 4,500 yr. The central section of Polar Bear Pass is characterized by various landforms such as braided channels, low-centred non-sorted tundra polygons, undercut lakeshore banks which expose ice wedges, and beaded streams. All of these features are illustrated in aerial photographs of the Polar Bear Pass area.

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During the melt season of each year, much of the valley bottom is inundated with water which results in deposition of silt on the tundra of the valley bottom. The lakeshore banks are undercut and large blocks of silty peat topple into the lake under a process of thermo-abrasion. At a point 3 mi north of the main channel of the Goodsir River a succession of marginal drainage channels has been cut across a ridge. These channels were excavated by meltwater flowing towards Goodsir Inlet at a time when Polar Bear Pass was still occupied by ice. Current water flow in these channels is high early in the summer while the outlet of the channel is still dammed by the winter's accumulation of snow. The last feature described at the eastern end of the pass is a miniature pingo which because of the solid core of ice resembles a pingo more than a palsa. In this pingo, dated at 1,170 + or - 150 yr, peat at 9 to 12 cm depth was frozen. (Ecol Can 893)(JTA) Ecol Can 893

376. **Blake, W., Jr.** 1975. Studies of Glacial History in the Queen Elizabeth Islands, Canadian Arctic Archipelago. *Naturgeografiska Institutionen, Forskningsrapport 21, (pp. 1-14).*

This paper contains summaries of five papers that together constitute a doctoral thesis (University of Stockholm). Paper 1 outlines the pattern of glacial isostatic rebound over the last 5000 years in the vicinity of Jones Sound. Paper 2 discusses Carbon 14 dated driftwood collected from beaches around the Queen Elizabeth Islands which show a maximum concentration of driftwood between 6500-4500 B.P. when it is presumed that the channels between the islands were seasonally ice free; Paper 5 documents in great detail a Carbon 14 dated emergence curve for Cape Storm, southern Ellesmere Island, eustatic sea level variations over the last 8000 to 3500 B.P. have not exceeded 2 m in amplitude or for periods of greater than 500 yr. (JTA)

377. **Blake, W., Jr.** 1976. Glacial Ice Cores, Climate, and Chronology Around Northern Baffin Bay. *Fourth Biennial Meeting of the American Quaternary Association, Tempe, Arizona, October 9 and 10, 1976, (pp. 20-21).*

This contribution is intended to summarize the available chronological evidence from land areas around northern Baffin Bay, because the chronology of events deduced from ice cores must accommodate the marine and terrestrial record as to when nearby areas were glacierized and when they were ice-free. The time scale for changes in delta (oxygen isotope ratios), as derived by Dansgaard and co-workers, is in good general agreement with the chronology derived from radiocarbon dating of marine molluscs on nearby coasts: 1. The faunal composition and the nature of the strata above the MYTILUS-bearing horizons suggest that environmental conditions as favourable as during the Holocene have not existed for a period of time exceeding 40,000 years; the same conclusion is implied by the delta record (Dansgaard and Johnsen, 1969; Dansgaard et al., 1971, 1973). 2. A pronounced change in delta is indicated as having occurred between 13,000 and 10,000 years B.P. The evidence from the marine fauna in no way contradicts the hypothesis that this was a period of warming, during which large volumes of ice were being removed, and that the incursion of the sea onto the existing islands (areas now above sea level) took place between 10,000 and 9,000 years ago. 3. In the Camp Century core the maximum values of delta during the Holocene occur between 6000 and 5000 years B.P. (Johnson et al., 1972). This coincides with the period, as determined by the distribution of Carbon 14 dated driftwood, during which there was apparently a less extensive cover of sea ice in the Canadian Arctic Archipelago (Blake, 1972). It is also the time when the ice shelf fringing the northern coast of Ellesmere Island was much less extensive, if in fact it existed at all. (Auth)(JTA)

378. **Blake, W., Jr.** 1977. Holocene Glacier Fluctuations and Sea Level Changes in Arctic Canada: A Reply. *Geografiska Annaler 59A(3-4):257-260.*

A reply to Ives' article entitled, "Late- and Postglacial Glacier Fluctuations and Sea Level Changes in Arctic Canada," Geografiska Annaler, Ser. A, v. 59A, no. 3-4, 1977, pp. 253-256. Blake states that his 1975 paper did not intend to claim that there were no postglacial glacier advances in the Canadian Arctic Islands, but only that there was no stratigraphic evidence of such advances in the Jones Sound Region. (SPIRES/ASTIS) SPIRES/ASTIS

379. **Blake, W., Jr.** 1978. Aspects of Glacial History, Southeastern Ellesmere Island, District of Franklin. *Geological Survey of Canada Paper 78-1A, (pp. 175-182).*

Field work in the summer of 1977 for the project "Quaternary geochronology, Arctic Islands" concentrated on the 100 km-long Makinson Inlet area of southeast Ellesmere Island. Remains of the ground beetle AMARA ALPINA, which today does not occur north of Cape Sparbo, Devon Island, found in peat deposits of a valley wall east of the inlet's north arm indicate former conditions more favourable than at present. At least two episodes are indicated by the peat bearing sequence when ice occupied Makinson Inlet. Dating of an aragonitic shell of HIATELLA ARCTICA collected at 40 m a.s.l. from marine sediments on Swinnerton Peninsula give a value of 8930 + or - 100 yr when marine waters penetrated the west arm of Makinson Inlet. Dating of shells from the head of the north arm suggest a further 1400 to 1800 radiocarbon years for this arm to be ice-free. (Ecol Can 2788)(JTA) Ecol Can 2788

380. **Blake, W., Jr.** 1981. Neoglacial Fluctuations of Glaciers, Southeastern Ellesmere Island, Canadian Arctic Archipelago. *Geografiska Annaler 63A(3-4):201-218.*

A series of age determinations related to fluctuations of outlet glaciers during Holocene time are reported. Dates of 5180 + or - 260 years (GSC-2909) and 2590 + or - 150 years (GSC-3191) for the bottom and top, respectively, of a massive peat deposit bracket a period during which outlet glacier 7A-45, north of the head of Makinson Inlet, was smaller than it is at present. Data from several sites suggest an advance of glaciers about 1000 years ago, and a second advance, during the last 100 years or so, is recorded at the margins of a number of glaciers draining the ice caps in central and southeastern Ellesmere Island. (Auth)(JTA)

Fourteen Carbon 14 dates are listed (Table 2) that pertain to neoglacial fluctuations. Nine of these are on Salix (willow) stems and two on Dryas. (JTA)

381. **Blake, W., Jr.** 1981. Lake Sediment Coring along Smith Sound, Ellesmere Island and Greenland. *Geological Survey of Canada Paper 81-1A, (pp. 191-200).*

During the 1979 and 1980 field seasons, cores of bottom sediments have been recovered from six lakes on the Ellesmere Island side of Smith Sound and from three lakes in Inglefield Land, northwestern Greenland. Radiocarbon age determinations on basal organic materials from a lake at 390 m on Pim Island and from a lake at 295 m above Ekblaw Glacier, innermost Baird Inlet, indicate that both areas were free of glacier ice by 9000 years ago. The basal moss-rich sediment from a pond at 300 m in a moraine above Baird Inlet is slightly younger, perhaps because dead ice may have persisted at that locality. (Auth)

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382. **Borns, H.W., Jr., and R.P. Goldthwait.** 1966. Late-Pleistocene Fluctuations of Kaskawulsh Glacier, Southwestern Yukon Territory, Canada. *American Journal of Science 264(8):600-619.*

The 45-mile long Kaskawulsh is one of many outlet glaciers draining the glacier-filled coastal Icefield Ranges into the dry interior of Yukon Territory. Its deposits express the major climatic changes of the last 10,000 years. A retreat occurred 12-9,000 years ago, leaving drift and alluvial fans. Up to 8 feet of Kluane loess were then deposited and buried 9700 years old vegetation near the present glacier terminus. During the Slims non-glacial interval weathering developed a bright red-yellow paleosol in the loess. In the lower part of a bog, just above the Neoglacial terminal moraine, there are dominant grass pollen and moss spores suggesting a wetter climate than today. Just above the 3300 year old date in this bog, peat with sedges, spruce and ARTEMISIA pollen show a marked change to a drier climate. A new unweathered loess (Neoglacial loess) covers the red-yellow paleosol and 2600 year old vegetation, representing the start of a Neoglacial advance 2600-3000 years ago. Kaskawulsh glacier reached its terminal position about 300 years ago (Carbon 14 dates) and was there as late as 145 years ago, when it bent over a spruce tree with countable rings. Halting retreat has left 2 ice-covered loop moraines completed in 1870 and 1933. (Auth) GA 69A/150

383. **Boulton, G.S.** 1979. Glacial History of the Spitsbergen Archipelago and the Problem of a Barents Shelf Ice Sheet. *Boreas 8:31-57.*

The popular concept of a Late Weichselian ice sheet covering the Barents Shelf and confluent with the Scandinavian and Russian ice sheets is based primarily on the 6500 B.P. isobase which rises to the east over Spitsbergen, and to the west over Franz Joseph Land. Analysis of uplift curves from the Spitsbergen archipelago shows, however, that the strongest early Holocene uplift occurs over northeastern Spitsbergen and eastern Nordaustlandet, falling both to east and west, and that the centre of uplift migrates to the southeast during the Holocene. Direct evidence of glacier fluctuation indicates an important Billefjorden Stage of glaciation at about 11,000 to 10,000 B.P., part of whose extent can be defined by moraines and by abrupt changes in the marine limit. The dominant ice masses of the Billefjorden Stage seem to have formed over eastern Spitsbergen, Edgeoya, Barentsoya and southern Hinlopenstretet, and it is the decay of this ice mass which is primarily responsible for the pattern of early Holocene uplift. (Auth)(JTA)

384. **Boulton, G.S.** 1979. A Model of Weichselian Glacier Variation in the North Atlantic Region. *Boreas 8:373-395.*

The evidence for the extent and timing of Weichselian glaciation in arctic regions shows, among other things, that a major period of glacier expansion was between 11,000 and 8,000 B.P., and thus that glacier fluctuations at the southern margins of the Laurentide and Fennoscandian ice sheets were out of phase with others in the Arctic which advanced during southern interstadials. Phases of glacier advance in the Arctic can be identified in deep sea cores by the peaks in concentration of iceberg-dropped detritus and an increase in sedimentation rates, which are highest when sub-polar water penetrates to the north. The expansion of glaciers within the Arctic between 11,000 and 8,000 B.P. was associated with the first and diachronous penetration of moisture into a still cool Arctic during decay of the two greatest ice sheets. (Auth)(JTA)

385. **Boulton, G.S., J.H. Dickson, H. Nichols, and S.K. Short.** 1976. Late Holocene Glacier Fluctuations and Vegetation Changes at Maktak Fiord, Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 8(4):343-356.*

Maktak Glacier is a major distributary of the Penny Ice Cap and thus changes in its frontal position reflect variations in the mass balance of the ice cap. The Neoglacial terminal moraine of this glacier consists of a 20-m thick sedimentary sequence of till, overlain by up to 18 m of sands and gravels which contain a 1-m thick peat bed. These sediments were deformed by glacier pushing and are overlain by a younger till. The basal till and the overlying sands and gravels beneath the peat were deposited during the retreat from the Cockburn Stade. The site was deglaciated at some time after 5000 to 6000 B.P. Peat on a terrace surface was studied using "absolute" pollen analyses, and clustering routines to distinguish pollen zones. The start of peat growth at 2500 B.P. (synchronous with such events elsewhere) is attributable to altered permafrost levels and/or increases in precipitation/evaporation budgets, producing wetter conditions locally. The vegetational history began with a moist willow episode, which was followed by a dominantly grass community as local conditions became drier. The initial rapid growth of peat became progressively slower throughout the profile, until by 1500 B.P. the slow accumulation of humified peat was overwhelmed by windblown sand which inhibited further growth. A subsequent Maktak Glacier advance deposited sands and gravels over the peat bed. Between 350 and 65 B.P., glacial pushing and overriding of the terrace and peat sediments occurred. Exotic tree pollens were identified in the sediments; their changing frequencies may provide some tentative measure of changing air flows into the High Arctic. The eastern part of the Penny Ice Cap, as represented by the the Maktak Glacier, may have a relatively simple Holocene history of post-Cockburn decline, growth after 4000 B.P., and decline in recent decades. This contrasts with more complex response patterns of small cirque glaciers in the same area. It is stressed that the data used in the paper cannot identify small-scale glacier oscillations. (Auth) BafBib 324

386. **Boyer, S.J.** 1972. Pre-Wisconsin, Wisconsin, and Neoglacial Ice Limits in Maktak Fiord, Baffin Island: A Statistical Analysis. *M.Sc. Thesis, University of Colorado, Boulder, CO, 117 pp.*

Ages of Wisconsin advances are established by correlation. The age of deglaciation (6350 + or - 110 years B.P.) is based on a radiocarbon date on shells in a marine limit. Ages of maximum Neoglacial ice advances (all within the last 100 years) are based on lichenometry. (Auth)(JTA)

387. **Bray, J.R.** 1964. Chronology of a Small Glacier in Eastern British Columbia, Canada. *Science 144(3616):287-288.*

The age of trees growing on the moraines of a small, high-altitude glacier in the Canadian Rockies suggests that the date of the maximum post- Pleistocene ice advance was around 1714 A.D., with another later advance about 1832. These two dates are synchronous with the two major periods of recent ice advance in the area. (Author(from Geoscience Abstracts)) GA 65/387

388. **Bray, J.R.** 1965. Forest Growth and Glacier Chronology in North-West North America in Relation to Solar Activity. *Nature 205(4970):440-443.*

For 1750-1960 A.D. a correlation of +0.47 is noted between the bole growth per decade of PICEA ENGELMANNII and mean yearly sunspot number per decade. Glacier readvances, inferred from tree ring information, are dated at 1700-1732, 1811-1853 and 1890-1914 A.D. (JTA)

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389. **Bray, J.R.** 1970. Temporal Patterning of Post-Pleistocene Glaciation. *Nature 228(5269):353.*

Most post-Pleistocene glaciation has been confined to four phases at intervals of about 2,600 years. The exact timing of these phases is examined in relation to recent radiocarbon ages and additional glacial chronologies. The apparent cyclic recurrence of the four phases and their synchronism in Europe, North America, and elsewhere suggest they have a similar cause; their occurrence near the thermal maximum suggests that the underlying mechanism is independent of that determining the predominant Holocene temperature trend. There are two major Holocene temperature patterns which are probably causally independent but additive in their expansion; one may result from changes in the Earth's orbit relative to the Sun, and the other may be related to cyclic intervals of decreased solar activity. If the patterns continue, the following changes may be expected; slow cooling to around A.D. 2450 followed by 3,000 years of more cooling, and a period of cooling and glaciation around A.D. 4300 according to the second pattern. A possible new glacial era may thus begin around A.D. 4300 (the next predicted 2,600-year temperature decline) or sooner if the rapid cooling predicted (from the first pattern) to occur after A.D. 2450 is sufficient. (Geophysical Abstracts) GA 72A/0656

390. **Bray, J.R.** 1974. Glacial Advance Relative to Volcanic Activity Since 1500 AD. *Nature 248(5443):42-43.*

Glacial advances are dated on the basis of tree ring studies and historical observations. A total of 128 dates was compiled with 112 from Europe and 16 from North America. Maximum recorded glacial advances occurred in 1700-1720 and 1840-1860 A.D. There is strong statistical correlation between dates of glacial advance and dates of volcanic eruptions: for the 128 maximum glacial advance dates, 111 occurred within 24 yr after the 23 volcanic eruptions. (JTA)

391. **Bryson, R.A.** 1967. Radiocarbon Isochrones of the Retreat of the Laurentide Ice Sheet. *University of Wisconsin, Department of Meteorology, Technical Report no. 35, 26 pp.*

This report presents a map showing the position of the ice front at 500 yr intervals over the last 13,000 yr. The retreat is shown to have averaged 12 mi/century over much of eastern North America. The computational method using radiocarbon dates is explained. Of the many dates used, isarithmic analysis showed that surprisingly few were clearly incorrect. The most striking conclusion is the continuous presence of the ice sheets until well after the accepted close of Wisconsin time ca 10,500 B.P., with continental ice sheets persisting through the entire hypsithermal period. Hudson Bay and Foxe Basin cleared early (ca 8000 B.P.), and a broad low corridor opened from the Arctic to the Plains in Boreal time (ca 8500 B.P.). The paleoclimatologic implications of the study are discussed. (Auth) AB94271

392. **Bryson, R.A., W.M. Wendland, J.D. Ives, and J.T. Andrews.** 1969. Radiocarbon Isochrones on the Disintegration of the Laurentide Ice Sheet. *Arctic and Alpine Research 1(1):1-14.*

The last great event of the Wisconsin Glacial Stage in North America was the distintegration of the Laurentide Ice Sheet. This occurred between 13,000 and about 5,000 years ago and had a profound effect upon the paleogeography of the continent. Analysis of present-day distribution of fauna and flora, the archaeological record, and climatic and sea-level fluctuations are intimately bound up with ice sheet disappearance, yet there has been no systematic attempt to utilize existing radiocarbon and geological data to attempt a plot of the ice sheet perimeter at specific intervals through time. The present paper makes this attempt in the form of two maps (Figures 1 and 2), the first being an objective portrayal of isolines drawn on the radiocarbon data, the only assumption being that the ice sheet perimeter tended to parallel the coastline or, more particularly, the trend of the outer edge of the continental shelves and the southern limit of Wisconsin till on land; the second map is a subjective interpretation of the first based upon geologic field evidence and the climatic and geomorphic intuition of the writers. Some of the immediate implications raised by the maps are discussed and a series of significant conclusions are derived: (1) The northern limit of the Laurentide Ice Sheet proper was close to the arctic mainland coast of Canada. (2) There was a dramatic change from an east-west ice barrier near latitude 60 deg N in late-glacial time, to a broad low corridor from the Arctic Ocean to the Great Plains in Boreal time. (3) The Laurentide Ice Sheet retained its identity as a distinct unit until about 8,400 years B.P. (Cockburn Stade) and had catastrophically disintegrated during Atlantic time, within a few centuries of 8,000 years B.P. (4) The three remaining ice remnants centered over Keewatin, Labrador-Ungava, and Foxe Basin–Baffin Island persisted through the Atlantic climatic episode (altithermal), that on Baffin Island surviving to the present day in the form of the Barnes Ice Cap. (Auth) BafBib 398

393. **Budyko, M.I.** 1966. Polar Ice and Climate. Russian, English Summary. *Memorandum RM-5233 NSF, Symposium on the Arctic Heat Budget and Atmospheric Circulation, J.O. Fletcher (Ed.), Proceedings, Lake Arrowhead, CA, Jan. 31-Feb. 4, 1966. Rand Corporation, Santa Monica, CA, (pp. 3-21), 567 pp.*

Discusses the quantitative relations between the regime of polar ice and climatic conditions. It is shown that if snow and ice covered the whole surface of the earth its mean temperature would decrease by 100 deg C. Theoretic computations of ice covers and thickness are compared with mean actual conditions. Graphs are presented which indicate that a small anomaly of the summer temp decreases ice thickness much more than a large anomaly in the cold months. A 4 deg C positive anomaly in summer will melt the old polar ice completely in four yr, although it is possible an even smaller anomaly could initiate a self-perpetuating trend producing the same result. The present polar ice depresses the winter temp 30-35 deg C and the summer temp 5 deg C. In an Arctic Ocean without pack ice, as in pre-glacial times, shore ice several hundred km in width forms each winter and melts completely each spring. A slight negative anomaly in temp could produce expansion of this to produce old ice covering most of the Arctic Ocean. The instability of the present ice cover is demonstrated and the possibility and effects of its artificial removal briefly considered. (AB94289) AB94289

394. **Burbank, D.W.** 1981. A Chronology of Late Holocene Glacier Fluctuations on Mount Rainier, Washington. *Arctic and Alpine Research 13(4):369-386.*

Lichenometric studies permit close dating for the timing of stabilization of the late Holocene moraines built by North Mowich, Carbon, Winthrop, Cowlitz, and Ohanapecosh glaciers on Mount Rainier. The moraine chronologies indicate synchronous responses among these glaciers during the past 200 yr. Periods of glacier recession began between 1768-1777, 1823-1830, 1857-1863, 1880-1885, 1902-1903, 1912-1915, and 1923-1924. Since the early 19th century, the mean equilibrium-line altitude has risen about 60 m on Mount Rainier. Minimum ages for earlier glacier variations are based on lichenometric, dendrochronologic, and tephrochronologic data. These data indicate that recessional phases commenced about 1328-1363, 1519-1528, 1552-1576, 1613-1623, 1640-1666, 1690-1695, 1720, and 1750. Whereas the pattern of glacier fluctuations at Mount Rainier agrees with the general chronologic framework of late Holocene variations from many other areas, comparisons of the detailed moraine chronologies from Mount Rainier for the past two centuries with those from Swedish Lapland indicate several differences in the timing of moraine stabilization. These differences imply some nonsynchrony in Northern Hemisphere glacier variations during the late Holocene. (Auth)

395. **Burrows, C.J.** 1973. Studies on Some Glacial Moraines in New Zealand–2. Ages of Moraines of the Mueller, Hooker, and Tasman Glaciers (S79). *New Zealand Journal of Geology and Geophysics 16(4):831-855.*

The criteria (lichen measurements, geomorphology, vegetation cover and degree of weathering of rocks) used for comparing and dating moraine ridges near the Mueller, Tasman and Hooker glaciers at Mount Cook are briefly discussed. Characteristic landforms, indicating that episodes of glacier expansion have occurred, include sharp-crested lateral moraines. A description is given of the chronology of moraine ridges formed by periods of expansion of three glaciers during the last 700-800 years, illustrated by maps, diagrams and photographs. There have been marked expansions of one or more of the glaciers in A.D. mid 12th century, early and mid-to-late 17th century, mid and late 18th century, early, mid, and late 19th century and about 1930. There may have been other minor expansions during this time span. (Auth)

396. **Burrows, C.J.** 1975. Late Pleistocene and Holocene Moraines of the Cameron Valley, Arrowsmith Range, Canterbury, New Zealand. *Arctic and Alpine Research 7(2):125-140.*

In the Cameron Valley in Central South Island, New Zealand, a chronology for 5 sets of moraines of different ages has been developed using available radiocarbon dates and inferred correlation with dated sequences in adjacent areas. The youngest moraines have been dated using lichenometry, shrub growth layers, and one radiocarbon date. The oldest moraines are believed to be of Waimaungan (penultimate glaciation) age. The Lake Heron moraines were formed in Late Otiran (last glacierization) time, possibly 17,000 to 14,000 years ago. The two Wildman moraines are Late Otiran surfaces, believed to be between 12,000 and 10,000 years old. The Aranuian (Holocene) moraines include the undated Lochaber set, the Marquee 1 and Marquee 2 moraines, probably spanning the period 4500 to 2000 yr B.P. and the Arrowsmith set, ranging from more than 600 years old to 40 years old. (Auth) GA 75A/1930

397. **Burrows, C.J.** 1979. Chronology for Cool-Climate Episodes in the Southern Hemisphere 12,000-1,000 yr. B.P. *Palaeogeography, Palaeoclimatology, Palaeoecology 27(3/4):287-347.*

A radiocarbon-dated chronology of glacial events and other phenomena related to cool climate shows that series of relatively cool episodes occurred in Southern Hemisphere localities about 11,500-9500 (several events), 8000, 5400, 4800-4500, 3600, 2700-2200, 1800-1500 and 1100-900 radiocarbon yr. B.P. Warmer periods presumably intervened between the cool episodes and the longest warm part of the Holocene seems to have been about 9000 (8000)-(6000) 5000 yr. B.P. There are indications of some regional differences in intensity of the cool periods. The data are considered in two time periods by regions: New Zealand; Australia and Tasmania; New Guinea; Antarctic Continent; circumpolar subantarctic islands and islands near the Antarctic Peninsula; northern Andes; southern Andes; and African tropical mountains. (Auth. mod.) AntB I-22322

398. **Burrows, C.J., and A.F. Gellatly.** 1981. Holocene Glacier Activity in New Zealand. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 41-47), 47 pp.*

Radiocarbon dates show that the last main Pleistocene glacial event in New Zealand ended before about 14,000 yr B.P. In the interval 14,000-9,000 yr B.P. there is evidence for several events during which, although glaciers were much smaller than those of the Pleistocene, they were much greater than at any subsequent time. More data are needed to establish a clear chronology for this period. A lesser glacial advance is dated about 8000 yr B.P. There are no definite dates for glacier activity, then, until about 4500 yr B.P. Then some glaciers advanced several kilometers beyond their modern terminal positions. Smaller advances (generally of decreasing magnitude) occurred about 3500, 2300, 1800, 1600, 1000, 860, 660, 530 and 340 yr B.P. There were subsequent small advances for which there are no radiocarbon dates. Relative dating, by rock weathering rinds, indicated that there were advances about 300, 550, 800, 1000, 1800, 2500, 4500 and 8000 years ago. The dates obtained by this method for some older surfaces, with the presently available calibration curve, are too young. (Auth)

399. **Cailleux, A.** 1973. Postglacial Cold Periods in Eastern Canada. Coups de Froid Postglaciares dans l'Est du Canada. French. *Cahiers Geologiques 89:10-15.*

This paper includes information from regions near Quebec City and Abitibi in the province of Quebec where polygonal terrain blocks 20 to 60 m in diameter, separated from each other by furrows, were formed under a cold climate, near the southern limit of permafrost. The most recent ones are dated, near Quebec, from 6000 B.P. (4000 B.C.) or younger. (Auth)(JTA)

400. **Calkin, P.E.** 1982. Holocene Glacial Chronology of the Brooks Range, Northern Alaska. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 3-8), 47 pp.*

Lichenometric mapping of deposits fronting 53 cirque glaciers and 9 valley glaciers in the Brooks Range, defines up to eight major episodes of Holocene glacial expansion near-equal in magnitude. Retreat and disappearance of most Pleistocene valley glaciers by 11, 000 yr B.P. was apparently followed by minimal early to mid Holocene glacial activity; glacier-cored rock glacier tongues may be the only exposed evidence. A limited number of moraines record the earliest major advances with lichenometric ages of 4400, 3500, and 2900 yr B.P. Evidence for subsequent morainal stabilization at 1800, 1150, 800, and 390 yr B.P. are increasingly more widespread. A date of 1120 yr B.P. on dead moss emerging from beneath a retreating glacier suggests that for the past 1000 yr glaciers may have been continuously more advanced than now. Preserved, emergent lichen at this site imply some ice masses were less extended for the preceding 1500 yr or more. Glaciers throughout Brooks Range, stayed close to their maxima following the 390 yr B.P. (A.D. 1410-1600) expansion and major end moraines were formed by many glaciers in the Atigun area and eastern Brooks Range around the late 1800's. Historic data help document subsequent accelerated recession until the early 1950's. (Auth)

401. **Calkin, P.E., and J.M. Ellis.** 1981. A Cirque-Glacier Chronology Based on Emergent Lichens and Mosses. *Journal of Glaciology 27(97):511-515.*

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Recession of "Golden Eagle" glacier in the central Brooks Range is exposing undisturbed lichen-cover boulders. Radiocarbon analysis of dead moss surrounding these boulders dates a Neoglacial advance across this site at 1,120 + or - 180 years B.P. Measurements of the preserved lichens indicate that a minimum ice-free period of 1,500 - 2,500 years preceded this glacial expansion. (Auth)

402. **Carrara, P.E.** 1972. Late and Neoglacial History in Smirling and Sulung Valleys, Eastern Baffin Island, N.W.T., Canada. *M.Sc. Thesis, University of Colorado, Boulder, CO, 50 pp.*

The glacier which headed in the south-facing corrie, (Sulung Valley), reached its maximum glacial extent before those glaciers which headed in the north-facing corries. These latter glaciers reached their maximum glacial position at approximately the same time, and this has been dated at between 6,000 and 8,000 years B.P. The four Neoglacial ice-cored moraines of the Akudlermuit Glacier have been dated at 850; 1,375; 1,825; and 3,850 years B.P. Ages for deposits were obtained using a published RHIZOCARPON GEOGRAPHICUM s.l. growth curve for the area. Ages for the older deposits (late-glacial) were obtained by using the dates of the Neoglacial deposits and comparing these to the relative age parameters on the moraines. When this was done it was found that it would take approximately 6,400 years to develop an 80% lichen covered surface and about 8,400 years to develop a weathering percent of eighty. (Auth)(JTA)

403. **Carrara, P.E.** 1975. The Ice-Cored Moraines of Akudnirmuit Glacier, Cumberland Peninsula, Baffin Island, N.W. T., Canada. *Arctic and Alpine Research 7:61-67.*

The Akudnirmuit Glacier, a small localized ice body during late- Wisconsin and Neoglacial times, deposited five morainal systems in the hanging cross valley between the heads of Narpaing and Quajon fiords (67 deg 35 min N, 65 deg 15 min W). The inner four of these moraines are ice-cored and the glacier's terminus is covered by ablation till. The outer-most morainal system, pre-Altithermal in age, has no ice core, indicating that conditions during the Altithermal were such that the former ice core did not survive this period. Currently, the ice cores are down-wasting. This is attested to by the presence of kettle lakes, the amount of stream dissection, the numerous slides occurring at the debris/ice interface, collapse features, and thermistor data. Many lichen-covered boulders at the bases of the moraines indicate that the ice-cored deposits were stable until quite recently. Thermistor data indicate that even with a thin debris cover much less heat is conducted into the ice of the moraines than into a debris-free site on a nearby glacier. (Auth)

404. **Carrara, P.E.** 1980. End of "Little Ice Age" in Glacier National Park. *U.S. Geological Survey Professional Paper 1175, (p. 222).*

From an analysis of tree-ring cores taken from the forest trimline areas in front of the Agassiz and Jackson Glaciers in Glacier National Park, Mont., P.E. Carrara found that an advance during the mid-1800's resulted in the maximum ice extent of the post-Pleistocene Epoch. Retreat from this "Little Ice Age" maximum began during the 1860's and has continued to the present day. Many glaciers of 200 yr ago have been reduced to stagnant ice bodies or have disappeared entirely. One of the most drastic reductions in ice volume has been that of the Agassiz Glacier. During the mid-1800's, this glacier was 3.5 m in length, approximately 2.5 sq km in area and at least 200 m in thickness. Today, it has been reduced to a small (0.25 sq km) stagnant ice mass that is probably less than 10 m thick throughout. Presently, its total volume is probably less than 5 percent of its "Little Ice Age" maximum. (Auth)

405. **Carrara, P.E., and J.T. Andrews.** 1972. The Quaternary History of Northern Cumberland Peninsula, Baffin Island, N.W.T. Part I: The Late- and Neoglacial Deposits of the Akudlermuit and Boas Glaciers. *Canadian Journal of Earth Sciences 9(4):403-414.*

Moraines of local glaciers predating the Neoglacial occur in sections of northern Cumberland Peninsula. A study of these deposits is reported for the area between the heads of Quajon and Narpaing Fiords. A chronology is developed based on lichenometry, percent of lichen cover, and the weathering of boulders and pebbles. Initial dating is done by lichenometry and dates older than about 6000 B.P. are attempted by establishing rates of weathering. About 12,500 B.P. glaciers existed in both south- and north-facing corries with an equilibrium line at 850 m a.s.l. During the next 5000 years the south-facing glaciers retreated and disappeared. About 7000 B.P., moraines were deposited in front of the Akudlermuit and Boas glaciers–these moraines are no longer ice-cored. The equilibrium line lay between 850 and 975 m a.s.l. A "warm" interval followed and the ice cores melted. This was followed by an early Neoglacial advance, dated about 3800 B.P. for the period of moraine stabilization; after a 2000 year interval four younger readvances are recorded. All Neoglacial moraines are ice-cored. During the last few decades the equilibrium line has risen. (Auth) BafBib 376

406. **Carrara, P.E., and J.T. Andrews.** 1975. Holocene Glacial/Periglacial Record; Northern San Juan Mountains, Southwestern Colorado. *Zeitschrift fur Gletscherkunde und Glazialgeologie 11(2):155-174.*

Field data, including weathering, morphological, vegetative, Carbon 14 and lichenometrical dating techniques are used to develop a chronology of glacial, periglacial, and climatic events from 16,000 B.P. to present. Several Carbon 14 dates of basal bog sediments from northeasterly-facing cirques at altitudes of approximately 3700 m indicate that deglaciation of much of the high country occurred prior to 9000 B.P. Two groups of pre-Altithermal moraines have been recognized in the alpine zone. The older group of moraines (Yankee Boy) may have been deposited between 9000 and 10,000 B.P. The younger group of moraines (Grenadier) is tentatively dated at around 8000 B.P. Many rock glaciers in this range probably began development immediately after deglaciation early in the Holocene prior to the Altithermal, and many in north-facing cirques have remained active to the present day. Evidence for recent lowering of treeline has been found in several areas and is correlated with the Gannett Peak glaciation. Currently, snowbanks in the area, many at the head of protalus ramparts, are rapidly wasting from what appears to be a recent local maximum 30 or 40 years ago. (Auth)(JTA)

The bog stratigraphy evidence from the area indicates that a major change occurred about 5000 years ago from an improving late glacial climate to the alternating Neoglacial climate. (JTA)

407. **Caseldine, C.J.** 1983. Resurvey of the Margins of Gljufurarjokull and the Chronology of Recent Deglaciation. *Jokull 33:111-118.*

The studies undertaken in 1981 which extended work started in 1979 have now led to the development of a more reliable chronology for the recent deglaciation of Gljufurardalur as summarised below: a) Gljufurarjokull began to retreat from its "Little Ice Age" maximum during the last decade of the 19th century and over the next twenty years retreated about 250 m. b) Between the middle of

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the second decade of the 20th century and 1930 this rate of retreat slowed and there may have been a short phase of glacial advance or stillstand. c) There was more rapid retreat in the 1930s, probably of the order of 200 m with the formation of more exstensive ridge systems in the mid-1930s. By 1940 the margin of Gljufurarjokull lay close to the position now defined by the major ridge system on which Station 6 stands. d) Retreat continued to the position marked by the 1946 aerial photograph and possibly slightly beyond this point before a period of readvance in the late 1940s, which eventually formed, at its maximal extent, the ridge system mentioned in c). This was completed in 1950-51. e) Glujufurarjokull then retreated to its minimum position in the mid-1970s before advancing by up to 50 m between 1977 and 1979, with a further 30 m of advance between 1979 and 1981. (Auth)

408. **Caviedes, C.N.** 1975. Quaternary Glaciations in the Andes of North-Central Chile. *Journal of Glaciology 14(70):155-170.*

The extension of the Quaternary glaciations has been studied in the semi-arid Andes of north-central Chile, where the glacial modelling is striking. In the Elqui valley (lat. 30 deg S), two glacial advances were identified reaching down to 3,100 m (Laguna glaciation) and 2,500 m (Tapado glaciation). In the Aconcagua valley (lat. 33 deg S), moraines from three major glacial advances were found, at 2,800 m (Portillo glaciation), 1,600 m (Guardia Vieja glaciation) and 1,300 m (Salto del Soldado glaciation). The Quaternary glaciations were linked with a decrease of temperature, but more significantly with a marked increase of precipitation probably related to an equatorward shift of 5-6 degrees of the austral polar front. The results obtained in the semi-arid Chilean Andes are correlated with those recently reported form other sectors of the southern Andes. (Auth)

409. **Craig, B.G.** 1964. Surficial Geology of East-Central District of Mackenzie. *Geological Survey of Canada Bulletin 99, 41 pp.*

Complete glaciation during Wisconsin time is indicated by an abundance of glacial landforms and glacially deposited material, and by modification of the bedrock surface. Deglaciation progressed eastward from the Artillery and Clinton-Colden Lakes area; glacial lakes were formed at several levels; final glacial Lake Thelon lay along the Thelon valley at 800 to 700 ft, and Hyper- Dubawnt lay west of present Dubawnt Lake at 900 ft. Final deglaciation was probably completed 7,000 yr ago. (AB86328)(JTA) AB86328

410. **Craig, B.G.** 1965. Notes on Moraines and Radiocarbon Dates in Northwest Baffin Island, Melville Peninsula, and Northeast District of Keewatin. *Geological Survey of Canada Paper 65-20, 7 pp.*

A linear belt of end moraines lies, both spatially and chronologically, midway in the sequence of deglaciation in the 400, 000 square miles northwest quadrant of the area covered by the Wisconsin Laurentide ice-sheet. This study presents nine new radiocarbon dates bearing on the age of these moraines, and offers a somewhat different interpretation of their significance in the deglaciation of the area from that given by G. Falconer and others. Carbon 14 dates suggest the formation of these so-called Cockburn moraine segments no more than 9,000 yrs BP, though their distribution is inadequate reconstruction of an ice marginal position on Melville Peninsula. (AB86327) AB86327

411. **Craig, B.G.** 1969. Late-Glacial and Postglacial History of the Hudson Bay Region. *Geological Survey of Canada Paper 68-53, (pp. 63-77).*

Reports data from 1967 Operation Winisk fieldwork in the Hudson Bay Lowland and with earlier, including unpubublished data, interprets the directions and chronology of deglaciation, marine invasion and uplift in the whole region. Retreat of the last Wisconsin ice sheet began in northern Canada some 13,000 yr B.P.; the final disappearance of ice in the Hudson Bay region occurred approximately 7000 yr B.P.; Carbon 14 dates of marine shells place the marine invasion via Hudson Strait at approximately 8000 yr B.P. A map shows the maximum limits of the Tyrrell Sea, which succeeded a lacustrine episode in the James Bay Lowland where the ice first disappeared. (AB102943) AB102943

412. **Curl, J.E.** 1980. A Glacial History of the South Shetland Islands, Antarctica. *Ohio State University, Institute of Polar Studies, Report No. 63, 129 pp.*

A glacial geology program was conducted in the South Shetland Islands. Field investigations concentrated on Byers Peninsula, Fildes Peninsula and in coastal embayments. A tentative glacial history reconstructed for the South Shetland Islands demonstrates at least two distinct ages of glaciation separated by a warmer climate interval that is interpreted as the Sangamon Interglacial. Radiocarbon dates and lichenometric ages suggest that the two late Neoglacial advances occurred at approximately 1475 A.D. and 1720 A.D. The ice margins have thinned gradually since the Neoglacial fluctuations probably in response to the secular warming trend that commenced recently and extended until about 1940. Both the long-term and short-term glacial fluctuations in the South Shetland Islands appear to be broadly synchronous with world-wide climatic trends. (Auth)

413. **Currey, D.R.** 1974. Probable Pre-Neoglacial Age of the Type Temple Lake Moraine, Wyoming. *Arctic and Alpine Research 6(3):293-300.*

When originally described in the the 1940s the type Temple Lake moraine was regarded as probably of latest Wisconsin, or late preclimatic optimum, age. In subsequent stratigraphic usage, however, the name Temple Lake has generally been applied to the initial, post-Altithermal stade of Neoglaciation. The present study indicates that the type Temple Lake moraine is indeed pre-Neoglacial, as originally suspected; evidence for this includes a minimum limiting date of 6,500 + or - 230 Carbon 14 years B.P. from the base of a bog on the type moraine. A group of moraines upvalley from the type moraine is probably correlative with the Temple Lake stade of Neoglaciation recognized elsewhere in the Rocky Mountains. Possible revisions of glacial stratigraphic nomenclature are discussed. (Auth)

414. **Dahl, R.** 1968. The Retreat of the Reintind Glacier (Frostisen). Note. *Norsk Geografisk Tidsskrift 22(4):271-273.*

In connection with a communication about the retreat of the Reintind glacier in Norsk Geogr. Tidsskrift 21:2 (Ritchie 1967), some complementary information is given here as a result of field investigations at Frostisen and Meraftesfjell during the summers of 1950 and 1951. According to Ritchie's (op.cit.) calculations the retreat of the ice margin was 12.8 m per annum during the period 1934-1963. If, however, account is taken of the fact that in the direction of measurement the ice margin only retreated 40 m from 1950 to 1963, the figures will be 21 m per annum in the years 1934-1950 and only 3 m per annum during 1950:1963. (Auth)(JTA)

A map showing the position of the retreating ice margins of the Reintind Glacier in 1906, 1934, 1950 and 1963 is presented and discussed. (JTA)

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415. **Davies, W.E.** 1961. Glacial Geology of Northern Greenland. German Summary. *Polarforschung 5(31):94-103.*

Summarizes studies of 1956-1960 which disclose four distinct phases of the latest glaciation. As it spread, it obliterated traces of previous ones. Retreat of the ice mass began some time prior to 6000 yr ago. This was followed by a rise in sea level which deposited clay-silt that was succeeded by kame gravels around stagnant ice lobes in the larger valleys. Marine terraces up to 129 m above present sea level developed as readjustment took place in the land free of ice. About 3700 yr ago an advance of glaciers down major fjords took place, followed by retreat to approx the present position of the ice. Peary Land till contains only locally derived materials indicating that the central Greenland icecap did not cover this area. (AB86421) AB86421

416. **Denton, G.H., and W. Karlen.** 1973. Holocene Climatic Variations–Their Pattern and Possible Cause. *Quaternary Research 3:155-205.*

In the northeastern St. Elias Mountains in southern Yukon Territory and Alaska, Carbon 14 dated fluctuations of 14 glacier termini show two major intervals of Holocene glacier expansion, the older dating from 3300-2400 calendar yr B.P. and the younger corresponding to the Little Ice Age of the last several centuries. Both were equivalent in magnitude. In addition, a less-extensive and short-lived advance occurred about 1250-1050 calendar yr B.P. (A.D. 700-900). Conversely, glacier recession, commonly accompanied by rise in altitude of spruce tree line, occurred 5975-6175, 4030-3300, 2400-1250, and 1050-460 calendar yr B.P., and from A.D. 1920 to the present. Detailed mapping and dating of Holocene moraines fronting 40 glaciers in the Kebnekaise and Sarek Mountains in Swedish Lapland reveals again that the Holocene was punctuated by repeated intervals of glacier expansion that correspond to those found in the St. Elias Mountains and elsewhere. The two youngest intervals, which occurred during the Little Ice Age and again about 2300-3000 calendar yrs B.P., were approximately equal in intensity. Advances of the two older intervals, which occurred approximately 5000 and 8000 calender yrs B.P., were generally less extensive. Minor glacier fluctuations were superimposed on all four broad expansion intervals; those of the Little Ice Age culminated about A.D. 1500-1640, 1710, 1780, 1850, 1890, and 1916. In the mountains of Swedish Lapland, Holocene mean summer temperature rarely, if ever, was lower than 1 deg C below the 1931-1960 summer mean and varied by less than 3.5 deg C over the last two broad intervals of Holocene glacial expansion and contraction (Auth)(JTA)

417. **Denton, G.H., and W. Karlen.** 1974. Holocene Climatic Variations, Their Pattern and Possible Cause. *Climatic Research Unit Research Publication No. 2; Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the Time of the Last Glacial Maximum about 17,000 Years Ago, Proceedings of an International Conference, Norwich, May 17-22, 1973. Collected Abstracts. Climatic Research Unit, University of East Anglia, Norwich, England, (pp. 59-60), 123 pp.*

Glacier fluctuations in the St. Elias Mountains of the southern Yukon Territory and Alaska have been determined for 14 glacier termini. Radiocarbon dates indicate that periods of glacier recession, commonly associated with a rise in the spruce treeline, occurred 5975-6175, 4030-3300, 2400-1250, 1050-460 calendar years B.P., and from 1920 A.D. to the present. Dated glacier fluctuations from the Swedish Mountains show similarly dated events. Throughout the Holocene, glacier expansion intervals lasted up to 1750 years. The evidence suggests that episodes of glacier expansion occurred every 2500 years. (JTA)

418. **Denton, G.H., and W. Karlen.** 1977. Holocene Glacial and Tree-Line Variations in the White River Valley and Skolai Pass, Alaska and Yukon Territory. *Quaternary Research 7:63-111.*

Complex glacier and tree-line fluctuations in the White River valley on the northern flank of the St. Elias and Wrangell Mountains in southern Alaska and Yukon Territory are recognized by detailed moraine maps and drift stratigraphy, and are dated by dendrochronology, lichenometry, Carbon 14 ages, and stratigraphic relation of drift to the eastern (1230 Carbon 14 yr B.P.) and northern (1980 Carbon 14 yr B.P.) lobes of the White River Ash. The results show two major intervals of expansion, one concurrent with the well-known and widespread Little Ice Age and the other dated between 2900 and 2100 Carbon 14 yr B.P., with a culmination about 2600 and 2800 Carbon 14 yr B.P. Here, the ages of Little Ice Age moraines suggest fluctuating glacier expansion between A.D. 1500 and the early 20th century. Much of the 20th century has experienced glacier recession, but probably it would be premature to declare the Little Ice Age over. The complex moraine systems of the older expansion interval lie immediately downvalley from Little Ice Age moraines, suggesting that the two expansion intervals represent similar events in the Holocene, and hence that the Little Ice Age is not unique. Another very short-lived advance occurred about 1230 to 1050 Carbon 14 yr B.P. Spruce immigrated into the valley to a minimum altitude of 3500 ft (1067 m), about 600 ft (183 m) below the current spruce tree line of 4100 ft (1250 m), at least by 8020 Carbon 14 yr B.P. Subsequent intervals of high tree line were in accord with glacier recession; in fact, several spruce-wood deposits above the current tree line occur bedded between Holocene tills. High deposits of fossil wood range up to 76 m above present tree line and are dated at about 5250, 3600 to 3000, and 2100 to 1230 Carbon 14 yr B.P. (Auth)(JTA)

419. **Denton, G.H., and S.C. Porter.** 1970. Neoglaciation. *Scientific American 222(6):101-110.*

Changes in glacier extent and sea ice limits are illustrated from sites in the Yukon Territory, Canada, Alaska, Switzerland, and the Cascade Range, Washington. A generalized diagram of neoglaciation mountain glacier fluctuations suggests wide-spread intervals of glacier expansion around 5000 and 2500 B.P. and during the Little Ice Age. (JTA)

420. **Denton, G.H., and M. Stuiver.** 1966. Neoglacial Chronology, Northeastern St. Elias Mountains, Canada. *American Journal of Science 264(8):577-599.*

In the northeastern St. Elias Mountains, Yukon, Canada, drift morphology and stratigraphy, combined with 13 Carbon 14 dates, suggest the following Neoglacial and pre-Neoglacial chronology for the Donjek and Kaskawulsh glaciers: 1) About 12,500 B.P. ice of the Kluane glaciation (= classical Wisconsin by Carbon 14 dating) receded from near Kluane Lake and about 9780 B.C. withdrew behind the position presently occupied by Kaskawulsh Neoglacial moraines; 2) During the Slims non-glacial interval (basically Hypsithermal) glaciers maintained retracted positions: the Kaskawulsh terminus was located at least 13.7 miles up-glacier from its present position; 3) The initial Neoglacial advance, represented by onset of loess deposition, began shortly before 2640 B.P.; 4) Continuous loess deposition suggests that throughout the Neoglaciation glaciers maintained positions more extensive than those occupied during Slims interval; 5) The youngest major Neoglacial advance, the most extensive of the last 9780 years, occurred through the last few centuries and is bracketed by seven Carbon 14 dates. Glacier retreat from this maximum began before A.D. 1874 (Donjek glacier) and A.D. 1865 (Kaskawulsh glacier). (Auth) GA 69A/149

421. **Denton, G.H., and M. Stuiver.** 1967. Late Pleistocene Glacial Stratigraphy and Chronology, Northeastern St. Elias Mountains, Yukon Territory, Canada. *Geological Society of America Bulletin 78(4):485-510.*

Reviews previous work on the glacial geology of this range and presents results of the author's field studies of drift, cirque floors, striation, fluting and other features of glacial morphology. Flow directions of glacier ice are mapped, drift sections are illus, and a glacial chronology presented with Carbon 14 dates indicated. This shows four glaciations separated by three non-glacial intervals between >49,000 B.P. and present. The glaciations are identified as Shakwak (>49,000 B.P.), Icefield (49,000-37,000), Kluane (30, 100-ca 10,000), and Neoglacial (2640-present); the non-glacial intervals are Silver (>49,000), Boutellier, and Slims. Correlations of both glaciological and climatic parameters with other regions appear to indicate broadly synchronous fluctuations. (AB94830) AB94830

422. **Derbyshire, E.** 1962. The Deglaciation of the Howells River Valley and the Adjacent Parts of the Watershed Region, Central Labrador Ungava. *McGill Sub-Arctic Research Paper No. 14, McGill University, Montreal, Quebec, Canada, 23 pp.*

Presents nine conclusions based on detailed examinations in 1956-1958, of this area within 54 deg 40 min - 55 deg 15 min N. 66 deg 45 min - 67 deg 35 min W., part of the divide between southeasterly-flowing Atlantic waters and those flowing north to Ungava Bay. Field evidence is mapped on a scale of about 1 in.: 3 mi., most remarkable glacial modification is the widespread till. Glacial erosion is chiefly shown in the many shallow rock-bound lakes. Conclusions support views of J.D. Ives and others. Final ice movements on a regional scale was probably north-northwest parallel to the ridges of the sedimentary rocks of the Labrador Trough and to the western rim of Howells valley. Subglacial and submarginal drainage were most effective in later stages of deglaciation. Estimated annual loss of ice indicates rapid downwasting of the ice sheet in this district. Summer temperatures were evidently at least as high as at present; certainly during the isolation of ice masses in the major valleys, the glacial regimen was strongly negative. (AB70982) AB70982

423. **Derkson, S.J.** 1976. Glacial Geology of the Brady Glacier Region, Alaska. *Ohio State University, Institute of Polar Studies, Report No. 60, 97 pp.*

During the Hypsithermal (9,000-4700 B.P.), the Brady Glacier was probably smaller than at present. However, by 4700 B.P., the glacier was again advancing, and by 2900 B.P. was large enough to deposit glaciomarine sediments in Southwestern Dundas Bay. The climax of early Neoglacial activity occurred between 1960 B.P. and 1230 B.P. when the glacier was much larger than at present. Three lines of evidence indicate that the Early Neoglacial climax of the Brady Glacier was due to an average firn line elevation at about 534 + or - 77 m. This indicates a maximum lowering of average firn line of less than 123 m from its present height. Significant recession of the Brady Glacier followed the period of Early Neoglaciation, and a spruce forest grew along the shores of a greatly lengthened Taylor Bay. However, by 700 B.P. Brady ice was advancing again, and was somewhat larger than at present by 1650 + or - 105 A.D. The maximum phase of this Late Neoglacial advance did not occur until the last quarter of the 19th Century. Since this maximum the glacier's behavior has been characterized by only minor, halting retreat until 1961 when it began a slow readvance. (Auth) (JTA)

424. **Detterman, R.L., B.L. Reed, and N. Rubin.** 1965. Radiocarbon Dates from Iliamna Lake, Alaska. *U.S. Geological Survey Professional Paper 525-D, (pp. 34-36).*

A radiocarbon date of 8,520 + or - 350 B.P. from a lacustrine sand deposit in a terrace at the west end of Iliamna Lake establishes a minimum age for the second major advance of the Brooks Lake Glaciation. The advance must be considerably older than 8,520 yr, as other terraces are cut into the moraine as much as 49 ft above the dated terrace. (AB94846) AB94846

425. **Dineley, D.L., and R.S. Waters.** 1960. Notes on the Recent Advance and Retreat of Sefstrombreen in Ekmanfjorden, Vestspitsbergen. *Journal of Glaciology 3(28):693-697.*

Reports observations on the position of the ice front of Sefstrombreen glacier made in 1958 while with the Birmingham and Exeter Universities Spitsbergen Expedition. Comparison is made with data of five previous observations from 1936 back to 1882, and behavior of the ice front is mapped and interpreted. A rapid 6 km advance at the end of the nineteenth century has been followed by a slower but equally extensive retreat. Similarity of the position and outline of the ice front in 1882 and 1956 is noted, and reasons for it are suggested. (AB64192) AB64192

426. **Donner, J.J.** 1978. Holocene History of the West Coast of Disko, Central West Greenland. *Geografiska Annaler 60A(1-2):63-72.*

A chronology for the main Holocene events in Nordfjord, Mellemfjord and Disko Fjord on the west coast of Disko could be established with the help of radiocarbon dates of marine shells and a comparison with earlier results, particularly from the area south of Disko Bugt. The glaciers had retreated from the fjords before 8000 B.P. but the retreat from the outer coast began at about 10,000 B.P., possibly somewhat earlier. The relative emergence of the coast during and after the deglaciation ended at about 3000 B.P. The highest marine limit recorded was 85 m in Disko Fjord. At lower altitudes, below 45 m, marine terraces and beach ridges were formed. After 3000 B.P., when there were no land/sea level changes or possibly only a small subsidence, Neoglacial rock glaciers advanced from the cirques, often down to the present shore, most of them reaching their maximum position in A.D. 1600-1920. Periglacial features are common in the whole area: pingos occur in some of the main valleys. (Auth)

427. **Dort, W., Jr.** 1968. Warm Weather Neoglacial Advance, Southern Victoria Land, Antarctica. *Geological Society of America Special Paper 101:57.*

Groups of concentric recessional moraines constitute widespread evidence of extensive glacier retreat in Southern Victoria Land, Antarctica. Contrasting degrees of rock weathering and landform modification indicate several retreatal phases. It is suggested that the most recent advance of southern Victoria Land glaciers occurred during the Altithermal episode of higher temperatures clearly recorded in New Zealand and Australia and well established throughtout the Northern Hemisphere. Onset of colder temperatures, causing glacier rejuvenation in temperate regions, here resulted in reduced precipitation and glacier retreat by starvation. Worldwide parallelism of minor climatic fluctuations is indicated. (Auth)(JTA)

Glacial geologic

428. **Duford, J.M., and G.D. Osborn.** 1978. Holocene and Latest Pleistocene Cirque Glaciations in the Shuswap Highland, British Columbia. *Canadian Journal of Earth Sciences 15(6):865-873.*

Ages of glacial deposits in cirques of the Shuswap Highland, British Columbia are approximated or bracketed using tephrochronology, radiocarbon dating and lichenometry. There is evidence for two minor Holocene glacial advances. The younger, named the Raft Mountain Advance, is defined by the type Raft Mountain moraine, about 100 years old judging from RHIZOCARPON lichens. No volcanic ash is found on the moraine or its equivalents. The older, named the Dunn Peak Advance, is defined by the type Dunn Peak moraine and equivalent deposits in the Dunn Peak area. These deposits bear Mazama ash and are thus older than 6600 years; one of the moraines has a minimum radiocarbon age of about 7400 years. The deposits are younger than the Late Wisconsin deglaciation in southern B.C. (about 11,000 years B.P.). In addition, an earlier event, possibly a stillstand, is represented by a moraine (the Harper Creek moraine) downstream of the type Dunn Peak moraine. This moraine is also bracketed between 6600 and 11,000 years in age. The Dunn Peak Advance may be correlative with an Early Holocene Advance reported from the Canadian Rockies and northern American Rockies, and the Raft Mountain Advance is correlative with very recent advances reported from several parts of the world. (Auth)

429. **Dyke, A.S.** 1974. Deglacial Chronology and Uplift History: Northeastern Sector, Laurentide Ice Sheet. *M.Sc. Thesis, University of Colorado, Boulder, CO, 113 pp.*

Using data contained in published literature and the Radiocarbon Data Bank of the Institute of Arctic and Alpine Research, an isochrone map is constructed which describes the pattern of deglaciation of the northeastern sector of the Laurentide Ice Sheet from the time of the late Wisconsin maximum (8000 yr to 8500 yr B.P.) to the present. The change in area and volume of the Northern Baffin Island Ice Cap from 7000 yr B.P. to the present is calculated using the isochrone map and two models relating ice area to volume. The volume measurements are then used to determine the contribution of the ice cap to world sea level rise since 7000 yr B.P. Based on 325 shoreline locations, radiocarbon dated between 250 yr and 8750 yr B.P., eight isobase maps of the study area are produced depicting the amounts of uplift accomplished since 8000 yr B.P. and 1000 yr intervals thereafter. (Auth)(JTA)

430. **Dyke, A.S.** 1978. Glacial History of and Marine Limits on Southern Somerset Island, District of Franklin. *Geological Survey of Canada Paper 78-1B, (pp. 218-233).*

Southern and western Somerset Island were inundated by a foreign ice sheet that flowed onto the island from a major but undefined, and hitherto unrecognized, area of ice dispersal to the west. On the southernmost part of the island this ice was sufficiently thick to inundate summits rising to 500 m elevation and to defy topographic channelling of flow. The apparent Holocene marine limit at the mouth of Creswell Bay is marked by a wave-cut notch in bedrock and dates from 9270 + or - 90 years B.P. (Auth) (JTA)

431. **Dyke, A.S.** 1978. Indication of Neoglacierization on Somerset Island, District of Franklin. *Geological Survey of Canada Paper 78-1B, (pp. 215-217).*

One 30 to 40 sq km "lichen-free" summit area is underlain by gneissic bedrock and cannot be explained in terms of active layer processes, soil toxicity, or any other obvious characteristic. It does not support late-lasting snowbanks today. Apart from its lichen-free nature, it appears identical to surrounding terrain. One must conclude, therefore, that it has not been available for colonization for as long as the surrounding terrain. In other words, until recently it was snow or ice covered. Numerous much smaller lichen-free areas occur along the escarpments of cryoplanation terraces which are common features in the vast tor-dotted areas of the gneissic plateau and are the sites of late-lasting snowbanks today. This indicates that during the Little Ice Age much larger snowbanks lasted throughout the summer. Near the northeastern corner of the island evidence of two Neoglacial ice caps is in the form of tiny lateral and subglacial meltwater channels and eskers. Ten glaciers, some of which are 30 m or more thick, survive today on the walls of deep canyons. These exist because of enhanced accumulation of snow in the canyons by wind drift and protection from ablation by shadowing by the adjacent canyon walls. (Auth)(JTA)

The lichen-kill area is a summit about 405 m a.s.l. Small icecaps existed at 335 m a.s.l. The modern glaciation level is mapped at about 400 m by extrapolation from nearby areas thus suggesting a snowline lowering during the Little Ice Age of less than 100 m. (JTA)

432. **Dyke, A.S.** 1979. Glacial and Sea-Level History of Southwestern Cumberland Peninsula, Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 11:179-202.*

Southwestern Cumberland Peninula has been glacierized at various times by eastward flowing Laurentide ice, by an expanded Penny Ice Cap, and by fiord and valley glaciers fed from cirques. During the Ranger Stade, Laurentide ice reached the head of Cumberland Sound and coalesced with the western lobe of the Penny Ice Cap, and outlet glaciers from the southern part of the ice cap reached 20 km beyond their present positions. General deglaciation from the Ranger stadial maximum and coastal emergence from the Holocene limit began about 8700 yr B.P. Relative sea level at the Laurentide margin at that time was 88 m above present. During an early Holocene warm interval, Penny outlet glaciers receded rapidly and were at or behind their present margins by 7000 yr B.P. The Laurentide ice retreated much more slowly, forming eleven recessional moraines before it uncovered the head of Clearwater Fiord at 5700 yr B.P. The lowland between the head of Cumberland Sound and Foxe Basin was deglaciated between 7000 and 5700 yr B.P. by an eastward calving bay. After separation from Laurentide ice, the western lobe of the Penny Ice Cap readvanced about 4500 yr B.P. to form the Outer Penny Moraine. This was followed in turn by several smaller advances. (Auth)(JTA) Ecol Can 3281

433. **Dyke, A.S.** 1979. Radiocarbon-Dated Holocene Emergence of Somerset Island, Central Canadian Arctic. *Geological Survey of Canada Paper 79-1B, (pp. 307-318).*

The coastal fringe of Somerset Island was overlapped by the early Holocene sea, and an earlier sea apparently extended higher. Holocene marine limit features have not been definitely correlated with glacial features. However, a delta at 157 m a.s.l. near Stanwell-Fletcher Lake probably was deposited by meltwater; if so, marine limit on the western side of the island was formed at the time of deglaciation, as it was on northern Boothia Peninsula (Dyke, 1979). Thirty-six radiocarbon dates on marine shells (17), whale bones (13), driftwood (5), and a walrus tusk (1) have been obtained. Nine of these are on the marine limit and are 9200 + or - 100 years old. The 9200 year old shoreline rises from 76 m a.s.l. in the northeastern part of the island to more than 157 m a.s.l. in the southwest and has a parabolic gradient that steepens westward. The area of steepest gradient (1.4 m x km(E-1)) contains numerous ice marginal features that Dyke (1978, 1978) considered to mark the Wisconsin glacial limit. The steep gradient, therefore, may have been caused by sharp crustal deflection near the late Wisconsin ice margin. (Ecol Can 3281) (JTA) Ecol Can 3281

434. **Dyke, A.S.** 1980. Redated Holocene Whale Bones from Somerset Island, District of Franklin. *Geological Survey of Canada Paper 80-1B, (pp. 269-270).*

Holocene emergence curves for Somerset Island were described by the author (Dyke 1979) based on the radiocarbon age of 36 associated marine shells, whale and walrus bone and driftwood samples. Three of the 13 whalebone samples have been re-aged because of suspected contamination from lichen and moss growing on the bone and anomalously young age determinations. The new dates and other dates from shell samples suggest 9,200 plus or minus 100 yr B.P. as the approximate date of deglaciation of the marine limit sites of the north, east and south coasts of Somerset Island. If the new date for the whalebone sample from Cape Anne is the true radiocarbon age, then whales and open water existed off northern Somerset Island before deglaciation of most of the marine limit sites. (Ecol Can 3811)(JTA) Ecol Can 3811

435. **Ellis, J.M., and P.E. Calkin.** 1979. Nature and Distribution of Glaciers, Neoglacial Moraines, and Rock Glaciers, East-Central Brooks Range, Alaska. *Arctic and Alpine Research 11(4):403-420.*

The east-central Brooks Range was just high enough to support cirque glacierization during the middle to late Holocene; presently glaciers are shrinking. The 133 glaciers in the field area are all above 1500 m altitude, and those fronted by stable moraines occur on a trend surface rising from 1600 m south of the Continental Divide to 2000 m, 25 km farther to the north. Glaciers that extend into unstable ice-cored rock glacier deposits occur on a parallel trend 100 m below. Both trend surfaces reflect depletion of moisture derived predominantly from the southerly sources. Ice masses associated with both stable and unstable deposits have similar orientations significantly concentrated (asymmetric) about 012 deg, strongly minimizing exposure to insolation. This contrasts markedly with the symmetric orientation of Pleistocene glaciers. The transition from existing glaciers through tongue-shaped to lobate rock glaciers is characterizd by increasingly symmetric orientations and expanding altitudinal and areal distributions. For example, lobate rock glaciers are weakly asymmetric indicating decreased climatic sensitivity and increased screening by surrounding terrain relative to the other forms. (Auth)

436. **Ellis, J.M., T.D. Hamilton, and P.E. Calkin.** 1981. Holocene Glaciation of the Arrigetch Peaks, Brooks Range, Alaska. *Arctic 34(2):158-168.*

Eleven cirque glaciers and associated deposits within the granitic Arrigetch Peaks of the West-Central Brooks Range face north, minimizing insolation. Shading by surrounding mountainous terrain decreases insolation on these landforms even more significantly, favoring the formation of glacier-cored moraines. Comparison of glacier photographs taken in 1911, 1962, and 1979 reveals a record of decelerating recession. Geomorphic and lichenometric mapping suggests at least three to possibly eight phases of Holocene glacial expansion. These date between around 5000 and 300 yr B.P., based on the application of a central Brooks Range RHIZOCARPON GEOGRAPHICUM growth curve. (Auth)

437. **Emerson, D.** 1983. Late Glacial Molluscs from the Cooking Lake Moraine, Alberta, Canada. *Canadian Journal of Earth Sciences 20:160-162.*

Several species of freshwater mollusc, with radiocarbon dates of 10,900-9050 years B.P., have been recovered from supraglacial and intraglacial lacustrine sediments in the Cooking Lake moraine region of south-central Alberta, Canada. The organisms indicate the onset of a warming trend in the region that lasted at least 2000 years, marking the final stages of melting in the continental Wisconsin ice sheet. This period of climatic amelioration correlates with a similar trend in southwestern Alberta during the time interval 13,000-9000 years B.P. based also on the evidence of late and early postglacial molluscan communities. (Auth)

438. **England, J.H.** 1974. Advance of the Greenland Ice Sheet on to North-Eastern Ellesmere Island. *Nature 252(5482):373-376.*

A system of discontinuous moraines along the southern margin of Hazen Plateau (at the head of Discovery Harbour, Chandler Fiord, Ida Bay, Beatrix Bay and Simmonds Bay) indicates the terminal position of ice that drained from the United States Range in the last glaciation. These moraines are given a maximum date of 8,130 + or - 200 B.P. and are correlative with the Cockburn Stade of eastern Baffin Island. The chronology of late Quaternary glacial activity is significant for dating and paleoclimatic interpretation of ice cores. There is evidence of one or more major glaciations in the High Arctic during Quaternary times. (Ecol Can 956)(JTA) Ecol Can 956

439. **England, J.H.** 1974. The Glacial Geology of the Archer Fiord/Lady Franklin Area, Northeastern Ellesmere Island, N.W.T., Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 234 pp.*

This thesis provides a late glacial chronology for the northeastern margin of the proposed Innuitan Ice Sheet on Ellesmere Island. The Hazen Moraines, a major system of terminal and lateral moraines that occur on the southern margin of the Hazen Plateau and in inner Archer Fiord are either a prominent boundary of a recessional position or the position of the last glaciation in this part of Ellesmere Island. Dates from 34 radiocarbon shells indicate that post-glacial uplift began along the margins of the Hazen Moraines about 8100 B.P. Inland deglaciation occurred 7000 to 7300 years ago. Several of the large outlet glaciers of northern Ellesmere Island are as advanced today as they have been during the post-glacial period and they appear to be advancing. (Ecol Can 957)(JTA) Ecol Can 957

440. **England, J.H.** 1976. Late Quaternary Glaciation of the Eastern Queen Elizabeth Islands, N.W.T., Canada: Alternative Models. *Quaternary Research 6:185-202.*

The presence of the Innuitian Ice Sheet during the last glaciation is principally based on two sets of data. These are: 1) on the occurrence of a broad zone of greatest synchronous emergence, greater than 25 m, about 5000 B.P. and the maximum elevations of post-glacial features that extend through an axis from Bathurst Island to Eureka Sound; and 2) on the timing of initial post-glacial emergence and subsequent occurrence of driftwood in the interisland channels and fiords of the Queen Elizabeth Islands between about 9,000 and 8,000 B.P. (Ecol Can 3290)(JTA) Ecol Can 3290

441. **England, J.H.** 1978. The Glacial Geology of Northeastern Ellesmere Island, N.W.T. French Abstract. *Canadian Journal of Earth Sciences 15:603-617.*

Thirty-five radiocarbon dates associated with former ice sheet margins and raised marine deposits are presented from northeastern Ellesmere Island. Along the southern margin of Hazen Plateau, and in inner Archer Fiord, a prominent morpho-stratigraphic boundary is marked by the Hazen Moraines. These moraines represent a restricted ice advance during the last glaciation and date ca. 8130 + or - 200 B.P. On the immediate distal side of the Hazen Moraines, eastward for 100 km towards northwestern Greenland, the majority of dates on marine limits show synchronous emergence beginning ca. 7500 B.P. This zone of synchronous emergence is considered to represent an ice-free corridor isostatically unloaded between the margins of the receding Greenland and Ellesmere Island ice sheets. A more widespread till, above and beyond the Hazen Moraines, extends out of Archer Fiord-Lady Franklin Bay to Robeson and Kennedy Channels. This maximum ice advance is considered to predate the last glaciation on the basis of Carbon 14 and amino acid dates from ice-marginal deposits; however, alternative interpretations of the data are presented. Previous evidence suggesting an older advance of the Greenland Ice Sheet onto this coastline is confirmed. Several glaciers in the area are presently at their maximum postglacial positions. (Auth)

442. **England, J.H., and J.T. Andrews.** 1973. Broughton Island - a Reference Area for Wisconsin and Holocene Chronology and Sea Level Changes on Eastern Baffin Island. *Boreas 2(1):17-32.*

Broughton Island is 50 km from the eastern margin of the 6,000 sq km Penny Ice Cap. During the early Wisconsin (>54,000 B.P.) Broughton Island was only partly glaciated; sea level at that time was ca. + 72 m. A younger glacial readvance is delimited by lateral moraines and glacio-marine deposits Carbon 14 dated at 24, 100 + or - 850 B.P.; sea level was + 18 m. During the late Wisconsin the glaciers terminated some distance inland from Broughton Island. The head of Maktak Fiord, which presently contains a major outlet glacier from the Penny Ice Cap, was deglaciated about 6,000 B.P. (Auth) BafBib 435

443. **Falconer, G.** 1962. Patterned Ground Under Icefields. *Journal of Glaciology 4(32):238-239.*

Comparison of air photographs taken in 1949 and 1958 of small ice fields in northern Baffin Island indicates that an average marginal recession of 180 m occurred in the nine-year interval. Patterned ground surrounds the ice fields, and in the exposed area large high-centered tundra polygons were observed to have diameters of 50 m. No marked variation in size of polygon was noted with distance from the ice field. Comparison of the 1949 and 1958 ice margin showed that the large polygons are actually being exposed from under glacier ice to give the ice edge a scalloped appearance. Patterned ground has also been reported immediately adjacent to the Barnes Ice Cap in central Baffin Island and from beneath receding glacier ice in northern Ellesmere Island, in addition to examples from Antarctica. It is believed the patterned ground features in northern Baffin Island predate the ice field formation, suggesting the ineffectiveness of the small ice fields as erosional agents, or suggesting the recent formation of the ice fields. One aerial photograph illustrates the ice fields, with the marginal changes in the ice field during the nine-year interval also distinguished. (Ecol Can 961) Ecol Can 961

444. **Falconer, G.** 1966. Preservation of Vegetation and Patterned Ground Under a Thin Ice Body in Northern Baffin Island, N.W.T. *Geographical Bulletin 8(2):194-200.*

A thin ice body in northern Baffin Island is undergoing rapid recession revealing undisturbed patterned ground features and vegetation. A sample of moss thus exposed has a radiocarbon age of 330 + or - 75 years, and supports previous estimates of the occurrence of a markedly more nival period in parts of arctic Canada two to three centuries ago. (Auth)(JTA)

445. **Falconer, G., J.T. Andrews, and J.D. Ives.** 1965. Late Wisconsin End Moraines in Northern Canada. *Science 147(3668):608-609.*

A system of end moraines nearly 2240 kilometers long has been identified by field investigation and aerial photography. It extends through north eastern Keewatin, Melville Peninsula and Baffin Island and marks the border of a Late Wisconsin ice sheet centered over Foxe Basin and Hudson Bay 8000-9000 years ago. In the north it is known as the Cockburn moraine and it may well correlate with the Cochrane limit of Ontario. (R.H. Johnson) GA 65/932

446. **Falconer, G., J.D. Ives, O.H. Loken, and J.T. Andrews.** 1965. Major End Moraines in Eastern and Central Arctic Canada. *Geographical Bulletin 7(2):137-153.*

A system of end moraines more than 2,000 km long, has been identified by field investigation and from air photographs. It runs parallel to the northeast coast of Baffin Island approximately along the line of the fiord heads; it extends down the west coast of Melville Peninsula and across northern Keewatin and demarcates the border of a late-Wisconsin ice sheet that was centered over Foxe Basin and Hudson Bay between 8,000 and 9,000 years ago. The various units of the system are described and related radiocarbon dates are discussed. A tentative correlation with the Cochrane Readvance and with moraine units in northwestern Ontario and in the Lake Athabasca-Cree Lake area is made. The names "Cockburn Glacial Phase" and "Cockburn Moraine System" are proposed for the use of a regional scale; this involves a redefinition of the Cockburn moraines of northeast Baffin Island as originally proposed by Ives and Andrews (1963). (Auth)

447. **Fink, J.** 1975. Changes of Climate and Land-Forms in the Eastern Alps. *Anais Academia Brasileira de Ciencias 47 (Suplemeto):327-336.*

By the beginning of the Holocene (Post-glacial) glaciers had retreated so much that their ice covered an area roughly equal to that in farthest readvances later on. That has been proved by Carbon 14 dates of peats (Bortenschlager & Patzelt, 1969), and it means that the Pleistocene/Holocene (or glacial/postglacial) boundary is an important stratigraphic mark for the Alps. In other regions no cut of this kind has been found out, e.g. there is no such caesura in the retreat of the Laurentide Ice Sheet (cf. Prest. 1970). Postglacial climate is characterized by an uninterrupted sequence of minor variations. Facts are incompatible with a lasting and gradually improving period of comparatively warm climate, termed "hypsithermal interval" by Deevey & Flint (1957), which is followed by a cool period Matthes (1939) informally called the "little ice age." (Auth)(JTA)

448. **Fulton, R.J.** 1971. Radiocarbon Geochronology of Southern British Columbia. *Geological Survey of Canada Paper 71-37, (pp. 1-28).*

The Postglacial record of southern British Columbia includes four dated ash falls: (1) Mazama, about 6,600 years B.P., (2) St. Helens Y, about 3,300 years B.P., (3) Bridge River, about 2,400 years B.P., and (4) St. Helens W (?), later than 1,200 years B.P. The climate was cold 12,000 years ago, but it warmed sufficiently to be similar to the present when most of southern British Columbia was deglaciated. A thermal maximum about 6,000 years ago was followed by a cooler period which persisted until present. Glacial advances took place 3,000 to 2,500 years ago and in the past few centuries. During this most recent advance, the alpine glaciers of southern British Columbia were more extensive than at any time since the end of Fraser Glaciation about 10,000 years ago. (Auth) (JTA)

Table V lists seventeen Carbon 14 dates associated with Holocene volcanic ash falls and Table VI records nine Carbon 14 dates and relates them with Holocene climatic events. The sites of the samples are mapped on Figures 6 and 7 respectively. (JTA)

449. **Funder, S., and C. Hjort.** 1973. Aspects of the Weichselian Chronology in Central East Greenland. *Boreas 2(2):69-84.*

It appears that the maximum glaciation during Weichselian times was attained more than 40,000 years ago, and that since then ice-free areas have existed. This assumption agrees with evidence of botanical refugia in the region, and the restricted glacier activity especially during the Upper Pleniglacial (ca. 30,000-15,000 years B.P.) is explained by a reduced supply of moisture. A comparison with evidence from other parts of Greenland indicates that different glacial histories can be expected for different sectors of the Greenland Inland Ice. (Auth)(JTA)

The extent of early Holocene ice is delimited by the Milne Land moraines Carbon 14 dated close to 9,000-10,000 years B.P. (JTA)

450. **Goldthwait, R.P.** 1963. Dating the Little Ice Age in Glacier Bay, Alaska. *International Geological Congress, XXI Session, Norden, 1960, Part XXVII, (pp. 37-46); Ohio State University, Institute of Polar Studies Contribution No. 31.*

More than 39 radiocarbon dates now available from IGY surveys and from earlier botanical studies in the fjords of Glacier Bay date the Hypsithermal accumulation and glaciation during the Little Ice Age. More than 7500 years ago, the Wisconsin Age glaciers withdrew farther back than today's glaciers. Gravel and lacustrine deposits filled the upper bays to present sea level about 7000 years ago and reached 100 m above present sea level, 1700 to 2500 years ago. These gradually killed a mature PICEA and TSUGA forest which grew on 10 to 30 cm rusty soil in the Wisconsin Age till and on the weathered bedrock slopes. More youthful forests of PICEA and POPULUS spread from time to time over these outwash and lacustrine plains, recording rates of accumulation of sand, silt, or gravel at 1 to 5 m/century. Then came the spasmodic southward invasion by advancing glaciers of the Little Ice Age, devasting (sic) some forests on upper slopes as long ago as 2735 BP. The great outwash masses were eroded from the middle of every valley: in protected lateral areas, remaining outwash was streamlined to drumlinoid forms; and a coating of silty gray till 0.1 to 30.0 m thick was added to the eroded top. Some buried forests at the south grew until 760 years ago, and forests buried by the terminal moraine indicate a glacial climax here 200 to 300 years ago. Other glaciers of Lynn Canal to the east or the Pacific Coast to the west indicate climaxes centuries earlier and later. Now glaciers have receded rapidly up to 100 km in well-documented retreat. (Auth)

The term Little Ice Age as used in this paper is equivalent to "neoglaciation" rather than the more restricted use of Little Ice Age (last few centuries) in papers of the late 1970's to present. (JTA)

451. **Goldthwait, R.P.** 1966. Evidence from Alaskan Glaciers of Major Climatic Changes. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 40-53), 229 pp.*

Studies of glaciers in the Glacier Bay National Monument, Alaska and the Icefield Ranges, Yukon Territory are reviewed, with maps and stratigraphic sections, and the main findings relevant to climatic change are summarized. They appear to establish a unified history of major glacial fluctuation, and indicate a 4400-yr warm period ending approx 2700 B.C., followed by ice expansion 2700-2200 B.C. and a greater expansion commencing ca 400 B.C. and in many cases reaching a climax as late as 1890 A.D. Some climatic deductions are discussed and a correlation with other Cordilleran glaciers attempted. (AB95641) AB95641

Temperatures during glaciation (8400-7100 B.C.) were 2 deg C cooler than present. During the Hypsithermal (7100-2200 B.C.) temperatures were 1 deg C warmer than today. Conditions were wetter c. 1380 B.C. Neoglaciation occurred between A.D. 1500 and 1850 when temperatures again dropped to 2 deg C cooler than today. (JTA)

452. **Goldthwait, R.P., I.C. McKellar, and C. Cronk.** 1963. Fluctuations of Crillon Glacier System, Southeast Alaska. *International Association of Scientific Hydrology Bulletin 8(1):62-74.*

Traces the historical and prehistoric changes of the South and North branches of this glacier 58 deg 37 min N. 137 deg 23 min W., terminating respectively in Crillon Lake and Lituya Bay. 1961 field study data indicate that the 10 m/yr. advance of South Crillon 1929-1961 may have been due to increased snowfall in the mountains, and the North Crillon advance of 28 m/yr. 1894-1933 caused by consolidation of two long calving ice cliffs into one deep-water front. Slow expansion of Crillon during the last 200 yrs. is unlike most Northern Hemisphere glaciers, though its prior history resembles that of most large Southeast Alaskan glaciers. Prehistoric advances of the Crillon system include the maximal push of the Little Ice Age 400-1000 yrs. ago, also the advance of 1500-1800 yrs ago. In Hypsithermal time, the Crillon termini were probably as retracted as at present; many outcrops of buried forest 3000-9000 yrs. old occur in alluvial deposits in Lituya Bay. Underneath is outwash gravel and till recording the last push of Wisconsin ice, ending at least 9000 yrs. ago. (AB79016) AB79016

453. **Gonzalez, E., T. Van der Hammen, and R.F. Flint.** 1965. Late Quaternary Glacial and Vegetational Sequence in Valle de Lagunillas, Sierra Nevada del Cocuy, Colombia. *Leidse Geologische Mededelingen 32:157-182.*

In a high Andean valley, (6 deg N, Lat., alt. 3800 to 4400 m) four bodies of glacial drift marked by many end moraines are recognized. Stratigraphically related to the drifts are small bodies of lake sediments, from which core- and outcrop samples were taken. The samples yielded a continuous pollen sequence from which climatic history was derived. The pollen sequence is calibrated by nine Carbon 14 dates from organic materials in the samples. The dated climatic history permits this correlation of the sequence with both Colombian pollen zones and northern European zones. It also permits approximate dating of the drifts, which are in good chronology agreement with those recognized in North America. The results therefore support the view that major climatic events in high altitude, tropical South America during at least the last 12,000 years were synchronous with those in mid- and high-latitude North America and Europe. (Auth)

454. **Gordon, J.E.** 1981. Glacier Margin Fluctuations during the 19th and 20th Centuries in the Ikamiut Kangerdluarssuat Area, West Greenland. *Arctic and Alpine Research 13(1):47-62.*

Lichenometric dating suggests that the maximum recent extent of cirque and small valley glaciers occurred before about A.D. 1850, although there is evidence for more extensive valley glacierization before about A.D. 1745. Between about 1850 and about 1968/69 progressive recession of the glaciers was interrupted by brief periods of reactivition during the 1880s, 1920s, and early 1940s. Since about 1968/69 the glacier fronts have advanced by up to 158 m following a marked climatic regression during the 1960s and early 1970s. In general, fluctuations of the glaciers have been in sympathy with prevailing climatic trends and show a relatively rapid response following temperature changes and a lagged response of at least 9 yr following precipitation changes. Fluctuations of larger valley and icefield outlet glaciers are out of phase with the others which may reflect a greater time lag of 20 to 30 yr in their response to precipitation changes. (Auth)

455. **Gribbon, P.W.F.** 1964. Recession of Glacier Tasissarssik A, East Greenland. *Journal of Glaciology 5(39):361-363.*

Dating the recession of Glacier Tasissarssik A at 66 deg 10 min N, 37 deg 45 min W was based on lichen measurements. Rapid glacier recession started in 133 B.P. Each of three glaciers had three closely spaced terminal moraines associated with a trim line 14.3 m above the glacier. The maximum diameter of lichen on this trim line was 16 + or - 1 mm and the age was estimated as 133 + or - 20 years, assessing the growth rate of the lichen at 12 + or - mm/100 years. Retreat has been faster since 1830 A.D. (C.A.M. King) GA 65/218

456. **Griffey, N.J., and J.A. Matthews.** 1978. Major Neoglacial Glacier Expansion Episodes in Southern Norway: Evidences from Moraine Ridge Stratigraphy with Carbon 14 Dates on Buried Palaeosols and Moss Layers. *Geografiska Annaler 60A(1-2):73-90.*

Excavations in the outermost end moraine ridges in front of three Jotunheimen glaciers exposed buried palaeosols and moss layers which were Carbon 14 dated. Pre-"Little Ice Age" Neoglacial maxima were indicated by Carbon 14 dates on various soil organic fractions at Styggedalsbreen and Leirbreen; the most probable dates for these maxima are ca. 2700 calendar years B.P. and ca. 1300 calender years B.P. A "Little Ice Age" maximum was confirmed by dates on Sphagnum moss layers at Storbreen. Use of replicate dates, dates on different kinds of organic material and on different fractions of soil organic matter were found useful in assessing the relative accuracy of the datings. It is concluded that the "Little Ice Age" glacier expansion episode is the most extensive in southern Norway, but that in at least two other periods of Neoglacial time, glaciers expanded to similar dimensions. No evidence was found for Neoglacial expansion episodes earlier than ca. 3000 Carbon 14 years B.P. Attention is drawn to the temporal and spatial complexities of Neoglacial glacier fluctuations in the European Alps; although similar complexities are suspected for southern Norway and elsewhere in Scandinavia, doubt is expressed in the ability of current glacial stratigraphic approaches to reconstruct the finer details of a Neoglacial chronology. (Auth)

Five sites are Carbon 14 dated with a total of twelve Carbon 14 dates reported on different fractions, etc. The Carbon 14 dates are calibrated according to the method of Clark (Clark, R.M., 1975: Antiquity 49:251-266). (JTA)

457. **Griffey, N.J., and P. Worsley.** 1978. The Pattern of Neoglacial Glacier Variations in the Okstindan Region of Northern Norway During the Last Three Millennia. *Boreas 7:1-17.*

Historical lichenometrical and stratigraphical evidence is combined to establish a provisional history of Neoglacial glacier variation in a mountainous environment approx. 66 deg N. Attention is focussed on end moraine chronoloyg. At five sites, derived organic materials have been located within end moraines and at two others in situ palaeosols occur buried beneath distal slopes. Organic rich samples from all the sites have been radiocarbon dated and the results permit the recognition of three major glacier expansion episodes, each of which contributes to the diachronous nature of the Okstindan outer Neoglacial limit. A widespread "Little Ice Age" event with a maximum extent of probable eighteenth century age is confirmed. Limited areas of older moraine ridges peripheral to the "Little Ice Age" maximal limit appear to date from about 3000-2500 Carbon 14 years B.P. and a younger period tentatively dated as about 1250-1000 Carbon 14 years B.P. which agrees with recent data from Engabreen in northwest Svartisen. No evidence for any extensive glacial activity after the inland ice wastage approx. 9000 Carbon 14 years B.P. and prior to 3000 Carbon 14 years B.P. was forthcoming. (Auth)

458. **Grosswald, M.G.** 1972. Glacier Variations and Crustal Movements in Northern European Russia in Late Pleistocene and Holocene Times. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 205-223), 511 pp.*

This paper discusses evidence for a Barents Ice Sheet covering much of the Barents Sea. On Franz Josef Land and Svalbard, Younger Dryas glaciers (ca. 10,700 B.P.) were only 2-5% larger than the Little Ice Age glacial maximum. On Franz Josef Land relative sea level changes amount to a rebound of 30 m in the last 7500 years. A core from 370 m water depth between Bear Island and the northern tip of Norway was examined for changes in sediment and foraminifera. A radiocarbon date of 12,385 + or - 280 B.P. is reported from Layer 3 at a depth of 37-52 cm in the core. Overlying units are correlated with the Younger Dryas cooling in northwest Europe. The upper layer, 4 cm thick, has an abundance of planktonic foraminifera and represents deposition throughout the Holocene. During the late Holocene glaciers advanced on Franz Josef Land ca. 2500 B.P. (the Sedov stage). A younger advance is suggested by dates on driftwood that are emerging from under the margin of present ice caps. The wood is dated ca. 1000 B.P. The author suggests that many of the small ice caps melted during the early medieval warm period and regenerated again during the Little Ice Age. (JTA)

459. **Grosswald, M.G. (Ed.)** 1973. Glaciers of Franz Josef Land, Results of Research under the Program of the International Geophysical Year. *Nauka, Moscow, 352 pp.*

Geomorphological studies and radiocarbon dates indicate that by the end of the Late Pleistocene the glaciers in west-central Franz Josef Land had nearly disappeared. Subsequently they experienced three periods of readvance: 1) the Rubini stage, prior to 8500 B.P.; 2) the Sedov stage, about 2500 B.P.; and 3) the Victoria stage, between the 14th and 19th centuries A.D. In recent years the glaciers have been retreating in the archipelago. Thirty years of mass balance data (1930-1959 A.D.) indicate retreat was rapid in the 1930s, slowed down during the 1940s, and then increased again during the 1950s. (JTA)

460. **Grosval'd, M.G., A.L. Devirts, E.I. Devirts, E.I. Dobkina, and D.V. Semevskii.** 1967. Uplift of the Earth's Crust and the Age of Glaciation Stages in the Spitsbergen Area. Dvizheniia zemnoi kory i vozrast lednikovykh stadii v raione

Shpitsbergena. Russian, English Summary. *Geokhimiia (1967)1:51-56.*

Four Carbon 14 datings of driftwood from raised shorelines in southeastern Spitsbergen give absolute ages of 5070 + or - 100, 4060 + or - 100, 3190 + or - 130, and 2400 + or - 120 yr. The uplift curve for this part of the archipelago is concave; its shape indicates a rate of uplift similar to that of Fennoscandia and Canada. Map shows the amount of uplift in Spitsbergen area for the last 5000 yr. Two stages of recent glacier advance are established and dated, the Hornsund stage at 10,000 yr and the Treskelen stage at less than 800 yr B.P. (AB95817) AB95817

461. **Grotzbach, E., and C. Rathjens.** 1969. Current and Lateglacial Glaciers of the Afghan Hindukush. Die heutige und die jungpleistozane Vergletscherung des Afghanishcen Hindukush. *Zeitschrift fur Geomorphologie/Annals of Geomorphology/Annales de Geomorphologie Supplementband 8:58-75.*

On several trips both the authors have made observations concerning the present and late Pleistocene glaciation of the Afghan Hindukush about which up to now only rather vague and mostly wrong ideas existed. Based on their observation data as well as by exploitation of air photos and topographical maps they try to give the general idea of the present glaciation of the mountains and also that of the Wurm period, the position of the snow line and its depression during the cold periods. The knowledge of the later stages of retreat of the glaciers is rather vague. With a difference of the snowline of 300-400 km between S and N exposition the climatic snow line rises in the central parts of the mountains up to 5200 m. By reconstruction of the glaciers of the cold period an increase of the depression of the snow line from 900-1000 m in the W and up to 1000-1100 m in the E can be observed. The glaciers of the cold period were up to several tens of km long. In the W they advanced to about 2800-3000 m.a.s.l., at the northern side of the central Hindukush even down to 2300 m. But contrary to former views they never reached the margin of the mountains. Only within these limits the high alpine mountains have developed glacial features, but beyond them fluviatile and solifluidal processes of sculpturing are prevailing. (English Summary) GA 72A/1094

462. **Grove, J.M.** 1979. The Glacial History of the Holocene. *Progress in Physical Geography 3(1):1-54.*

This substantial review paper summarizes the known records of glacial variations from many of the glaciated sectors of the world. Figures are included for most regions giving available Carbon 14 dates and the dates on glacial advances/retreats. A summary figure compares the glacial variations for 11 major regions. The data indicate that whereas there is agreement on the age and extent of glacial growth during the Little Ice Age there are many differences in the timing of older Holocene events. However, 9 out of 11 records suggest a glacial readvance close to 2500 B.P., and 7 out of 11 have evidence for an advance about 5000-4500 B.P. A ten page bibliography is included. (JTA)

463. **Hamilton, T.D., and S.C. Porter.** 1975. Itkillik Glaciation in the Brooks Range, Northern Alaska. *Quaternary Research 5:471-497.*

During the Itkillik Glaciation the Brooks Range supported an extensive mountain-glacier complex that extended for 750 km betwen 141 degrees and 158 degrees-west longitude. Individual ice streams and piedmont lobes flowed as much as 50 km beyond the north and south margins of the range. Itkillik glaciers may have largely disappeared from Brooks Range valleys by the beginning of the Holocene. (Auth) (JTA)

The early disappearance of glaciers from the Brooks Range contrasts with glacier response in the eastern Canadian Arctic and Greenland. (JTA)

464. **Harrison, D.A.** 1964. A Reconnaissance Glacier and Geomorphological Survey of the Duart Lake Area, Bruce Mountains, Baffin Island, N.W.T. *Geographical Bulletin 22:57-71.*

Describes the 1963 survey of glacier fronts in this northeast Baffin Island area, about 71 deg 20 min N 72 deg 45 min W, part of a worldwide study of the variations in existing glaciers recommended by the Snow and Ice Commission of the International Assoc. of Scientific Hydrology. Also considered is the geomorphic and botanical evidence of the former extent of glaciation; recent phases of the process are compared with those in such other areas as Barnes Ice Cap, northern Sweden, western Norway, and Greenland. This survey shows some correlation between glacier advance and moraine in this and other areas, particularly in high latitudes, though techniques are needed to date the initial formation of the young end moraines and the old moraine remnants. The study is to be extended in 1964 and during the International Hydrological Decade. (AB87739) BafBib 380

465. **Haselton, G.M.** 1965. Glacial Geology of Muir Inlet, Southeastern Alaska. *Ohio State University, Institute of Polar Studies, Report No. 18, 34 pp.*

Prior to about 10,400 years ago glaciers in Muir Inlet were probably as far back as those of today. During this recessional position, marine deposits accumulated in the arms of Muir Inlet. (2) About 10,400 years ago, in Late Wisconsin, glaciers in Muir Inlet advanced, but their maximum extent is not known. (3) Following this Late Wisconsin advance, the climate became warmer, glaciers retreated, outwash began filling the arms of Muir Inlet, and a forest re-established itself. The interstadial interval (the Hypsithermal) lasted about 5,000 years, during which time lakes were established. (4) A Neoglacial advance in Muir Inlet may have started about 3,000 years ago because radiocarbon dates indicate that ice had reached the 200 m level on the Curtis Hills about 2,700 years ago, and was well up the side of White Thunder Ridge 2,200 years ago. No information is available about the next 2,000 years, but in the 17th century the ice reached its maximum post-glacial position in Bartlett Cove at the lower end of Glacier Bay. This may have been an entirely separate but greater advance from that beginning 3,000 years ago, the terminal position of which is unknown. (5) Ice may have started to retreat from the lower reaches of Glacier Bay in the early 1700's, because it was already north of Bartlett Cove in 1794. Since then, ice has retreated from lower Glacier Bay back up Muir Inlet about 70 kms. (6) Forests are once again re-establishing themselves on the deglaciated terrain around Muir Inlet. The arms of Muir Inlet are once again filling with outwash. Small ponds and lakes are forming along the edges of several glaciers in this region. (7) Uplift from ice unloading that started in Late Wisconsin time is continuing today. The maximum rate of land emergence relative to sea level is at Bartlett Cove. Here the annual rate of uplift is about 4 cm a year. In Muir Inlet between 1940 and 1959 uplift was calculated to be 3.5 cm a year. (Auth) (JTA)

466. **Hawkins, F.F.** 1980. Glacial Geology and Late Quaternary Paleoenvironment in the Merchants Bay Area, Baffin Island, N.W.T., Canada. *M.Sc. Thesis, University of Colorado, Boulder, CO, 145 pp.*

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The Illusion Drift, deposited during the Illusion Stade, includes fresh, ice-cored moraines and related deposits that are closely associated with present ice. On the basis of lichenometry, substades of the Illusion Stade date approximately 1670, 350 and 65 years B.P. A relatively warm, moist interstade between 1600 and 1000 B.P. is indicated by radiocarbon-dated organic matter at four sites. A pre-Illusion episode of climatic amelioration represented by a single peat monolith on Padloping Island, is dated 2570 B.P. Gilbert Drift is typified by extensive end-moraines and associated ice-contact drift. Submerged deltas related to Gilbert Drift exist at depths of 30-40 m below sea level. The depth of these deltas, the existence of extensive ice stagnation features and paleoclimatic reconstructions suggest that the Gilbert Stade predates by 2000-4000 years a widespread advance at 8000-10,000 B.P. that is recognized elsewhere on Baffin Island. (Auth)(JTA)

467. **Heine, K.** 1973. The Glacial Morphology and Pre-Ceramic Archaeology of the Mexican Highlands during the Late Glacial Period (Wisconsin) and the Holocene. Zur Glazialmorphologie und prakeramischen Archaeologie des mexikanischen Hochlandes wahrend des Spatglazials (Wisconsin) und Holozans. German, English Summary. *Erdkunde 27(3):161-180.*

Four glacier advances can be identified on the 4461 m high Malinche volcano, recognisable through moraines, glacier abrasions, periglacial deposits (sands, periglacial deposits, varves) and cryoturbations. The sediments of the individual glacier advances are separated from each other by volcanic brecchias, ash and pumice deposits, mud flows and various fossil soils. The stratigraphic arrangement of the glacial and periglacial sediments has been based on tephrochronological and palaeopedological observations. A number of Carbon 14 age determinations on fossil soils and charcoal supplement the field-work. The fourth glacier advance emerges as having occurred at around 2,000 years B.P., and a fifth at around the beginning of the 19th century. Up to four recent moraines show evidence of the stage-wise back-melting of the glacier since about 1890. A paleoclimatic interpretation of the morphological indices yields new insights into the climatic development of the last 40,000 years B.P. for Mexico. The extra-tropical periods of maximum glaciation (high glacial) correspond in Mexico to periods of time with a cold and dry climate without significant glacier formation. Apart from the oldest glacier advance, it is not until later Wisconsin Ice Age that a number of glacier advances occur on the Mexican volcanoes, caused by increased precipitation and having only a short duration. Comparison of the recent Pleistocene and Holocene glacial deposits and fossil soils of Mexico with the Quaternary stratigraphy of the north American Rocky Mountains shows amazingly good agreement. On the basis of these research results, the age of Tepexpan man and the Hueyatlaco (State of Puebla) archaeological site are discussed. (from English Summary)

468. **Heine, K.** 1976. Changes in Climate in the Central Mexican Highland during the Upper Pleistocene and Holocene: Evidence from Glacial Morphology and Tephrochronology of the Volcanoes. *International Geography '76, I.P. Gerasimov, (Ed.), Proceedings of the 23rd International Geographical Congress, Moscow, USSR, 1976. Volume 1, Geomorphology and Paleogeography, (pp. 298-301), 409 pp.*

Four glacial advances can be identified on the 4461 m high Malinche volcano. Two of these occurred prior to the Holocene. The third glacial advance has two distinct phases and occurred between 10,000 and 9000 B.P. Moraines from these two events are found between 2900-3100 m and between 3000-3200 m above sea level. The glaciers advanced for the fourth time during the Neoglaciation about 2000 years ago, although glaciation at this time was restricted to small N and W slope glaciers at 4000 m elevation. On volcanoes Popocatepetl and Izataccibuatl there are traces of glacial activity which are reportedly associated with glaciation during the last century. Moraine loops are found between 4250 and 4650 m above sea level. (Auth)(JTA)

469. **Henoch, W.E.S.** 1964. Postglacial Marine Submergence and Emergence of Melville Island, N.W.T. *Geographical Bulletin 22:105-126.*

Raised shore features from various parts of Melville Island are described. The highest features occur in the northern part of the island, but there is no systematic distribution. Seven radiocarbon dates were obtained below the marine limit and an uplift curve has been constructed. It is similar in shape to other curves obtained from northern Canada and shows uplift of more than 3.3 metres per century in the period 7500-9000 years B.P. Eskimo dwellings at 1.8 m above high tide level were dated at 1100-1700 years B.P. showing that the net emergence over the last some 2000 years has been negligible. One of the shell samples collected below the marine limit gave a radiocarbon age of >30,000 years. The significance of the dates for the history of deglaciation is discussed and multiple glaciation is postulated. (Olav H. Loken) GA 65/425

470. **Heuberger, H.** 1966. Investigations Concerning the History of Glaciers in the Central Alps between Sellrain- and Otz Valley. Gletschergeschichtliche Untersuchungen in den Zentralalpen zwischen Sellrain- und Otztal. *Wissenschaftliche Alpenvereinshefte, Innsbruck, 20:1-126.*

During the Larstig stage firn, ice, block glaciers and flow regolith sheets developed. The snow line was located 200 m below the present limit. The moraines prefer slopes facing E. The glaciers developed at the foot of steep rock walls. Often they reshaped the Egesen sediments. Near the tree line in the Larstig Valley a thick bed of iron pan is located between the Egesen and Larstig ridge. The Larstig oscillation is to be located between the older and younger postglacial Climatic Optimum, and according to Carbon 14 data has an age of 4720 + or - 110 years B.C. Strongly weathered moraines, overgrown with lichens and separated from older deposits by a soil are located in front of the present glacier fore fields extending conformably with the older ridges and belonging to the Subatlantic stage. At this time the snow line was located 100 m below the present value. The Egesen, Larstig, and Subatlantic stages cannot always be differentiated easily from each other. (Therese Pippan)(JTA) GA 68A/483

471. **Heuberger, H.** 1968. The Alpine Glaciers during the Late and Post-Glacial Stages. Die Alpengletscher im Spat- und Postglazial. *Eiszeitalter und Gegenwart 19:270-275.*

The chronological survey is based on glacial advances from late glacial times (Buhl, Steinach, Gschnitz) to post-glacial epochs (Daun, Egesen). For all the postglacial, including mediaeval and modern times, all glacial advances have been listed and surveyed. (L. Holzner) GA 71A/1787

472. **Heuberger, H.** 1974. Alpine Quaternary Glaciation. *Arctic and Alpine Environments, J.D. Ives and R.G. Barry (Eds.). Methuen, London, (pp. 319-338), 999 pp.*

The glacial record from the Alps and other mountain areas indicates that glaciers expanded several times between the Late Preboreal and the Little Ice Age. Seven major periods of glacier advances to an extent equal to or somewhat exceeding that of the maxima of the Little Ice Age are as follows: 1) 8700-8000 B.P.; 2) 6400-6000 B.P.; 3) 5200-4600 B.P.; 4) 3500-3300 B.P.; 5) 2850-1250 B.P.; 6) 1900-1200 B.P.; and 7) 400-30 B.P. The paper concludes that "...the Hypsithermal was too short to leave a decisive mark on the history of alpine glaciation." (p. 333). (JTA)

473. **Hillaire-Marcel, C., and S. Occhietti.** 1980. Chronology Paleogeography and Paleoclimatic Significance of the Late and Post-Glacial Events in Eastern Canada. *Zeitschrift fur Geomorphologie N.F. 24(4):373-392.*

In a tentative synthesis of statistical marine Carbon 14 chronology, isostatic and eustatic movements, continental glacial features and post-glacial marine limits, the paleogeographic evolution during the late and post-glacial times in eastern Canada, with special reference to Quebec, is here reassessed. Publications on these data, and fieldwork by the authors, are used in the drawing of maps of isochrones of Laurentide ice retreat, maximum diachronous extension of post-glacial lakes and seas, emergence observed since 7,500 B.P. and of paleogeography at 10,000 to 10,500 B.P. The post-glacial uplift of Quebec is reconsidered with new regional emergence curves. A time-span diagram from 15,000 to 8,000 B.P. indicates the main steps in the retreat of the Laurentide ice-sheet in eastern Canada and the associated marine episodes. (Auth)

474. **Hillaire-Marcel, C., S. Occhietti, and J.-S. Vincent.** 1981. Sakami Moraine, Quebec: A 500-km-long Moraine Without Climatic Control. *Geology 9:210-214.*

The Laurentide ice sheet in eastern Canada disintegrated step by step, as evidenced by several morainic complexes. Although commonly interpreted as reflecting climatic events, it seems probable that the disintegration simply related to changes in the dynamics of the ice margin, without climatic control. (Auth)

The Sakami moraine dates from close to 8000 BP. (JTA)

475. **Hjort, C.** 1979. Glaciation in Northern East Greenland During the Late Weichselian and Early Flandrian. *Boreas 8:281-296.*

The frontal positions of glaciers in fiords, sounds and larger valleys during the glaciation maximum around 10,000 B.P. and the extent of ice-free areas at that time are shown, together with an isobase map of the altitude of the contemporaneous (or younger) marine limit. A number of Carbon 14 and some Amino Acid datings related to the glacial advance, culmination and retreat are presented. Some time after a Middle Weichselian period with restricted glaciation the glaciers advanced and stood at their maximum positions at about 10,300 B.P., in some areas remaining there until about 9500 B.P., at which time sizeable lowland areas outside the ice-fronts were unglaciated and a large number of nunataks of various types occurred. The retreat of the glaciers started about 10,300 B.P. in the south, but seems to have been delayed towards the north. However, by 9000 B.P. all outer parts of the fiords were deglaciated and their central parts by 8500 B.P. (Auth)(JTA)

476. **Hodgson, D.A., and G.M. Haselton.** 1974. Reconnaissance Glacial Geology, Northeastern Baffin Island. *Geological Survey of Canada Paper 74-20, 10 pp.*

Surficial geological materials and the principal glacial depositional landforms of northeastern Baffin Island have been mapped at a scale of 1:500,000. Major end moraines on Bylot Island are outlined. Surficial materials, largely coarse glacial till and fluvial deposits, are thickest and most varied in two zones - at the heads of fiords, coincident with the Cockburn Moraine System, and on the outer coast where glacial ice issued from the fiords onto the continental shelf. The oldest moraines, remnants of an ice sheet assumed to be of continental origin, are found on the Baffin Bay Coastal Foreland, the continental shelf, and on the shores of Navy Board Inlet and Lancaster Sound. The latter case is a record of glacial ice, possibly 1,000 m thick, that moved through Lancaster Sound north of Bylot Island. The Cockburn Moraines, crossing the heads of the fiords, are part of a system which can be traced through much of eastern Arctic Canada; the most distinct of the readvance moraine ridges in the study area has a Carbon 14 age greater than 6,330 + or - 140 years (GSC-1094) and was in the process of formation, 8,090 + or - 140 years ago (GSC-1060). End moraines, channels, and lichen trimlines record fluctuations in the size of local icefields. Bylot Island glaciers have expanded greatly both prior and subsequent to the glaciation of Lancaster Sound; the northeast Baffin icefields expanded by several magnitudes prior to the formation of the inner Cockburn Moraines; most icefields, outlet glaciers, and glacierets currently are receding from a recent (post-continental glaciation) maximum. (Auth) BafBib 237

477. **Hoel, A., and W. Werenskiold.** 1962. Glaciers and Snowfields in Norway. *Norsk Polarinstitutt Skrifter, nr. 114, 291 pp.*

Valid reports on glacial variations are available only since the early 1700's, although earlier fluctuations can be deduced from archeological finds. The general glacial advance during the late 17–early 18th centuries was accompanied by widespread crop failure and famine; but recession has been common since 1750. Some glaciers in northern Norway, e.g. Svartisen, have had fluctuations corresponding to those in southern Norway; others, e.g. those around Oksfjordjokulen, have reacted differently. Svalbard glaciers have also receded unevenly; some have even advanced at times. (AB72180)(JTA) AB72180

478. **Ives, J.D.** 1962. Indications of Recent Extensive Glacierization in North-Central Baffin Island, N.W.T. *Journal of Glaciology 4(32):197-205.*

Studies of the geomorphology and rock lichen development north of the Barnes Ice Cap prompt the conclusion that 70% of this extensive, interior region was covered by permanent ice some 300-400 years ago. The northern Barnes Ice Cap was signifcantly larger then than now; it dammed a lake in the upper Isortoq valley, over 80 km long and up to 300 m deep. Excluding the icecap, less than 2% of the area is glacierized today. Proof of former extensive ice cover rests largely upon restricted rock lichen development. When sufficient time has elapsed for complete colonization, few indcations of the former existence of an ice cover will remain. This type of glacierization may have affected large areas in the high Arctic. Absence of evidence of glaciation, therefore, cannot be relied upon to delimit nunatak areas (plant refugia) during the last glaciation. (From author's abstract)(AB72489) BafBib 381

479. **Ives, J.D.** 1964. Deglaciation and Land Emergence in Northeastern Foxe Basin, N.W.T. *Geographical Bulletin 21:54-65.*

Preliminary report on 1961 field work, supplemented by findings of Sim, Ives, and Andrews, dealing with the glacial geomorphology of western Baffin Island between Longstaff Bluff and Steensby Inlet, 68 deg 55 min N 75 deg 07 min W - 70 deg 15 min N 78 deg 35 min W. Late-glacial marine submergence ranged 315-345 ft. Five collections of marine molluscs between 290 and 30 ft above sea level yielded radiocarbon ages ranging from 6725 + or - 250 yrs to 2050 + or - 170 yrs, permitting construction of an uplift curve similar to others from Canada and Greenland. Age of max

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marine submergence in this region, 6725 + or - 250 yrs, is recent compared with that found elsewhere in Canada. Geomorphological studies revealed glacial outwash at various levels below the marine submergence limit, indicating that Baffin Island inland ice penetrated a high-level Foxe Basin more recently than 6725 yr ago. At least 30 ft of land uplift occurred in the last 2000 yr, and is probably taking place today. (AB88191) BafBib 407

480. **Ives, J.D.** 1977. Late and Postglacial Glacier Fluctuations and Sea Level Changes in Arctic Canada. *Geografiska Annaler 59A(3-4):253-256.*

Ives presents counter arguments to Blake's contention (Geografiska Annaler, 1975, 57A:1-71) that "...the areal extent of the ice is now, or has been within the last few centuries, as great as at any time since general deglaciation occurred some 9500 to 9000 years ago." Cirque and valley glacier moraines on Baffin Island have been dated to between 8000 and 9000 B.P. and extend in some localities well beyond the neoglacial ice limits. (JTA)

481. **Ives, J.D., H. Nichols, and S.K. Short.** 1976. Glacial History and Palaeoecology of Northeastern Nouveau-Quebec and Northern Labrador. *Arctic 29(1):48-52.*

This note outlines the preliminary research findings of a 1975 expedition to northern Labrador-Ungava. Lake sediment cores were obtained from a variety of lakes and some peat monoliths were collected. The modern pollen rain will be determined from an analysis of Tauber trap collections and moss and lichen polsters collected across the region. Some objectives of this expedition were to provide information for studying the fluctuations in the position of the forest-tundra ecotone over the last 8,000 years, and the climatic and environmental fluctuations affecting plant communities and human occupancy during the Holocene. A map shows retreat phases of the Laurentide Ice Sheet. (JTA)

482. **Johnson, P.G.** 1971. Ice Cored Moraine Formation and Degradation, Donjek Glacier, Yukon Territory, Canada. *Geografiska Annaler 53A(3-4):198-202.*

The ice core of moraines at the terminus of the Donjek glacier is primarily composed of glacier ice and not snow bank ice. The widespread occurrence of these ice cored moraines in the area is the result of two main processes, one a shear–push mechanism of buried stagnant ice and the other due to ablation and fluvial deposits accumulating on a stagnant ice wedge being pushed in front of the presently surging glacier. Degradation of these moraines is due to five main processes, all of which are directly related to the occurence of the ice core. (Auth)

483. **Jones, V.K.** 1974. Late-Neoglacial Regimes of an Inland Cirque Glacier and Their Paleoclimatic Implications. *Geographical Monographs No. 5; Quaternary Environments: Proceedings of a Symposium, Mahaney, W.C. (Ed.), First York Symposium on Quaternary Research, 1974. Department of Geography, Atkinson College, York University, Toronto, Ontario, Canada, (pp. 293-294), 318 pp.*

Cathedral Glacier, a compound sub-Polar cirque glacier at 59 deg 20 min N., is located in Atlin Provincial Park on the continental flank of the northern Boundary Range in northwestern British Columbia. Active ice fills a bifurcated upper basin near 7,000 feet and flows past the eastern side of a medial nunatak at 5,400 feet to a receding terminus at 5,200 feet. Seasonal neve-lines for 1971, 1972 and 1973 were at 5,700, 6,300 and 5,500 feet, respectively. An ice-cored terminal moraine at 4,800 feet, laid down about 1920, continues to advance slowly. This is overriding a stable moraine, dated lichenometrically as mid-19th century, at its base. These terminal moraines mark the maximum post-Wisconsinan extension of the glacier. (Auth)(JTA)

484. **Jorgensen, P., and R. Sorensen.** 1979. Late Glacial and Holocene Deglaciation and Sedimentation in Lagendalen, Southeastern Norway. *Norsk Geologisk Tidsskrift 59:337-343.*

At the end of the Ra period, approximately 10,600 years ago, the icefront retreated mostly by calving with intermittent stops through the long and narrow Numedalfjorden. Average recession rates lie between 90-100 m per year. Detailed mapping of Glacial and Postglacial sediments, combined with radiocarbon and geophysical data, allowed reconstruction of Late Glacial and Holocene development, dating of glaciofluvial and river valley terraces, and calculation of average sedimentation rate during Preboreal time in a deep ice eroded basin. (Auth)

485. **Karlen, W.** 1973. Holocene Glacier and Climatic Variations, Kebnekaise Mountains, Swedish Lapland. *Geografiska Annaler 55A(1):29-63.*

Detailed mapping of well-preserved moraine systems fronting 23 small glaciers in the Kebnekaise Mountains in Swedish Lapland reveals that the Holocene was punctuated by four prolonged intervals of glacier expansion. The youngest interval corresponds to the well-known Little Ice Age and lasted from at least A.D. 1500 until the 20th century. Minor fluctuations superimposed on this broad interval of expansion are dated by lichenometry and historical records; they culminated about A.D. 1916, 1890, 1850, 1780, 1710, and 1500 to 1640. The next youngest interval, which also involved a number of minor fluctuations spread over several centuries, is associated with Carbon 14 dates of 2320 + or - 160 years B.P.(St-3811) and 2460 + or - 90 years B.P.(I-6854) (Corrected for variation in atmospheric Carbon 14: 2370 and 2475-2720 years B.P., respectively). The two oldest glacial intervals center around tentative lichenometric dates of 5000 and 8000 years B.P., respectively. Advances of the two older intervals were the least extensive. Advances of the two youngest intervals were approximately equal in magnitude although the relative extents of drift sheets suggest that in many cases the older of these two intervals may have been slightly more intense. Within the Little Ice Age the advances between A.D. 1500 and 1640 were commonly the most extensive. (Auth)(JTA)

486. **Karlen, W.** 1975. Lichenometric Dating in Northern Scandinavia–Reliability of the Method and its Regional Use. Lichenometrisk Datering i Norra Skandinavien–Methodens Till Forlighet och Regionala Tillampning. Swedish. *Naturgeografiska Institutionen, Forskningsrapport 22, 70 pp.*

This paper describes the construction of lichen growth curves and the application of the curves to the dating of neoglacial moraines. Figure 7 shows the diameters of lichens associated with substrates dated between 1898-1903 A.D. between Narvik (Norway) and Gallivare (Sweden), a distance of over 200 km with an elevation difference of over 500 m. Lichen diameters ranged from approx. 30 mm on the coastal transect to 38 mm inland. Lichen diameters in front of 53 glaciers (Table 5) cluster into several discrete units. Within the last 350 years approximately 6 glacier moraines are recognized and dated at 1925, 1890, 1850, 1780, 1710, and 1600-1650 A.D. (JTA)

487. **Karlen, W.** 1976. Lacustrine Sediments and Tree-Limit Variations as Indicators of Holocene Climatic Fluctuations

in Lappland, Northern Sweden. *Geografiska Annaler 58A(1-2):1-34.*

In this paper Holocene climatic changes recorded in Lappland, northern Sweden, are described. Recorded changes are dated in three different ways; (1) moraines fronting alpine glaciers are dated lichenometrically, (2) lacustrine sediments, in which the silt content varies with size fluctuations of a small glacier, are Carbon 14 dated, and (3) variations in altitude of the pine tree limit are Carbon 14 dated. The area around Vuolep Allakasjaure probably became deglaciated just before 9000 BP. About 8600 BP climate began an improvement which culminated between 7000 and 6000 BP. Shorter fluctuations are superimposed on this long-term climatic change. The most pronounced periods of relatively cold climate occurred about 7500-7300 BP, 4500 BP, 2800-2200 BP, and during recent centuries. (Auth)(JTA)

488. **Karlen, W.** 1976. Holocene Climatic Fluctuations Indicated by Glacier and Tree-Limit Variations in Northern Sweden. *Naturgeografiska Institutionen, Forskningsrapport 23, (pp. 1-10).*

This paper summarizes four papers submitted for a Swedish doctoral thesis, all of which concentrate on the timing of Holocene climatic changes. Studies were made of: 1) glacial moraines, dated by lichenometry; 2) variations in lake sediment properties; and 3) altitudinal variations in tree line species. (JTA)

489. **Karlen, W.** 1979. Deglaciation Dates from Northern Swedish Lappland. *Geografiska Annaler 61A(3-4):203-210.*

A minimum date of 8480 + or - 155 Carbon 14 yr BP on the deglaciation is reported. The date was obtained on a sample of wood fragments and is therefore not affected by old carbonate. The date is regarded as a reliable minimum date of the deglaciation. Another slightly older minimum date (8900 + or - 140 Carbon 14 yr BP) obtained on peat from the same locality is probably also reliable. (Auth)(JTA)

490. **Karlen, W.** 1979. Glacier Variations in the Svartisen Area, Northern Norway. *Geografiska Annaler 61A(1-2):11-28.*

Moraine systems fronting 25 glaciers in the Svartisen, Okstindan, and Saltfjell areas were studied. Samples for Carbon 14 dating were obtained from 7 moraines, and lichenometric data were gathered from about 125 moraines. The earliest Carbon 14 dated maxima were from 2800 Carbon 14 yr B.P., but there was evidence that a few glaciers reached relatively advanced positions prior to this: early advances may have occurred about 6000 and 4500 yr B.P. Radiocarbon dates suggested that glaciers reached Holocene maxima around 2800, 1900, 1500-1300, 1100 and 600 Carbon 14 yr B.P. The majority of the moraines dated by lichenometry were from the 14th century or later. During this interval spanning 600 years glaciers advanced frequently, but no single period was marked by an outstandingly large number of well-preserved moraines. (Auth)

491. **Karlen, W.** 1980. Reconstruction of Past Climatic Conditions from Studies of Glacier-Front Variations. *WMO Bulletin, April, 1980:100-104.*

Although pollen data suggest a relatively warm middle Holocene climate was followed by a distinctly cooler climate commencing between 2000 and 3000 B.P. evidence for glacial advances exists for periods during both the middle and early Holocene as well as the late Holocene "neoglacial". Recurrent intervals of glacial advance have been suggested at 2500 years although other areas have a much shorter return period of between 300 to 1600 years. The "little ice age" is dated in different regions as occurring in the 16th, 17th, or 18th century. Other periods of marked glacial advances occurred between 1000-1100, and 2000-3000 B.P. There is also evidence for a significant glacial advance between 4000 to 5000 B.P. (JTA)

492. **Karlen, W.** 1981. A Comment on John A. Matthews's Article Regarding Carbon 14 Dates of Glacial Variations. *Geografiska Annaler 63A(1-2):19-21.*

An article by Matthews in a previous number of Geografiska Annaler is discussed. The improbability of the statement that 1750 marks the time of the maximum advance of Norwegian glaciers is emphasized. Also the marked difference in the size of lichens on end moraines in Norway and on moraines in northern Sweden is pointed out. (Auth)(JTA)

Matthews's article discusses the problems associated with obtaining reliable dates from buried soils. (JTA)

493. **Karlen, W.** 1981. Holocene Glacier Fluctuations in Scandinavia. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 26-34), 47 pp.*

Holocene glacier variations are investigated using information obtained from historical records, from moraine studies and from lacustrine sediment studies. A large number of Carbon 14 dates obtained on buried soils and sheared off tree stumps are believed to be correct within a few hundred years or less. A detailed and possibly continuous record of glacier fluctuation is obtained from sediments taken from a lake receiving glacier melt water. The information on glacier advances is to some extent supported by dates on variations in the pine tree limit. Historical information indicates a glacial advance around A.D. 1340. Several advances are documented to the first half of the 18th century. Advances are well-dated to 1748, 1868-1873, 1880-1890, 1909-1911 and 1921-1931. Lichenometric dates on moraines from Lappland indicate that moraines were open to lichen immigration around 1650, 1700-1720, 1780, 1800-1810, 1850-1860, 1880-1890, 1910-1920 and 1930. Periods of glacier expansion are dated to about 7500, 6300, 5600, 5100, 4800, 4500, 3000, 2200, 1900, 1400, 1050, 600 and 430 B.P. (Auth)

494. **Karlen, W.** 1981. Lacustrine Sediment Studies; a Technique to Obtain a Continuous Record of Holocene Glacier Variations. *Geografiska Annaler 63A(3-4):273-281.*

Sediments from four lakes receiving glacial meltwater are discussed, and then compared with sediments from a lake not receiving glacial meltwater. Characteristic differences were observed in the inorganic content of the sediments; sediments from non-glacial lakes were much more homogenous. The glaciers studied were small during parts of the Holocene, particularly the mid-Holocene. Information obtained from the lake below Kalanvare indicates that episodes of glacier advances began about 7500, 4800 and 3000 Carbon 14 years B.P. During the last 1800 years the glacier has been small only during short periods; the most marked of these being dated to approximately 1400 and 900 Carbon 14 years B.P. During recent years the glacier has also been small. (Auth)(JTA)

495. **Karlen, W., and G.H. Denton.** 1975. Holocene Glacial Variations in Sarek National Park. *Boreas 5:25-56.*

Detailed mapping of well-preserved moraine systems fronting 17 small alpine glaciers in Sarek National Park in Swedish Lapland reveals two Holocene intervals of prolonged glacier expansion, each involving a complex of minor fluctuations. The younger interval, which corresponds to the Little Ice Age, experienced advances that culminated about A.D. 1916-1920, 1880-1890, 1850-1860, 1800-1810, 1780, 1700-1720, 1680, 1650, and 1590-1620. The older expansion interval, which probably centered around 2500 Carbon 14 yr BP, experienced several minor fluctuations spread through about 600 years. (Auth)(JTA)

The majority of age estimates are based on lichenometry, with ages calibrated from surfaces of known age or Carbon 14 dated substrates. (JTA)

496. **Karlstrom, T.N.V.** 1957. Tentative Correlation of Alaskan Glacial Sequences, 1956. *Science 125(3237):73-74.*

Carbon 14 dates around Cook Inlet, Alaska, are used to define a sequence of Holocene glacial variations. Glacial events are proposed at 450, 2500, 3500, and 4500 B.P. Glacial events within the middle and early Holocene are also recognized and dated at 9000 B.P. The boundary between the Naptowne and Alaskan glaciations is placed at 6000 B.P. (JTA)

497. **Karlstrom, T.N.V.** 1960. The Cook Inlet, Alaska, Glacial Record and Quaternary Classification. *U.S. Geological Survey Professional Paper 400-B, (pp. B330-B332).*

The dated sequence of five major Pleistocene glaciations and Recent glacial advances is summarized and portrayed graphically. Comparisons with the midcontinental drift sequence, and with other independently dated chronologies, indicate the standard classification of Pleistocene events is generally valid, so that the standard nomenclature needs only minor changes, not the drastic revision that some workers have proposed. (Auth)

498. **Karlstrom, T.N.V.** 1964. Quaternary Geology of the Kenai Lowland and Glacial History of the Cook Inlet Region, Alaska. *U.S. Geological Survey Professional Paper 443, 69 pp.*

Maps at various scales show extent of glaciations, climatic zonation, etc., landforms, geology, etc.; sea-bluff and river bluff stratigraphy, and the glacial and glaciohydrologic record from 12,000 B.C. to the present, are depicted graphically. (AB88399)(JTA) AB88399

499. **Karlstrom, T.N.V.** 1966. Quaternary Glacial Record of the North Pacific Region and World-Wide Climatic Changes. *Pleistocene and Post-Pleistocene Climatic Variations in the Pacific Area, A Symposium, 10th Pacific Science Congress, Honolulu, 1961. Bishop Museum Press, Hawaii, (pp. 153-182).*

Glacial chronology in Alaska is analysed in relation to Northern Hemisphere dated chronologies and compared with Pacific equatorial and Southern Hemisphere chronologies. The case is strengthened for: interhemispheric climatic synchronism and cyclicity; usefulness of Carbon 14 and Protactinium 230 to Thorium 231 dating; functional validity of traditional Pleistocene classification, and justification for constructing a comparable one for late-glacial and postglacial time. Revisions in concepts suggested are: subdivision of the Pleistocene into five glaciations of 300,000 years duration; elimination of two- or three-fold subdivisions of the last ice age, and dating the last interglacial at 45,000; downgrading of Two Creeks warm interval to a subordinate event; dating maximum postglacial warmth and dryness around 3,500 B.C.; and subdivision of Alaskan interval into a series of cooler and wetter intervals. (Abstracts N. American Geology) GA 68A/787

500. **Karlstrom, T.N.V.** 1980. Holocene Sea Level Change–a Possible Record of Global Climatic Change. *U.S. Geological Survey Professional Paper 1175, (p. 224).*

Karlstrom suggests that in the last 5000 to 6000 years eustatic sea level has oscillated within a few meters of present with periodicities of about 1,100, 500 and 275 years. Analysis of published biologic and paleoclimate data from western North America supports the conclusion that synchronous climatic change has occurred from Alaska to Mexico on time scales of a few hundred to a few thousand years. (JTA)

501. **Kerschner, H.** 1978. Paleoclimatic Inferences from Late Wurm Rock Glaciers, Eastern Central Alps, Western Tyrol, Austria. *Arctic and Alpine Research 10(3):635-644.*

The main period of activity of large fossil rock glaciers, situated 500 to 600 m below the belt of presently active rock glaciers in some areas of Western Tyrol, is though to have been closely correlated with the Egesen Stade readvance (probably Younger Dryas, 11,000 to 10,000 B.P.). A depression of annual temperature below the present of -3 to -4 deg C can be deduced from the depression of the rock glacier belt. This value is about twice the depression of summer temperature, derived from the lower equilibrium line of glaciers in the same area. Thus a more continental climate with summers cooler (2 deg C below present) and winters much colder (5 to 6 deg C below present) should have existed in this part of the Alps during Younger Dryas times. (Auth)

502. **King, C.A.M.** 1969. Glacial Geomorphology and Chronology of Henry Kater Peninsula, East Baffin Island, N.W.T. *Arctic and Alpine Research 1(3):195-212.*

Henry Kater Peninsula was ice covered at least between 34, 000 and 10,000 B.P. The ice advanced into the sea along the outer part of the peninsula, spreading a thin morainic covering over shell-bearing marine sediments. Ice curved inland from the fiords along the margins of the peninsula, while ice from inland covered the interior. Much of this ice decayed in situ, leaving extensive dead-ice areas. The sea was relatively high as the ice withdrew. The plane of the marine limit slopes down toward 083 deg from 50 m in the inner part of the peninsula to 25 m at the outer coast. Planes of synchronous isobases slope down toward 052 deg. Deglaciation took place at about 10,000 B.P. at the outer coast, at about 8,500 B.P. in Isabella Bay on the north side, and 8,000 B.P. in Itirbilung Bay on the south side. The last major incursion of fiord ice into the embayments along the inner peninsula took place between approximately 8,700 and 8,000 B.P. This moraine may be contemporaneous with the Cockburn moraines. The ice-cored moraines of the present glaciers in the mountain valleys have been static for several years, but it is suggested that locally generated ice was more powerful and vigorous at an earlier period. (Auth) BafBib 445

503. **King, C.A.M., and J.T. Buckley.** 1967. The Chronology of Deglaciation Around Eqe Bay and Lake Gillian, Baffin Island, N.W.T. *Geographical Bulletin 9(1):20-32.*

The stages of deglaciation in the area between Ikpik Bay on the Foxe Basin coast of Baffin Island, N.W.T. Canada and the inner part of Lake Gillian are traced and related to sea level by means of the numerous glacial-marine deltas which link the ice front positions, as indicated by ice contact facies, with sea level as suggested by the level of the delta fronts. The marine limit, contemporaneous with an ice margin close to the sea, had a height of about 95 metres along the northern sector of the coast. It slopes down toward the northeast at 0.6 metre/km. The sea entered Lake Gillian until about 5,200 years ago when the sea level had fallen below 56 metres. (Auth) (JTA)

504. **King, C.A.M., and J.T. Buckley.** 1969. Geomorphological Investigations in West-Central Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 1:105-120.*

Glacial geologic

The paper discusses a variety of glacial, glaciofluvial, and periglacial forms in western Baffin Island. Glacial forms, especially striations and crag-and-tail, reveal the effects of erosion by ice from the proto-Barnes Ice Cap, which reached the coast about 7,000 years ago. Moraine stones near its margin show a preferred orientation perpendicular to the moraine crests. Glaciofluvial forms include deltas, eskers, and kames, the latter occurring mainly in dead-ice areas. A relationship between delta slope and stone size is established. Esker-like ridges in the dead-ice areas are of two types; some are true eskers, showing evidence of flow, and others represent material collected in elongated hollows within the dead-ice areas. Kames and kame terraces are also described; the slope of the latter is found to indicate the ice-margin gradient. The effects of material size and shape on the nature of periglacial forms, including ice-wedge polygons, sorted features, and solifluction lobes, are considered. Ice-wedge polygons are best developed in well-sorted material and the sorted features in mixed material. Finally, a number of icings (Aufeisen) are described. These icings occur where spring water flows and subsequently freezes during the winter. (Auth) BafBib 109

505. **King, L.** 1974. Postglacial History of Glaciers and Vegetation in the Sustenpass Region. Studien zur postglazialen Gletscher- und Vegetationsgeschichte des Sustenpassgebietes. German, English Summary. *Basler Beitrage zur Geographie 18:1-123.*

In order to get more information about postglacial history of glaciers and vegetation in the Sustenpass region (Bernese Oberland, Swiss Alps) we mainly applied the pollen analysis in moors near the timber line and close to glaciers, morphological mapping and digging in moraine ridges. 1) For the youngest Alpine Lateglacial Stade a minimum age of 9300 B.P. was obtained. 2) In the older Boreal Period (8750-8050 B.P.) large glacier advances for the Steinglacier and the Triftglacier were discovered. Rocky moraine ridges of the glaciers Sustlifirn and Chalchtalfirn in the upper Meien valley may be of the same age. 3) In the Atlanticum Period (7850-650 B.P.) traces of large movements of the Steinglaciers and Triftglaciers could also be found, and strong advances are also very probable for the glaciers in the upper Meien valley. 4) In the Young Atlanticum (6050-4850 B.P.) and for the most part of the Subboreal (4850-2850 B.P.) there was no sign of glacial or climatic changes of a similar size (as cited under 2 and 3). 5) A large oscillation of the Steinglacier is proved for the period 3040-2820 B.P. It is the last advance of the Steinglacier which is clearly greater than the glacial changes of modern times. 6) The changes which were taking place between 300-600 A.D. and in the 12th, 17th, 18th and 19th century are of similar size. The distinction of these deposits is only possible by the use of and combination of various methods (as lichen studies, historical studies, morphological mapping, digging and soil stratigraphy in moraine ridges). 7) For the Steinalp region the following Carbon 14 dates for the postglacial reafforestation were obtained: CORYLUS–9200 B.P.; ABIES–6380 B.P.; PICEA–4840 B.P.; ALNUS VIRIDIS–after less than 4840 B.P. 8) In the Steinglacier area the highest postglacial timber line lay at most about 100 m higher than the current potential timber line. (Auth)(JTA)

506. **Kiver, E.P.** 1974. Holocene Glaciation in the Wallowa Mountains, Oregon. *Geographical Monographs No. 5; Quaternary Environments: Proceedings of a Symposium, Mahaney, W.C. (Ed.), First York Symposium on Quaternary Research, 1974. Department of Geography, Atkinson College, York University, Toronto, Ontario, Canada, (pp. 169-195), 318 pp.*

Most alpine regions in western North America contain moraines, rock glaciers, and protalus ramparts well upvalley from late Wisconsin moraines. With few exceptions, they have not been studied in detail other than in the Colorado Rocky Mountains and Cascade Mountains where the histories recorded are significantly different. The Wallowa Mountains of northeastern Oregon, lying midway between these areas, provide an opportunity to determine how Holocene alpine climates varied over an 1,800 km transect across western North America. Based on Carbon 14 tephrochronology, lichenometry, and relative weathering, a tentative correlation with deposits from the Wallowa Mountains, Colorado and Wyoming, the Sierra Nevada, and the Cascade Mountains is given. Decreasing severity of Neoglacial climates with time in the Sierra Nevada and the eastern Rocky Mountains is indicated by the restricted extent of successively younger advances. Increasing climatic severity with time occurred in the Pacific Coast and Wallowa Mountain areas where older Neoglacial deposits are usually overridden by younger. (Auth)(JTA)

507. **Koerner, R.M., and W.S.B. Paterson.** 1974. Analysis of a Core through the Meighen Ice Cap, Arctic Canada, and its Paleoclimatic Implications. *Quaternary Research 4:253-263.*

Analyses of crystal size, bubble content, oxygen isotope ratio, specific electrolytic conductivity, and the distribution of firn and dirt layers in a core, 121.2 m long, from surface to bedrock near the highest point of the Meighen Ice Cap, leads to the following outline of the ice cap's history. The ice cap, which has always been stagnant, originated in the cold period that followed the postglacial Climatic Optimum. After initial growth came a period of negative mass balance in which the area and thickness of the ice cap diminished and the surface slope at the core site steepened. The end of this period, at least 600 y.a., is marked by a discontinuity at 54 m depth in the core; above this level, the values of most parameters differ significantly from their values below. There followed a period of growth by the end of which, some 80 y.a., the ice cap had attained its maximum thickness; this period included the coldest interval in the ice cap's history. Ablation has predominated since then and up to 13 m of ice have been lost at the core site. This history resembles that of the Ward Hunt Ice Shelf. (Auth)

508. **Kukla, J.** 1969. The Cause of the Holocene Climate Change. *Geologie en Mijnbouw 48(3):307-334.*

The worldwide repeated changes of climate through the whole Quaternary era make it clear that the recent general weather conditions will not last forever, but will be substituted by a severe Glacial stage, similar to those recorded in the close geological past. It is highly important for humanity to know, at what time the climate deterioration is to be expected, which processes are ruling it and how to fight the incoming cooling trend. The first results of a new method are described, based on the calculation of the main part of the past earth's heat budget. The heat reaction of the snowline is detected as being the principal key controlling the global climate change and as strongly amplifying any slight thermal impulse of interplanetary or terrestrial origin. The perturbations of the earth's orbital elements are found to be responsible for the general long-time climatic changes including the start and the end of the Holocene interglacial. The convincing proof for this statement lies in the isotope-dated geological evidence of the past 250,000 years. We are now able to date astronomically the various gross past climatic trends with a relatively high accuracy. The short-range oscillations of climate observed during Holocene, may partly reflect the short-time movements of earth's rotational axis and/or the changes of the solar constant, both up to now very poorly investigated. Strong suspicion, however, exists that the Little Ice Ages of the Late Holocene and the global warming which started at around A.D. 1890 are both the results of mans activity. Further investigation in this branch is urgently needed, because the pronounced weather deterioration is expected to come in the close future. (Auth)

509. **Lamb, H.H., J.R. Probert-Jones, and J.W. Sheard.** 1962. A New Advance of Jan Mayen Glaciers and a Remarkable Increase of Precipitation. *Journal of Glaciology 4(33):355-65.*

Reports observations of the University of London Jan Mayen and Beerenberg expeditions of 1959 and 1961, on the advance of glaciers around Beerenberg, which began about 1954 and accelerated since 1959. Annual precipitation in the area has been rising, and in the 1950's was almost double that of the 1920's. Other places around the Greenland Sea with increased precipitation attained a maximum in 1930-1940. Likely causes; changes in atmospheric circulation, etc., are discussed, as is the lag in the glaciers' response. The increase of precipitation seems to be the main factor in the glacial advance. (AB73287) AB73287

510. **Lind, E.K.** 1983. Holocene Paleoecology and Deglacial History of the Cape Rammelsberg Area, Southern Baffin Island, N.W.T., Canada. *M.Sc. Thesis, University of Colorado, Boulder, CO, 219 pp.*

Deglaciation of Frobisher Bay began ca. 10,760 + or - 150 B.P. following deposition of the Hall moraines. Prior to this time, ice was probably gone from Frobisher Bay because water temperatures reached 1 deg C and salinities were close to SMOW. Frobisher Bay ice retreated to the northwest of Cape Rammelsberg after 10,760 B.P. and readvanced to Jaynes Inlet by 8,690 B.P. Water temperatures and salinities in the Jaynes Inlet area were ca. -1 to -2 deg C and 10 to 24 ppt, respectively, due to glacial meltwater influx. Ice retreated to Cape Rammelsberg ca. 8,230 + or - 240 B.P. Marine temperatures and salinities northwest of Cape Rammelsberg remained low until at least 7,140 + or - 115 B.P., although they increased substantially in the Jaynes Inlet area. Subarctic molluscs migrated into the Jaynes Inlet area between 8,230 and 7,595 B.P. Ice was gone from inner Frobisher Bay by 6,440 + or - 160 B.P., when marine conditions were warmer than present. (Auth)(JTA)

511. **Locke, C.W., and W.W. Locke, III.** 1977. Little Ice Age Snow-Cover Extent and Paleoglaciation Thresholds: North-Central Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 9(3):291-300.*

On air photgraphs, light-colored areas representing reduced lichen cover indicate the maximum extent of permanent snow cover in the recent past. Lichen-free areas were mapped on 1:50,000, 1:250,000, 1:1,000,000 map sheets of north-central Baffin Island using air photographs and LANDSAT-1 satellite imagery. Present ice and lakes cover 37% of the study area (97,000 sq km). During the Little Ice Age (350 to 100 yr B.P.), ice and lakes covered about 50% of the study area–an increase of 35%. The amount of lichen-free area is greatest in the elevational range of 450 to 600 m a.s.l. A limited amount of lichenometrical measurements indicate that the lichen-free areas probably represent a period of more extensive snow cover approximately synchronous with the Little Ice Age. Paleoglaciation thresholds and paleoequilibrium-line altitudes increased in elevation toward the northeast with lowest elevations southwest of the Barnes Ice Cap. Paleoglaciation thresholds ranged from 500 to 850 m a.s.l. whereas paleoequilibrium-line altitudes ranged from 300 to 900 m a.s.l. Present glaciation thresholds and equilibrium-line altitudes ranged from approximately 100 to 400 m higher than the paleovalues. The difference between present and paleovalues is greatest over the mountainous east coast and decreases to the west. (Auth)

512. **Locke, W.W., III** 1980. The Quaternary Geology of the Cape Dyer Area, Southeasternmost Baffin Island, Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 331 pp.*

The Gilbert Stade of the Cumberland Interglaciation occurred at least 8500 yr B.P. and was a time of ice extent only slightly greater than at present. The distinctive moraines, with steep distal and gentle proximal slopes, are the most extensive in the northwestern portion of the study area, and are not found to the south and east. No raised marine deposits of Gilbert age were found, but submerged benches at approximately 56 m b.s.l. may have been formed during the Gilbert Stade. Most surface boulders show grain relief or greater weathering, the hornblende etching decreases from approximately 2.5 micrometers at the surface to 1.5 micrometers at 100 cm depth. The climate during most of the Gilbert Stade was probably much colder and drier than the present throughout the year, with warmer and wetter conditions than present prevailing at the end of the stade. The Shannagh Stade of the Cumberland Interglaciation, approximately 3200 yr B.P., is recorded by moraines with moderately steep proximal and distal slopes, a dark surface tone, and surface boulders that are oxidized or show grain relief. Hornblende etching in the soil ranges from approximately 1.6 micrometers at the surface to 0.5 micrometers, typical of unaltered parent material, at a depth of 65 cm. The Shannagh Stade resulted from a slightly warmer and wetter annual climate than at present. The Illusion Stade of the Cumberland Interglaciation includes several phases of glacial expansion caused by decreases in summer temperature and dated by lichenometry at approximately 330, 210, 150, 95 and 68 years ago. Moraines of Illusion drift have steep slopes, sharp crests, little dissection, and a light tone because of limited lichen cover. Surface boulder weathering and soil development are both negligible. (Auth)(JTA)

513. **Loken, O.H.** 1965. Postglacial Emergence at the South End of Inugsuin Fiord, Baffin Island, N.W.T. *Geographical Bulletin 7(3-4):243-258.*

A beach deposit from Inugsuin Fiord, Baffin Island, is described and its mode of formation is outlined. It is possible to relate a number of shell samples to the sea levels prevailing when the shells lived. An accurate emergence curve has been drawn which is similar in form to curves obtained from other areas. The early part of postglacial time was characterized by a rate of emergence much smaller than observed in other areas and there are distinct differences between the pattern of emergence on the west and the east coasts of Baffin Island. A pronounced bench on the beach deposit is discussed and is believed to be associated with a postglacial halt in the process of emergence. This is possibly a parallel to a postglacial transgression in northern Labrador and of late Tapers age. Fossil evidence suggests a climate in early postglacial time warmer than the present. (Auth) BafBib 288

514. **Luckman, B.H., and G.D. Osborn.** 1979. Holocene Glacier Fluctuations in the Middle Canadian Rocky Mountians. *Quaternary Research 11:52-77.*

Holocene glacial advances in the Banff-Jasper-Yoho area of the Canadian Rocky Mountains have been extremely limited in extent. Limiting Carbon 14 dates from two sites within 1 km of contemporary glaciers or fresh terminal moraines indicate that the late Wisconsin Ice Sheet and valley glaciers disappeared prior to 9660 yr B.P. Two subsequent glacial advances are recognized. The earlier Crowfoot Advance is represented by moraines and rock-glacier deposits overlain by Mazama ash (6600 yr B.P.) and is therefore early Holocene or possibly late Wisconsin in age. The late Neoglacial Cavell Advance of the last few centuries is dated by dendrochronology and lichenometry. In addition, there is fragmentary, undated evidence of intermediate-age advance(s), mainly from rock-glacier deposits. All these advances were of limited extent (1-2 km beyond present ice margins) and the Cavell Advance was usually the most extensive. Major exceptions to this pattern occur only where rock glaciers or extensive ice-cored moraines developed during the earlier advance(s?). These deposits were not overrun by glaciers during the Cavell Advance because of their relatively greater downvalley extent and the physical barrier they presented to subsequent glacial advances. Earlier work which postulated more extensive early Holocene advances in the Canadian Rocky Mountains is shown to have inadequate dating control: Many of the features previously attributed to older Holocene events are late Wisconsin in age. (Auth)

515. **Lyons, J.B., and J.E. Mielke.** 1973. Holocene History of a Portion of Northernmost Ellesmere Island. *Arctic 26(4):314-323.*

Radiocarbon dates and glaciological features of the Ward Hunt area along northernmost Ellesmere Island suggest the following chronology, which is consistent with world-wide climatic oscillations: 1) 10,000-4100 B.P.: deglaciation, and development of several marine levels, particularly one now 40 m above sea level, at 7500 + or - 300 B.P.; 2) 4100-2400 years B.P.: climatic deterioration, glacial readvance and formation of ice shelves; 3) 2400-1400 years B.P.: general climatic amelioration; development of dust ablation horizon on Ward Hunt Ice Shelf, glacial retreat; 4) 1400 B.P. - present: climatic deterioration, with renewed thickening of Ward Hunt Ice Shelf, and beginnings of growth of ice rises; the last-mentioned experience maximum growth in the interval between 350-170 years ago; slight glacial readvance. (Auth)(JTA)

516. **Madole, R.F.** 1980. Time of Pinedale Deglaciation in North-Central Colorado: Further Considerations. *Geology 8:118-122.*

The stratigraphy and Carbon 14 ages obtained at three sites near Buffalo Pass, in the Park Range, and two sites on La Poudre Pass, in the Front Range, Colorado, suggest that (1) termination of Pinedale Glaciation in most of the Park Range and Front Range occurred at least 10,000 yr ago, and possibly as early as 11,000 B.P.; (2) in the southern part of the Park Range, where the Continental Divide is relatively low and broad and glaciers descended from an ice cap rather than from cirques, Pinedale deglaciation was completed before 11,000 B.P.; (3) the deposits of the Long Draw Stade or Wisconsin IV of previous publications are at least 10,000 Carbon 14 yr old; and (4) the recession of Pinedale glacier margins from the terminal moraines into the cirques appears to have occurred in less than 4,000 yr in north-central Colorado. (Auth)

517. **Madsen, D.B., and D.R. Currey.** 1979. Late Quaternary Glacial and Vegetation Changes, Little Cottonwood Canyon Area, Wasatch Mountains, Utah. *Quaternary Research 12:254-270.*

Glacial geology and Carbon 14 dating in the central Wasatch Mountains indicate late Holocene periglaciation. Pollen ratios from bog profiles in the mid to upper reaches of the canyon suggest that temperatures cooler than the Holocene average occurred until after about 8000 yr B.P. Warmer and dryer than average conditions were initiated about 8000 to 7500 yr B.P. During the later portion of this Altithermal period conditions became relatively warm and wet. Two subsequent episodes of cooler than average temperatures correspond chronologically to the initial stades of Neoglaciation elsewhere in the Rocky Mountains. However, there is no geomorphic evidence of corresponding glacial activity in the canyon area. Relative moisture during these two periods differs significantly, suggesting that Neoglacial conditions were controlled primarily by changes in summer temperature. (Auth)(JTA)

518. **Mahaney, W.C.** 1972. Audubon: A New Name for Colorado Front Range Neoglacial Deposits Formerly Called "Arikaree". *Arctic and Alpine Research 4(4):355-358.*

Two glacial fluctuations, Temple Lake (4,500 to 2,700 B.P.) and Gannett Peak (300 to 100 B.P.), are recognised in the Colorado Front Range. Lichenometrical investigations led to the identification and dating of an intermediate period of ice and rock glacier advance, locally called the Arikaree (1,900 to 950 B.P.). Because the name Arikaree is preempted in the Colorado stratigraphical column, it is suggested that the intermediate age Neoglacial deposits be renamed Audubon. (Auth) GA 73A/0992

519. **Markgraf, V., and J.P. Bradbury.** 1982. Holocene Climatic History of South America. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 40-45), 110 pp.*

Holocene paleoclimatic records from South America document roughly synchronous changes over this topographically diverse and geographically extensive region. The end of the Pleistocene in the tropical lowlands occured about 10,000 years ago with a change from cooler and drier climates to warmer and moister conditions. Similarly, cooler temperatures but increased effective moisture promoted glacier growth in mountainous regions before 10,000 years ago, and there is some evidence that such environments persisted longer in the high (southern) latitudes than in the north. Holocene climates are warmer but variable throughout South America. Conditions somewhat warmer than present are frequent in early Holocene records, and were relatively arid in the northern and southern Andes, but moister in the tropical lowlands. Cooler environments are recorded in the mid Holocene with increased effective moisture at high elevations and increased evaporation in the tropical lowlands. Late Holocene climates appear even more variable and frustrate simple chronostratigraphic correlation. The approximately synchronous but individualistic climatic changes occuring in various regions of South America are a consequence of the continent's wide geographic area and the interplay of major climatic systems that cross this region. (Auth)

520. **Marthinussen, M.** 1962. Carbon 14 Datings Referring to Shore Lines, Transgressions, and Glacial Substages in Northern Norway. *Norges Geologiske Undersokelse Skrifter 215:37-66.*

Reports preliminary datings of wood, peat, and seashells from a score of locations. Discusses their significance in interpreting the oscillations in shore levels during the past 13,000 years. Evidence of changed shorelines is described and the nature of the Carbon 14 materials and their dates considered for each locality. Related changes in climate are noted. The data are referred to a standard chronology. Correlations are verified with other parts of Scandinavia and western Europe. Variations in glacial maxima, thickness of the ice, and direction of its flow are also considered. (AB81124) AB81124

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521. **Matthews, B.** 1962. Glacial and Post-Glacial Geomorphology of the Sugluk Wolstenholme Area, Northern Ungava. *McGill Sub-Arctic Research Paper No. 12, McGill University, Montreal, Quebec, Canada, (pp. 17-46).*

North of the metamorphosed sediments and lavas of the Cape Smith-Wakeham Bay belt, granite-gneisses are truncated by a plateau surface at about 2000 ft., which is bounded northward by the cliff shoreline of Hudson Strait. Northward moving ice covered the whole area during the maximum of the last glaciation with the possible exception of the Asbestos Hill area of the metamorphic belt. During the retreat of the ice lakes were held in southward-draining valleys south of Cape Wolstenholme, while northward draining valleys to the east were occupied by tongues of ice. Small cirque glaciers appear to have redeveloped near the coast after the last glaciation. Evidence of the post-glacial marine transgression was found to 580 feet in the west, and to near 500 feet to the east, and numerous strandlines were measured below the marine maximum. Shells from 281 feet at Deception Bay have a Carbon 14 age of 10,450 + or - 250 years, indicating that Hudson Strait was free of ice at an early date. (Joyce C. Brown) GA 63/53

522. **Matthews, B.** 1966. Radiocarbon Dated Postglacial Land Uplift in Northern Ungava, Canada. *Nature 211(5054):1164-66.*

Presents a provisional glacio-isostatic uplift curve for the area between Deception Bay and Cape Wolstenholme, northern Ungava, based on ten radiocarbon dates of molluscs from raised marine terraces; it has the general form of such curves constructed for other parts of Canada and Greenland, but represents a later deglaciation period than in most other areas. The various dates suggest that sections of the south coast of Hudson Strait may have been open by 10, 450 yr B.P., the general deglaciation of coastal areas in north Ungava by 8000 yr B.P., and inland areas by 6700 yr B.P. (AB97945) AB97945

523. **Matthews, B.** 1967. Late Quaternary Events in Northern Ungava, Quebec: The Glaciation of Deception Bay, Lac Watts and Sugluk Areas. *McGill Sub-Arctic Research Paper No. 23, McGill University, Montreal, Quebec, Canada, (pp. 42-63).*

During the last glaciation northern Ungava was covered by a predominantly northward moving ice sheet. Towards the end of that phase local ice caps developed and ice moved in a radial direction. There is some evidence that a small tongue of ice, from a Hudson Strait ice sheet moving in an easterly direction, overrode the Deception Bay area. The high cliffs along most of the coast probably acted as a major barrier to penetration far inland of this ice sheet. The preferred orientations of the long axes of a number of glaciated boulders were obtained to determine the direction of ice flow in a region where the usual indications - striae, roches moutonnees and drumlins were markedly lacking. A shell date from marine sediments interdigitated with glacial outwash deposits near the mouth of the Riviere aux Roches valley indicates that a valley glacier existed until 6,800 years ago. If a general advance took place regionally at that time it may be contemporaneous with readvances elsewhere in Alaska and northern Canada. (J.T. Gray) GA 68A/1125

524. **Matthews, B.** 1967. Late Quaternary Land Emergence in Northern Ungava, Quebec. *Arctic 20(3):176-202.*

Twenty-one Carbon 14 dates of material from Late Quaternary marine terraces are used to construct an isostatic uplift curve. The phase of rapid uplift averaged about 26 ft per 100 years, while for the past 5,200 years uplift was just under 1 ft per 100 years. Updoming resulted in an upward (southerly) tilt of the "Glacier Beach" (460-ft strandline) and "Upper Tunit Beach" (100-ft strandline) at about 5.6 ft per mile and 3.6 ft per mile respectively. The Carbon 14 dates indicate that the general deglaciation of northern Ungava occurred about 7,000 to 8,000 years ago. Twelve well-formed marine terraces have been identified at the heads of the major fjords. The fauna of the "Upper and Lower APORRHAIS Beaches" (40 ft and 55 ft strandlines) suggests that optimal marine conditions occurred about 3,900 to 5,230 radiocarbon years ago during a possible marine transgression. Hydroclimatic conditions during the formation of APORRHAIS deposits in Sugluk Inlet (62 deg 10 min N) corresponded to those at 58 deg 15 min N. (Auth)

525. **Matthews, J.A.** 1976. "Little Ice Age" Palaeotemperatures from High Altitude Tree Growth in South Norway. *Nature 264(5583):243-245.*

Liestol, working on the Storbreen glacier, has calculated the mass balance of the glacier since A.D. 1816 (ref. 9) and working on the glacier-foreland, I have reconstructed former glacier margin positions back to A.D. 1750. This information has been used to estimate the tree growth corresponding to the glacier in equilibrium (that is, no net change in the glacier margin) from A.D. 1700 to 1950. The information derived from equilibrium-line displacement permits calibration of the tree-growth variations in terms of summer temperatures. The calibrated curve provides a continuous record of summer temperatures over the past 250 yr. At least 10 major oscillations are indicated, superimposed on a long-term temperature rise of 1.0 deg C since A.D. 1750. Cool fluctuations were up to 1.0-2.0 deg C below present; warm fluctuations were up to 1.0 deg C above present temperatures. (Auth)(JTA)

526. **Mayr, F.** 1964. Investigations of the Extent and Consequence of Climatic and Glacier Fluctuations since the Beginning of the Post-Glacial Warm Phase. Untersuchungen uber Ausmass and Folgen der Klima- und Gletscherschwankungen seit dem Beginn der postglazialen Warmezeit. *Zeitschrift fur Geomorphologie/Annals of Geomorphology/ Annales de Geomorphologie 8(3):257-285.*

Five episodes of glacial readvance are recognized from a sequence of moraines and associated drifts, which include disturbed soils and peat beds, in the Stubai Mountains of Tyrol. They succeeded the postglacial warm phase, and are dated on palynological and radiocarbon evidence at 1400-1300 B.C., 900-300 B.C., 400-750 A.D., 1150-1250 A.D., and 1600-1850 A.D. (E.C.F. Bird) GA 65/ 422

527. **Mayr, F.** 1968. Postglacial Glacier Fluctuations and Correlative Phenomena in the Stubai Mountains, Eastern Alps, Tyrol. *University of Colorado Studies, Series in Earth Sciences No. 7, Glaciation of the Alps, G.M. Richmond (Ed.), Proceedings of the VII Congress, Vol. 14, International Union of Quaternary Research, Boulder—Denver, Colorado, 1965. University of Colorado Press, Boulder, CO, (pp. 167-177), 177 pp.*

The Stubai mountains contain the type deposits of late-glacial and post-glacial advances of Alpine glaciers, the Steinach, Gschnitz, Daun and Egesen advances and the Larstig, Simming and Fernau advances. There are 60-70 cirque and (short) valley glaciers, which now terminate at 2400 to 2700 m.: a hundred years ago most of them extended 1-2 km further downstream to flat trough floors at 2100-2400 m. The three glaciers discussed here are the Grunauferner, Sulzenauferner and Ferauferner. The Larstig advance started about

6000 B.P. and is marked by MOORSTAUCHMORANE (thrust moraines developed in peat deposits). The Simming series are 3000-1700 B.P. Periglacial activity was much greater during these two early advances than during the Fernau (Little Ice Age). (K.M. Clayton) GA 70A/512

528. **Mayr, F.** 1969. Postglacial Glacier Fluctuation in the Mont-Blanc Area. Die Postglazialen Gletscherschwankungen des Mont Blanc-Gebietes. German, English and French Summaries. *Zeitschrift fur Geomorphologie/Annals of Geomorphology/Annales de Geomorphologie Supplementband 8:37-57.*

The publication is a guide to the postglacial history of some of the major (and easily accessible) glaciers of Mont Blanc, on both sides of the French-Italian border. There is evidence of four distinct groups of moraines, separated from each other by buried soils. The moraines were correlated with and named according to the Stubai Series of the Eastern Alps, i.e. Egesen, Larstig, Simming and Fernau. Figure 1 shows the glaciers of the uppermost Val Veni and their post-hypsithermal maximum size as well as their modern Fernau maximum. The area in between the glaciers is the site of the extinct (ice-dammed) lake Combal. The arcuate moraines of Glacier du Miage, east of this former lake, were supposed to be either modern (Sacco 1918) or hypsithermal (Capello 1940) in age; both interpretations proved to be wrong: the 17th century fortifications on these moraines were constructed on top of a well developed buried soil, and on the other hand the moraines are younger than the last post-hypsithermal lake Combal. The modern moraines are nearly unweathered; they surround a small lake basin (Lac du Miage), the varved silt of which gives a complete record of the rates of ablation since about 1860 A.D. (fig.2). Figure 5 gives an idea aobut the relations between the modern Fernau moraines, the Egesen moraines and an intermediate group which, in front of Glacier du Tour, was found to be more than 6000 years old (VRI-106, 6400 + or - 100 a. B.P.). The date corresponds with other data for Larstig moraines in the Eastern Alps (Mayr, 1968; G. Patzelt, unpublished thesis). (Auth)(JTA)

529. **Mayr, F., and H. Heuberger.** 1968. Type Areas of Late Glacial and Post-Glacial Deposits in Tyrol, Eastern Alps. *University of Colorado Studies, Series in Earth Sciences No. 7, Glaciation of the Alps, G.M. Richmond (Ed.), Proceedings of the VII Congress, Vol. 14, International Union of Quaternary Research, Boulder—Denver, Colorado, 1965. University of Colorado Press, Boulder, CO, (pp. 143-165), 177 pp.*

The most extensively studied glaciated region in western Austria is that of the former Inn glacier comprising all the type areas of late- and post-glacial deposits in the Eastern Alps. The fact that all but one of these type deposits are in the same drainage system provides a reliable opportunity for studying their interrelations. Following a review of the literature, morphological maps of the type areas are presented, the field evidence is discussed and conclusions are reached. Buhl: the type deposits belong to at least two independent stades. Little is known about later interruptions of the general retreat of the Inn Glacier. Schlern: The type area is outside the Inn river system, the deposits are probably Buhl in age. The "moraines" include rock slides and ice-contact features. Gschnitz: The steinach moraines indicate a pronounced advance of independent Gschnitz valley glacier, followed by two substades. There is a time of soil formation between the Steinach advance and the Gschnitz stade. Stubaital: The main moraines are related to the Steinach and Gschnitz stades: kame terraces are associated with the older Schoenberg Halt. Daun: Three substades are recognised. (K.M. Clayton) GA 70A/51

530. **McCoy, W.D.** 1983. Holocene Glacier Fluctuations in the Torngat Mountains, Northern Labrador. *Geographie physique et Quaternaire 37(2):211-216.*

Lichen measurements and other relative-age data were collected from deposits of several cirque glaciers in the Torngat Mountains of northern Labrador. Lichen growth stations were established, but no lichen-growth curve has yet been determined for the local area. However, moraines can be correlated between valleys on the basis of the largest diameter thallus of RHIZOCARPON GEOGRAPHICUM SENSU LATO combined with other relative-age data. These data suggest several discrete periods of Holocene glacier recession. If the R. GEOGRAPHICUM S.L. growth curve established for the northern Cumberland Peninsula of Baffin Island (Miller, 1975) is valid for similar environments in the Torngat Mountains, then glacier recession occurred c. <150, 400, 550-750, 950, > or = 1850, >1850, > or = 2800, >2800, > or = 4000, and >>4000 yr BP. The latest three periods of glacier recession may correlate with periods of glacier recession on the Cumberland Peninsula of Baffin Island. (Auth)

531. **McGregor, V.R.** 1967. Holocene Moraines and Rock Glaciers in the Central Ben Ohau Range, South Canterbury, New Zealand. *Journal of Glaciology 6(47):737-748.*

Young Pleistocene moraines on the eastern side of the southern Alps are described from examples in small tributary valleys in the Ben Ohau Range. The moraines are divided into Birch Hill Formation and Ben Ohau Formation. They post-date Kumara III stage, which ended 14,000 years ago. The Ben Ohau moraines are subdivided into three stages, the youngest occurring as rock glaciers with ice cores. The Birch Hill advance occurred soon after 8460 + or - 120 years ago. The latest moraines were probably built about A.D. 1745. The latest advance was probably due to cooling, rather than increased precipitation. (C.A.M. King) GA 67A/1205

532. **McKenzie, G.D.** 1968. Glacial History of Adams Inlet, Southeastern Alaska. *Ph.D. Thesis, Ohio State University, Columbus, OH, 227 pp.*

This inlet is in the Chilkat-Baranof Mts in the east part of Glacier Bay National Monument. The depositional sequence and conditions, composition and dates, where known, of seven formations are described. From oldest to youngest, these are Granite Canyon Till, Forest Creek glaciomarine sediments, Van Horn Formation, Adams lacustrine-till complex, Berg gravel and sand, Glacier Bay drift and Seal River gravel. Wood at the top of Forest Creek Formation is dated approx 10,940 B.P., the Glacier Bay Formation was deposited in the early 19th century. Ice-contact deposits such as eskers, kames and pitted outwash are common. Buried ice is present in parts of the Inlet. (AB105536) AB105536

533. **McKenzie, G.D., and R.P. Goldthwait.** 1971. Glacial History of the Last Eleven Thousand Years in Adams Inlet, Southeastern Alaska. *Geological Society of America Bulletin 82(7):1767-1782.*

Thick sections of Wisconsin and younger deposits exposed in recently deglaciated Adams Inlet, Glacier Bay National Monument, southeastern Alaska, reveal the glacial history of the area. Following deposition of the late Wisconsin Granite Canyon till, Forest Creek glaciomarine sediments were laid down. These sediments contain volcanic ash that may have been derived from Mt. Edgecumbe 200 km south of Adams Inlet on Kruzof Island. Wood on top of the For-

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est Creek sediments is dated at 10,940 + or - 155 years B.P. Land was nearly 90 m lower than present levels; it rose an average of at least 2 cm per year, causing retreat of the sea. Adams Inlet and tributary valleys were then filled in Hypsithermal time with glacial outwash and inwash gravel. By 1700 B.P., the entrance to Adams Inlet had been dammed by growing fans forming glacial Lake Adams in the inlet and adjacent valleys. Glacier ice of Neoglacial time then advanced into the lake. Subsequent ice retreat and the stabilization of Adams Inlet Glacier possibly coincides with the Little Optimum (A.D. 1150-1300). Adams Inlet Glacier then expanded to its maximum Neoglacial extent about A.D. 1700, and it may have remained there as late as 1835. Several glacial lakes formed in tributary valleys during subsequent deglaciation. Deposits of these lakes, glaciofluvial deposits, and till comprise the Glacier Bay Formation in Adams Inlet. Retreat from Neoglacial position is well documented by historical observations. (Auth) GA 72A/0739

534. **McLaren, P., and D.M. Barnett.** 1978. Holocene Emergence of the South and East Coasts of Melville Island, Queen Elizabeth Islands, Northwest Territories, Canada. *Arctic 31(4):415-427.*

Twenty-five radiocarbon dates from the coast of Melville Island show that there has been up to 100 m of Holocene emergence. This evidence of post-glacial rebound suggests there was significant late-Wisconsin glacier cover on or near the island. The Winter Harbour moraine on the south coast is thought to mark the maximum northward advance of the Laurentide Ice. However, emergence for this area appears to be essentially complete, whereas the northeast coast is still recovering at a rate of approximately 0.35 cm/yr. Ice cover in the region to the northeast must, therefore, have been thicker and/or lasted longer than in the peripheral areas of the Laurentide Ice, lending support to the concept of an Innuitian Ice Sheet, rather than local ice masses over the central Queen Elizabeth Islands. Unfortunately, there is an absence of fresh glacial landforms and stratigraphy that can be attributed to the Innuitian Ice Sheet. We suggest that this ice sheet may have had a thermal regime below the pressure melting point, thus depriving the ice of much of its erosive and depositional capabilities, but with a sufficient mass to account for the observed pattern of emergence. (Auth)

535. **Mercer, J.H.** 1965. Glacier Variations in Southern Patagonia. *Geographical Review 55(3):390-413.*

Previous reconstructions of the glacial chronology of southern Patagonia since the late-glacial are summarised, and the age and characteristics of moraines are described in three areas; the valley of the Rio Fitz Roy, the Puta Bandera area, and in the vicinity of the Upsala glacier. End moraines in the Punta Bandera area are older than the Sub-Atlantic and probably date from the late-glacial. The glaciers may then have become smaller than at present. A subsequent advance, culminating about 3600 years B.P., may have occurred into forest that had become established under more favourable climatic conditions than have prevailed since. An advance between 2300 and 2000 B.P. is well established from wood and peat deposits associated with the glacial deposits of the Upsala glacier, and this would have occurred during the cool, wet Sub-Atlantic period. In contrast with glaciers of the Northern Hemisphere, those in Patagonia apparently rarely extended so far during their advance in recent centuries (A.D. 350 and 800 years B.P.), as they did in the Sub-Atlantic and thus the record of these earlier advances may be better preserved than elsewhere. (K.J. Gregory) GA 66A/324

536. **Mercer, J.H.** 1967. Glacier Resurgence at the Atlantic/Sub-Boreal Transition. *Quarterly Journal of the Royal Meteorological Society 93(398):528-534.*

Some mountain glaciers in both the Northern and Southern Hemispheres advanced in late Atlantic and early sub-Boreal time, between about 5,200 and 4,600 radiocarbon years ago, and several in the Southern Hemisphere reached their greatest post-glacial extents. This suggests that the cool phase was as severe as at the start of the sub-Atlantic (ca. 2,800 radiocarbon years ago), but many botanists believe that the fluctuation was weak. Much botanical evidence indicates that the cool phase was followed by renewed warmth and divided the Hypsithermal Interval into two parts of unequal length. (Auth)

537. **Mercer, J.H.** 1968. Variations of Some Patagonian Glaciers since the Late Glacial. *American Journal of Science 266(2):91-109.*

After a Late-Glacial readvance, the glaciers in Argentine Patagonia receded quickly, and by 10,000 B.P. at least one glacier was little larger than it is today. Three episodes of Postglacial readvance followed, the first culminating about 4600 B.P. during early Sub-Boreal time, the second about 200 B.P. during the Sub-Atlantic, and the third during recent centuries. In contrast to most other parts of the world, no glacier, so far as is known, reached its maximum Postglacial extent in recent centuries. (Auth) GA 70A/489

538. **Mercer, J.H.** 1970. Variations of Some Patagonian Glaciers since the Late-Glacial:II. *American Journal of Science 269(1):1-25.*

In Chilean Patagonia, the ice on the east side of the cordillera receded into the mountains before 12,500 yr B.P. after an undated final Late-Glacial readvance. On the west coast, by 11,000 B.P. glaciers were smaller than they are today, implying the start of the Hypsithermal Interval. Three post-Hypsithermal Neoglacial readvances culminated before 4200 B.P., between 2700 and 2200 B.P., and in the late 18th century A.D. Between readvances, glaciers receded to within their present borders. (Auth) GA 71A/0224

539. **Mercer, J.H.** 1972. Chilean Glacial Chronology 20,000 to 11,000 Carbon 14 Years Ago: Some Global Comparisons. *Science 176(4039):1118-1120.*

Chilean glaciers at a latitude of 41 deg S reached a maximum extent about 19,400 Carbon 14 years before the present (B.P.), shrank 50 percent by 16,000 years B.P., and readvanced to a smaller maximum after 14,800 years B.P. These fluctuations were closely in step with those of the Laurentide ice sheet east of the Mississippi River but differ somewhat from the accepted sequence in New Zealand. A corresponding pattern is not apparent in the Antarctic paleotemperature curve deduced from changes in oxygen isotope ratios. (Auth)

540. **Mercer, J.H.** 1981. Holocene Glacier Variations in Southern South America. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 35-40), 47 pp.*

The last major glacial readvance in southern South America occurred no later than 13,000 years B.P. The deglaciation that followed was rapid. By 12,500 years B.P. the ice had withdrawn into the mountains, opening ice-free corridors through which former ice-dammed lakes east of the Cordillera drained westward to the Pacific Ocean. Recession continued and by 11,000 years B.P. the ice had withdrawn to within its present borders, implying the start of the local Hypisthermal Interval. No readvance during the Younger Dryas chron has been detected. Neoglaciation began after 6,800 years B.P. as glaciers readvanced past their present borders. It comprises three intervals of readvance, culminating 4,500-4,000 years B.P., 2,700-2,000 years B.P., and during recent centuries, separated by times when the glaciers were smaller than they are now. On average the first readvance was the greatest, but some glacier reached its greatest Neoglacial extent during each interval of readvance. During the present century most glaciers have receded, to a much greater extent on the east side of the mountains than on the west. Some have been readvancing, however; on the east one is now at its most advanced position of the last 10,000 years, and on the west one has grown by 35 sq km since 1945. (Auth)

541. **Merrill, R.K., and T.L. Pewe.** 1972. Late Quaternary Glacial Chronology of the White Mountains, East-Central Arizona. *Journal of Geology 80(4):493-501.*

Evidence for at least four late Quaternary glaciations can be recognized on Mount Baldy and Mount Ord in the White Mountains of east-central Arizona. A single well-preserved, very bouldery moraine, represents the least extensive and youngest glaciation–the Mount Ord Glaciation–of Holocene age. (Auth)(JTA)

542. **Messerli, B., H.J. Zumbuhl, K. Ammann, H. Kienholz, H. Oeschger, C. Pfister, and M. Zurbuchen.** 1976. The Fluctuations of the Lower Grindelwald Glacier since the Middle Ages, an Interdisciplinary Study of Climate History. Die Schwankungen des Unteren Grindelwaldgletschers Seit dem Mittelalter. German, English Summary. *Zeitschrift fur Gletscherkunde und Glazialgeologie 11(1):3-110.*

These papers deal with the question of how much information can be obtained from historical and natural science data in elaborating the history of climates and glaciers. The historical methods show an increase of density and precision of information–due to the development of nature observation and natural science–whose importance might too often have been overlooked. In particular, from such data, one may document glacier variations occurring since the advance of 1600 A.D. with good accuracy. These fluctuations may be correlated with the interpretation of concurrent climatic variations. The methods of natural science may also be employed in these studies, to shed light on the question of maximal extension of glaciation offering independent support for the historical methods. In addition they allow the extension of our understanding into the late middle ages, where the historical data become insufficient. Using this interdisciplinary approach should become increasingly important in the future in the study of the last 500 years period, and may perhaps yield a better understanding of the last 1000 years period. (from the English Summaries)

543. **Metz, B., and H. Nolzen.** 1973. New Evidence from the Forefield of the Grunau Glacier (Stubai Alps, Tirol): An Attempt at Dating Postglacial Glacier Limits. Neue Ergebnisse aus dem Vorfeld des Grunauferners (Stubaier Alpen/ Tirol): Ein Beitrag zur Datierung Postglazialer Gletscherhochstande. *Zeitschrift fur Geomorphologie/ Annals of Geomorphology/Annales de Geomorphologie Supplementband 16:73-89.*

In this study the authors try to find evidence for the extent of the Grunau glacier in the Stubai Mountains/Tyrol during the different post-Pleistocene readvances of this glacier. In several exposures within the moraine embankments samples were collected and analysed. Carbon 14 dates give the possibility for exact statements. This study is a synthesis of the authors' results, and most of the results which were published by other authors which seemed to be incoherent. The authors show that the Grunau glacier had a so far unknown extent during the sub-Atlantic period equivalent to those of the 17th to 19th centuries. The problem whether the front of the glacier during the early Fernau-fluctuation (c 1600 A.D.) was located farther N than the high embankment of 1850 or whether this morainic material is worked into the high dam is solved by the authors since they found remnants of the Fernau moraine outside the 1850-embankment. (English summary) GA 74A/0184

544. **Mickelson, D.M.** 1971. Glacial Geology of the Burroughs Glacier Area, Southeastern Alaska. *Ohio State University, Institute of Polar Studies, Report No. 40, 149 pp.*

Burroughs Glacier is a sprawling, stagnating remnant of a much larger Neoglacial ice mass in Glacier Bay National Monument. In 1892, when the earliest phototgraphs were taken of it, an ice plateau 10 km by 25 km was present. Since that time the ice surface has downwasted as much as 750 m and its calving margin has retreated 27 km. The ice mass separated into the Burroughs Glacier with its margin on land and Plateau Glacier with its terminus at sea level. Between 1960 and 1970 ice surface lowering averaged 9.5 m/year at 205 m elevation (in 1960) to 4.6 m/year at 440 m elevation (in 1960). Retreat of the land-based ice front was up to 140 m/year and of the calving ice margin up to 350 m/year during this time. (Auth)

545. **Miller, C.D.** 1969. Chronology of Neoglacial Moraines in the Dome Peak Area, North Cascade Range, Washington. *Arctic and Alpine Research 1(1):49-66.*

Dendrochronology, tephrochronology, and lichenometry, together with geological evidence establish a chronology of glacier fluctuations during Neoglaciation in the Dome Peak area. Tree-ring counts proved to be the most satisfactory method for dating moraines. Dated W and Y ash layers in the Dome Peak area made it possible to assign limiting ages to some glacial deposits. Lichenometry could not be used reliably for absolute dating, but proved useful in relative dating of Neoglacial deposits. The earliest recognized Neoglacial advance in the area was that of South Cascade Glacier about 4,900 years ago. South Cascade, Dana, and Le Conte Glaciers reached their Neoglacial maxima in the 16th century and subsequently built moraines in the 19th and 20th centuries. Chickamin Glacier, however, reached its Neoglacial maximum in the 13th century and later built several moraines between the 16th century and the early part of the 20th century. The apparently anomalous behavior of Chickamin Glacier may reflect a steeper profile and higher accumulation area than for the other three glaciers. Glacier fluctuations in the Dome peak area during the later part of Neoglaciation appear to be broadly synchronous with those elsewhere in the Pacific Northwest and are in agreement with a generalized curve constructed by Porter and Denton (1967). The Neoglacial record, however, is incomplete, for no evidence was found of an early period of glacier expansion about 2,800 to 2,600 years ago, which is well documented in other parts of western North America. (Auth)

546. **Miller, G.H.** 1973. Late Quaternary Glacial and Climatic History of Northern Cumberland Peninsula, Baffin Island, N.W.T., Canada. *Quaternary Research 3(4):561-583.*

Radiocarbon dates on molluscs in marine facies associated with glacial deposits in northern Cumberland Peninsula indicate both main fiord (Laurentide) ice and local glaciers remained at their late Wisconsin maxima until ca. 8000 B.P. Essentially continuous deglaciation followed; local corrie glaciers melted out by 7100 B.P. and by 5500 B.P. fiord glaciers had receded behind the present margin of the Penny Ice Cap. The Hypsithermal warm interval probably lasted from ca. 8000 to 5000 B.P. Lichenometry and radiocarbon dates on peat and buried organic horizons delimit a detailed Neoglacial chronology. Of 46 outlet and corrie glaciers investigated, the oldest Neoglacial moraines are dated lichenometrically at 3200 + or - 600 B.P. Subsequent advances terminated immediately prior to ca. 1650, 780, 350, and 65 yr B.P., the most recent of which marked the most extensive ice coverage during the Neoglacial. The highest occurrence of lateral moraines from late Wisconsin advances of local and Laurentide ice suggest that at the late Wisconsin glacial maximum, depression of snowline varied from 450 m below present at the coast to 350 m below present level in the vicinity of the Penny Ice Cap. Moraines, surrounded by glacial ice and lying above the present steady-state ELA, suggest that during the Hypsithermal snowline was up to ca. 200 m above its present elevation. A radiometrically controlled reconstruction of relative summer paleotemperatures for the post-glacial derived independently of lichenometry agrees well with the lichenometric age datings of moraines. The data suggest that between ca. 1650 and 900 B.P. climatic conditions were unfavorable for glacier growth, whereas the period ca. 800-65 yr B.P. was one of general glacial activity. During the last decade permanent snow cover has been increasing in the area. Previously reported data on climatic trends in the Canadian Arctic based on palynological analyses are similar to the chronology reported here. (Auth) BafBib 383

547. **Miller, G.H.** 1975. Glacial and Climatic History of Northern Cumberland Peninsula, Baffin Island, Canada, during the Last 10,000 Years. *Ph.D. Thesis, University of Colorado, Boulder, CO, 253 pp.*

Late Wisconsin moraines have been identified throughout the field area on the basis of morphology, weathering, position and their association with marine deposits of known age. Radiocarbon dates on mollusks in marine facies associated with late Wisconsin glacial deposits in the northern field area indicate both main fiord (Laurentide) ice and local glaciers remained at their late Wisconsin maximum until ca 8500 B.P. Slow (15 to 20 m/yr) but continuous recession followed, with local glaciers essentially melted out by ca 7000 B.P. and by 5500 B.P. the main fiord ice had receded behind the present margin of the Penny Ice Cap. The regional Neoglacial chronology is delimited by detailed lichenometric studies on over 100 distinct moraine crests fronting 46 glaciers in the study area. A histogram of frequencies of maximum thalli diameters on moraine crests defines periods of Neoglacial moraine stabilization. The earliest recorded advance terminated immediately prior to 3200 + or - 600 B.P. (Snow Creek Advance). Periods of moraine stabilization following subsequent advances are lichenometrically dated at ca 1620, 780, 370, and 65 years B.P. The earlier of these periods relates to moraine stabilization following the Dorset advance, whereas the three younger periods all occurred within the Cumberland advance. The most recent glacial episode (ca. 350 to 65 B.P.) was the most severe nival period during the Neoglacial, and ice coverage at that time was more extensive than at any other time during the preceding 5000 to 5600 years. (Dissertation Abstracts International 36:2121-B)(JTA) Ecol Can 2046

548. **Miller, G.H.** 1976. Anomalous Local Glacier Activity, Baffin Island, Canada: Paleoclimatic Implications. *Geology 4(8):502-504.*

Some local cirque glaciers on eastern Baffin Island were more extensive during the "Little Ice Age" than at any time in at least the past 34,000 yr and possibly the past 60,000 yr. The most reasonable paleoclimatic explanation of such anomalous glacier activity is that during the last glacial maximum in southern Canada, Arctic regions experienced diminished precipitation. (Auth) BafBib 450

549. **Miller, G.H.** 1980. Late Foxe Glaciation of Southern Baffin Island, N.W.T., Canada. *Geological Society of America Bulletin, Part 1, 91:399-405.*

A continental outlet glacier terminating in outer Frobisher Bay, southern Baffin Island, Arctic Canada, deposited the Hall moraine immediately prior to 10,760 B.P. (dated by Carbon 14). This moraine and associated Carbon 14 dates provide the first documentation of a pre-Holocene late Foxe (late Wisconsin) ice advance from the eastern Canadian Arctic. A second moraine system deposited near the head of the bay is of Cockburn age (8,000 to 9,000 yr), and it correlates with the late Foxe advance farther north on Baffin Island. A compilation of Carbon 14 dates related to the maximum late Foxe advance and marine paleoclimatology along 2,500 km of eastern Arctic coastline suggests a parallel but time transgressive latitudinal relationship. There is considerable evidence for dominantly local ice accumulation centers and a prominent glacial advance between 11,000 and 10,000 yr B.P. from widely scattered sites surrounding the North Atlantic Ocean. (Auth)

550. **Miller, G.H., and A.S. Dyke.** 1974. Proposed Extent of Late Wisconsin Laurentide Ice on Eastern Baffin Island. *Geology 2(3):125-130.*

The apparent outer limit of late Wisconsin Laurentide ice on eastern Baffin Island (roughly correlative with the "classical" Wisconsin of the southern Laurentide margin) is delimited in broad terms on the distal side by the presence of undisturbed glaciomarine deposits for which associated molluscan fauna have Carbon 14 ages beyond the useful radiocarbon age range. This is supported by the distribution of drowned cirques, submerged late Wisconsin glaciomarine deltas, moraines from local ice moraines. Within this maximum outer limit of late Wisconsin glaciation, only the previously mapped Cockburn Moraine system is associated with marine deposits of finite Carbon 14 age. This system forms a largely continuous and prominent end and lateral moraine overlying till showing extensive tundra polygon development, and it is associated with ice-contact raised marine features dating between 7,500 and 8,500 Carbon 14 yr B.P. A map depicting the late Wisconsin ice margin based on these criteria shows that most of the eastern coastal margin of Baffin Island remained ice free throughout the last glacial stade (approximately 8,000 to 25,000 yr B.P.). This interpretation is supported by the occurrence of deposits dated more than 25,000 yr B.P., 30 to 60 km inland from the outer coast, which have not been glacially overridden; the pattern of postglacial isostatic uplift since 8,000 yr B.P.; and the complete absence of features dating between 10,500 and 25,000 yr B.P., whereas less than 8 percent are between 9,000 and 10,500 yr old. A consideration of the pattern of atmospheric circulation at the last glacial maximum suggests that few cyclonic disturbances penetrated the North American Arctic and that consequent decreased precipitation allowed only minimal glacial expanison. (Auth) BafBib 454

551. **Miller, G.H., W.W. Locke, III, and C.W. Locke.** 1980. Physical Characteristics of the Southeastern Baffin Island Coastal Zone. *Geological Survey of Canada Paper 80-10, The Coastline of Canada, S.B. McCann (Ed.), Geological Survey of Canada, Ottawa, (pp. 251-265), 439 pp.*

A recent rise of relative sea level along eastern Baffin Island is documented by the submergence of river valleys and the burial of in situ terrestrial vegetation beneath beach sediment. The extent of sea level rise is the greatest (ca. 2 m) along the outermost east coast and decreases to the west. Radiocarbon dates suggest that the onset of submergence occurred between 1500 and 2500 years B.P. (Auth) (JTA) Ecol Can 3993

552. **Miller, M.M.** 1964. Inventory of Terminal Position Changes in Alaskan Coastal Glaciers since the 1750's. *Proceedings of the American Philosophical Society 108(3):257-273.*

Southeastern coastal Alaska is divided into seven glaciological provinces in which at least 80% of the glaciers in Alaska are located. The Stikine district is extremely mountainous and has all the characteristics of a submerged coast line. The dominant characteristic of these ice masses has been shrinkage with only a few of them near equilibrium. The most impressive geomorphic feature in the Taku District is the extensive network of glaciers which comprise the Juneau Icefield. In the Glacier Bay District a phenomenal disappearance of ice has been observed in recent years. There have been several instances of minor readvances. The Chilkat District comprises a small icefield whose glaciers are thinning and in retreat. In the Lituya Bay District, the glaciers were considerably receded at the end of the 18th century while the Glacier Bay ice sheet was at its maximum. The St. Elias District is covered with more than 10, 000 sq. miles of ice. Prince William Sound and the Chugach Range District have a regional snow-line and mean neve-line which are much lower than elsewhere along the coast. Although many of the small glaciers are in retreat, over the past 60 years a larger proportion has been advancing in the two latter districts than in the other districts. (B.L. Evans from CRREL Bibliography, 19, 1965) GA 67A/140

553. **Miller, M.M., and J.H. Anderson.** 1974. Out-of-Phase Holocene Climatic Trends in the Maritime and Continental Sectors of the Alaska-Canada Boundary Range. *Geographical Monographs No. 5; Quaternary Environments: Proceedings of a Symposium, Mahaney, W.C. (Ed.), First York Symposium on Quaternary Research, 1974. Department of Geography, Atkinson College, York University, Toronto, Ontario, Canada, (pp. 33-58), 318 pp.*

Comparative field studies of Quaternary glacial sequences and palynological profiles in kettle-hole bogs are described with respect to the coastal and interior flanks of the Alaska-Canada Boundary Range on a transect from Juneau, Alaska (Taku District) to Atlin, B.C. (Cassiar District). Based on radiocarbon dating of key horizons in the stratigraphic sequence, a table of climatic trends is noted for each region where today the mean annual sea-level precipitation regimes are 228 cm (in the temperate Sitka spruce and hemlock forest of the Juneau sector) and 25 cm (in the dry semi-arid white spruce and pine forests of the Atlin sector. (Auth)(JTA)

Seven climatic episodes are delimited for the two areas during the Holocene. The thermal maximum is dated 8000-5500 B.P. in the Atlin District, whereas it occurred between 5500-3250 B.P. in the Taku District. The period 2500-750 B.P. was cold and dry in the interior but cooler and wetter on the coast. (JTA)

554. **Moran, J.M.** 1974. Possible Coincidence of a Modern and a Glacial-Age Climatic Boundary in the Montane West, United States. *Arctic and Alpine Research 6(3):319-321.*

A steep Glacial-age cirque-altitude contour gradient and a modern winter climatic boundary occupy similar positions in the montane western United States. This suggests that the anchoring effect of mountains upon Glacial-age air masses may have outweighed the effect of any departure from modern air mass characteristics in determining the location of frontal boundaries during the Glacial Epoch. (Auth)

This study argues that major climatic changes differ in magnitude but not in kind from present climatic year-by-year variations. Thus by analogy the climatic pattern for the Altithermal may be sought in the climate of a recent "warm/dry" summer. (JTA)

555. **Morner, N.-A.** 1976. Eustatic Changes During the Last 8,000 Years in View of Radiocarbon Calibration and New Information from the Kattegatt Region and other Northwestern European Coastal Areas. *Palaeogeography, Palaeoclimatology, Palaeoecology 19:63-85.*

In view of the calibration of the non-absolute radiocarbon chronology and the accumulation of new field data and radiocarbon dates, the calculated eustatic and isostatic factors responsible for the shore-level displacement in the Kattegatt region are revised for the period covering the last 8,000 sidereal years. The eustatic amplitude variations reflect the Earth's glacial history. The transgression/regression sequence reflects cyclic variations in the world climate of irregular frequency. (Auth)(JTA)

556. **Morner, N.-A.** 1976. Paleoclimatic Records from South Scandinavia Global Correlations Origin and Cyclicity. *Paleolimnology of Lake Biwa and the Japanese Pleistocene, Vol. 4, Contribution no. 155, (pp. 499-528), 836 pp.*

Ice recession during the Preboreal and Boreal in southwestern Scandinavia reached values of 350 + m/yr. Dates on the pollen zonation boundaries are: Younger Dryas/Preboreal 10,000 B.P.; Preboreal/Boreal 9700 B.P.; Boreal/Atlantic 7750 B.P.; Atlantic/Subboreal 5000 B.P.; and Subboreal/Subatlantic 2200 B.P. Detailed paleomagnetic records are presented for a series of cores which record Holocene regression/transgression events. The paper argues that there are correlations between the magnetic events, sea level fluctuations, and Carbon 14 production. The suggestion is made that these may have a common origin in variations of the mantle/core boundary. Major peaks in magnetic intensity are recorded during the Boreal period. (JTA)

557. **Muller, D.S.** 1980. Glacial Geology and Quaternary History of Southeast Meta Incognita Peninsula, Baffin Island, Canada. *M.Sc. Thesis, University of Colorado, Boulder, CO, 211 pp.*

Evidence from the field area suggests that deglaciation of Frobisher Bay involved more than just simple retreat of Laurentide ice toward the head of the bay. Ice from a dispersal center on the Meta Incognita Peninsula continued to occupy York Sound and Jackman Sound more than fifteen hundred years after ice had left Countess of Warwick Sound across the bay. A late readvance is indicated between 8500 and 8000 B.P. for Fox Jaw Glacier, an outlet of Terra Nivea Ice Cap. Between 8000 B.P. and at least 2500 B.P., and perhaps as late as 1000 B.P., the margins of Terra Nivea outlet glaciers were behind their present margins. Ice has withdrawn from the maximum advance of the Neoglaciation within the last 200 years. (Auth) (JTA)

558. **Nelson, A.R.** 1978. Quaternary Glacial and Marine Stratigraphy of the Qivitu Peninsula, Northern Cumberland Peninsula, Baffin Island, Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 331 pp.*

Very distal glaciomarine facies in the lower beds of the Kangaajuk Member of the Qivitu Formation suggest a very limited ice extent during the pre-Holocene portion of the Baffinland Stade. Upward gradation of the glaciomarine sediments into facies W sands overlain by peat horizons indicate the arrival of warm water and concurrent regression just prior to 10,000 B.P. Relative sea level then rose from a low point of less than 4 m at 8200 B.P. to 15 m. (Dissertation Abstracts International 39(1978):5285-B)(JTA) Ecol Can 3485

559. **Osborn, G.** 1981. Holocene Glacier and Climate Fluctuations in the Southern Canadian Rocky Mountains: A Review. *Holocene Glaciers, Striae 18, W. Karlen (Ed.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 15-25), 47 pp.*

In the southern Canadian Rockies Late Pleistocene glaciers retreated to close to their present limits by roughly 10,000 B.P. There is evidence of two minor readvances of ice since that retreat, one prior to 6600 B.P. and one within the last several centuries. Another minor advance of intermediate age is suggested by deposits at one site. With regard to interpretation of pollen spectra and macrofossils, there is some consensus that a) prior to c. 7500 years B.P. one or more episodes of relatively cool/wet climate occurred, b) a shift toward cool/wet climate at c. 6000 years B.P. ended the warmest/driest part of the Holocene, c) further cooling occurred at c. 3000 years B.P., and d) the last few centuries may have been the coolest/wettest episode of the Holocene. Preliminary, unpublished results of oxygen isotope analysis of wood by B. Luckman suggest that mean annual temperature at c. 5900 years B.P. was 1.9 deg C higher than at present at a site in Jasper National Park. (Auth)

560. **Ostrem, G.** 1965. Problems of Dating Ice-Cored Moraines. *Geografiska Annaler 47A(1):1-38.*

Samples of buried ice underlie many neoglacial moraines. Studies have indicated that in many cases the ice is formed by the compaction of frontal snowbanks and is not of glacial origin. Large samples of ice (100-400 kg) were melted down and the contained organic materials Carbon 14 dated. Fourteen radiocarbon dates are reported. A map of the moraines fronting the Grasubreen Glacier, Norway, indicates that the outermost moraine is dated ca 1300 B.P. and dates increase in age toward the glacier with the innermost moraine having a Carbon 14 date of 6770 B.P. In one case a boulder was located with a moss cover. The moss was dated at 720 + or - 170 B.P. whereas organic material in the ice had an age of 1300 + or - 100 years. Radiocarbon dates were also obtained on humus in soil pits near the neoglacial moraines. Ages in the top 3-5 cm of the soil varied between 385 and 3815 years old. One sample at 20 cm depth was dated at 8350 + or - 120 years. Radiocarbon dates on organics from buried ice are probably too old by several hundreds to thousands of years because of various causes of contamination. (JTA)

561. **Page, N.R.** 1968. Atlantic/Early Sub-Boreal Glaciation in Norway. *Nature 219(5155):694-697.*

An isolated pocket of peaty sand from Glomen in the Glomfjord of Nordland, Norway has been radiocarbon dated at 4550 + or - 170 B.P. (GaK 1445). The sample was obtained from the base of a freshly cut section into a hillside hollow formed by the Glomen outer moraine, consisting of a low till-covered ridge of large blocks and glacifluvial sands. It is supposed from the site and stratigraphy of the section (paper in preparation) that an ice lobe of the Glomen advance at this site occupied the 160 m deep fjord up to at least 135 m a.p.s.l. (above the present sea level) about the time that peat was formed in the sub-Boreal. (Auth)

562. **Palmer, W.H., and A.K. Miller.** 1961. Botanical Evidence for the Recession of a Glacier. *Oikos 12(1):75-86.*

Plant succession was studied on the foreland of Rotmoos Glacier, Austria. The ages of recent moraines were determined by counting the number of bud scale scars along the stem of SALIX shrubs. It is suggested that willow growth starts one year after deglaciation. Two moraines dated by this method have ages of 1900 and 1940 A.D. (JTA)

563. **Patzelt, G., and S. Bortenschlager.** 1973. Postglacial Glacier and Climate Variations in the Venedigergruppe, High Tauern, Eastern Alps. Die postglazialen Gletshcer - und Klimaschwankungen in der Venedigergruppe (Hohe Tauern, Ostalpen). *Zeitschrift fur Geomorphologie/Annals of Geomorphology/Annales de Geomorphologie Supplementband 16:25-72.*

Several profiles were dug out in order to analyse soil and peat stratigraphy; six pollen profiles of peat bogs in close vicinity of glaciers and 25 radiocarbon dates are analysed. Nine periods of glacial advance are described. It is assumed that the Egesen Stade and possibly also the Daun Stade took place in the Younger Dryas (10,800-10,200 B.P.), thus being parts of the Alpine Late Glacial. The Alpine Postglacial sets in with the final reduction of ice masses to modern size that was reached around 9500 B.P. None of the later advances reached as far as the Schlaten advance. Even for the largest postglacial advances the snowline was not necessarily much lower than during the advance of 1850 A.D. Already in 9500 B.P. and maybe somewhat earlier, the climatic condition in the Alpine region equalled the present day long term averages. By 9000 B.P. at the latest stone pine (PINUS CEMBRA L.) grew in the Southern Venedigergruppe in 2300 m elevation which means that already in the late Preboreal they reach elevations typical for the climatic optimum. Even in the climatically most favourable periods of the Postglacial (from 7500 to 6600 B.P. and from 6000 to 5800 B.P.) the timberline did not exceed an elevation of 2400 m in this region. For comparison, the potential timberline today lies approximately at 2300 m. Presumably timberline and snowline varied only in a range of 200 m during the entire Alpine Postglacial indicating long period climatic variations since 9500 B.P. of small amplitude. (from English summary) GA 74A/0183

564. **Payette, S., and M.K. Seguin.** 1979. The Cryogenic Mineral Mounds of the Leaf River Lowlands, Nouveau-Quebec. Les buttes minerales cryogenes dans les basses terres de la riviere aux Feuilles, Nouveau-Quebec. French, English and German Summaries. *Geographie physique et Quaternaire 33(3-4):339-358.*

The sandy terraces in the mid-section of the Leaf River (58 deg 15 min N, 72 deg W) are generally underlain by permafrost. An estimated maximum permafrost thickness of 35 m was measured by electrical resistivity soundings. The main permafrost landforms found in mineral sediments are respectively convex and flat cryogenic mineral mounds. As proposed from stratigraphical and Carbon 14 data, permafrost became active only after 3000 years B.P. Significant permafrost expansion was recorded during a cold period sometime after 450 years B.P. Under permafrost conditions, the sandy terraces were less permeable, which probably caused more water to flow downstream. The convex mounds represent landforms resulting from permafrost aggradation, under the influence of the growing volume of segregation ice. During the twentieth century a minor climatic amelioration has been probably responsible for thermokarst activity. Many flat mounds originated probably from this period, due to local permafrost regression, namely in linear depressions where running water thawed frozen sediments. The cryogenic mineral mounds form particular periglacial landforms, distinct from those associated with bayd zharakhs-alas system. (Auth)

Glacial geologic

565. **Peretti, L., and G. Charrier.** 1967. Description and Pollen Analysis of Peat Deposits in Front of the Present Rutor Glacier (Val d' Aosta). Consideration of the Paleogeography and Local Paleoclimatology. Segnalazione e analisi pollinica di torba deposta alla fronte attuale del Ghiacciaio del Rutor (Valle d'Aosta). Considerazioni di paleogeografia e paleoclimatologia locale. Italian, French and English Summaries. *Bollettino del Comitato Glaciologico Italiano 14:13-31.*

The author communicates the emergence of typical peat in small blocks at the end moraine of the great Rutor Western Glacier (Aosta Valley), which is nowadays rapidly regressing. This phenomenon, here observed for the first time, is a clear proof that in the past the glacier has regressed still further than in the present-day position (of at least several hundred of meters); the corresponding local snow line stood at least one hundred meters higher. The palynologic analysis, performed by G. Charrier, indicates the age of the peat with a sufficient approximation, as being of several thousands of years. (Eng. Summary)

566. **Pessl, F., Jr.** 1962. Glacial Geology and Geomorphology of the Sortchjorne Area, East Greenland. *Arctic 15(1):73-76.*

Reports studies in 1959 and 1961 of glacial features in five valleys of this area (approx. 72 deg N, 24 deg W) near Mesters Vig. Moraines, erratics, striae, kame terraces, emerged marine deltas, and glacial control of drainage patterns are described. Evidence from these features indicates that: during maximum glaciation, the ice margin extended considerably beyond the present coastline; the higher peaks were nunataks; deglaciation was primarily by lateral thinning and downstream wasting; the sea was at least 75 meters above its present level; a minor readvance of the glaciers occurred in recent time; and the isostatic adjustment of the land caused rejuvenation of the streams, with extensive canyon cutting. (AB74741) AB74741

567. **Peterson, J.A., and G.S. Hope.** 1972. Lower Limit and Maximum Age for the Last Major Advance of the Carstensz Glaciers, West Irian. *Nature 240(5375):36-37.*

Glacial deposits have been mapped as low as 1705 m a.s.l. Radiocarbon dates on wood from IN SITU till from these deposits gave ages of 10,000 + or - 130 yr B.P. and 10,540 + or - 130 yr B.P. 7.5 km up the valley a lens of peat found beneath 4 m of till was dated at 11,330 + or - 150 yr B.P. and 11,820 + or - 150 yr B.P. These findings indicate that a major advance of the Carstensz ice took place with a glacier reaching 3,500 m less than 11,300 yr ago and extending to 1,700 m less than 10,000 yr ago, with a length of about 15 km. At present, ice accumulation in the Carstensz Mountains occurs down to 4,400 m. Precipitation probably exceeds 400 cm yr(E-1). (Auth)(JTA)

568. **Pewe, T.L.** 1962. Age of Moraines in Victoria Land, Antarctica. *Journal of Glaciology 4(31):93-100.*

"Fresh-looking" moraines lying within a mile of glaciers in the lowlands of the McMurdo Sound area, Victoria Land, Antarctica have been interpreted by some to be only 50 or 100 yr old and to have been left by recent glacier retreats. The present author believes that these moraines were considerably older because a comparison of the position of existing glacier fronts in the area with positions on photographs of 50 yr ago shows no movement of the front or appreciable thickening or thinning of the glaciers during the last 50 yr. Radiocarbon dating of mummified seal carcasses lying near glacier fronts indicates that the glaciers have not been more extensive for at least 1,000 yr. The youngest moraines in the area are ice-cored moraines to the existing glaciers. Radiocarbon dates of algae from extinct ephemeral ponds in the ice-cored moraines indicate the moraines to be at least 6,000 yr old. Additional evidence for the antiquity of the near-glacier moraines is the presence of a rather uniformly well-developed micro-relief pattern of sand-wedge polygons on both the end moraines and the ground moraines extending up to the existing glacier front. Studies show that it requires hundreds if not thousands of years for such well-developed polygonal patterns to form. (Auth)

569. **Pheasant, D.R.** 1971. The Glacial Chronology and Glacio-Isostasy of the Narpaing/Quajon Fiord Area, Cumberland Peninsula, Baffin Island. *Ph.D. Thesis, University of Colorado, Boulder, CO, 232 pp.*

The late Wisconsin glacial maximum occurred ca. 10,000 B.P. and was not as extensive as the preceding early and mid-Wisconsin glaciations. During the Cockburn Phase the fiord glaciers were almost as extensive as they were at the late Wisconsin maximum. The fiord heads were deglacierized by ca. 6,000 B.P. (Auth)(JTA)

570. **Planhol, X. de, and T. Bilgin.** 1964. Present and Quaternary Glaciation and Periglaciation in the Karagol Massif - Pontic Mts., Turkey. Glaciaire et periglaciaire quaternaires et actuels dans le massif du Karagol (Chaines pontiques - Turquie). *Revue de Geographie Alpine 52(3):497-512.*

The region is the most westerly of the great Pontic massifs in east Turkey, attaining 3,107 m and rarely falling below 2,500 m. Since 1938, cirques and moraines have been known to exist, and the Quaternary snowline on the northern slopes is now placed at about 2,600 m. Today, permanent snow occurs near the 2,850 m level, and a few small glaciers remain in north-facing cirques, descending to 2,850 m. Some features of these present glaciers and their moraines are described. Periglacial features observed include ancient screes, hummocky ground, patterned ground (small stone circles noted at 1,800 m), and altiplanation terraces. Periglacial forms are best developed and most wide-spread on the northern slopes of the massif. Between 2,000 and 2,500 m here, there are regularly stepped terraces separated by talus banks 5 or 6 m high. On the summit surface of the massif, a thick mantle of debris is patterned by polygons. Forms of glacial erosion dating from the Quaternary include cirques with minor rock basins and steps. Moraines are noted as low as 2,300 m. The lower limits of solifluction and cryoturbation appear to be about 2,400 m today, compared with about 2,000 m in the Pleistocene. The present and the Quaternary snowlines seem to be separated by only 250 m, which may reflect post-Glacial uplift of the mountains. (C. Embleton) GA 64/902

571. **Porter, S.C.** 1964. Late Pleistocene Glacial Chronology of North-Central Brooks Range, Alaska. *American Journal of Science 262:446-460.*

End moraines and exposed stratigraphic sections of glacial sediments along the Anaktuvuk and Chandler Rivers represent four substages of the late Pleistocene Itkillik glaciation in the north-central Brooks Range, Alaska. Ice of the maximum advance, the Banded Mountain, flowed north along the Anaktuvuk Valley from an ice divide south of the present stream-drainage divide and formed a broad piedmont lobe extending 23 miles north of the mountain front. Two subsequent readvances, the Anayaknaurak and Antler Valley, left morainal borders 4 and 7 miles, respectively, behind the moraine of the maximum advance. Ice of the still later Anivik Lake readvance built a moraine 6 miles north of the drainage divide at Anaktuvuk Pass. Radiocarbon dates indicate that the Anayaknaurak readvance occurred soon after 13,270 + or - 160 years B.P. The Itkillik glaciation is correlated broadly with the classical Wisconsin glaciation of central North America; its four substages are provisionally correlated with four substages (Tazewell, Port Huron, Valders, and Cochrane) of the classical Wisconsin. Moraines in tributary valleys record three post-Itkillik advances that were restricted to the highest parts of the range. The Alapah Mountain advance, radiocarbon-dated at 2830 + or - 120 years B.P., and the Fan Mountain I and II advances were post-Hyspithermal events that appear comparable to correlative advances noted elsewhere in the North American Cordillera. (Auth)

572. **Porter, S.C.** 1966. Pleistocene Geology of Anaktuvuk Pass, Central Brooks Range, Alaska. *Arctic Institute of North America, Technical Paper 18, 100 pp.*

During the Itkillik glaciation, correlated broadly with the late Wisconsin glaciation of central North America on the basis of radiocarbon dates, the Anaktuvuk Pass was under ice to a minimum depth of 2,000 ft. A prominent end moraine across the valley floor north of the pass is attributed to the Anivik Lake re-advance, which occurred during the final phases of glacier recession. Two post-Wisconsin phases of the valley glaciation, the Alapah Mountain and Fan Mountain, were restricted to cirque valleys in the higher parts of the range. Present alpine glaciers are remnants of the Fan Mountain glaciers. There is evidence that, except for a mean summer temp at least 3.8 deg C lower, the climate at Itkillik maximum was similar to that of today. A recent warming of the climate, promoting melting of ground ice, northward extension of floral and faunal habitats, and recession and thinning of existing glaciers is indicated by abundant evidence. (AB99172) AB99172

573. **Porter, S.C.** 1981. Glaciological Evidence of Holocene Climatic Change. *Climate and History, T.M.L. Wigley, M.J. Ingram, and G. Farmer (Eds.). Cambridge University Press, Cambridge, (pp. 82-110), 530 pp.*

Evidence for repeated fluctuations of glaciers during the Little Ice Age of the last four to five centuries is widespread in glaciated alpine regions. Most glaciers achieved maxima in seventeenth, eighteenth, or nineteenth centuries and began a period of marked recession during the second half of the nineteenth century. Apparent non-synchrony of second-order advances among geographic areas may reflect different climatic histories, differences in response lags of temperate and subpolar glaciers, or uncertainties in dating. Earlier intervals of glacier expansion similar in magnitude to the Little Ice Age occurred about 1100-1200, 2800-3000, and 5000-5300 years ago in a number of areas, but as yet no convincing well-dated global pattern has been demonstrated. During glacial maxima the snowline typically was lowered about 100-200 m, representing a depression equivalent to about 15 percent of the maximum of the last glaciation. An inadequate data base severely restricts any attempt to make a comprehensive global synthesis of Holocene glacier fluctuations. With additional carefully collected information from selected sites along three major latitudinal and logitudinal transects, important insights can be gained regarding the intra- and interhemispherical synchrony and relative magnitude of glacier advances, possible periodicities of glacier variations and their causes, the extent of ice recession between advances, and the magnitude and climatic significance of snowline fluctuations. (Auth)

574. **Porter, S.C., and G.H. Denton.** 1967. Chronology of Neoglaciation in the North American Cordillera. *American Journal of Science 265(3):177-210.*

Justifies the term neoglacial for the period of cooler climate and glacial advances which followed the post-Wisconsin Hypsithermal and which some authors have called the little ice age. Data is combined from geologic, botanic and historical sources to establish a tentative chronology of the glacial fluctuations which characterize this event, most pronounced in Alaska and Yukon Terr. Advances dated by Carbon 14, dendrochronology, and lichenometry in these areas are identified and detailed work on many sites is summarized. These studies suggest initial glacial expansion shortly before 2800-2600 B.P., and a major advance which, except for glaciers in the Malaspina district, culminated during the last several centuries. The max neoglacial stand on Alaskan coastal glaciers varied from ca 1750 to a few decades ago. Examples showing that glaciers in close proximity may be out of phase are given. Problems of sea level changes as a result of the Neoglacial are considered, the data being susceptible to varied interpretation. Recent persistent eustatic rise is believed due to melting of ice on Antarctic and/or Greenland. Glaciological evidence from other continents suggests probable world-wide synchrony of glacial fluctuations during the Neoglacial in repsonse to climatic change. (AB99170) AB99170

575. **Price, R.J.** 1965. The Changing Proglacial Environment of the Casement Glacier, Glacier Bay, Alaska. *Institute of British Geographers Transactions 36:107-116.*

Retreat of the Casement Glacier between 1894 and 1962 is derived from a study of photographs. In 1903 the ice front ended in Muir Inlet but by 1907 the ice front no longer terminated in the sea and instead was land-based. A profile of the ice margin at 1907, 1911, 1919, 1929, 1931, 1935, 1941, 1946 and 1948 is included. (JTA)

576. **Price, R.J.** 1969. Moraines, Sandar, Kames and Eskers near Breidamerkurjokull, Iceland. *Institute of British Geographers, Transactions and Papers, Publication No. 46, (pp. 17-43).*

Prior to 1890 A.D. Breidamerkurjokull had been advancing for at least 100 years. However, since 1890 A.D. there has been rapid and continuous retreat. Maps of the ice margin at 1890 and 1937 A.D. are included based on local information and a 1:100,000 map produced in 1937 A.D. Ice margins in 1945, 1951, 1961 and 1965 A.D. were reconstructed from air photographs. The glacier had retreated approximately 2.75 km between 1890 and 1965 A.D. (JTA)

577. **Rabtseva, K.M.** 1968. Lithological-Geochemical Characterisation of Holocene Morainic Deposits of Khibin. Russian. *Uchenye Zapiski, Moskovskii Gosudarst. Pedagogicheskii Instituta im V.I. Lenina, 302, (pp. 40-49).*

Four retreat stages of Holocene glaciers of Khibin are established. A lithological study is made of all four stage moraines (granulometric composition, textural characteristics, toughness of the fragmental material, petrology and mineralogy of deposits). It is pointed out that the most ancient Holocene moraines (Stages I-II) contain a large quantity of transport material, and have layered structures. Stable and secondary minerals predominate in the heavy fraction of the moraine. An enhanced content of quartz grains plus a low content of feldspar is characteristic of the light fraction. 3 buried soils were discovered, indicating landscape climatic fluctuations in the Holocene; the age of the lower soil belongs to the sub-Atlantic period. Study of the Holocene glaciation in the Khibins makes it possible to mark a rhythmic fluctuation in climate, affecting the dynamics of the glaciers. (trans. F. Hilton) GA 71A/0585

578. **Rampton, V.** 1970. Neoglacial Fluctuations of the Natazhat and Klutlan Glaciers, Yukon Territory, Canada. *Canadian Journal of Earth Sciences 7:1236-1263.*

The Natazhat and Klutlan Glaciers are surging valley glaciers whose present termini are located at the northern edge of the St.

Elias Mountains. Both glaciers have massive ice-cored Neoglacial morainal complexes extending downvalley from their ice termini. At least six separate Neoglacial moraines adjacent the Klutlan Glacier and four adjacent the Natazhat Glacier have been identified from changes in the geomorphic, pedologic, limnologic, vegetational, dendrochronologic, and lichenometric characteristics across the morainal complexes. Dating of the individual moraines by lichenometry, dendrochronology, and Carbon 14 implies that most were constructed within the last 550 years, although both glaciers have been relatively inactive near their termini since 1947. Stratigraphy and Carbon 14 dates suggest that the initial Neoglacial advance of the Natazhat Glacier near its Neoglacial maximum occurred ca. 3300 B.P. and that of the Klutlan Glacier ca. 1520 B.P. Intervals during which the glaciers constructed a number of moraines near their Neoglacial maxima probably were caused by cool summer temperatures, even though individual moraines were formed by glacial surges. A number of factors make impossible precise dating of the intervals of cool summer temperatures. (Auth)

579. **Reger, R.D.** 1968. Recent History of Gulkana and College Glaciers, Central Alaskan Range, Alaska. *Journal of Geology 76(1):2-16.*

Moraines were dated to 1580(?), 1650(?), 1830 and 1875 by lichenometry. Two post-Wisconsin advances before 1580(?) may be recorded by buried moraines. During all four of the latest advances, Gulkana Glacier has grown more than College Glacier, and the first three of these advances were successively larger. During the 1830 and 1875 advances Gulkana Glacier dammed the stream draining from College Glacier leading to the formation of a lake. Some correlations with other Alaskan advances are made, and the whole period of advances is thought to correlate well with the world-wide cold epoch following the climatic optimum. (M.J. Kirkby) GA 68A/1429

580. **Reger, R.D., and T.L. Pewe.** 1969. Lichenometric Dating in the Central Alaska Range. *The Periglacial Environment, Past and Present, T.L. Pewe (Ed.). Arctic Institute of North America, McGill-Queen's University Press, Montreal, (pp. 223-247), 487 pp.*

To establish a lichenometric dating scale for the Delta River area of the central Alaska Range, a tentative growth curve for RHIZOCARPON GEOGRAPHICUM was determined based upon lichen diameters on dated Recent moraines of Black Rapids and Canwell glaciers. The ages of these prominent moraines, whose terminal sectors lie below treeline, were dated by dendrochronology to be 1650(?) and 1830. Maximum diameter R. GEOGRAPHICUM on the 1830 terminal moraine of Black Rapids Glacier average 24 mm. Lichens could not be measured on the 1650(?) terminal moraine. A preliminary growth rate curve for R. GEOGRAPHICUM was constructed in the Canwell Glacier area where maximum-diameter lichens on the 1830 moraine average 30 mm and on the 1650(?) moraine average 144 mm. The prominent Recent moraines of nearby Gulkana and College glaciers, which lie entirely above tree-line, were dated by comparison of maximum-diameter R. GEOGRAPHICUM with the preliminary growth curve and were determined to have been formed by advances in 1580(?), 1650(?), and 1875. Maximum-diameter R. GEOGRAPHICUM in the Gulkana-College glacier area average 9 mm on 1875 moraines, 31 mm on 1830 moraines, 137 mm on 1650(?) moraines, and 177 m on 1580(?) moraines. The growth rate of R. GEOGRAPHICUM in the central Alaska Range compares favourably with growth rates recorded in the Alps. (Authors) GA 70A/545

581. **Reheis, M.J.** 1975. Source, Transportation and Deposition of Debris on Arapaho Glacier, Front Range, Colorado, U.S.A. *Journal of Glaciology 14(72):407-420.*

Lichenometry gave relative ages of the tills, and suggests that the Gannett Peak till is of at least three ages and probably overlies Audubon till. (Auth)(JTA)

Gannett Peak age is considered to be no more than about 300 years old; Audubon age about 1850-950 yr B.P. (JTA)

582. **Reid, J.R.** 1970. Late Wisconsin and Neoglacial History of the Martin River Glacier, Alaska. *Geological Society of America Bulletin 81:3593-3603.*

The debris-veneered, dead-ice area near the present terminus of the glacier marks the maximum Neoglacial advance, which culminated about 1650 A.D. Although the main lobe has been thinning and retreating ever since, a small moraine formed during a 1910 advance is present in the valley of the Charlotte Lobe. Tree-ring measurements document the past 400 yrs of this glacier and permit the interpretation that the striking change in degree of soil development, at the 14th of the 21 successive lateral moraines of the Charlotte Lobe, separates the Neoglacial from the Late Wisconsin ice levels. (Auth)(JTA)

583. **Retherford, R.M.** 1972. Late Quaternary Geologic Environments and Their Relation to Archaeological Studies in the Bella Bella-Bella Coola Region of the British Columbia Coast. *M.Sc. Thesis, University of Colorado, Boulder, CO, 128 pp.*

Less extensive lines of geological evidence for past environments include a glacial advance, and a period of dune building. A date of 3010 + or - 100 years B.P. defines the end of a Neoglacial advance of ice in a cirque along South Bentinck Arm. Several cirque glaciers show evidence of recession in the very recent past. The period of dune building occurred prior to about 4000 years B.P. (Auth)(JTA)

584. **Richmond, G.M.** 1972. Appraisal of the Future Climate of the Holocene in the Rocky Mountains. *Quaternary Research 2(3):315-322.*

Consideration of the history of Holocene climate in the Rocky Mountains indicates that the over-all trend during the past 2500 yr has been toward increasing warmth, interrupted by cooler times of minor advances of cirque glaciers. Comparison of Holocene climatic history with the record of past interglacials in the region suggests that the present interglacial is not complete and that the climate may become first warmer and subsequently wetter before it is completed. Correlation of the timing of the regional glacial-interglacial record for the past 140,000 yr with the record of major sea level changes and with the calculated changes in the earth's insolation suggest that the present interglacial may be completed within a few millennia and that it may be followed by a significant cooling of the climate. (Author) GA 73A/1311

585. **Roche-Bellair, N.** 1976. Climatic Variations during the Upper Holocene in the Kerguelen Islands According to a Peat Section of the Dante Plain (S. Coast). Les Variations Climatiques de l'Holocene Superieur des Iles Kerguelen: d'apres la Coupe d'une Tourbiere de la Plain de Dante (Cote Meridionale). French. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D, 282(13):1257-1260.*

The area studied in the Kerguelen Islands showed a succession of climatic periods covering 6,000 years, three cold periods and two temperate. Age determinations were done by means of Carbon 14. It appears that these climatic variations do not correspond to those of the northern hemisphere: subboreal arctic climate is contemporaneous with a temperate phase in the Kerguelen Islands. (AntB I-16953) AntB I-16953

586. **Rowan, D.E., T.L. Pewe, R.H. Pewe, and R. Stuckenrath.** 1982. Holocene Glacial Geology of the Svea Lowland, Spitsbergen, Svalbard. *Geografiska Annaler 64A(1-2):35-51.*

The Svea Lowland, located in eastern van Mijenfjorden, central Spitsbergen, is composed of both marine clay and glacial till. These deposits have been divdied into three geologic units based on their differing lithology and topographic expression: (1) the Geikie Moraine, (2) the Dames Moraine, and (3) an organic-rich marine clay. The sediments were deposited during two surges of the Paula Glacier in Holocene time. The first surge of the Paula Glacier is suggested by the limited Carbon 14 age range of marine mollusk shells, between 7800 and 8500 years old, incorporated in all three deposits. This surge provides a mechanism to kill the molluscs at this time while producing a deposit of limited-age material available for redeposition and incorporation with younger material by a later surge of the Paula Glacier. A second surge of the Paula Glacier is suggested by (1) the ice-cored nature of the moraine deposits on the lowland, (2) the semi-arcuate distribution of the moraine deposits traceable to the current glacial front, (3) young radiometric dates of driftwood and whalebone incorporated within and on the surface of the marine clay, and (4) the presence of a datable turf horizon underlying the glacially pushed marine clay. These features suggest this surge occurred between 600 and 250 years ago. As the Paula Glacier surged across the fjord, the fjordbottom clay, possibly deposited in the past by a previous surge, was both pushed before the advancing glacier and incorporated into its till. Some of the ice-shoved marine clay was pushed before the ice-cored Dames Moraine, over the existing tundra-covered lowland. Recent strandlines present up to 20 m above sea level surrounding Braganza Bay suggest that the Paula Glacier dammed Braganza Bay producing a lake at this time. Subsequent to the last surge, partial melting of the ice in the Dames Moraine has resulted in the striking knob and kettle terrain and associated small lakes over much of the area. A recent surge of the Sabbarp Glacier deformed moraine material (Dames Moraine) produced by the second surge of the Paula Glacier. Intense frost action has created frost-split debris on the moraine surfaces. (Auth)

587. **Rutter, N.W.** 1972. Geomorphology and Multiple Glaciation in the Area of Banff, Alberta. *Geological Survey of Canada Bulletin 206, 54 pp.*

Glacial deposits, consisting mainly of till and glaciofluvial deposits, indicate three or possibly four, major Wisconsin ice advances. The fourth advance, the Eisenhower Junction advance, extended roughly as far as Eisenhower Junction. Evidence includes well-preserved ground and lateral moraines, breaks in slope, fresh cirques, and a terminal moraine. That a minor readvance followed is shown by till over ice-contact fluvial deposits laid down during the wastage of the Eisenhower Junction ice. A radiocarbon date of 9330 + or - 170 years B.P. (GSC-332), obtained in a nearby area, is correlated with the time of the Eisenhower Junction retreat. Three stades of the Pinedale glaciation (late Wisconsin) in the north-western United States are tentatively correlated with the Bow Valley advance, the Canmore advance, and the Eisenhower Junction advance. The Altithermal interval is suggested by wind-blown material, containing a volcanic ash layer correlated with Mazama ash, overlying glacial deposits. (Auth)(JTA) GA 73A/0927

588. **Ryabtseva, K.M.** 1970. Dynamics of the Glaciation of the Khibiny Mountains in the Holocene as Related to Rhythms of Moistness of the Northern Hemisphere. Dinamika oledeneniya Khibin v golotsene v svyazi s ritmami uvlazhnennosti severnogo polushariya. *Voprosy Geografii 79:105-120.*

Questions are discussed of the dynamics of the glaciation of the Khibiny Massif (Kola Peninsula) in the Holocene. Rhythms in the variation of moistness with a period of 1800-1900 years were the most essential ones for the dynamics of glaciation of highlands in the postglacial time. It was established by numerous ivestigators that, in the majority of mountain systems of the northern Hemisphere, glaciation retreat after the Wurm maximum went through eight stages. In the Khibiny, due to the later disappearance of the Valdai ice cover, the number of such rhythms is fewer (namely, 4) than in the mountains of the temperate zone. A comparison of the results of the studies carried out in the Khibiny and the data on rhythmical changes of the natural environments in the Holocene in the Kola Peninsula territory and adjacent regions reveals their similarity, thus confirming the correctness of our conclusions as to the dynamics of the glaciation of the Khibiny in the Holocene. (Author) GA 71A/1800

589. **Salinger, M.J.** 1976. New Zealand Temperatures since 1300 A.D. *Nature 260(5549):310-311.*

New Zealand experienced a climatic deterioration starting around 1300 A.D. Being most severe between 1600 and 1800, it correlates well with the Little Ice Age of the Northern Hemisphere. Since 1800, a slow warming has occurred, culminating in the rapid, 1 deg C warming of the past 40 yr. (Auth)(JTA)

590. **Salvigsen, O.** 1977. Radiocarbon Datings and the Extension of the Weichselian Ice-Sheet in Svalbard. *Norsk Polarinstitutt Arbok 1976:209-224.*

Some earlier published radiocarbon datings from Svalbard older than 10,000 years B.P. are reviewed, and the results of a total of sixteen datings from Amsterdamoya, Danskoya, Prins Karls Foreland, and Bellsund are presented. Ten of them have finite ages of between about 28,500 and 44,000 years, the rest having ages of between about 9400 and 12,600 years. The datings and other observations indicate that considerable areas on the western coast of Svalbard have been ice-free in an interstadial and that e.g. Prins Karls Forland has not been covered by ice later. At Amsterdamoya and Danskoya moraines from one and probably two stadials have been dated. In the western part of Svalbard the maximum extension of glacier ice has clearly taken place prior to 40,000 years B.P. (Auth)

591. **Salvigsen, O.** 1979. The Last Deglaciation of Svalbard. *Boreas 8(2):229-231.*

Svalbard has been completely covered by an extensive ice sheet at least once, but not in the Late Weichselian (max. 18,000-20,000 years ago). Areas in the western and northwestern parts of Svalbard have been ice-free for more than 40,000 years. The extension and time of a Barents Shelf glaciation are questions still open for discussion. For most of the Svalbard area we do not know when the last deglaciation started, geographically and in time. The oldest datings for the interval 15,000 to 10,000 years B.P. have an age of about 12,600 years, and datings from between 11,000 and 10,000 years B.P. are rather frequent in the western and northern parts of Spitsbergen. No moraines from Younger Dryas have been found in Svalbard and the glaciers were probably less extensive 10,000 years ago then today. The maximum extension of glaciers in the Holocene took place only a few hundred years ago. (Auth)

592. **Schubert, C., and S. Valastro.** 1974. Late Pleistocene Glaciation of Paramo de La Culata, North-Central Venezuelan Andes. *Geologische Rundschau 63(2):516-538.*

Late Pleistocene glacial features in the Paramo de La Culata region, north-central Venezuelan Andes, include: 1. depositional features: morainic till and fluvio-glacial deposits (terrace gravels); 2. sculptured features: glaciated valleys, cirques, horns, and aretes; and 3. erosional features: striation and grooving, polished rock, roches moutonees and whaleback forms, and erratic boulders. Two main levels of moraines were found, an older one at 2600 m elevation, and a younger one between 3000 and 3500 m. The difference in age is reflected by the higher degree of weathering, erosion, and vegetation cover of the lowest level, as compared with the higher level. Radiocarbon dating, and a comparison and correlation of these glacial features with those of adjacent regions, indicates that the lower morainic level (2600 m) is probably the result of the main glacial advance of the Late Wisconsin Glaciation. The main morainic level (3000 to 3500 m) was probably formed by the latest Wisconsin glacial advance. The Late Pleistocene snow-line depression reached approximately 1200 m below the present snow-line (i.e., down to approximately 3500 m). (Auth)

593. **Shnitnikov, A.V.** 1961. The Present Phase of Intrasecular Variability of Mountain Glaciation in the Northern Hemisphere. *International Association of Scientific Hydrology Publication 54:449-465.*

Mountain glaciers of the whole world, in the course of the development of the regular (VIII) post-Wurm multisecular stage, in its regressive phase, will be diminishing during many centuries. (2) The glaciers, in the course of their intrasecular variability, in the next few years will enter a regular intrasecular regressive phase, i.e. retreat phase, which will replace the weakly expressed or nearly unexpressed transgressive phase, i.e. advance phase, which is ending now. (3) Inasmuch as the forthcoming regressive intrasecular phase is superimposed on the multisecular regressive phase, the retreat of glaciers in the next decade or two will be even more vigorously marked than in the thirties and forties of the current century. (4) This process may be somewhat weakened only if the abatement of solar activity, to begin in the next few years in the course of transition of its secular cycle, now at maximum, to a phase of intensive decrease, determines the appearance of some climatic phenonema non-existent throughout last century. (Auth)

594. **Sirkin, L.A., and S. Tuthill.** 1972. Late Pleistocene Palynology and Stratigraphy of Controller Bay Region, Gulf of Alaska. *Etudes sur le Quaternaire dans le Monde, M. Ters (Comp.). VIII Congress INQUA, Paris, 1969. Supplement au Bulletin de l'Association francaise pour l'etude du Quaternaire 4, (pp. 197-208), 1053 pp.*

Radiocarbon dated pollen stratigraphy provides a means of identifying late-Pleistocene glaciation in the Controller Bay Region, and extends late-glacial environmental reconstructions well into the late-Pleistocene. The oldest pollen evidence, probably representing a late-Pleistocene Interstadial, was derived from the base of a clay section under-lying till at Whale Island, Cape Martin, and thus predates the late-Pleistocene glacial advance through Katalla Valley. Pollen of spruce, pine, hemlock, poplar, sedge and grass, suggest climate warmer than today. The late-glacial pollen record predates 14, 000 years B.P. and contains herb and shrub-herb pollen assemblages, indicating tundra vegetation. This record relates to glacially controlled climate and serves to associate the glacial drift with late-Pleistocene rather than prior glaciation. The tundra record persists through the late-glacial, with alder gaining dominance prior to 10, 000 years B.P. Marine conditions, including intertidal environments, existed in the upper Katalla Valley through late glacial and early postglacial time, although crustal adjustment sucessively raised 13 beach ridges oceanward. The early postglacial record is characterized by the continued dominance of alder and the climatic optimum around 7,000 years B.P. Spruce, hemlock forests achieve dominance in the late postglacial. (Authors) GA 73A/0184

595. **Smith, D.I.** 1959. Geomorphology. *D Phys R (G) Hazen 4, Operation Hazen, Narrative and Preliminary Reports 1957-1958, G. Hattersley-Smith (Ed.), (pp. 58-60), 88 pp.*

The snouts of ten glaciers draining the main ice cap, and other margins of small ice caps were studied to ascertain if the glaciers were advancing or retreating. In general, the glacier termini were stable and vegetation extended to within a few feet of the margins in all cases. There is limited evidence, e.g. the presence of former glacial lake shorelines, that the glaciers are thinning. (JTA)

596. **Sollid, J.L., S. Andersen, N. Hamre, O. Kjeldsen, O. Salvigsen, S. Sturod, T. Tveita, and A. Wilhelmsen.** 1973. Deglaciation of Finnmark, North Norway. *Norsk Geografisk Tidsskrift 2:233-325.*

Figure 66 illustrates the major end moraines in North Norway. Several of these were formed during Pre-Boreal and Boreal times as the Fennoscandinavian ice sheet retreated. Correlations and ages are largely inferred because of the association of the moraines with specific raised marine shorelines. (JTA)

597. **Stalker, A. MacS.** 1969. A Probable Late Pinedale Terminal Moraine in Castle River Valley, Alberta. *Geological Society of America Bulletin 80(10):2115-2122.*

Radiocarbon dates from the Castle River Valley of southwestern Alberta indicate that the last major glacier advance down that valley reached its maximum extent 6,200 radiocarbon years ago. This advance is considered to be the late Pinedale in age. The Pinedale then ended with onset of the "Climatic Optimum" or "Altithermal", which lasted in that region from about 6000 to 4500 years B.P. The dates were obtained on bison bones found in outwash near the base of a 250 ft-high cliff. This cliff, here called Mountain Mill Bluff, lies on the south side of Castle River, 7 miles east of the Rocky Mountains and six miles west of the town of Pincher Creek. The lower part of the outwash extends downvalley from a terminal moraine (Mountain Mill Moraine) of the former Castle Valley Glacier. The bison wandered into a meltwater stream draining from that glacier about 6200 years ago, drowned, and were buried by outwash accumulating below the moraine. As moraine and outwash were laid down comtemporaneously, dates on the bison bones indicate the time of construction of the moraine. (Author) GA 70A/1235

598. **Stidd, C.K., W.H. Berger, R.M. Born, and J.C.K. Huang.** 1973. Conference Summary: Climatic Changes on Time Scales Ranging from a Month to Millenia. *Bulletin American Meteorological Society 54:425-432.*

This conference, held at Scripps Institution of Oceanography, 15-17 November 1972, was, technically speaking, a workshop meeting of the AMS Committee on Paleoclimatology. Denton reported that mountain glaciers in southeast Alaska and northern Sweden had advanced and retreated several times during the Holocene. "Little Ice Ages" are recognized at 0-400, 800, 2600, and 5300 B.P. LaMarche reported on bristle-cone pine tree ring data from the White

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Mountains of California. The "Little Ice Age" is reflected in slow tree growth between 1300-1850 A.D. with another "little ice age" occurring between 2600-3100 B.P. but with a minor recovery at 2900 B.P. Since 1850 A.D., tree growth has increased. (Auth)(JTA)

599. **Sugden, D.E.** 1972. Deglaciation and Isostasy in the Sukkertoppen Ice Cap Area, West Greenland. *Arctic and Alpine Research 4(2):97-117.*

Three groups of landforms of deglaciation are analyzed, namely those associated with (1) the disappearance of Inland ice (main Greenland ice sheet), (2) the withdrawal of local Sukkertoppen ice, and (3) the changing of relative sea level. Consideration of their interrelationships in space and time allows a reconstruction of the process of deglaciation. There was an overall westerly movement of Inland ice across the area and this persisted during the early stages of deglaciation. Later stages of deglaciation reflect progressive downwasting with ice persisting in the troughs while adjacent plateau areas became free of ice. The highest marine limit is at 123 m and this incursion of the sea took place ca. 8,800 to 9,000 radiocarbon years B.P. Local Sukkertoppen ice appears to have played an insignificant role during this main phase of deglaciation. Subsequently several Sukkertoppen outlet glaciers have advanced over marine deposits. The paper concludes with consideration of some wider implications. The importance of downwasting and meltwater activity during deglaciation is stressed. Also it is noted that isostatic recovery follows the Greenlandic pattern with high initial rates of uplift, apparently ceasing ca. 3,000 to 5,000 years B.P. Unlike arctic Canada and Scandinavia where uplift has continued to the present day, the continued existence of a major ice sheet in Greenland is probably responsible for this recent stabilization. Finally, it is suggested that the last Inland ice sheet accomplished little erosion in the area compared to earlier ice sheets. (Auth)

600. **Sugden, D.E., and C.M. Clapperton.** 1980. West Antarctic Ice Sheet Fluctuations in the Antarctic Peninsula Area. *Nature 286(5771):378-381.*

The West Antarctic ice sheet is believed to be inherently unstable because much of it is grounded below sea level. It has been suggested that the ice sheet has withdrawn from its late Wisconsin maximum position, grounded at the edge of the continental shelf, and it is now undergoing a collapse as a delayed response to the warming and sea-level rise of the Holocene, and that the ice sheet is likely to collapse shortly in response to rising CO2 levels in the atmosphere. Some geomorphological evidence from Alexander Island and the Antarctic Peninsula is presented which does not agree with either hypothesis. Rather, following deglaciation from the Wisconsin maximum, there was less ice than at present around 8,000 years ago. The ice shelf in George VI Sound has built up subsequently. (Auth) ORNL/EIS-195

601. **Sugden, D.E., and B.S. John.** 1972. The Ages of Glacier Fluctuations in the South Shetland Islands, Antarctica. *Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Volume 8, Scientific Committee on Antarctic Research Conference on Quaternary Studies, Canberra, August 9-12, 1972, E.M. van Zinderen Bakker (Ed.). A.A. Balkema, Cape Town, Chapter 9, (pp. 139-159), 198 pp.*

Radiocarbon dating of organic material from raised beaches has yielded information about glacier fluctuations since the last glacial maximum. Glaciers had withdrawn to at least their present positions circa 9000 years ago. A glacier readvance correlating with a raised beach at an altitude of c 6 m took place 500-750 radiocarbon years ago. Probably this was an early reponse to the world- wide climatic deterioration of the Middle Ages. Problems of radiocarbon dating in the Carbon 14-deficient waters of Antarctica are discussed. An adjustment of circa 750 years was made to dates on marine-based organic remains from the South Shetland Islands. (Auth)(JTA)

602. **Svensson, H.** 1973. Distribution and Chronology of Relict Polygon Patterns on the Laholm Plain, the Swedish West Coast. *Geografiska Annaler 54A(3-4):159-175.*

Earlier observations of relict patterns of ice-wedge polygons in a coastal area of southern Sweden were followed up by photography from a small air craft during dry periods of summer. The polygons showed up very distinctly as crop marks in the cultivated area and could easily be mapped. The stratigraphical characteristics of the polygon lines were studied in test pits, all of which revealed clear ice-wedge casts. The distribution of polygons and their connection with shore levels from the Late-Glacial time is analysed from the map of polygon marks, combined with field data. A maximum age of polygon formation can be estimated from dated shorelines. In the innermost, highest part of the plain the ice-wedge polygons may have begun to form at the end of the Oldest Dryas phase. The elevation of the land continuously brought ground surfaces into the realm of frost activity during the cold phases of the deglaciation period. The lowest observed polygons are situated in surfaces which were elevated above the sea level as late as the Allerod phase. Topographically and geologically the Laholm plain was well suited for the formation of ice-wedge polygons during the Late-Glacial period. Also in recent time with its temperate climate, frost cracking accompanied by earthquake-like shocks and sharp sounds from the ground may occur in the area, when north-east winds bring intense cold in late winter. (Auth)

603. **Ten Brink, N.W.** 1971. Continued Investigations of Quaternary Deposits in the Area Bounded by Sondre Stromfjord, the Inland Ice, and the Sukkertoppen Ice Cap. *Gronlands Geologiske Undersogelse Rapport 35, (pp. 13-17).*

The abandoned shorelines in this area, centering at approx 66 deg 40 min N 51 deg W, are noted, as are their elevations which appear to rise progressively from east to west. Marine shells, other organic materials and lake sediment cores were collected for Carbon 14 dating and pollen analysis. Lichenometric surveys were made to estimate age of moraines, but microclimatic variations may make this effort ineffective. Available dates on marine shells, in the 6000 + B.P. range, vary rather widely in elevation and location. Mapping of glacial deposits is in progress. (AB107784) AB107784

604. **Ten Brink, N.W.** 1975. Holocene History of the Greenland Ice Sheet Based on Radiocarbon-Dated Moraines in West Greenland. *Gronlands Geologiske Undersogelse Bulletin 113, 44 pp.*

The Greenland ice sheet margin retreated at least 125 km in West Greenland during the Holocene, but frequent halts or readvances interrupted the general trend and formed extensive moraine systems. Local deglaciation was synchronous with marine invasion of the fjords, resulting in deposition of interrelated glacial and marine sediments. The marine deposits have been uplifted by postglacial isostatic rebound and now occur as emerged-marine sediments and strandlines up to 125 + or - 5 m a.s.l. The age and altitude values of 21 radiocarbon-dated samples of mollusc shells collected from the emerged-marine sediments define two postglacial emergence curves, which have been used to date moraine systems by means of their relations to former relative sea levels. Major moraine systems were constructed by the inland ice about 8800 B.P., 8300 B.P., 7300 B.P., 6500 B.P. to perhaps 6000 (?) B.P., and presumably c. 4800-4000 B.P. and 2500-2000 B.P. An advance of the inland ice about 3 km beyond its present margin c. 700 lichenometric years B.P. was followed by oscillatory retreat and advance, culminated by an advance 330 + or - 75 Carbon 14 years B.P. Moraines adjacent to the present ice margin were formed by a series of small advances culminated by local maxima between A.D. 1880 and 1920. The episodes of moraine construction were probably caused by slight decreases in mean temperature over periods of several decades to a few centuries, resulting in decreased ablation and immediate growth of the ice sheet margin. Long-term dynamic reponses of the entire ice sheet, requiring thousands of years, were not necessary to form the moraines. The suggested short-term climatic cause of Holocene moraine construction is supported by palynologic and regional glacial geologic evidence as well as historic temperature-glacier fluctuations in West Greenland. Net retreat of the ice sheet margin during the Holocene was almost undoubtedly caused by hemisphere-wide climatic warming recorded in the Oxygen 18/Oxygen 16 data for Camp Century, Greenland, ice core as well as palynologic data from several sites in the Northern Hemisphere. (Auth)

605. **Terasmae, J., and O.L. Hughes.** 1960. Glacial Retreat in the North Bay Area, Ontario. *Science 131(3411):1444-1446.*

Geological and palynological studies in Ontario and Quebec, supported by radiocarbon dates, suggest that the opening of the North Bay outlet and the initiation of the Stanley-Chippewa stages in the Huron and Michigan basins took place 10,000 to 11,000 years ago. (Auth)

606. **Vincent, J.-S.** 1975. Glacial and Postglacial History of the Area East of Lake Temiscamingue, Quebec. Le Glaciaire et le Postglaciaire de la Region a l'est du Lac Temiscamingue, Quebec. French, English Abstract. *Revue de Geographie de Montreal 29(2):109-122.*

The purpose of this article is twofold: a) to reconstruct the Late Quaternary history of the area situated east of Lake Temiscamingue, and b) to relate it to the postglacial evolution of the Clay Belt of northwestern Ontario. The Wisconsin ice flow in the area was to the south-southwest and a till cover was deposited. Deglaciation occurred about 10,200 years ago. Pro-glacial Lake Barlow-Ojibway, which was dammed up between the northern ice margin and the Lake McConnell moraine to the south, flooded the study area to present day elevations of 305 m in the north. At the ice margin, subglacial streams deposited sand and gravel in the form of eskers, while clays and silts were deposited as varves in the deeper waters of Lake Barlow-Ojibway. With isostatic rebound and downcutting of the outlet, lake drainage occurred and beaches were constructed at progressively lower elevations and in varying materials. In the southeastern portion of the study area, the highest beach was vegetated about 9,090 + or - 240 years B.P. (GSC-1432). After final drainage of the lake, streams quickly incised the Barlow-Ojibway glaciolacustrine clays. This, combined with mass-wasting, initiated rapid slope development. (Auth) GA 60/29

607. **Vorren, T.O.** 1973. Glacial Geology of the Area between Jostedalsbreen and Jotunheimen, South Norway. *Norges Geologiske Undersokelse 291:1-46.*

Ice movement and the course of deglaciation are reconstructed. The age of and the climate during the deglaciation are discussed in the light of equilibrium line displacement, shoreline positions, pollen analysis and radiocarbon datings. The oldest regional ice movement was towards and out of Lusterfjord. Deglaciation is divided into five climatostratigraphic units: the Luster Interstadial (10200 + or - 200 to 9800 + or - 200 B.P.) a period of extensive glacial recession; the Gaupne Stadial (9800 + or - 200 to 9500 + or - 200 B.P.), a period of glacial advance and stagnation; a relatively short period of retreat follows this before the glaciers stagnate in the Hogemo Stadial; and finally (after 9100 + or - 200 B.P.), a period of rapidly receding valley glaciers and downwasting of mountain glaciers. (Auth)

608. **Weidick, A.** 1963. Ice Margin Features in the Julianehab District, South Greenland. *Meddelelser om Gronland 165(3):1-133.*

Presents results of the geological investigations of 1967-1960, the 1960 work concentrated in the Narssaq and Narssarssuaq regions, where presumed interglacial deposits were found. A Holocene chronology for the ice margin deposits is tentatively established, based on their association with raised marine shore lines in addition to the fluctuations of individual glacial stages in Holocene times. Detailed study of the Narssarssuaq region resulted in a relative chronology for the ice margin deposits there, and tentative incorporation of the remaining deposits into that chronological scheme. Four post-Wisconsin "stages" are identified which seem to have produced ice deposits: the earliest, Niaqornakasik (older Dryas?); then Tunugdliarfik (probably younger Dryas); Narssarssuak (probably Roman time); and the maximum extent of the ice in historical times (approx. 1750-1900 A.D.). Superficial conditions of the ice cover, i.e. height, shrinkage, etc. above about 1700 m altitude, seem not to have altered much since the Tunugdliarfik stage. Deposits from former ice-dammed lakes in the Narssarssuaq region show that all these lakes at the glacier front had a maximum water depth of 120-150 m. (AB84354)(JTA) AB84354

609. **Weidick, A.** 1963. Glacial Variations in West Greenland in Postglacial Time. *International Association of Scientific Hydrology Bulletin 8(1):75-82.*

Surveys variations of glaciers on the coast between Julianehab and Upernivik Is. in prehistoric and historic time. Prehistoric glacial stages closely resemble the present ice-margin; this similarity suggests an overall uniform response of most of the ice-margin to postglacial climatic changes. In historic time, 50 years of records exist on most West Greenland glaciers; for about 320, pictures, maps and photos have been collected. Variations of 21 selected glaciers are listed; time of maximum extent is shown on a small scale map. Generalizations are not attempted, because of numerous exceptions, but an overall picture of the 1700-1960 trends is suggested. (AB84353) (JTA) AB84353

610. **Weidick, A.** 1964. Glacier Fluctuations in Holocene Time in the Julianehab District, Southwest Greenland. *Report of the VIth International Congress on Quaternary, Warsaw, 1961. Vol. II (pp. 333-340).*

Four glacial events of Holocene age are delimited. The oldest stage – the Niaqornakasik – represents a lowering of the glaciation limit by 400 - 500 m which suggests a decrease in mean annual temperature of between 2 and 4 deg C. On the basis of raised marine strandlines this episode of glaciation is dated to Younger Dryas interval just prior to 10,000 B.P. The three younger glacial events have suggested ages of ca 9000, 2000, and 300-0 B.P. A graph (Fig. 3) shows the change in elevation of the glaciers as a function of elevation for the four major glacial stages. Maximum changes of thickness occurred between the present and the third glacial stage (the Tunugdliarfik) and amounted to a thinning of 700 m above the snouts of present glaciers. This value compares with changes of 350 and 150 m for the last two neoglacial fluctuations. (Auth)

611. **Weidick, A.** 1968. Observations on Some Holocene Glacier Fluctuations in West Greenland. *Meddelelser om Gronland 165(6):1-202.*

Historical and contemporary data record a major fluctuation of the position of the Inland Ice and local glaciation ice margins in the area. Regardless of the glacier type these frontal fluctuations are mostly in phase, with glacial readvances occurring around 1650(?), 1750(?), 1850(?), 1890 and 1920 A.D. Correlation with meteorological data suggests the operation of a delay of a few to twenty years before glacier response to climatic fluctuation. Whilst the individual readvances generally are recognisable throughout the area their magnitude shows a regional variation. Thus, near the coast and in South Greenland the readvances before 1850 produced the historical maximum extent of glaciers, whilst in the northernmost part of the area, Nugssuaq peninsula and Umanak district, the advance of 1920 in part was responsible for the maximum extent. The historical frontal fluctuation corresponded with a fluctuation of the glaciation limits of 100-200 m. As a whole the deposits of the historical glacier advance form a zone marking a single stage in the extent of the glaciers. Zones of Inland Ice margin deposits of a similar magnitude of prehistoric age, have been widely recognized in the area. Three zones have been distinguished; an inner zone, an outer zone and a nunatak zone. The inner zone possibly includes several stages, but the main features date from sub-boreal or early subatlantic times. The outer zone comprises two stages formed at 7,500-8,500 and 9,000-9,500 B.P., whilst the nunatak zone (comprising several stages) was formed before or around 10,000 B.P. Prehistoric ice margin stages of local glaciers have been less extensively investigated. In general, they indicate only late and slight development of local glaciers due, it is believed, to the glaciation limit at the time of the retreat of the continental glaciation being already too high for their widespread development. An exception from this general trend is in the Julianehab district where the more rapid disappearance of the continental glaciers may have favoured the better development of local glaciers. (Auth)

612. **Weidick, A.** 1969. Investigations of the Holocene Deposits Around Jakobshavns Isbrae, West Greenland. *The Periglacial Environment, Past and Present, T.L. Pewe (Ed.). Arctic Institute of North America, McGill-Queen's University Press, Montreal, (pp. 249-262), 487 pp.*

The fluctuations of Jakobshavns Isbrae during the period from 1850 to 1964 A.D. have been summarised, and it seems that the altitudinal difference in surface levels of the glacier are in better accordance with the climatic fluctuations than are the frontal fluctuations of the glacier. Fluctuations in the surface level of the Nunataptasia Lake are treated in conjunction with the fluctuations of the glacier. Two prehistorical stages of the front of Jakobshavns Isbrae have been found. One has a minimum age of 2,500 years B.P. and formed at a sea level near the present one. The other stage is represented by marine levels between 35 and 80 m above the present sea level. This stage is considered to have an age of Upper Dryas or Lower Boreal. (Auth)

613. **Weidick, A.** 1972. Notes on Holocene Glacial Events in Greenland. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 176-204), 511 pp.*

The present review incorporates new information on West Greenland Holocene ice margin deposits which have been correlated and dated by means of former shore-lines. The main deglaciation of this area took place between 10,000 and 6,000 years ago and there is evidence that the recession just prior to about 6,000 years B.P. had reduced the Inland Ice so that its margin was situated further to the east than today. The general recession was interrupted by halts and re-advances of which the youngest one, about 6,000 years B.P., marks the end of the recession. The subsequent period is charactersed by further oscillations of the Inland Ice margin which have been divided into stages, of which the youngest one occurred in historical time with advances initiated around A.D. 1500 and with several fluctuations, of which the last one about A.D. 1890 was still close to the maximum for this period. This was followed by a recession in the present century. Local glaciers in West Greenland generally have an earlier maximum extent in historical time, presumed to be around A.D. 1750 or 1850. The East Greenland deglaciation seems to have occurred contemporaneously with that of West Greenland as far as the Inland Ice retreat is concerned. With regard to the local glaciers at least their most recent fluctuations are comparable with those of West Greenland. In North Greenland the initial deglaciation took place at least a millenium later than in West and East Greenland, and here the re-advance of 6,000 years B.P. seems to have been more extensive than further south. The general impression given is that many local glaciers in North Greenland have not had an extent greater than that of historical time and while advances of possibly 1750 seem to be maximum ones for the coastal local glaciers in historical time in West Greenland and in East Greenland, the North Greenland glaciers often appear to have kept their maximum extent for this period up to this century. The glacier recession was then initiated in the 1920s. (Auth)

614. **White, S.E.** 1981. Neoglacial To Recent Glacier Fluctuations on the Volcano Popocatepetl, Mexico. *Journal of Glaciology 27(96):359-363.*

Neoglacial to historic and recent fluctuations of the firn field and one glacier on Popocatepetl, Mexico, include advance prior to 1519 to possible mid-Neoglaciation stadial position on gentle, north flanks at 4,150 m, then retreat up-valley to 4,335 m by 1906, and to 4,435 m by 1920 at 7 m/year. After volcanic eruptions and melting to about 4,800 m in 1921, growth of firn field and advance of a thin ice lobe before 1949 to 4,573 m by 1950, then retreat in next eight years at about 34 m/year, re-advance of the firn edge as an ice-bulge to about 4,700 m 1968, and as a thick double-lobed glacier to about 4,600 m by 1978 and 1979. A 37 year crevasse study shows continuous active firn-field movement on the north-west side of the cone. (Auth)

615. **Williams, J.R., and O.J. Ferrians, Jr.** 1961. Late Wisconsin and Recent History of the Matanuska Glacier, Alaska. *Arctic 14(2):83-91.*

The depositional features associated with the Matanuska Glacier in southern Alaska are described. From the study of these deposits and from the age of a peat deposit determined by radiocarbon analysis, a chronology is established for the late Wisconsin of the area. The snout of the glacier has not been more than 6,000 feet in advance of its present position in the last 8,000 years. A bibliography for the area is given. (D. Ingle-Smith) GA 61/381

616. **Williams, V.S.** 1983. Present and Former Equilibrium-Line Altitudes near Mount Everest, Nepal and Tibet. *Arctic and Alpine Research 15(2):201-211.*

Glacial geologic

New information on equilibrium-line altitudes (ELAs) of present and former glaciers in the Mount Everest area of eastern Nepal and southern Tibet has been derived from field mapping and interpretation of topographic maps and Landsat imagery. Present ELAs rise from south to north across the Himalayan Range from 5200 to 5800 m, as indicated by the altitudes of lowest cirque glaciers and highest lateral and medial moraines on valley glaciers. In contrast, ELAs during maximum late Pleistocene glaciation rose in altitude from 4300 to 5500 m across the range, as indicated by altitudes of lowest cirque floors and maximum extent of glacial deposits. Highest ELAs occurred on previously unrecognized ice caps that formerly covered extensive highland areas in Tibet north of the range crest. During four distinct Holocene glacial advances of subequal magnitutude, ELAs were depressed about 30% as much as the late Pleistocene maximum depression. Depression of ELAs during the late Pleistocene glaciation was about twice as great south of the range crest (950 m) as north of it (400 m). Although the present northward decrease in precipitation causes ELAs to rise northward for 85 km at 7.1 m km (E-1), the gradient during maximum late Pleistocene glaciation was 11 m km (E-1). Such a great contrast in glacier response to climate change over a short distance is remarkable and probably reflects increased aridity on the Tibetan Plateau and increased climatic contrast across the Himalayan Range during glacial ages. (Auth)

617. **Worsley, P.** 1974. On the Significance of the Age of a Buried Tree Stump by Engabreen, Svartisen. *Norsk Polarinstitutt Arbok 1972:111-117.*

The correct radiocarbon age of the Engabreen site is 1600 + or - 100 years B.P. whereas previously it had been taken to be 350 + or - 100 years B.P. This finding necessitates a re-appraisal of the stratigraphic significance since it now appears to be unrelated to the eighteenth century advance. The date suggests that there was a phase of glacier advance in the early first millenium A.D. and this is inconsistent with the previously accepted interpretation of climatic conditions at that time. Alternatively the relationships may possibly be explained by a glacier surge mechanism. (Auth)

618. **Worsley, P.** 1975. Neoglacial Palaeoenvironmental Change at Engabrevatn, Svartisen Holandsfjord, North Norway. *Norges Geologiske Undersokelse 321:37-66.*

A stratigraphical analysis is made of a sedimentary sequence forming a low lakeside cliff within the zone of Neoglacial ice margin fluctuation. Two principal lithological units are distinguished, a lower fluvial unit overlain by a till. The fluvial unit, the Svartis Gravel Formation, comprises gravels passing up into sands and are considered to be braided stream deposits possibly related to proglacial drainage. After a phase of main channel deposition, a change in the channel pattern is inferred to have led to the abandonment of a channel reach, with only occasional subsequent flooding being responsible for the sand deposition. The sands contain IN SITU trees and an associated extensive organic bed. The sub-fossil vegetation is comparable with that of today in the general area. The organic bed and immediately subjacent sediments are interpreted as poorly developed palaeosols which, by analogy with a contemporary soil of known age near to the site, appear to have required approximately 100 years for their formation. Following a period of essentially stable conditions an advance of Engabreen initiated a further shift in the drainage pattern causing erosion of part of the fluvial sequence. Finally the area was overridden by glacial ice and the uppermost unit, the Enga Till Formation, deposited. The whole sequence reveals no direct glacial disturbance and the only prominent post-depositional effects are clastic dyke injections. Five new radiocarbon dates suggest that the fluvial sedimentation is largely late first millennium A.D. in age and the glacial advance over the locality probably closely followed this. Hence during the early second millennium A.D. the glacier was possibly more extensive than that since circa A.D. 1935. (Auth)

619. **Worsley, P., and M.R. Ward.** 1974. Plant Colonization of Recent "Annual" Moraine Ridges at Austre Okstindbreen, North Norway. *Arctic and Alpine Research 6(2):217-230.*

A sequence of minor "annual" moraine ridges formed between ca. A.D. 1950 and 1968 have been sampled to identify the pattern and timing of plant colonization. The first pioneer species appeared within just over 1 year following the ice recession. The species pattern established shows one jump in an otherwise progressive succession and this is tentatively linked to either the elimination of one annual ridge by a winter readvance of greater magnitude than normal or the nonproduction of a ridge in 1 year. (Auth)

620. **Wright, C.** 1975. Lichen-Free Areas as Indicators of Recent Extensive Glacierization in North-Central Baffin Island, N.W.T., Canada. *M.A. Thesis, University of Colorado, Boulder, CO, 107 pp.*

Extensive stagnant ice and snow patches covered large areas of north-central Baffin Island 200 to 350 B.P. (the Little Ice Age) and left little permanent record of their existence. One indication of former ice and snow cover is the absence of lichens on the ground surface. "Lichen-free" areas were mapped on 1:50,000 and 1:250, 000 scale National Topographic Sheets using air photographs (1:60, 000 scale) and ERTS-1 satellite imagery (1:1,000,000 scale) in order to determine the extent of Little Ice Age ice and snow cover. The term "lichen-free" area is defined as an area having no lichen cover, or very small diameter lichens, or fewer numbers of individuals than lichen-covered areas. Distinctions were made based on the tonal differences on the air photographs, satellite imagery, and the ground surface. Changes in temperature and precipitation required for computed changes in snowline elevation during the Little Ice Age are discussed using preliminary mass balance data. A computer model predicts that a temperature lowering of 1 deg to 1.5 deg C, a decrease in solar radiation of 5%, or approximately a doubling in precipitation compared to 1963 to 1972 values would be necessary to obtain the snow and ice cover that was present during the Little Ice Age. (Auth)(JTA)

621. **Wright, H.E., Jr.** 1964. Late Quaternary Climates and Early Man in the Mountains of Kurdistan. *Report of the VIth International Congress on Quaternary, Warsaw, 1961. Vol. II, (pp. 341-348).*

The matter of late Pleistocene and early Holocene climtic change hold special interest for the student of prehistory, because the caves of the limestone ridges have yielded the remains of Upper Paleolithic hunting cultures and the low mounds of the intermontane valleys and the Mesopotamian piedmont show the traces of incipient agriculture and village life (Braidwood, Howe et al., 1960). According to radiocarbon dates, this change in living economy took place about 9,000-11,000 years ago. The paleoclimatic evidence for western Europe implies that by this time the climatic change that brought the Pleistocene to a close had essentially run its course. The question remains, however, whether the glacial history of the Kurdish mountains matched that of the Alps and western Europe in any details of chronology, and if so whether the climatic changes had anything to do with this important cultural revolution. (Auth)(JTA)

Glacial geologic

622. **Yafeng, S., and W. Jingtai.** 1981. The Fluctuations of Climate, Glaciers and Sea Level since Late Pleistocene in China. *International Association of Scientific Hydrology Publication 131:281-293.*

At 5000-6000 years B.P., the temperature in China was higher than that at present by 2 deg - 4 deg C. Glaciers in several mountains completely melted away. The coastline moved to 200 km west of Shanghai. The temperatures of the cold periods beginning 3000 years ago, 2000 years ago and between 600 and 100 years ago were 1 deg - 2 deg C lower than present and caused prominent advances of glaciers. (Auth)(JTA)

623. **Young, J.A.T.** 1972. Ice Margins of the 19th and 20th Centuries in the Venedigergruppe, Hohe Tauern, Austria. *Arctic and Alpine Research 4(1):73-83.*

The main west-southwest / east-northeast backbone of the eastern Alps runs through the center of the Venedigergruppe. Nine valleys head in interlocking troughs and radiate from the central arete and horn divide. A pattern of deglacierization is reconstructed from early descriptions of the glaciers and their forelands, maps, surveys, climbing records, and field investigation. There has been major, overall wastage of the ice through thinning and retreat at the termini, along the margins, and in the firn areas of glaciers since the mid-19th century. While the history of the glacier changes fits a general, known sequence for the European Alps, the details of of ice loss have varied greatly; local factors of aspect and topography have been important in the long-term, behavioral patterns of the glaciers. Despite a trend toward weather that would seem to have been more advantageous to a positive glacier mass balance in recent years, decay and wastage have continued. (Auth)

Glaciologic

624. **Andrews, J.T., R.G. Barry, R.S. Bradley, G.H. Miller, and L.D. Williams.** 1972. Past and Present Glaciological Responses to Climate in Eastern Baffin Island. *Quaternary Research 2(3):303-314.*

Much of Baffin Island is close to the modern glaciation limit and climatic changes within the last decade are already being reflected in snow cover extent. Statistical analysis of glacierised and ice-free corries indicates that changes in direct solar radiation due to astronomical factors are inadequate to account for glacierisation of those at present ice-free. These and other sources of evidence demonstrate the need for augmented winter snowfall in order to increase the extent of glacierisation. The Barnes Ice Cap did not disappear in the Holocene as it did in the Last Interglacial. The area is highly suitable for long-term monitoring of climatic change and glacial response. (Auth)(JTA) GA 73A/1314

625. **Andrews, J.T., R.G. Barry, P.T. Davis, A.S. Dyke, M. Mahaffy, L.D. Williams, and C. Wright.** 1975. The Laurentide Ice Sheet: Problems of the Mode and Speed of Inception. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 87-94), 503 pp.*

The extent of permanent ice and snow during the Little Ice Age is mapped from 1:1,000,000 LANDSAT imagery. Paleoglaciation levels were estimated using available topographic maps. Evidence suggests that during the Little Ice Age the regional snowline was between 200 and 400 m lower and thus suggests the climate may have been 1.4 to 2.8 deg C cooler than present. Analysis of factors that might control the elevation of the glaciation level--summer temperatures, incoming radiation, and winter snowfall amounts--indicates the uplands of Baffin Island are most sensitive to slight changes in summer conditions. (JTA)

626. **Andrews, J.T., and G.H. Miller.** 1972. Quaternary History of Northern Cumberland Peninsula, Baffin Island, N.W.T., Canada: Part IV: Maps of the Present Glaciation Limits and Lowest Equilibrium Line Altitude for North and South Baffin Island. *Arctic and Alpine Research 4(1):45-59.*

Maps of the glaciation limit and lowest equilibrium line altitude (ELA) are presented for southern and northern Baffin Island. The glaciation limit was determined by "summit method;" the ELAs were determined by assuming a steady state accumulation area ratio of 0.65. Data was derived from the 1:250,000 map series based on between six and eight points per map. The isoglacihypses are roughly parallel to the east coast of the island and rise inland at approximately 4 m km (E-1). Along the outermost coast a typical elevation is 700 m a.s.l. rising to between 1,000 and 1,300 m inland. (Auth) (JTA) BafBib 302

627. **Arnold, K.C.** 1965. Aspects of the Glaciology of Meighen Island, Northwest Territories, Canada. *Journal of Glaciology 5(40):399-410.*

Meighen Island fronts the Arctic Ocean and an ice cap of 76 km (E+2) covers 1/10 of the island. It has a maximum thickness of 150 m. in the south and 30 cm. in the north. Evidence of movement is unequivocal. The ice-cap lies on unresistant rocks, and wind and periglacial action have destroyed signs of earlier greater glaciation if it took place; rafting could have brought the erratics found in the island to their present position. At present the icecap appears to be wasting slowly due to lack of precipitation. Accumulation in 1959-60, 1960-61, 1961-62, and 1962-63 in cm water equivalent was 12.6, 18.2, 1,4.1 and 19.4, respectively, gross ablation for the first three seasons was 98, 46, and 122 cm water equivalent, respectively. At the rate of loss recorded in these years the ice cap would disappear in 90 to 100 years, but this seems unlikely. (C.A.M. King) GA 65/588

628. **Baranowski, S.** 1975. Glaciological Investigations and Glaciomorphological Observations Made in 1970 on Werenskiold Glacier and its Forefield. *Acta Universitatis Wratislaviensis 251 (Spitsbergen Expeditions I) :70-94.*

In his study the author presents the preliminary results of glaciological investigations and glaciomorphological observations carried out in the framework of a Polish Spitsbergen Expedition on Werenskiold Glacier and its forefield during the summer of 1970. It was found that since 1958 the surface of Werenskiold Glacier had decreased 0.9 square km. In the 12 year period from 1958 to 1970 the glacier retreat has averaged 25 m per year. (Auth)

The paper includes a map of the glacier (1 cm = 325 m) limit in 1970 and contour lines of 1958. Long profiles illustrate changes in surface height of the glacier between 1958 and 1970 A.D. (JTA)

629. **Barkov, N.I., F.G. Gordienko, E.S. Korotkevich, and V.M. Kotliakov.** 1974. First Results of Ice Core Studies from the Vostok Drill Hole (Antarctica) by the Oxygen-Isotope Technique. Pervye Rezul'Taty Izucheniia Ledianogo Kerna iz Skvazhiny so Stantsii Vostok (Antarktida) Izotopno-Kislorodnym Metodom. Russian. *Akademiia Nauk SSSR, Doklady 214(6):1383-1386.*

A drillhole about 1,000 m deep was made at Vostok Station in 1970 in ice estimated to be 3,500 thick. The oxygen isotope analysis of the core stratigraphy to 500 m shows that the ice has been accumulating uniformly during the last 5,000 years at an average rate of 2.9 cm or 2.6 gr/sq cm per year. A paleoclimatic profile of the 507-m core, which accumulated during 21,000 years, indicates the periodical warmings and coolings in Antarctica. The last cooling period occurred 1700 to 1200 years ago. The study proves the usefulness of the oxygen-isotope ratio. (AntB F-13725) AntB F-13725

630. **Barkov, N.I., E.S. Korotkevich, F.G. Gordienko, and V.M. Kotlyakov.** 1977. The Isotope Analysis of Ice Cores from Vostock Station (Antarctica), to the Depth of 950 m. *International Association of Scientific Hydrology Publication 118:382-387.*

Interpretation of the results of oxygen isotope analysis of ice cores obtained from the borehole at Vostock station is carried out. The borehole reached the depth of 950 m. To interpret the age of the samples the model of ice deformation with non-uniform strain rates by Nye was used. The series of samples represented 46,500 years. It is shown that the isotope profile of the Vostock borehole is mainly formed under the influence of a climatic agent and is not complicated by the proper effect of glacial cover. At the beginning of the Holocene, climatic warming occurred in Central America between 15,000 and 11,000 years ago; isotope shift made up 5 0/00, which is in keeping with a temperature increase of about 5 deg C. Four cold periods are distinguished during the period between 46,500 and 15,000 years ago. They are separated by three warmer periods. Mean delta (Oxygen 18) makes up -58.6 0/00 in cold periods and -56.8 0/00 in "warm" periods. During the last 11,000 years mean delta (Oxygen 18) equals -53.8 0/00. The main result of the study is that for the last 50,000 years the basic temperature changes occurred synchronously in polar areas of both hemispheres. (Auth)

Glaciologic

631. **Bengston, K.B.** 1962. Recent History of the Brady Glacier, Glacier Bay National Monument, Alaska, U.S.A. *International Association of Scientific Hydrology Publication 58:78-87.*

This paper describes the variation of this 300-sq km piedmont glacier at 58 deg 38 min N 136 deg 50 min W, during a period of intensive glacierization ending about 300 years ago by Carbon 14 dating, and followed by a period of diminished activity ending with the Little Ice Age which crested in 1876. Brady Glacier currently is nearly in equilibrium, slightly smaller than its maximum of 1876; a condition due in part to outwash deposits in Taylor Bay having eliminated tidal action as a cause of ice wastage. During the intensive activity, ice thickness near the present terminus was about 300 m greater than at present; the period of diminished activity was marked by salt water in Brady valley, and along the shore by a mature forest which was destroyed with onset of the Little Ice Age, and some of its trees and stumps carried up into valleys on the east. Since the Little Ice Age peak of 1750 A.D. in Glacier Bay, a 11 km retreat has taken place, catastrophic in Muir Inlet and other areas, but practically in equilibrium on the northwestern part of the Bay. (AB70131) AB70131

632. **Bradley, R.S., and J.H. England.** 1977. Past Glacial Activity in the High Arctic. *University of Massachusetts, Department of Geology and Geography, Contribution No. 31, 184 pp.*

Subsequent to the outermost Ellesmere Island glaciation there was a limited advance of late Wisconsin ice marked by the Hazen Moraines formed approximately 8100 B.P. The N.W. Greenland Ice Sheet terminated in Hall Basin during the late Wisconsin and recession began approximately 8400 B.P. Following maximum postglacial ice recession there was a late Holocene readvance (possibly initiated approximately 3000-4000 B.P.) which has resulted in present glacier margins reaching their maximum postglacial extent. An abrupt change in the summer climate of the Canadian High Arctic and northwestern Greenland occurred around 1963/64. No evidence for a return to pre-1963 conditions is apparent. The change in climate involved: a lowering of mean July freezing level heights of up to 500 m; a decrease in mean July maximum temperatures (at the surface) of up to 2.7 deg C; a marked decrease in annual melting degree day totals (down as low as 65% of pre-1963 values); a concomitant increase in mean annual precipitation of up to 140% of pre-1963 levels. Conditions after 1963 thus favored reduced net mass losses on glaciers in the region. (Ecol Can 2808)(JTA) Ecol Can 2808

633. **Bray, J.R.** 1972. Cyclic Temperature Oscillations from 0-20,300 yr B.P. *Nature 237(5353):277-279.*

Table 1 lists data from the literature in terms of temperature maximum or glacial retreat and temperature minimum or glacial advance. Over the last 10,000 years the table shows: 1) cool conditions 200-750 B.P.; 2) warm conditions 800-900 B.P.; 3) cool conditions 1300-1500 B.P.; 4) warm conditions 1700-1800 B.P.; 5) cool conditions 2300-2800 B.P.; 6) variable conditions 3300-4500 B.P.; 7) cool conditions 4600-5100 B.P.; 8) warm conditions 5800-6500 B.P.; 9) cool conditions 6600-8400 B.P. (one exception at 7100 B.P.); 10) warm conditions 8500-8800 B.P.; and 11) warm conditions 9600-9700 B.P. The data appear to suggest a 1325 year cycle. (JTA)

634. **Budd, G.M., and P.J. Stephenson.** 1970. Recent Glacier Retreat on Heard Island. *International Association of Scientific Hydrology Publication 86:449-458.*

A survey of glaciers on Heard Island in 1963 showed that general major retreat had recently occurred. Re-survey in 1965 suggested possible readvance in 2 glaciers. Photographic and other records from expeditions visiting the island in 1874, 1902 and 1929, and from the ANARE occupation of 1947-1955, show no apparent changes until 1947 but general minor recession by 1955. Meteorological records show a rise in air temperature since 1948, which seems to be the major cause of the retreat. Possible movement of the Antarctic Convergence cannot be demonstrated and volcanic activity is discounted as a general influence. (from Antarctic Bibliography) GA 71A/1739

635. **Budd, W.F., and V.I. Morgan.** 1977. Isotopes, Climate and Ice Sheet Dynamics from Core Studies on Law Dome, Antarctica. *International Association of Scientific Hydrology Publication 118:312-321.*

Oxygen isotope studies have been carried out on surface samples and seven cores ranging in depth from 70 to 380 m from Law Dome at various elevations from 160 to 1390 m. Detailed studies of 15 years accumulation have been made to compare the isotope variations with the climatic record at Wilkes-Casey over the same period. Although strongly influenced by sastrugi and dunes the records do show some correlation with annual mean temperatures. Two cores 12 km apart covering the most recent decades and centuries show considerable similarity in fluctuations which are considered primarily climatic. Two deep cores reaching close to bedrock near the coast show little change from steady state since about 8000 years ago. Prior to that the ice was of much colder origin. Gas content analyses of the cores suggest the surface elevation was also considerbly greater for that time period. An estimation is made of the extent of the ice during the maximum ice age period. (Auth)

636. **Burbank, D.W.** 1982. Correlations of Climate, Mass Balances, and Glacial Fluctuations at Mount Rainier, Washington, U.S.A., since 1850. *Arctic and Alpine Research 14(2):137-148.*

Despite the complex interrelationships between climate, mass balance, and glacier response, simplified mass-balance calculations can be correlated with observed glacial behavior. A monthly temperature and precipitation record, extending back to 1850, has been reconstructed for Longmire, Washington, on the southwest flank of Mount Rainier. Calculated mass-balance variations agree with observed glacier behavior since 1850 and with five sets of moraines constructed between 1850 and 1930 at Mount Rainier. Following periods of positive mass balances, trends toward more negative mass balances precede glacial recession with lag times of 1 to 5 yr. Analyses of the reconstructed temperature record and former ice frontal positions suggest that much of a 1 deg C temperature rise since the latest Neoglacial advances occurred prior to 1850. Correlations of the Mount Rainier mass-balance record with similar ones from Norway and Antarctica indicate generally synchronous climatic trends in the Northern Hemisphere and opposing short-term trends in the Southern Hemisphere since 1850. (Auth)

637. **Burrows, C.J.** 1977. Late-Pleistocene and Holocene Glacial Episodes in the South Island, New Zealand, and Some Climatic Implications. *New Zealand Geographer 33:34-39.*

The paper summarizes Carbon 14 dated glacial chronologies and discusses the possible changes in temperature associated with variations in glacial snowlines. Four Holocene glacial episodes are identified as follows: 1) 20-400 yr BP; 2) greater than 1000 BP; 3) about 4500 BP; and 4) 8000-9500 BP. Temperature depression estimated by a 0.6 deg C/100 m lapse rate calculation indicates variations of 1 to 4.5 deg C. (JTA)

Glaciologic

638. **Chinn, T.J., and I.E. Whitehouse.** 1980. Glacier Snow Line Variations in the Southern Alps, New Zealand. *International Association of Scientific Hydrology Publication 126:219-28.*

End-of-summer glacial snow line elevation estimates have been made on several hundred glaciers over some 400 km of the Southern Alps from oblique photographs taken over the past two seasons. Aspect correction factors were applied to put all elevations in terms of south-facing glaciers. Accuracy is estimated at + or - 50 m, but in comparing photographs of successive years very small changes are detectable. The results show that the snowline elevations follow closely the precipitation distribution and exhibit a similar steep west-east gradient, together with a north-south gradient casued by latitude. The glacial snow line remains slightly below the "glacial limit snow line" despite extensive glacial recession over the past century. Historical data indicate that over the past half-century glacial snowlines have generally undergone an accelerating increase in elevation which continued until the mid 1970s. (Auth)

639. **Clark, J.A.** 1979. Predicted Relative Sea-Level Changes (18,000 Years B.P. to Present) Caused by Late-Glacial Retreat of the Antarctic Ice Sheet. *Quaternary Research 11(3):279-298.*

Predictions of global changes in relative sea level caused by retreat of the Antarctic Ice Sheet from its 18,000 yr B.P. maximum to its present size are calculated numerically. When combined with the global predictions of relative sea-level change resulting from retreat of the Northern Hemisphere ice sheets, the results may be compared directly to observations of sea-level change on the antarctic continent as well as at distant localitites. The comparison of predictions to the few observations of sea-level change on Antarctica supports the view that the Antarctic Ice Sheet was larger 18,000 years ago than at present. The contribution of the Antarctic Ice Sheet to the total eustatic sea- level rise is assumed to be 25 m (25% of the assumed total eustatic rise). If as little as 0.7 m of this 25-m rise occurred between 5000 yr B.P. and the present, few mid-oceanic islands would emerge. If the Antarctic Ice Sheet attained its present dimensions by 6000 yr B.P., however, and if the volume of the ocean has remained constant for the past 5000 years, numerous islands throughout the Southern Hemisphere will emerge. It is suggested that a thorough study of Pacific islands, believed by some to have slightly emerged shorelines of Holocene age, would yield useful information about ocean volume changes during the past 5000 years, and hence on the glacial history of the Antarctic Ice Sheet. (Auth) AntB J-22512

640. **Derbyshire, E.** 1960. Glaciation and Subsequent Climatic Changes in Central Quebec-Labrador: A Critical Review. *Geografiska Annaler 42(1):49-61.*

Recent theories on the origin and dissipation of the Laurentide ice sheet suggest the relationship of ice-dispersion centers to precipitation rather than to relief. Assuming the necessary secular drop in temperature, the climatic regime during glaciation is reconstructed in terms of present climatic features. Present climate is the result of two basic factors: geographic position, and relation of the physical character and configuration of the land-mass to marine areas. Chief features of oceanic and atmospheric circulation are described; proximity of present climate to glacial conditions (6 deg to 11 deg F.) is estimated. Some late-glacial and postglacial pollen correlations (table) indicate similarity of the climatic history of Quebec-Labrador and the rest of the North Atlantic region. (AB64162) AB64162

641. **Dort, W., Jr.** 1970. Climatic Causes of Alpine Glacier Fluctuation, Southern Victoria Land. *International Association of Scientific Hydrology Publication 86:358-362.*

Although southern Victoria Land is well known for the present development of "oases" or dry (i.e. ice-free) valley areas, there is ample evidence that this region has been much more extensively glacierised in the past. Till and erratics are widespread; recessional moraines are numerous. The retreat has affected all types of glaciers - outlet glaciers from the interior ice cap, piedmont glaciers along the coast, and local alpine glaciers emanating from cirques and high basins. Field evidence suggests that fluctuations of the alpine glaciers have been caused by local climatic variations in the mountainous area which, in turn, reflect regional changes. (Auth)

642. **Dort, W., Jr., E.F. Roots, and E. Derbyshire.** 1969. Firn-Ice Relationships, Sandy Glacier, Southern Victoria Land, Antarctica. *Geografiska Annaler 51A(3):104-111.*

Sandy Glacier is situated near McMurdo Sound and occupies the head of a 3 km by 1 km cirque valley and is composed of a unique alternation of ice layers and sand layers. The sand was apparently brought by occasional very strong winds from Onyx River outwash 5 km away and 1,200 m lower. Pits dug in the accumulation zone revealed 115-210 cm of firn and sand layers directly overlying glacier ice that also contains sand layers. It is believed that not long ago there was no cover of firn on any part of this glacier. Accumulation appears to have recommenced perhaps 2-3 decades before the present. (Auth) GA 70A/490

643. **Duval, P., and C. Lorius.** 1980. Crystal Size and Climatic Record down to the Last Ice Age from Antarctic Ice. *Earth and Planetary Science Letters 48:59-64.*

Crystal size measurements were performed along a 905-m-long ice core obtained from east central Antarctica (Dome C). The expected increase of crystal size with age is observed in the ice deposited during the Holocene; further down major changes appear to be associated with climatic events and, in particular, with the transition from the last glacial age to present conditions. Physical mechanisms which may explain these data are discussed. A tentative estimation of the age of the deep ice is made from the ice crystal growth law. (Auth)

644. **Epstein, S., R.P. Sharp, and A.J. Gow.** 1970. Antarctic Ice Sheet: Stable Isotope Analyses of Byrd Station Cores and Interhemispheric Climatic Implications. *Science 168:1570-1572.*

Oxygen and hydrogen-isotope analyses from the core hole through the Antarctic Ice Sheet at Byrd Station define temperature variations over more than 75,000 years. Synchronism between major climatic changes in Antarctica and the Northern Hemisphere is strongly indicated. (Auth)(JTA)

The report indicates that since 10,000 B.P. the overall trend has been toward heavier Oxygen 18/Oxygen 16 ratios, indicating post-Wisconsin temperature increase. Superimposed on this are low amplitude peaks and troughs but the Holocene is covered by only approximately 22 data points. (JTA)

645. **Epstein, S., R.P. Sharp, and A.J. Gow.** 1971. Climatologic Implications of Stable Isotope Variations in Deep Ice Cores, Byrd Station, Antarctica. *Antarctic Journal of the United States 6(1):18-20.*

Oxygen- and hydrogen- isotope analyses of the Byrd Station core indicates that the Wisconsin cold interval took place from about 75,000 to 11,000 B.P. Major temperature fluctuations in the Northern Hemisphere and Antarctica appear to have been synchronous. The Wisconsin was significantly colder in Antarctica than the post-Wisconsin, with warmer intervals which were all too cold to qualify as anything other than interstadials within the Wisconsin. These relationships suggest that the ice sheets never completely disappeared from the North American and Eurasian continents during the Wisconsin. Isotope values near the bottom of the Byrd core indicate a pre-Wisconsin climate even warmer than the present in Antarctica. (from Antarctic Bibliography) GA 71A/2182

646. **Fisher, D.A.** 1979. Comparison of 10(E+5) Years of Oxygen Isotope and Insoluble Impurity Profiles from the Devon Island and Camp Century Ice Cores. *Quaternary Research 11:299-305.*

The paper outlines the possible causes in the variation of delta oxygen 18 in ice and examines differences between the Devon Island and Camp Century (Greenland) isotopic records. Attention is focused on the longer time scales. (JTA)

647. **Fisher, D.A.** 1981?. Some Aspects of Climatic Change in the High Arctic during the Holocene as Deduced from Ice Cores. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 249-271), 464 pp.*

Time series of climate-related variables obtained from Greenland and Arctic Canada are presented and compared to each other and to other climate-related time series. Oxygen isotope ratios from the Devon Island Ice Cap are shown to provide a detailed proxy temperature record of a 2 - 3 deg C cooling over the last 5000 years. They also contain variations in anti-phase with Carbon 14 production rates, thus lending some support to the solar-constant theory of climate change. Insoluble micro-particle concentrations and acidity of the Devon ice core samples are nearly constant over the last 5000 years, suggesting that atmospheric turbidity and volcanic activity have not been the primary controlling mechanism in the cooling since the climatic optimum 5000 years ago. There is a significant trend of decreasing ionic content of the ice, which is explainable in terms of decreasing availability of marine-derived salts and sulphates and/or decreasing cloudiness over the 5000 years of record. The data representing the last 500 years are examined in detail and both the delta (Oxygen 18), and the varying amounts of ice layering, attest to the unique coldness of the Little Ice Age some 200 years ago, and the equally unique warmth of the first half of the present century. A preliminary study of acid layers, delta (Oxygen 18), and melt layers in the cores, lead the authors to conclude that it is dangerous to assume that volcanic activity has caused major temperature fluctuations in this 500-year interval. (Auth)

648. **Fisher, D.A.** 1982. Carbon 14 Production Compared to Oxygen Isotope Records from Camp Century, Greenland and Devon Island, Canada. *Climatic Change 4:419-426.*

Carbon 14 production rate variations that are not explainable by geomagnetic changes are thought to be in antiphase with paleotemperature records or proxy temperature histories such as those obtainable from oxygen isotope analyses of ice cores. Oxygen isotope records from Camp Century, Greenland and Devon Island Ice Cap are in phase with each other over thousands of years and in antiphase to the Carbon 14 production rate residuals. (Auth)

649. **Fisher, D.A., and R.M. Koerner.** 1983. Ice-Core Study: A Climatic Link Between the Past, Present and Future. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 50-69), 343 pp.*

Graphs of recorded temperatures from 1877-1975 A.D. from Godthab and Upernivik, West Greenland, have similar trends to the stable oxygen record from the Devon Island Ice Cap over the same interval of time. On the longer time-scales the Little Ice Age is evident in the Devon Island record between 1600 and 1800 A.D. An ice core record from the Agassiz Ice Cap, northern Ellesmere Island, is compared to the Devon Island record since ca 1150 A.D. An early warm period (1200-2300 A.D.) declines to a cold interval about 1400 A.D. There is then a rise prior to a decline to the Little Ice Age minimum about 1700 A.D. In both ice core records the shift in isotopic values by 1.5 ppt represents a temperature change of 2.5 deg C. Prediction of the record into the future indicates that the present cooling trend will continue to at least 1990 A.D. Graphs of changes in the amount of surface melt on the two ice caps for the past 800 years shows substantial agreement between the two sites. Highest melt occurred within the last 100 years with other notable intervals centered on 1150, 1350 and 1450 A.D. (JTA)

650. **Flohn, H.** 1973. Antarctic, Arctic and Global Variations of Climate. Antarktis, Arktis und Globale Klimaschwankungen. German, English Summary. *Salzburg. Universitat. Geographisches Institut. Arbeiten, Band 3:27-35.*

Possible global temperature variations due to partial Antarctic ice surges ejecting large masses of tabular ice and smaller floes into the southern oceans during the period 1840-1900 are quantitatively discussed. The increase of the surface albedo (according to the Manabe-Wetherald model) together with the short-lived heat loss by melting may have produced a global cooling of the order of 0.5-1 C. This effect together with the extremely high volcanic activity during the 19th century can be interpreted as causing the observed global variations. The possible influence of Antarctic surges on the water budget in tropical latitudes is discussed. (Auth) AntB I-16622

651. **Fushimi, H., T. Ohata, and K. Higuchi.** 1981. Recent Fluctuations of Glaciers in the Eastern Part of Nepal Himalayas. *International Association of Scientific Hydrology Publication 131:21-29.*

As a part of the Glaciological Expedition of Nepal (GEN), the fluctuations of the glacier termini of 14 glaciers were measured in the Dudh Kosi region, east Nepal, from 1970 to 1978. The results showed six retreating glaciers, four stationary glaciers, three advancing glaciers and one irregular glacier. Many glaciers have been retreating in recent years. A glacier retreats when, at the terminus, the total annual ablation rate is larger than the total annual flux rate. The retreat of the snout of the Gyajo Glacier in 1976 is described in terms of the estimated mass balance of the terminus. (Auth)

652. **Giovinetto, M.B.** 1968. The Antarctic Ice Sheet and Its Probable Bi-Modal Response to Climate. *International Association of Scientific Hydrology Publication 86:347-358.*

The net mass budget estimates reported elsewhere for the Amery Ice Shelf drainage system and the eastern and western parts of the Ross Ice Shelf system are combined with (1) an alternate estimate for the Amery Ice Shelf system, and (2) alternate estimates for the eastern part of the Filchner Ice Shelf system. These systems make up the interior province of Antarctica and their comined net budget is estimated to be positive and in the order of (3 + or - 1) 10(E+17 g/yr(E-1). The Ross Ice Shelf system as a whole is the only system of the interior province for which the estimate of a positive net budget is significant ((18 + or - 5) 10(E+16) g/yr(E-1)); direct and indirect evidence confirms that the western part of the system is a region with the interior province where the net budget is positive. A comparison of the net budget for the interior province with data on sea level change during the last 100 yr indicates that the net budget in the peripheral province should be negative. Empirical and heuristic two province models of the ice sheet suggest that its reponse is bi-modal to the present and as yet undetermined climatic regime. (Auth) AntB F-8331

653. **Gordienko, F.G., and V.M. Kotliakov.** 1976. Influence of Climatic and Glaciological Factors on Paleotemperature of Continental Ice Sheets. O sootnoshenii klimaticheskogo i gliatsiologicheskogo faktorov formirovaniia paleotemperatur materikovykh lednikov. *Problemy paleogidrologii, Moscow, Nauka (1976):282-288.*

Oxygen isotope analysis of ice cores from deep crevasses at Camp Century in Greenland and at Byrd and Vostok Stations in Antarctica is discussed. The synchronicity of Holocene climatic warming at both poles is established and conclusions are drawn about the extent of Greenland and Antarctic ice sheets in the upper Pleistocene. (AntB F-19973) AntB F-19973

654. **Gordiyenko, F.G., V.M. Kotlyakov, Ya.-K.M. Punning, and R. Vaikmae.** 1981. Study of a 200-m Core from the Lomonosov Ice Plateau on Spitsbergen and the Paleoclimatic Implications. *Polar Geography and Geology 5(4): 242-251.*

A 200-m ice core obtained in 1976 on the Lomonosov Plateau in Spitsbergen is compared with isotope profiles obtained at the Camp Century and Crete stations on Greenland and on Devon Island as well as temperature curves for Iceland and England. All of them clearly show a cool 19th century and a warm 16th centruy. The Spitsbergen data, both for 1730-1890 and for the 13th-15th centuries, come closest to those for the two Greenland stations. The Spitsbergen hole also suggests warm conditions for the 12th century, similar to the march of temperature in Iceland, although the warm period in England was 100 to 150 years longer. (Auth)

The core base is dated at 1130 A.D. A pronounced feature is the increase in Oxygen 18/Oxygen 16 (= warmer conditions) after 1900 A.D. in all ice core records from the northern hemisphere. (JTA)

655. **Gow, A.J., and T. Williamson.** 1971. Volcanic Ash in the Antarctic Ice Sheet and its Possible Climatic Implications. *Earth and Planetary Science Letters 13:210-218.*

Approximately 2000 individual ash falls are preserved in deep cores from Antarctica. The bulk of the debris is composed of dust-sized particles of glass that can probably be attributed to volcanic sources in Antarctica, though sources outside Antarctica cannot be entirely discounted. A period of sustained infall of ash occurred during the interval 30,000 to 16,000 years ago, and isotopic (paleotemperature) data from the same cores indicate that a significant cooling of the atmosphere over Antarctica occurred at the same time. (Auth)(JTA)

Only one ash layer is shown in the Byrd Station ice core for the last 14,000 years and the number of dust bands per meter is close to zero throughout the Holocene. (JTA)

656. **Grosval'd, M.G., and V.M. Kotlyakov.** 1969. Present Day Glaciers in the U.S.S.R. and Some Data on Their Mass Balance. *Journal of Glaciology 8(52):9-22.*

There are four major glacier regions in the U.S.S.R.: the Atlantic-Arctic, Atlantic-Eurasian, East Siberian and Pacific-Asian, which can be divided into 19 separate glacier areas. The total area of the glaciers in the country amounts to 81,900 km (E+2), and the volume of water stored in them to 13,750 km (E+3). A comparison of the variations in mass balance of the Lednik IGAN in the Polar Urals, and the Grosser Aletschgletscher in the Swiss Alps, over a period of several decades suggests a cyclic trend of the variations in both regions (with a wave-length of about 22 years), and the direct opposition in their phase. The analogy of 22-year cycles of the balance variations with the cyclic fluctuations of the same wave-length in solar activity seems to be quite evident, whereas the atmospheric circulation appears to be one of the main intermediate variables in the chain sun-glaciers responsible for the out-of-phase relationship in glacier variations of certain areas. (Auth)(JTA)

A strongly positive mass budget regime is shown between 1872 and 1882 A.D. This was followed by a largely negative regime up until 1960 A.D. (JTA)

657. **Grosval'd, M.G., and A.N. Krenke.** 1962. Recent Changes and the Mass Balance of Glaciers on Franz Josef Land. French Summary. *International Association of Scientific Hydrology Publication 58:194-200.*

Reports different opinions on recent glaciation on this archipelago clarified by the Academy of Sciences' Institute of Geography expedition of 1957-1959: Sharp retreat, which began not later than the 1920's is indicated. Lower limit of the accumulation region lies at 300-320 m, much higher than hitherto thought. Direct indications of shrinkage and data concerning the rate of shrinkage were also obtained from the the Sedov, Jackson, and Churlyanis Domes on Gukera Island. Similar shrinkage elsewhere, e.g. Novaya Zemlya, is noted, as caused by increase in the sum of positive air temperature and intensified summer melting. It is surmised that late-glacial shrinkage 11,000-12,000 yrs ago ended in the complete disappearance of glaciers; glaciation reappeared in the archipelago at the time of the Fenno-Scandinavian (Salpausselka) stage in Europe and the Sartan stage in Siberia about 10,500 yrs ago, when the ice sheet was larger than at present. During the post-glacial climatic optimum, ice sheets were smaller than at present; the latest stage of Holocene glaciation began 2500 yrs ago. Present-day shrinkage may be the beginning of disintegration of this latest Holocene stage. (AB71881) AB71881

658. **Haefeli, R.** 1970. Changes in the Behavior of the Unteraargletscher in the Last 125 Years. *Journal of Glaciology 9(56):195-212.*

The Unteraargletscher up to a level of 2600 m a.s.l. has lost 2.4 cu km since its 1871 advance, with a mean surface lowering of 0.67 m/year. The velocity has also decreased due to reduction of the sliding component. The ogives provide an accurate means of checking the continuity of glacier movement, the mean wave length of the ogives equating with the mean velocity of 44.5 m/year. (C.A.M. King) GA 71A/0563

659. **Hamilton, T.D.** 1965. Comparative Glacier Photographs from Northern Alaska. *Journal of Glaciology 5(40):479-487.*

Photos of glaciers in the Arrigetch Peaks (67 deg N, 154 deg W) were taken in 1911 and repeated from the same sites in 1962. The peaks are more than 2000 m high, and there are 6 active and 5 stagnant glaciers. The two sets of photos show some loss of ice, and the development of trim lines in the head-wall gully of one glacier. The ice-cored, unstable moraine has lost 10% of its thickness, decreasing by about 20 m. Lichen cover has increased significantly on boulders in front of the snout. The second pair of photos also shows thinning and trim line formation. Two major rock falls have also occurred in the 51 year interval. Recession has been greater since 1911 than before this date. The ice-cored moraines are unstable, and form two series in many places. The inner ones are more unstable than the outer; these may date from the mid-eighteenth and mid- to late- nineteenth centuries. These advances were probably more extensive than any during several previous millenia. (C.A.M. King) GA 65/589

660. **Hammer, C.U.** 1977. Dust Studies on Greenland Ice Cores. *International Association of Scientific Hydrology Publication 118:365-370.*

Firn and ice cores from seven Greenland ice sheet locations were analysed for dust concentration by means of the light scattering method and the Coulter counter technique. Comparison with Lamb's dust veil indices suggests that the deposition of dust in South Greenland is essentially of nonvolcanic origin, at least since A.D. 1780. (Auth)

661. **Hammer, C.U.** 1977. Dating of Greenland Ice Cores by Microparticle Concentration Analyses. *International Association of Scientific Hydrology Publication 118:297-301.*

Seasonal variations of microparticle concentration in 6000 samples were compared with delta Oxygen 18 and gross beta activity analysis and may be used for dating beyond the ranges of the latter techniques. (Auth)

Graphs showing detailed particle counts and Oxygen 18 variations are presented for the period from 1629 to 1655 A.D. and around 10,500 B.P. (JTA)

662. **Hammer, C.U.** 1980. Acidity of Polar Ice Cores in Relation to Absolute Dating, Past Volcanism, and Radio-Echoes. *Journal of Glaciology 25(93):359-372.*

A simple method is described for detecting annual stratification of ice cores, and layers of high acidity due to violent volcanic eruptions in the past. The method is based on a relationship between the H3O(+) concentration (pH) of melted samples and the electrical current between two brass electrodes moved along the cleaned ice-core surface. The "conductivity" is explained in terms of the initial current in historically well-known volcanic eruptions, such as Katmai, A.D. 1912, Tambora, A.D. 1815, Laki, A.D. 1783 Hekla, A.D. 1104, and Thera (Santorin) c. 1400 B.C. High-acidity layers seem to be the cause for the internal radio-echo layers in polar ice sheets. (Auth)

663. **Hammer, C.U., H.B. Clausen, and W. Dansgaard.** 1980. Greenland Ice Sheet Evidence of Post-Glacial Volcanism and its Climatic Impact. *Nature 288(5788):230-235.*

Acidity profiles along well dated Greenland ice cores reveal large volcanic eruptions in the Northern Hemisphere during the past 10,000 yr. Comparison with a temperature index shows that clustered eruptions have a considerable cooling effect on climate, which further complicates climatic predictions. In Fig. 1 an ice core is dated with an uncertainty of + or - 1 yr in the past 900 yr, increasing to + or - 3 yr at AD 554, which makes possible the identification of several large eruptions known from historical sources, and the accurate dating of the Icelandic Eldgja eruption shortly after the settlement that was completed AD 940. (Auth)(JTA)

664. **Hastenrath, S.** 1975. Glacier Recession in East Africa. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 135-142), 503 pp.*

Analysis of glacier variations in the high mountains of East Africa is important because it is believed that high altitude equatorial glaciers may be sensitive indicators of large-scale environmental change. Temperature and rainfall records dating back several decades show no simple relationship to observed glacier fluctuations. Records for the Lewis Glacier go back to 1899 A.D. Graphs are presented of changes in volume, area, and length of this ice mass. Volume decreased from 40 x 10(E+6) m(E+3) in 1899 to 10 x 10(E+6) m(E+3) in 1947 A.D. (JTA)

665. **Hattersley-Smith, G.F.** 1961. Geomorphological Studies in Northwestern Ellesmere Island. *Defence Research Board, Canada, Directorate Phys. Research, D Phys R (G) misc. G-5, 16 pp.*

This report is illustrated by 19 oblique aerial photographs. After a brief survey of the geology of the area, follows an account of the geomorphology, former glaciation and recent glacial history of the area. The area is dealt with in two parts; the coastal area between Cape Aldrich and Cape Evans, with an ice-free zone averaging 20 km between the coast and the outer glaciers of the main ice-cap to the south; second the area between Cape Evans and Lands Lokk, here the inland ice-cap is separated from the main ice-cap to the east by a glacially deepened trough. Evidence is presented that suggests a much more extensive glaciation during at least one earlier phase of the Pleistocene - most impressive here are the large fiords beyond the present ice margin. It is thought that the ice was not less extensive during the "Climatic Optimum", but that it has not since then advanced much farther than its present extent. Raised beaches have been found on the ground at heights of up to 90 m. Similar features recognizable on air photographs could, in the absence of ground observations, be kame terraces. River terraces and delta surfaces show abundant evidence of recent emergence. There is a map of the whole of Northern Ellesmere Island (scale 17 miles to 1 inch), and some 35 references. (K.M. Clayton) GA 62/60

666. **Hattersley-Smith, G.F.** 1963. Climatic Inferences from Firn Studies in Northern Ellesmere Island. *Geografiska Annaler 45(2/3):139-51.*

Presents results of studies made in 1958 and 1961 on Gilman Glacier and on the northern Ellesmere icecap, as part of the Canadian IGY and subsequent programs. The firn stratigraphy is described for an elevation which is close to the boundary between the dry snow and the percolation facies. Evidence of increased summer melting on the icecap in the last 35 yrs is correlated with a 2 deg C increase of mean summer temperature at Upernavik on the west coast of Greenland, to show that the climatic warming of the late 1920's and the 1930's in central West Greenland and elsewhere also affected northern Ellesmere Island, where no continuous meteorological records were kept before 1948. The Upernavik record, on the other hand, goes back to 1874, with minor gaps, and is a useful indicator of conditions over a fairly wide area. (AB79308) AB79308

667. **Hattersley-Smith, G.F.** 1964. Rapid Advance of Glacier in Northern Ellesmere Island. *Nature 201(4915):176.*

A comparison between air photographs taken in 1950 and 1959 shows a rapid advance of the Otto Fiord Glacier, which is the main western outlet for the vast ice cap between Tanquary Fiord and Phillips Inlet in the north of Ellesmere Island. Much crevassing had occurred, stagnant marginal ice had been overridden and the terminus had advanced 3 km as a floating tongue with the calving of many icebergs. (Ada W. Phillips) GA 65/914

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668. **Hattersley-Smith, G.F.** 1969. Recent Observations on the Surging Otto Glacier, Ellesmere Island. *Canadian Journal of Earth Sciences 6(4, Part 2):883-889.*

Air photographs show that the Otto Glacier in northwestern Ellesmere Island started to surge sometime between 1950 and 1959, with the result that the terminus advanced about 3 km as a floating ice tongue. Maps prepared from the 1959 photographs and from additional photographs taken in 1964 show a further advance of 2-3 km. Information from a subglacial relief map of the terminal part of the glacier, constructed from the results of radio-depth sounding over the glacier in 1966, may have a bearing on the mechanism of glacier surges. Other glaciers in northern Ellesmere Island show features indicative of past surges. (Auth)

669. **Hattersley-Smith, G.F.** 1971. The Regime of the Ward Hunt Ice Shelf and of Ice in the Mouth of Nansen Sound, Ellesmere Island. *Glaciers, Proceedings of the Workshop Seminar sponsored by Canadian National Committee for the International Hydrological Decade and assisted by University of British Columbia, September 24-25, 1970. The Secretariat, Canadian National Committee for the International Hydrological Decade, Ottawa, Canada, (pp. 21-22), 61 pp.*

An analysis of the 1958-68 records of accumulation and ablation on the ice rise, and 1965-68 data for the ice shelf. Apart from 1962-65 for the rise, all balances were negative. Massive calving is more likely to be the result of unusual tides than of changes in mass-balance. (K.M. Clayton) GA 72A/1847

670. **Hattersley-Smith, G.F.** 1972. Climatic Change and Related Problems in Northern Ellesmere Island, N.W.T., Canada. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 137-148), 511 pp.*

Glacial geological studies indicate that Tanquary Fiord became free of glacial ice at least 6,500 years ago. The evidence comes from radiocarbon dating of marine shells from the highest level at the head of the fiord (6,320 + or - 140 B.P.; GSC-373) and of a sample from a nearby peat deposit (6,480 + or - 200 BP; SI-468). The climatic amelioration that caused deglaciation led to subsequent isostatic uplift at the rate of about 3.5 m/100 yr in the period from 6,500 to 5,000 B.P., as against an uplift of about .25 m/100 yr in the period since 5,000 B.P. (Hattersley-Smith and Long 1967). A long period of river erosion followed the recession of the ice, but after a climatic deterioration within the last 4,000 years glaciers advanced to reoccupy V-shaped valleys (Hattersley-Smith 1969). One such advance was responsible for the damming of Lake Tuborg (Fig. 2). Some time after 3,000 B.P. ice shelves started to form off the north coast of Ellesmere Island; this approximate date is set by the radiocarbon age of the youngest driftwood so far discovered on beaches behind the Ward Hunt Ice Shelf (3,000 + or - 200 B.P.; L-254D; Crary 1960). In the last 900 years the climate appears to have been relatively stable in so far as there has been little change in the terminal positions of most of the major glaciers, as shown for example by radiocarbon dating of plant material from deposits near the margins of the Air Force Glacier (Tanquary Fiord) and the Gilman Glacier. Both these main glaciers are advancing slightly, although many of the side glaciers have receded from well-marked terminal moraines, probably as a result of the climatic warming centred around 1930 (Hattersley-Smith 1963b, 1969). (Auth)

671. **Hattersley-Smith, G.F., and R.B. Sagar.** 1959. Glaciology. *D Phys R (G) Hazen 4, Operation Hazen, Narrative and Preliminary Reports 1957-1958, G. Hattersley-Smith (Ed.), (pp. 24-28), 88 pp.*

At 5,900 ft on the ice cap near Mount Oxford, investigation of snowpits and cores indicated that the annual accumulation on the Gilman Glacier averaged 12.75 cm between 1938-1958. Ablation studies and other observations indicate that the glaciers flowing southwards from the high ice cap are thinning, although their snouts are not receding. Small ice masses throughout the Queen Elizabeth Islands are receding at their margins, whereas large trunk glaciers show little evidence of retreat. (JTA)

672. **Hattersley-Smith, G.F., and H. Serson.** 1970. Mass Balance of the Ward Hunt Ice Rise and Ice Shelf: A 10 Year Record. *Journal of Glaciology 9(56):247-252.*

The results of 10 years' (1958-68) record of accumulation and ablation from the Ward Hunt ice rise and of 3 years' (1965-68) record from the Ward Hunt Ice Shelf are presented. The net mass balances on the ice rise for the 3 years 1962-65 are positive, while the net mass balances measured in the other years on both ice rise and ice shelf are all negative. (Auth)

673. **Hendy, C.H., T.R. Healy, E.M. Rayner, J. Shaw, and A.T. Wilson.** 1979. Late Pleistocene Glacial Chronology of the Taylor Valley, Antarctica, and the Global Climate. *Quaternary Research 11:172-184.*

Carbonate-rich lacustrine and deltaic deposits, containing thin beds of finely laminated carbonates and thick beds of silt, crop out at several sites in the Taylor Valley and have been encountered in cores obtained by the Dry Valley Drilling Project (DVDP). Fragments of the more indurated carbonate beds have widespread occurrence as part of the desert "lag gravel" which covers much of the valley floor. Analysis of the carbonates suggests that they were deposited as algal limestones from waters derived from the East Antarctic Ice Sheet via the Taylor Glacier at times which correspond to the previous three global interglacial periods, as evidenced by the ice volumes deduced from oxygen-isotopic analysis of oceanic cores. The lacustrine carbonates have been found up to 30 km beyond the present terminus of the Taylor Glacier, and up to 100 m above the level of Lake Bonney, into which the Taylor Glacier at present discharges. It is concluded that the Taylor Glacier has advanced during each of the previous three interglaciations, and it is suggested that this has been caused by a thickening of the East Antarctic Ice Sheet during the interglaciations. (Auth)

674. **Henoch, W.E.S.** 1971. Estimate of Glaciers Secular (1948-1966) Volumetric Change and its Contribution to the Discharge in the Upper North Saskatchewan River Basin. *Journal of Hydrology 12:145-160.*

The recent trend of glacier recession in the Rocky Mountains began in the late 19th century. Since that time numerous studies of glaciers have been made but estimates of glacier volume decrease and the resultant increase in river discharge are lacking. Quantitative measurements show that glacier volume loss in the Upper North Saskatchewan River Basin during the period 1948-1966 was 1000 times 10(E+6)cubic meters. This is approximately 4% of the total discharge determined from the records of the hydrometric stations at Saskatchewan Crossing and Mistaya River. (Auth)

Glaciologic

675. **Herron, M.M., S.L. Herron, and C.C. Langway, Jr.** 1981. Climatic Signal of Ice Melt Features in Southern Greenland. *Nature 293(5831):389-391.*

The stratigraphic record of melt features in intermediate depth of polar ice cores has provided valuable data on past summer climate. The thermal drilling technique used in previous studies precluded extending this record beyond a few hundred years. Recently, however, a 901-m deep core was mechanically drilled in southern Greenland. The excellent core quality and improved techniques for measuring melt features have resulted in an approximately 2,200 yr record with consistently high quality data. We report here that the temporal variations in melt feature abundance, expressed as annual melt per cent (AMP), provide proxy data on summer climate that can complement other records extending back thousands of years. The AMP profile indicates that relatively warm summers prevailed from about A.D. 950 until A.D. 1500 culminating in the thirteenth and fourteenth centuries. The periods from about 300 to 150 B.C., A.D. 350 to 550, and A.D. 1550 to 1800 had relatively little summer melting. (Auth)

676. **Hibler, W.D., III, and S.J. Johnsen.** 1979. The 20-Yr Cycle in Greenland Ice Core Records. *Nature 280(5722):481-483.*

We have examined characteristic oscillations in Greenland ice core oxygen isotope records. The results show that the strongest spectral peak occurs at a period of 20 + or - 0.5 yr with a statistically significant amplitude. This period is essentially the same as that found in eastern North American winter temperatures. Moreover this 20-yr oscillation is found to be coherent in phase with the dominant variation in the Sun's motion about the centre of mass of the Solar System. This motion has been hypothesised to be closely linked with sunspots. On the basis of these observations we speculate here that a 20-yr oscillation may be a more fundamental solar and/or climatic oscillation than the nominal 22-yr cycle often mentioned. (Auth)(JTA)

677. **Hollin, J.** 1970. Is the Antarctic Ice Sheet Growing Thicker?. *International Association of Scientific Hydrology Publication 86:363-374.*

The Antarctic ice sheet has existed for several million years, it has fluctuated but never disappeared, and the last major retreat of its margin ended several thousand years ago. The evidence is discussed for and against a subsequent growth of the ice sheet center, on a time scale of thousands of years. The evidence includes ice- and sand-wedges, cavernous weathering and lichens, all to the ice edge; possibly advancing glaciers flowing from the ice sheet into the McMurdo Oasis; positive mass budgets for the ice sheets and for individual drainage basins; a possible sea-level fall over the last 4000 yr (that the Netherlands and Gulf Coast show a sea-level rise may be because they are sinking now as part of collapsing "peripheral bulges" stretching further than usually imagined, though not as far as the Equator as has been suggested), though part of this fall may be due to a post-Hypsithermal cooling; the aseismicity of Antarctica; temperature profiles in the ice sheet; strain networks on the ice surface; deep coring studies; ice position surveys; and gravity data. The most likely causes for a growth of the ice sheet would be a post- 18, 000 B.P. accumulation increase over Antarctica, or else a build-up in one or more basins towards a mechanical surge. (Auth) AntB F-8333

678. **Hooke, R. LeB., and H.B. Clausen.** 1982. Wisconsin and Holocene Delta Oxygen 18 Variations, Barnes Ice Cap, Canada. *Geological Society of America Bulletin 93:784-789.*

New delta Oxygen 18 measurements on ice samples from Barnes Ice Cap show a relatively large shift from about -23 0/00 in the blue ice that makes up the bulk of the ice cap to -38 0/00 in a basal layer of clean white ice. This strongly suggests that the latter is of Pleistocene age, thus confirming an earlier interpretation based on less comprehensive data. The shift between the Pleistocene and Holocene ice is attributed in part to the change in climate at the end of the Pleistocene, and in part to a decrease in elevation of the accumulation area of approximately 700 m. Beneath the clean white ice, there is a layer of dirty white ice with less negative delta Oxygen 18 values. This ice is believed to have been deposited during a climatically warm period in early to middle Wisconsin time. In addition, however, the less negative Oxygen 18 values in it are, in part, attributed to fractionation at a time in the past when the basal ice was at the melting point, and some of the water produced by pressure melting was lost through a permeable bed. (Auth)

679. **Johnsen, S.J.** 1977. Stable Isotope Profiles Compared with Temperature Profiles in Firn with Historical Temperature Records. *International Association of Scientific Hydrology Publication 118:388-392.*

Shallow temperature profiles (50-100 m) from polar ice caps contain information about recent climatic changes. Correlation with delta (Oxygen 18) records and temperature records is possible by using a method described in this paper. The method helps to understand the climatic information of delta (Oxygen 18) records, and allows the climatic regime of ice cap stations to be established. (Auth)

680. **Johnsen, S.J., W. Dansgaard, and H.B. Clausen.** 1970. Climatic Oscillations 1200-2000 A.D. *Nature 227:482-483.*

This paper presents the results of a detailed study of the ice which accumulated during the last 800 years, as determined from Oxygen 18 variations in the 1400 meter long ice core from Camp Century, Greenland. Long term oscillations of the climate with periods of 400 and 2400 years are indicated. Major cool periods occurred about 1280, 1420-1510, 1680, and 1820 A.D. with major warm intervals centered about 1240, 1390, 1550, 1700-1800, and 1950 A.D. (Auth)(JTA)

681. **Johnsen, S.J., W. Dansgaard, H.B. Clausen, and C.C. Langway, Jr.** 1972. Oxygen Isotope Profiles through the Antarctic and Greenland Ice Sheets. *Nature 235(5839):429-434.*

The Camp Century, Greenland, deep ice core reveals seasonal variations in the isotopic composition of the ice back to 8,300 years B.P. This is not the case for the Byrd Station, Antarctica, deep ice core. Both cores show long-term perturbations in isotopic composition reflecting climatic changes from before the beginning of the last glaciation. But the complexity of the glaciological regime at Byrd Station precludes a rational choice of a time scale. Pole-to-pole correlations of the palaeoclimatic data therefore become speculative except for the more pronounced features and general trends. (Auth) GA 72A/1827

682. **Johnson, P.G.** 1980. Glacier-Rock Glacier Transition in the Southwest Yukon Territory, Canada. *Arctic and Alpine Research 12(2):195-204.*

In the southwest Yukon Territory rock glaciers of both the glacier debris system type and the talus type are common. In addition there are many examples of the transition between glaciers and the glacier-ice-cored type of feature. The glacier-ice-cored forms characteristically develop within or emanate from cirque basins where the formation of a complete debris cover of the glacier surface has been possible. Flow of these rock glaciers is due to periods of glacier advance with some secondary deformation of the ice under the debris cover after the retreat of the glacier. This secondary deformation accounts for movements measured at the present day. Comparisons are made among an ice-cored moraine system, a transitional form, and a large glacier-ice-cored rock glacier. The different flow lobes of the Grizzly Creek Rock Glacier indicate a number of periods of glacier activity in post Pleistocene times which may fit with the Denton and Karlen Holocene fluctuation model. (Auth)

683. **Koerner, R.M.** 1977. Devon Island Ice Cap: Core Stratigraphy and Paleoclimate. *Science 196(4285):15-18.*

Valuable paleoclimatic information can be gained by studying the distribution of melt layers in deep ice cores. A profile representing the percentage of ice in melt layers in a core drilled from the Devon Island ice cap plotted against both time and depth shows that the ice cap has experienced a period of very warm summers since 1925, following a period of colder summers between about 1600 and 1925. The earlier period was coldest between 1680 and 1730. There is a high correlation between the melt-layer ice percentage and the mass balance of the ice cap. The relation between them suggests that the ice cap mass balance was zero (accumulation equaled ablation) during the colder period but is negative in the present warmer one. There is no firm evidence of a present cooling trend in the summer conditions on the ice cap. A comparison with the melt-layer ice percentage in cores from the other major Canadian Arctic ice caps shows that the variation of summer conditions found for the Devon Island ice cap is representative for all the large ice caps for about 90 percent of the time. There is also a good correlation between melt-layer percentage and summer sea-ice conditions in the archipelago. This suggests that the search for the northwest passage was influenced by changing climate, with the 19th-century peak of the often tragic exploration coinciding with a period of very cold summers. (Auth)

684. **Koerner, R.M.** 1977. Distribution of Microparticles in a 299-m Core through the Devon Island Ice Cap, Northwest Territories, Canada. *International Association of Scientific Hydrology Publication 118:371-376.*

Three ice cores taken from the Devon Island ice cap at 1800 m a.s.l. were analysed for microparticles (1.0 to 2.0 micrometers). The first core taken in 1973 penetrated to 223 m and the second and third cores taken in 1972 to 1973 penetrated to bedrock at 229 m depth. The general distribution of particulate matter throughout the core indicates: 1) no significant changes of dust fallout (dry and as precipitation nuclei) over the past 10,000 yr; 2) a very high dust content was encountered in ice deposited during the last glacial period ending 10,000 yr ago; 3) the dirtiness of such Wisconsin ice is attributable to the increase in small size range of 1.5 micrometer particles with no similar increase in particles of 2 or 3 micrometer diameter. The dirtiness of this ice depth could be a result of a decrease in precipitation rate, a decrease in size of the snow grain and therefore an increase in the volume ratio of nucleus to snow, or increased volcanic activity or a non-volcanic increase in atmospheric content of dust. The increase in particle numbers, their changed size distribution and the lower content of water soluble material (determined by another study) indicate the source of dust was distant. One distinctive dirt horizon spanning two years with ten times the normal particle count is most likely the result of a volcanic eruption. Dust distribution in ice cores showes seasonal peaks and three patterns of seasonal variation of particulate content in the ice were determined. Surface samples from the drill site showed a double-peak annual dust profile, but at depth they become a single peak due to densification of the ice. A tentative interpretation of these features is that the snow accumulation rate at the drill site has not varied significantly over the past 200 years. (Ecol Can 2932) Ecol Can 2932

685. **Koerner, R.M.** 1977. Ice Thickness Measurements and their Implications with Respect to Past and Present Ice Volumes in the Canadian High Arctic Ice Caps. *Canadian Journal of Earth Sciences 14:2697-2705.*

Snow accumulation and ice volume measurements made at eastern and western sides of cross-ice-cap traverses confirm the conclusion that the thickness asymmetry of the ice caps is largely controlled by snow accumulation. The combined effect of open water in Baffin Bay and the persistence of a low pressure cell there throughout the year brings a high accumulation of precipitation to the mountain slopes facing Baffin Bay. Warmer and more open conditions during the period 5000 to 8000 years B.P. brought strong melting conditions to the entire Queen Elizabeth Islands but only over the slopes facing Baffin Bay was there increased snow accumulation to maintain a glacier mass balance. Asymmetry then developed as the high accumulation sides maintained their volume while westerly areas did not. Ice thickness asymmetry is not developing further. The asymmetry, once developed, is accumulation controlled. Ice caps away from Baffin Bay do not show such asymmetry; mass balance values are similar on both sides of the Devon Ice Cap. (Ecol Can 2933) Ecol Can 2933

686. **Koerner, R.M.** 1979. Accumulation, Ablation, and Oxygen Isotope Variations on the Queen Elizabeth Islands Ice Caps, Canada. *Journal of Glaciology 22(86):25-41.*

Measurements made on traverses over ice caps in the Queen Eizabeth Islands show that there is a region of very high acumulation (>40 g/sq cm/year) on the slopes facing Baffin Bay and one of low accumulation (<15 g/sq cm/year) in the interior parts of northern Ellesmere Island. Ablation rates in summer show much less regional variation over the same ice caps except for lower rates along the north-west edge of the islands and possibly on the Baffin Bay slopes as well. However, there is a stronger relationship between ablation and elevation which is exponential below the firn line. From the fractional Oxygen 18 content of the snow it is shown that Baffin Bay contributes significant amounts of moisture (>20% of the total)to the Baffin Bay slopes. In addition the Arctic Ocean is seen as another, but much less significant, moisture source. The delta Oxygen 18 data show two effects on the condensation processes–an orographic one (i.e., adiabatic cooling) and a distance-from-source effect (isobaric cooling) where the source is somewhere to the south-east of the islands. (Auth)

687. **Koerner, R.M.** 1980. Instantaneous Glacierization, the Rate of Albedo Change, and Feedback Effects at the Beginning of an Ice Age. *Quaternary Research 13:153-159.*

A study of the average annual- and melt-season albedos for the northwest side of the Devon Island Ice Cap shows that there is no step in the average albedo either at the equilibrium or firn line. Similarly, during a period of increasing glacierization there is nowhere any dramatic increase in the average annual- or melt-season albedo with time as the equilibrium line graduallly moves downslope. This means that the inception of ice caps and permanent snowfields does not make a significant change to the rate of increasing albedo and its associated feedback effects during the same period of glacierization. The extension of the annual period of snowcover generally is much more important to the feedback process (by increasing albedo) than the specific lowering of the equilibrium line. A decreased variability of summer climate, and hence the disappearance of "anomalously" warm summers, may be an integral part of the glacierizing process. (Auth)

688. **Koerner, R.M., and D.A. Fisher.** 1981. Studying Climatic Change from Canadian High Arctic Ice Cores. *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 195-218), 220 pp.*

Oxygen 18 studies from the Devon Island Ice Cap suggest that temperatures have cooled 2.7 to 3.5 deg C since 5000 B.P. Detailed graphs of Oxygen 18, percentage of melt in the core, and electrolytic conductivity are shown for the last 800 years on the Devon Island Ice Cap. A period of maximum melt occurred about 430 B.P. and within the last 100 years. Minimum surface melt on the ice cap is shown to have occurred 150 years ago between 250 and 350 B.P. An episode of minimum melt is also indicated about 650 years ago. (JTA)

689. **Koerner, R.M., W.S.B. Paterson, and H.R. Krouse.** 1973. Delta Oxygen 18 Profile in Ice Formed between the Equilibrium and Firn Lines. *Nature Physical Science 245(148):137-140.*

Stable isotopic and bubble content profiles are shown for the Meighen Ice Cap, in the Canadian arctic at 80 deg N, 100 deg W. Warm periods when considerable ablation occurs result in discontinuities in the records. It is concluded that the Meighen Ice Cap grew during a cold period probably less than 5000 years ago, and certainly less than 10,000 years ago. Stable isotope records from ice caps that experience ablation in warm summers are more difficult to interpret than sites, such as Camp Century, which lie within the dry snow facies. (JTA)

690. **Koerner, R.M., and R.D. Russell.** 1979. Delta 18 Oxygen Variations in Snow on the Devon Island Ice Cap, Northwest Territories, Canada. *Canadian Journal of Earth Sciences 16:1419-1427.*

A study of delta 18 oxygen variations of snow samples taken on traverses across the Devon Island ice cap in June 1971, 1972 and 1973 has shown a difference between the accumulation conditions on the southeast and northwest sides of the ice cap. On the southeast side there is an increasing depletion of 18 oxygen in the snow with increasing elevation. This pattern is attributed to the effect of orographic uplift of air masses moving over the ice cap from the southeast, which promotes condensation and precipitation due to adiabatic cooling. On the northwest side of the ice cap there is no evidence of any further depletion of 18 oxygen in snow, neither with increasing distance from the possible moisture source in Baffin Bay to the southeast nor with increasing elevation if the air mass comes from the northwest. In this case condensation is due to isobaric cooling so that precipitation is generally from level cloudbases. The changes inferred for the isotopic composition of the water vapour as it rises up the southeast slope are found to be consistent with its depletion through precipitation under near-equilibrium conditions. It is calculated that approximately 30% of the moisture at sea level on the southeast side of the ice cap and 8% at the top of the ice cap are of local origin. Lower temporal and aerial variability of the delta values on the southeast side of the ice cap is attributed to dominance of the Baffin Bay low on that side effecting consistency of storm conditions there. The delta values of ice in the ablation zone of the Sverdrup Glacier show the combined effect of ice movement from the accumulation to the ablation zone and climatic change during the period of movement from cold to warm and back to cold conditions again. An earlier analysis of delta values in two cores drilled to bedrock at 1,800 m a.s.l. on the crest of the Devon Island ice cap indicated a continuous cooling trend for the last 5,000 years and a warm period for the 4,000 years preceding that period. Based on calculations of ice velocity and delta values of ice, the ice at the end of the Sverdrup Glacier is 3,600 to 9,000 years old, an age corresponding with the Climatic Optimum. (Ecol Can 3386)(JTA) Ecol Can 3386

691. **Konecny, G.** 1964. Glacial Surveys in Western Canada. *Photogrammetric Engineering 30(1):64-82.*

The correlation between climate and glacial changes has led to a world-wide observation program of glaciers typical for advance or retreat. In western Canada, accurate glacier mapping was started by aerial photgrammetry during the last decade. A research project of the University of New Brunswick applied terrestrial phototheodolite surveys to glacial mapping and to the determination of speed profiles in 1962. The paper compares economy and accuracy of terrestrial versus aerial photgrammetric surveys of the Athabaska glacier area. Methods for determining glacial retreat are discussed along with the results obtained. (Auth) GA 64/657

692. **Kosiba, A.** 1964. Last Climatic Oscillations in Some Arctic Regions and in Central Europe. *Report of the VIth International Congress on Quaternary, Warsaw, 1961. (pp. 285-289).*

In recent years a retarded ablation and recession of glaciers is observed. The author had the opportunity to prove this on SW-Spitsbergen by means of geodetical, and photogrammetrical surveys as well as by means of ablation stakes measurements during his observations during the Polish IGY and IGC Spitsbergen Expeditions in 1957 through 1960. The yearly decrease in thickness of the Werenskiold glacier during these 4 years amounted to about 2 m/year (against a decrease of about 3.3 m/year during the period 1915-57). (from Internat. Biblog. Photogrammetry.) GA 67A/686

693. **Kotlyakov, V.M., and M.G. Grosswald.** 1981. Climatically and Non-Climatically Induced Glacier Changes: A Review of Soviet Studies. *International Association of Scientific Hydrology Publication 131:361-368.*

The response of glaciers in the USSR to predict changes of temperature associated with the CO2 increase would vary depending on the type of glacier and its geographical position. Within Eurasia it is suggested that the mass balance of glaciers would remain essentially unchanged as the increased ablation would be balanced by an increased winter accumulation. However, the ablation of glaciers and ice caps in the Soviet Arctic would be much higher than any change in accumulation and the forecast predicts that these ice masses would disappear in a matter of decades. In Greenland the authors predict that the equilibrium line would rise by 25-650 m leading to an annual average lowering of the Greenland Ice Sheet by 0.5 - 0.7 m/yr. The East Antarctic Ice Sheet would remain essentially unchanged but the West Antarctic Ice Sheet might surge and collapse. (JTA)

694. **Kukla, G.J.** 1981. Climatic Role of Snow Covers. *International Association of Scientific Hydrology Publication 131:79-107.*

Snow cover is the critical variable of the climate system because of its high reflectivity, high emissivity, low water vapor pressure, and low conductivity. Formation and dissipation of snow covers closely depends on the amount, as well as the spectral and the angular distribution of incoming shortwave radiation. The deposition of snow induces a step in the response of surface temperature to insolation forcing. Weak energetic impulses are multiplied by potent feedbacks which operate in the marginal belt of snow and ice, here called the transition zone. Combined impact of the industrial and volcanic aerosols and of the Carbon Dioxide on the deposition and melt of the snow in the high and middle northern latitudes is an urgent problem of immediate concern. This is because (a) the concentration of industrial aerosols and of Carbon Dioxide reach a seasonal peak in spring when the sensitivity of snow to energy forcing is high; (b) the future concentrations of aerosols and of Carbon Dioxide in high latitudes will be affected by the worldwide energy policies; and (c) contrary to the expectations of climate models, the Carbon Dioxide increase in the last 30 years is accompanied by a marked oscillatory cooling of the northern high and middle latitudes. (Auth)

695. **Langway, C.C., Jr.** 1967. Stratigraphic Analysis of a Deep Ice Core from Greenland. *CRREL RR 77, Cold Regions Research and Engineering Laboratory, Hanover, NH, 130 pp.*

Presents a major scientific study of a 411 m ice core from the Greenland inland ice (76 deg 59 min N 56 deg 04 min W). The logistics of the drilling program are reviewed and the site procedures explained. The criteria for macroscopic stratigraphic analysis are discussed, including features, physical characteristics, crystallography, and density. When viewed by transmitted light, distinctive layers of winter and summer accumulation can be identified. Results of Oxygen-isotope studies indicate that seasonal variations in Oxygen 18 provide a good means of estimating annual accumulation. Analyses of chemical composition and cosmic dust content are summarized and their climatological implications assessed. Spherules in the core are considered to be extra-terrestrial rather than volcanic in origin. The core records of accumulation from 934 A.D. to 1957 show that conditions were similar in 934 to today. From that date slow decrease in accumulation and temperature appears to have taken place which reached a minimum around the late 18th century; thereafter warming and increase in accumulation has been a continuing trend. (AB97326) AB97326

696. **Langway, C.C., Jr., W. Dansgaard, S.J. Johnsen, and H.B. Clausen.** 1973. Climatic Fluctuations during the Late Pleistocene. *The Wisconsinan Stage, GSA Memoir 136, R.F. Black, R.P. Goldthwait and H.B. Willman (Eds.). Geological Society of America, Boulder, CO, (pp. 317-322), 334 pp.*

The oxygen-isotope ratio in polar snow is determined mainly by the temperature of formation of the precipitating clouds. A continuous core 1390 m long through the ice sheet at Camp Century, Greenland, reveals a climatic record, inferred from those ratios, spanning possibly the last 100,000 yrs. The depth-age relationship of the core is calculated from present ice-flow patterns and simple assumptions; the palaeoclimatic data are interpreted from the analysis of oxygen-isotope-ratio measurements on nearly 7000 individual samples cut from the core. The ice-core record reveals that the Wisconsin Stage started 73,000 yrs B.P. Many perturbations of the oxygen-isotope ratios are observed within the Wisconsin Stage that agree with climatic oscillations dated by radioactive methods. An 11 percent shift in the Oxygen isotope data shows that the Wisconsin Stage ended very rapidly, within a 2500 yr interval, at about 13,000 yrs B.P. Spectral analyses of the data show oscillations with periods of 78, 181, 400, and 2400 yrs. (Auth) GA 74A/1393

697. **Langway, C.C., Jr., and B.L. Hansen.** 1970. Drilling through the Ice Cap: Probing Climate for a Thousand Centuries. *Bulletin Atomic Scientists 26(10):62-66.*

One of the major questions of polar research has been whether climatic changes in the northern and southern hemispheres have occurred at the same time. It bears on theories of ice ages which range from local to solar-cosmic processes. One approach to the answer is the analysis of ice in deep cores taken out of the ice caps of Greenland and Antarctica by drilling rigs capable of perforating the great sheets. Stored within the ice is a record of climate, extending back into time for thousands of years. The record is now beginning to show that climate changes in the northern and southern hemispheres are contemporaneous. (from Antarctic Bibliography) GA 72A/0376

698. **Lawson, M.P., K.C. Kuivinen, and C. Balling, Jr.** 1982. Analysis of the Climatic Signal in the South Dome, Greenland Ice Core. *Climatic Change 4:375-384.*

The purpose of this research was to investigate the statistical relationship between an oxygen isotope chronology from southern Greenland and climatic variables recorded at a coastal village. The response of the oxygen isotope time series to monthly temperature and precipitation data was calculated using a combination of principal components factor analysis and multiple regression analysis. Orthogonal eigenvectors extracted from 35 yr of climatic data reliably explained 59% of the temporal variance in mean annual oxygen isotope values. The response functions demonstrate an apparent seasonal reversal in the relationship between oxygen isotope values and temperature and, with the response varying between a positive (direct) relationship in winter, spring, and autumn, and a negative (indirect) relationship in summer. The results, and their implications, are shown to be useful in the historical climatic reconstructions of the South Greenland region. (Auth)

699. **Loken, O.H.** 1969. Evidence of Surges on the Barnes Ice Cap, Baffin Island. *Canadian Journal of Earth Sciences 6(4, Part 2):899-901.*

Study of detailed topographic maps shows that the trend of the surface contours generally conforms to the outline of the icecap. In an area near Generator Lake on the south and near Blanchfield Lake on the west, however, lower contour lines bulge out towards the ice margin, but higher on the icecap the contours curve in the opposite direction. This suggests mass transfer from a higher reservoir to the lower part of the icecap. Moraine patterns adjacent to the icecap show that the ice margin in the two areas has recently advanced in contrast to the general retreat in adjacent areas. The discussion indicates that the surge occurred prior to 1950 and after the formation of the old moraines some 700-800 B.P.(AB105413) BafBib 186

700. **Loken, O.H.** 1972. Growth and Decay of Glaciers as an Indicator of Long-Term Environmental Changes. *International Commission for the Northwest Atlantic Fisheries Special Publication Number 8, (pp. 71-85).*

The paper presents a general survey of glacier response to climatic changes mainly during the 1960s. Average mass gain or loss is graphed for several glaciers in the Northern Hemisphere, including examples from Norway, Sweden, Polar Urals, and Arctic Canada. In general, glaciers diminished in volume during the last two or three decades. (JTA)

701. **Loken, O.H., and J.T. Andrews.** 1966. Glaciology and Chronology of Fluctuations of the Ice Margin at the South

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End of the Barnes Ice Cap, Baffin Island, N.W.T. *Geographical Bulletin 8(4):341-359.*

Climatic considerations strongly suggest that a proto Barnes Ice Cap must have existed over central Baffin Island during the Hypsithermal as subsequent climatic deterioration was insufficient to redevelop an ice cap. The chronology of the ice margin fluctuations on the south dome over approximately the last 1200 years are outlined and comparisons made with margin elsewhere on the ice cap. In general the ice margin has retreated, but major readvance moraines were formed in approximately A.D. 1300, 1500 and 1700. (Auth)(JTA)

The chronology of glacial variations discussed above has been reviewed by Andrews and Barnett (1979) who recalculated the ages of the moraines based on a Carbon 14 controlled lichen growth curve. (JTA)

702. **Loken, O.H., and R.B. Sagar.** 1968. Mass Balance Observations on the Barnes Ice Cap, Baffin Island, Canada. *International Association of Scientific Hydrology Publication 79:282-291.*

The current mass balance investigations on the Barnes Ice Cap are described. The southern part receives more winter accumulation than the northen part of the ice cap, but the difference varies from year to year. The winter balance on the top of the ice cap exceeds the winter season precipitation at nearby weather stations by an average factor of 3-4. The 1965-66 mean mass balance for the ice cap was -93 cm, a loss equal to 2-3 times the mean annual winter accumulation. The 1964-65 mass balance near the northern end was close to 0, and the equilibrium line there was at an altitude of about 800 m a.s.l. An east-west asymmetry of the mass balance exists across the rest of the ice cap; the northeast side has a relative positive mass balance when compared to the southwest side. Studies of moraine patterns around the ice cap indicate that this pattern has persisted for a long time possibly as much as five thousand years. (Auth)(JTA)

703. **Lorius, C., L. Merlivat, P. Duval, J. Jouzel, and M. Pourchet.** 1981. Evidence of Climatic Change in Antarctica over the Last 30,000 Years from the Dome C Ice Core. *International Association of Scientific Hydrology Publication 131:217-225.*

Climatic interpretation of isotopic records for the 906 m deep Dome C ice core (74 deg 39 min S, 124 deg 10 min E, elev. 3240 m) includes: 1) Snow accumulation remained almost constant during the last 10,000 years. 2) Major events in the Dome C record which can be recognized in other Antarctic studies are: a possible shift of the mean annual temperature by 7 deg C between the late Pleistocene and the Holocene; and the occurrence of the warmest interval in the record which is dated between 11,000 and 8000 B.P. (JTA)

704. **Lorius, C., L. Merlivat, J. Jouzel, and M. Pourchet.** 1979. 30,000-Yr Isotope Climatic Record from Antarctic Ice. *Nature 280(5724):644-648.*

Simple glaciological conditions at Dome C in east Antarctica have made possible a more detailed and accurate interpretation of an ice core to 950 m depth spanning some 32,000 yr than that obtained from earlier ice cores. Dated events in comparable marine core has enabled the reduction of accumulation rate during the last ice age to be estimated. Climatic events recorded in the ice core indicate that the warmest Holocene period in the Southern Hemisphere occurred at an earlier date than in the Northern Hemisphere. (Auth) AntB F-22665

705. **Lorius, C., L. Merlivat, J. Jouzel, and M. Pourchet.** 1979. Climatic Changes in Antarctica during the Last 30, 000 Years. *Colloque International/International Conference, Evolution des Atmospheres Planetaires et Climatologie de la Terre/Evolution of Planetary Atmospheres and Climatology of the Earth, Nice, 16-20 Octobre, 1978. Centre National D'Etudes Spatiales, France, (pp. 71-82), 574 pp.*

The delta Oxygen 18 percent profile from a 905 m deep ice core recovered from central East Antarctica (Dome C) shows significant climatic events. Using a relationship between the present mean isotopic composition of the surface snow and the mean annual surface temperature leads to a tentative estimate of about 7 deg C for the surface temperature change between the coldest part of the ice age and the present climate. This change occurred from about 15, 000 to 10,000 years B.P. (Auth)(JTA)

706. **Lyons, J.B., R.H. Ragle, and A.J. Tamburi.** 1972. Growth and Grounding of the Ellesmere Island Ice Rises. *Journal of Glaciology 11(61):43-52.*

Analysis of glaciological data indicates that grounding of the Ward Hunt Ice Shelf and its conversion into an ice rise was primarily the result of local thickening of a floating ice shelf and the availability of a very gently sloping sea floor on which the ice shelf came to rest. Application of heat conduction theory to a series of thermal profiles through the Ward Hunt Ice Shelf, and the Ward Hunt, Camp Creek and Cape Discovery ice rises shows that present heat flow in this area of northern Ellesmere Island is more than twice normal, and that the outer and intermediate parts of the Ward Hunt ice rise grounded 250-350 years ago, during a cycle of climatic deterioration. Development and localization of ice rises along northern Ellesmere Island are strongly influenced by topography, and all ice rises we have studied seem to have formed within the past 1,600 years, possibly with major growth in the interval from 1,000 to 150 years ago. (Auth)

Growth of the ice rises coincides in time with other evidence in Arctic Canada for severe conditions during the Little Ice Age and earlier (e.g. Andrews et al., 1980). (JTA)

707. **Manley, G.** 1971. Interpreting the Meteorology of the Late and Post-Glacial. *Palaeogeography, Palaeoclimatology, Palaeoecology 10(2/3):163-175.*

In Baltic lands the Late Glacial Allerod Oscillation of North European climate has been recognised through its effects for upwards of 50 years and later confirmed in Britain. Studies of glacier behaviour in association with climatic fluctuations supported the probability that evidence for contemporary Late Glacial climatic oscillations should be found in other continents. About 1950 it began to appear from pollen analysis supported by early radiocarbon dating that a similar episode occurred in eastern North America. Subsequently, more detailed studies in the longitude of the Upper Great Lakes have failed to support the occurrence of a climatic recession precisely contemporary with that in northwest Europe. Assemblage of dates with regard to the Late Glacial on a global scale is now possible and Mercer has recently argued that the climatic episode represented by the Allerod oscillation is virtually confined in its effects to Europe. He offers an explanation based on the consequences of the probable behaviour of the Arctic ice. Recent developments in knowledge of the behaviour of the high-altitude wave pattern in the upper westerlies allow for a reconciliation of the controversial evidence with regard to the character and timing of apparent climatic anomalies in differing longitudes. The Allerod oscillation should not be expected to be world-wide in its effects, or even in the Northern Hemisphere. Recent studies in northern Canada of the chronology of peat growth lend support to the view that a small but persistent change of the atmospheric circulation might cause the vegetation to register climatic effects differing considerably between, say, northern Manitoba and eastern Labrador. Further results from Siberia would be helpful. (Auth) GA 72A/1071

708. **Marcus, M.G.** 1964. Climate-Glacier Studies in the Juneau Ice Field Region, Alaska. *Chicago University, Department of Geography, Research Paper No. 88, 128 pp.*

The purpose of this study is to identify and evaluate the interactions between glaciers and climate, the basic hypothesis being that short-term changes in the hydrological regimen of a temperate glacier can be explained in terms of short-term climatic fluctuations. Investigations were focussed on the Juneau Ice Field region of southeastern Alaska, and particularly on Lemon Creek Glacier. Comparing nearby glaciers to the Lemon Creek Glacier record, it was found that, with the exception of Taku Glacier, they have behaved similarly during the 20th century. The majority of Juneau Ice Field glaciers have existed only precariously since the termination of the "little ice age" in the mid-19th century, a fact that may be true of most low-altitude, temperate valley glaciers. Small climatic changes appreciably affect these glaciers; they are, in a sense, hydrological gauges which respond to the slightest climatic fluctuations. Although each of these glaciers has its own peculiar morphological and structural attributes, it does appear that the hydrological behavior and climatological interactions identified on Lemon Creek Glacier provide a reasonable approximation of the glacier-climate relationships which exist on many neighboring glaciers. (Auth from Geoscience Abstracts) GA 65/913

709. **Marcus, M.G., and R.H. Ragle.** 1970. Snow Accumulation in the Icefield Ranges, St. Elias Mountians, Yukon. *Arctic and Alpine Research 2(4):277-292.*

Snowpack characteristics in the St. Elias Mountains were examined as part of the Icefield Ranges Project for 1961 and 1965, emphasising particularly the 1964-65 glacier balance year, together with reconstructions for 1953 to 1961. Analysis was carried out along a hydrological traverse on the Kaskawulsh, Hubbard, and Seward-Malaspina glaciers, and at a single location through a period of time. The data obtained are summarised in graphs and tables. The relationships between precipitation, elevation, and topography, and effects of continentality and exposure are considered. In neither case are the relationships clearly defined but it is evident that elevation is a critical factor in the maintenance of continental slope glaciers and spring runoff. Fluctuations in net accumulation are determined and evaluated; a stable period is indicated for the late 1950s, followed by an increase of 200 to 300 mm in the early 1960s and a minimum in 1964-65 and 1965-66 of winter nourishment and mass balance. Climatic implications are drawn from the snow accumulation data. (Auth) GA 71A/2178

710. **Meier, M.F.** 1961. Distribution and Variations of Glaciers in the United States Exclusive of Alaska. *International Association of Scientific Hydrology Publication 54:420-429.*

A cooperative program of investigations of the distribution of existing glaciers in the United States south of Alaska and the variations of these glaciers was instituted during the International Geophysical Year. Approximately 1,000 glaciers were found to exist: 77 percent of the glacier area occurs in the State of Washington. The total glacierized area is 513 sq km. Quantitative data on surface rise, advance of terminus, gross accumulation, late summer ablation rate, and measured precipitation were obtained for seven glaciers, and qualitative data were obtained on the condition of many other glaciers. These data indicate that during 1957 glaciers were generally thickening and advancing in Washington and perhaps in Oregon, were thinning slightly in Montana, and were retreating in California. The summer of 1958 was one of exceptional ablation and caused a marked volume reduction in all glaciers measured as well as a decrease in numbers of glaciers advancing. The 1958-59 budget year was slightly favorable for the growth of glaciers but there is no indication that a cycle of advancing glaciers has resumed. (Auth)

711. **Meier, M.F., and A.S. Post.** 1962. Recent Variations in Mass Net Budgets of Glaciers in Western North America. *International Association of Scientific Hydrology Publication 58:63-77.*

Accumulation and ablation studies on three glaciers in Western Washington during 1957-1961 are analyzed with the aid of graphs showing variation of net budget with altitude. For any one glacier, the graphs are displaced from year to year but show little change in gradient. During any one year, curves for different glaciers reveal minor but important variations, demonstrating the effect of topography and exposure on glacier budgets. Comparable data from other areas show major differences. The vertical gradient in net budget is greatest for glaciers in a zone near the Pacific Ocean and western Washington (14 mm/m) to southeastern Alaska. The gradient decreases in all directions away from this zone and reaches an apparent minimum in northeastern Alaska (2 mm/m). Yearly determinations of specific net budgets for five glaciers in southeastern Alaska, Montana, and western Washington are reduced to an equivalent basis, and the data extended in time using snowline information. The data show large but generally synchronous variations about equilibrium until 1958, and prevalently negative values from 1958 to 1961. The data obtained by regime studies are extended with results of aerial photographic reconnaissance. The reconnaissance data show recent increases in glacier activity from the Northern Cascade Range in Washington through the Coast Range of British Columbia to southeastern Alaska. The increased activity is manifest by high accumulation area ratios and a relatively higher percent of glaciers which appear to be advancing. The effect is most pronounced for small, high altitude glaciers. Large, low valley tongues show continued retreat and little or no rejuvenation. The prevalence of healthy net budgets diminishes in all directions from the Coast Range. In the Sierra Nevada, California, and in the Alaskan Range, most glacier net budgets have been strongly negative for the last few years. In the Wind River Range in Wyoming net budgets have been even more generally negative. Glacier equilibrium lines are lowest in the Coast Range of southeastern Alaska and British Columbia and occur at higher elevations north, east, and south of this zone. (Auth)

712. **Meier, M.F., and W.V. Tangborn.** 1965. Net Budget Flow of South Cascade Glacier, Washington. *Journal of Glaciology 5(41):547-566.*

Ice velocity, net mass budget and surface elevation change data were collected over the length and width of a small (3.4 km long) valley glacier from 1957 to 1964. Ice velocities range up to about 20 m/yr.; three prominent velocity maxima along the length of the glacier correspond to maxima in surface slope. Net mass budgets averaged over the glacier surface range between -3.3 m of water equivalent (1957-58) and +1.2 m (1963-64). Except for the year 1960-61 the glacier became thinner at a rate averaging 0.93 m/yr. The net budget and thinning data are internally consistent. (Auth) (JTA)

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713. **Miller, G.H., R.S. Bradley, and J.T. Andrews.** 1975. The Glaciation Level and Lowest Equilibrium Line Altitude in the High Canadian Arctic: Maps and Climatic Interpretation. *Arctic and Alpine Research 7(2):155-168.*

The glaciation level (GL) over the Queen Elizabeth Islands is highest over the main mountain areas. There are extremely steep gradients approaching 15 m km(E-1) along the northwestern margin of the archipelago where the glaciation level is very low (300 m a.s. l.). Although the glaciation level mirrors topography on a gross scale, at the finer level the relationship breaks down probably because of the effect of the mountains on precipitation patterns. There appears to be a sharp decline in the elevation of the glaciation level between the Canadian islands and northwest Greenland. The elevation of the lowest equilibrium line altitudes (ELAs) are 100 to 200 m below the GL with a minimum elevation of 200 m a.s.l. The GL represents a theoretical surface where winter net mass accumulation is equalled by summer mass ablation. The two primary controls on elevation and gradient are, therefore, related to the pattern of winter snow accumulation and summer snowmelt. An analysis of available climatic data (one meteorological station per 100,000 sq km) is limited by the sparcity of records and the bias of existing stations to a coastal location. Nevertheless, on the shorter time scale, fluctuations in the height of the July freezing level correlate strongly with changes in glacier ELAs. However, there is little spatial correlation between decadal maps of July freezing levels and either GL or ELA surfaces. (Auth)

714. **Miller, M.M.** 1963. The Regional Pattern of Alaskan Glacier Fluctuations (with Some Comments on the Problems of Earthquake Avalanching and Climatic Change). *Foundation for Glacier Research, Seattle, Washington, 17 pp.*

To sum up the regional pattern, in spite of marked differences in the geographical factors affecting glacier nourishment, the dominant characteristic throughout southeastern Alaska during the past 50 years has been shrinkage. The recessional rate on many glaciers, especially those having source neves at low elevation, became much accelerated in the 1920's and 1930's, while a few have experienced spasmodic readvance between 1938 and the present. The only persistently strong departures from the general trend have been on large trunk glaciers. For each such case of significant advance, however, there has been a marked and contemporaneous retreat of another valley glacier of comparable size. Invariably, this opposite behavior has been on glaciers coming from the same or adjoining neves. (after Author; from Geoscience Abstracts) GA 66A/323

715. **Moran, J.M., and R.A. Bryson.** 1969. The Contribution of Laurentide Ice Wastage to the Eustatic Rise of Sea Level 10,000 to 6,000 B.P. *Arctic and Alpine Research 1(2):97-104.*

The contribution of the wasting Laurentide Ice Sheet to eustatic sea-level rise between 10,000 and 6,000 B.P. was estimated. Volumetric models were constructed on the basis of the present Greenland profile and past areal distributions of ice as delineated by the radiocarbon isochrone map of Bryson and Wendland. It was found that even with the assumption of negligible ice in the Arctic Archipelago, the Laurentide sheet was by far the major contributor to sea-level rise. A double-dome model resulted in a eustatic sea-level curve which conforms quite well with those derived in other independent studies. (Auth) BafBib 290

716. **Mosley-Thompson, E.** 1980. 911 Years of Microparticle Deposition at the South Pole: A Climatic Interpretation. *Ohio State University, Institute of Polar Studies, Report No. 73, 134 pp.*

A detailed analysis of the particles within a 101 meter firn core from Amundsen-Scott South Pole Station, Antarctica, was conducted. 6218 samples were analyzed for particle concentration and size distribution. Individual particles within selected sections of the core were examined for morphology and elemental constituents using a scanning electron microscope and an x-ray energy dispersive system. A 911-year time scale was constructed using the annual cycle of particle concentration. Accurate dating of firn and ice cores is essential if appropriate climatic interpretations are to be obtained from the isotopic species and gases contained within these cores. This investigation demonstrated that the microparticle variations provide a method for dating cores from regions of low annual accumulation. This is exceedingly important as the longest cores, and hence the longest paleoclimatic records, will come from East Antarctica where accumulation rates are low. The record of the concentration of insoluble particles with diameters > or = 0.5 micrometers reveals a two-fold increase during the period A.D. 1450-1850. This period of reduced mean global temperature, the Little Ice Age, was also marked by frequent and explosive volcanic activity. The remarkable similarity between the profiles of nonsoluble particle concentration and global volcanic activity suggests that some of the additional material is volcanic, although further substantiation is required. A 911-year record of net annual surface accumulation was constructed from this core using the annual variations in particle concentration. This is the longest record of its type from Antarctica. Net accumulation does not exhibit a general trend over the entire 911-year interval, although a 90-year period, A.D. 1597-1686, exhibits consistently low values. This time interval was characterized by the lowest global temperatures during the last thousand years. On the basis of all the data, it is suggested that the South Pole snow strata are recording the fluctuations in the concentration of insoluble particles in the stratosphere, not only in the southern hemisphere, but in the global stratosphere as well. Thus, microparticle data from deep ice cores will provide valuable information about the global particulate mass over many millenia. (Auth)

717. **Mosley-Thompson, E., and L.G. Thompson.** 1982. Nine Centuries of Microparticle Deposition at the South Pole. *Quaternary Research 17:1-13.*

The analysis of microparticles in a 101 m core from Amundsen-Scott South Pole Station, Antarctica has revealed a substantial increase in total particle concentration between approximately 1450 and 1850 A.D., a period encompassing the latest Neoglacial interval or Little Ice Age. It is likely that this reflects a simultaneous increase in the concentration of particulate material in the Antarctic atmosphere. This is important climatologically, for the Antarctic atmosphere may represent the closest approximation to the natural background aerosol. Thus cores from East Antarctica may contain long and detailed records of the natural global background aerosol. Such records are unavailable from any other medium. Additionally, a cyclical variation which appears to be annual has been detected in the south Pole particle record. These features allow construction of a relative time scale for ice cores older than 100 yr from regions of low accumulation (<10 g a(E-1)) where many traditional techniques are not applicable. This is especially significant, as the comparison of climatic data extracted from ice cores with other records of proxy data depends upon the ability to assign an accurate time scale to the ice core. An estimated nine-century record of net annual accumulation at the South Pole has been compiled and the calculated error in the time scale is + or - 90 yr. (Auth)

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718. **Muller, F.** 1962. Glacier Mass-Budget Studies on Axel Heiberg Island, Canadian Arctic Archipelago. *International Association of Scientific Hydrology Publication 58:131-142.*

Detailed mass-budget investigations were carried out on the White Glacier, a medium-size valley glacier of subpolar type, on western Axel Heiberg Island (80 deg N). The mass-balance for 1960 was strongly negative, and for 1961 slightly positive. For comparison, measurements were made to obtain approximate budget figures for the main ice cap of the island and for a small remnant glacier. (Auth)

719. **Muller, F.** 1963. Radiocarbon Dates and Notes on the Climatic and Morphological History. *Axel Heiberg Island Research Reports, Preliminary Report 1961-1962, F. Muller (Ed.). McGill University, Montreal, (pp. 169-172), 241 pp.*

Reports 12 dates from the expedition area, two from other parts of the island and one from Ellesmere Island. They establish that the Thompson Glacier has never advanced more than 2 km in the last 4,000 years, and that 5,300 years ago the sea still occupied the area now covered by the Thompson Glacier snout. Shells from raised beaches gave the following dates: 35 m above sea level–5330 + or - 195 years B.P.; 40-45 m above sea level–6840 + or - 120 years B.P.; 58 m above sea level–7100 + or - 100 years B.P.; 80 m above sea level–9000 + or - 200 years B.P. (K.M. Clayton) GA 65/424

720. **Muller, F.** 1966. Evidence of Climatic Fluctuations on Axel Heiberg Island, Canadian Arctic Archipelago. *Memorandum RM-5233-NSF, Symposium on the Arctic Heat Budget and Atmospheric Circulation, J.O. Fletcher (Ed.), Proceedings, Lake Arrowhead, CA, Jan. 31-Feb. 4, 1966. Rand Corporation, Santa Monica, CA, (pp. 135-156), 567 pp.*

Presents 1959-65 summer's investigations on the ice cap and glaciers of this island. Glaciologic and morphologic data are used as evidence of climatic change, though the preliminary and tentative nature of such a link is stressed. The glacial mass budget studies are summarized, and these show that glacier mass changes reflect net radiation values and the summer sunshine total. A study of 41 annual layers in a deep firn profile reveals marked annual variations but little sign of a trend, except that summers were colder in the decade before 1930. Changes in position of glacier snouts and margins are analyzed, the marked recessions of small glaciers indicating conditions less favorable for glaciers since 1930 and the advance of large glaciers being a delayed reaction to an increase in ice mass occurring 50-100 yr ago. The evidence of peat deposits, dated driftwood, and morainic material is discussed. All results suggest that glaciers have changed relatively little over the last 9000 yr, although a postglacial optimum at 6000 B.P. is apparent. Climatic changes during this period seem therefore to have been considerably smaller than in more southerly latitudes. (AB98267) AB98267

721. **Muller, F.** 1980. Present and Late Pleistocene Equilibrium Line Altitudes in the Mt. Everest Region–an Application of the Glacier Inventory. *International Association of Scientific Hydrology Publication 126:75-94.*

UNESCO's pilot glacier inventory of the Mt Everest area was extended to include some 450 glaciers. After evaluation of various methods to establish the ELA, the pattern of the ELA isolines was analysed in relation to the orography, precipitation and temperature. The dominant role played by precipitation is recognized, and the unusually low mean AAR value of 0.41 is explained. Based on the assumption that the elevations of the numerous empty cirques in the area represent the ELA at the time of their formation, a map and subsequently a comparative SSW - NNE profile of present and late Pleistocene ELAs was constructed. The difference between the two curves, only 100 m at the main crest and almost 600 m at the southern end, must be attributed, in part, to differential uplifting of the Mt Everest area. After making allowance for this effect, the late Pleistocene temperature depression was estimated to be 4-5 deg C on the monsoon-affected Indian side and 2-3 deg C near the main mountain crest. It is concluded that the present pattern of monsoonal moisture supply also existed during late glacial times. Glaciation in the late Pleistocene was as it is today–small in comparison to that of the other ice-prone parts of the globe. (Auth)

722. **Muller, F., and W.P. Adams.** 1963. Glaciology. *Axel Heiberg Island Research Reports, Preliminary Report 1961-1962, F. Muller (Ed.). McGill University, Montreal, (pp. 7-89), 241 pp.*

Seven separate reports: 1) Measurements of ablation and runoff in 1961 by W.P. Adams, and 2) Accumulation studies, 3) Investigations in an ice shaft in the accumulation area of the McGill Ice Cap, 4) Ablation measurements in 1962, 5) Glacier mass budget and climate, 6) Surveying of glacier movements and mass changes, 7) Englacial temperature measurements, all by F. Muller. The appreciable changes in net accumulation were more a function of the changing areas of the various zones of the glacier than changes in the amount of accumulation or ablation at a fixed point. The fluctuations experienced by the smaller White glacier were far more severe than those for the McGill ice-cap. The White Glacier appears to be far larger than present accumulation would warrant. All the ice areas react particularly strongly to changes in the climate of the 3-month summer period (June, July and August). (K.M. Clayton) GA 65/389

723. **Nichols, R.L.** 1964. Snowdrift-Ice Slabs and Historic Antarctic Climatic Warming. *Journal of Glaciology 5(39):345-51.*

Several snowdrift-ice slabs near McMurdo Sound (77 deg 24 min S and 163 deg 40 min E) were studied; certain features suggested a recent melting of the ice asociated with a climatic amelioration. (JTA)

724. **Nishio, F., Y. Fujii, and K. Kusunoki.** 1981. Measured and Computed Temperature Profiles at Mizuho Station, East Antarctica. *International Association of Scientific Hydrology Publication 131:239-246.*

At Mizuho station in East Antarctica, an ice temperature profile down to 145 m was measured in 1977. The measured profile near the surface shows a large negative temperature gradient, i.e. the surface temperature is higher than in lower layers; however only small negative temperature gradients are obtained from theoretical steady state temperature profiles under the assumption of present accumulation rate, flow rate and ice thickness. The observed negative gradient is interpreted as climatic warming or the lowering of the surface elevation of the ice sheet or the superposition of both effects. Detailed analysis of the measured and computed temperature profiles suggests that either a warming trend of about 1 deg C or the thinning of the ice sheet by about 70 m began 50 years ago. Oxygen isotope analysis of snow in the upper layers also suggests that the start of warming was about 50-70 years ago. (Auth)

725. **Orheim, O.** 1977. Global Glacier Mass Balance Variations during the Past 300 Years. *Polar Oceans, M.J. Dunbar*

(Ed.), Proceedings of the Polar Oceans Conference, McGill University, Montreal, May 1974. Arctic Institute of North America, Calgary, (pp. 667-681), 682 pp.

Records of recent annual mass balance variations of glaciers and ice sheets are available from both the northern and southern hemispheres. The data are of varying quality, with the best and longest records available covering 300 years. The most precise of these records show that short-term (approx 10 years) variations in mass balance between two hemispheres are anticorrelated. This anticorrelation applies particularly to glaciers situated adjacent to the far southwestern and far northeastern part of the Atlantic Ocean. Longer-term variations in mass balance appear to be in phase in the two hemispheres. (Auth) AntB F-20046

726. **Orheim, O., C. Bull, and V. Schytt.** 1972. Glaciological Studies of Past Climatic Variations in the South Shetland Islands. *Antarctic Journal of the United States 7(4):99-100.*

Glaciological studies were carried out from Jan 10 to Feb 2, 1972 at Deception and Livingston Is., the work at Livingston I. including studies of the shear-plane moraine ridges that border the western edge of Rotch Dome. The main result of the Deception I. study has been the establishment of the annual mass balance variations of the island from about 1680 A.D. to the present. Recent analyses of this record show that short-term mass balance variations in the Northern and Southern Hemispheres are negatively correlated. The Deception I. mass balance record has been confirmed for the period from 1946 to the present and is the only precise mass balance record from the Southern Hemisphere for this period. Comparisons of meteorological data suggest an anticorrelation between summer temperatures in middle to high latitudes in the Northern Hemisphere. (from Antarctic Bibliography) GA 73A/1815

727. **Ostrem, G.** 1961. A New Approach to End Moraine Chronology, a Preliminary Report. *Geografiska Annaler 43(3-4):418-419.*

Describes the results of a 1961 study of ice-cored terminal moraine ridges in the Kebnekaise area in northern Sweden and in the Jotunheimen district in central Norway. Pits were dug during the winter; under 1-3 m of moraine, ice was found. It originated from snow in situ, not from glacier ice according to crystallographic studies. Mineral fragments and organic material (mosses, algae, worms) were found by analysis at the radio-carbon laboratory in Trondheim. Carbon 14 dating of a Jotunheimen sample gave the age 2600 + or - 100 years B.P. for a moraine ridge hitherto supposed to date from the great 18th century glacier advance. The new dating agrees well with the post-glacial climatic depression identified by Bergstrom. (AB74467) AB74467

728. **Ostrem, G.** 1962. New Methods for Dating End Moraines. Nya metoder for aldersbestamning av andmoraner. Swedish. *Ymer 82(4):241-252.*

Describes how electric resistance measurements and seismic soundings proved the existence of ice cores in some unusually large end moraines. Ice samples obtained by mechanical drilling and blasting, and very small ice crystals and presence of extraneous material indicated the ice to have been formed directly from a snowdrift subsequently covered by moraine material. Some results of Carbon 14 dating are given for such ice from Kebnekaise in north Sweden, and Jotunheimen in central Norway. At the latter site, moss on a stone proved to be 600-700 yrs. old, ice beneath about 1,300 yrs., and the oldest ice 2,600 yrs. For Kebnekaise also high ages are found, tentatively. (AB74468) AB74468

729. **Paterson, W.S.B.** 1968. A Temperature Profile through the Meighen Ice Cap, Arctic Canada. *International Association of Scientific Hydrology Publication 79:440-449.*

Temperatures were measured in a 121 m borehole through the small (85 sq km) ice cap on Meighen Island, Arctic Canada. The ice cap is virtually stagnant: thus advection of ice is not a factor in determining the temperature distribution. Temperatures below 10 m depth were in the range -16 to -18 deg C. Below 100 m, temperature varied linearly with depth at a rate which corresponds to a geothermal heat flux of 0.8 x 10(E-6) cal cm(E-2) sec(E-1). The shape of the temperature–depth curve over the range 20 to 100 m can be explained if one assumes that (1) the mean annual temperature at the surface has decreased by some 1.5 deg C since the year 1940 and (2) the mean annual surface temperature was increasing during the period 1880-1940, the total increase being about 3.5 deg C. (Auth)

730. **Paterson, W.S.B., R.M. Koerner, D.A. Fisher, S.J. Johnsen, H.B. Clausen, W. Dansgaard, P. Bucher, and H. Oeschger.** 1977. An Oxygen-Isotope Climatic Record from the Devon Island Ice Cap, Arctic Canada. *Nature 266:508-511.*

Isotope measurements taken from two adjacent cores through the Devon Island ice cap provide a climatic record for the past 5,000 years at this location based on Oxygen 18/Oxygen 16 ratios which are compared with similar ice cores from the ice cap at Camp Century, Greenland 600 km distant. Ten-year mean ratios from the Devon Island ice cores dated from A.D. 1200 to the present show prominent brief warm periods with peaks at 1240 and 1380, and cold peaks at 1430, 1520 and 1560. The Little Ice Age was continuously cold from 1680 to 1730. Another temporary cool period occurred at 1760 and a pronounced warming occurred at 1910 with relatively warm temperatures continuing to 1960, followed by a marked cooling. The Camp Century ice core record shows many similarities to the Devon Island data, with some differences in dates (the Little Ice Age occurs at 1660) and some features are absent. The warmest part of the Climatic Optimum occurred on Devon Island at about 5,000 + or - 800 B.P. A long-term decrease in the Oxygen 18/Oxygen 16 ratio occurred from 5,000 B.P. to the present. Beyond 5,250 B.P. the time scale is unreliable. Comparison of the ice cores with the record from Camp Century, Greenland helped to separate climatic changes from changes in ice thickness or flow patterns. (Ecol Can 3038) Ecol Can 3038

731. **Pewe, T.L.** 1961. University of Alaska Gulkana Glacier Expedition. *Arctic 14(1):74-75.*

Describes investigations, in summer 1960, of this 2.5 mile long glacier in interior Alaska, 135 miles southeast of Fairbanks. Its ablation, movement, and structure (foliation and crevasses) were studied, gravity measurements taken, and topography mapped at scale 1:2000. At least two recent advances are indicated probably to be correlated with those of glaciers in the north, in 1750 and 1850. Summer 1961 fieldwork is noted in the same journal December 1961, p. 236-37: two two-man parties studied the ablation and surface motion of the glacier; meteorological observations and gravity measurements were also made. (AB74769) AB74769

732. **Pewe, T.L.** 1963. University of Alaska Gulkana Glacier Project, 1962. *Arctic 16(1):46-47.*

Notes studies on glaciology and glacial geology in the central Alaska Range. The re-formation of foliation at the base of the Gulkana and East Gulkana were especially considered. Recent moraines, dated by lichenometry, indicate minor advances in the mid-18th and mid-19th centuries. (AB82064)(JTA) AB82064

Glaciologic

733. **Pewe, T.L.** 1966. Quaternary Climatic Variations in Antarctica as Suggested by Glacial Fluctuations. *Pleistocene and Post-Pleistocene Climatic Variations in the Pacific Area, a Symposium at the Tenth Pacific Science Congress of the Pacific Science Association, held at the University of Hawaii 21 August to 6 September, 1961. Bishop Museum Press, (pp. 57-82).*

Radiocarbon dates on algae buried by dead-ice deposits indicate that the end of the Koettlitz Glaciation dates between 5,900 and 2,480 B.P. Climatic studies show that the mean annual temperature on the seacoast of eastern Antarctica rose 3.6 deg C from 1912 to 1959 A.D. Comparison of photographs of the position of glacier fronts in McMurdo Sound taken in 1957-1958 by Pewe with photographs taken 46 years earlier by Taylor indicate little or no change. (JTA)

734. **Pewe, T.L., and R.E. Church.** 1962. Glacier Regimen in Antarctica as Reflected by Glacier-Margin Fluctuation in Historic Time with Special Reference to McMurdo Sound. *International Association of Scientific Hydrology Publication 58:295-305.*

The stability of glacier margins in historic time in many areas in Antarctica suggests that the regimen of the glaciers is sluggish and perhaps some glaciers are close to equilibrium. Photographic evidence on the west side of McMurdo Sound region indicates that there has been no appreciable change in the position of many glacier termini or glacier thicknesses between 1911 and 1958. In addition to work in the McMurdo Sound region, studies of recent glacier fluctuations on the Mac-Robertson Coast and Kemp Coast near Mawson in east Antarctica show that the ice neither thinned nor retreated to any detectable degree during the past 21 years. Botanical evidence suggests that the volume of ice may have been constant for a longer period of time. In Queen Maud Land the ice is not measurably in retreat, and detailed work in the mountains shows that there is no active ice growth. Studies in some parts of Antarctica show evidence for historic glacier retreat, however. On the Palmer Peninsula, Northwest Glacier retreated more than 60 meters between 1940 and 1947, while Neny Glacier retreated over a hundred meters in this interval. The tongue of Vanderford Glacier on the Budd Coast near Wilkes Station has retreated 2.4-3.2 km from its position in 1948. There is a definite thinning of the glacier ice in this area but it is not drastic. It is interesting to note that these later examples are quite near the Antarctic Circle where the climate may not be so rigorous as elsewhere. Termini of many Antarctic glaciers reveal no appreciable fluctuations in the past several decades; in sharp contrast to the trend for most glacier margins to recede in nearly all other parts of the world. (Auth)

735. **Porter, S.C.** 1977. Present and Past Glaciation Threshold in the Cascade Range, Washington U.S.A.: Topographic and Climatic Controls, and Paleoclimatic Implications. *Journal of Glaciology 18(78):101-116.*

Isoglacihypses depicting the configuration of the glaciation threshold (= "glaciation limit") in Washington broadly parallel the crest of the Cascade Range and curve around the west and south flanks of the Olympic Mountains. In both uplands the glaciation threshold rises inland (eastward) with a mean gradient of 10-12 m/km. However, the gradient in the Cascades is more variable (7-25 m/km) due to five east-trending troughs in the glaciation threshold surface that coincide with topographic depressions along the range crest and that apparently result from greater eastward penetration of moist maritime air. Mean accumulation-season precipitation correlates strongly (r (E+2)= 0.86) with altitude of the glaciation threshold in the North Cascade Range, but the correlation of glaciation threshold with altitude of the July freezing isotherm, determined from the calculated July lapse rate within the mountains, is much weaker (r (E+2) = 0.40). Multiple regression analysis relating independent climatic variables that effect the height of the glaciation threshold indicates that 90.4% of variance is explained by accumulation-season precipitation and estimated mean annual temperature at the glaciation threshold. The glaciation threshold during the greatest ice advance of the last (Fraser) glaciation in the southern North Cascade Range (c. 18,000-22,000 years B.P.) was 900 + or - 100 m below that of the present. Depression of the glaciation threshold by this amount most likely resulted from a change in accumulation-season precipitation of no more than 30% from present values and a decrease in mean ablation-season temperature of 5.5 + or - 1.5 deg. (Auth)

736. **Quervain, M. de** 1969. Snow Research by the International Glaciological Expedition in Greenland. Schneekundliche Arbeiten der Internationalen Glaciologischen Gronlandexpedition (Nivologie). *Meddelelser om Gronland 177(4):1-283.*

This report deals with snow research by the International Glaciological Expedition in Greenland in 1959-60. After description of operations and topography in the working areas, chapters 6-12 deal with measurements of accumulation across central Greenland, from Camp VI EGIG to Station Jarl-Joset, firn stratigraphy, and study of deformation of the neve crust to depths of 40 m in the Dumont (1957) shaft. A slight temperature decrease at a depth of 20 m suggests a colder period about a century ago. Evaporation was not an important factor in the mass balance. Strong variations of summer temperature gradient in the uppermost layer provoke a high rate of "constructive metamorphism" even without melting. Preferred orientation of the C-axis, shown in thin sections of firn from the shaft, was attributed to snow drift direction rather than a rheological process. (from Abstracts N. American Geology) GA 71A/2174

737. **Radok, U.** 1980. Climatic Background to Some Glacier Fluctuations. *International Association of Scientific Hydrology Publication 126:295-304.*

Glaciers communicate with climate through their net mass balance profiles. Early attempts at reconciling glacier fluctuations and net balance changes have used Nye's kinematic wave model. The general recession of glaciers since the Little Ice Age has now been studied with a dynamic glacier model due to Budd and Jenssen. The experimental reconstruction by Kruss, Smith and Allison of net balance profiles, which could account for the observed fluctuations of several well documented glaciers in different climate regions, is reviewed. The results agree in pointing to rises in mean temperature of somewhat less than 1 deg C since the Little Ice Age. (Auth)

738. **Raynaud, D., and C. Lorius.** 1973. Climatic Implications of Total Gas Content in Ice at Camp Century. *Nature 243(5405):283-284.*

When firn turns into ice through densification and recrystallisation, the volume of atmospheric gas trapped as the pores close off depends in particular on the atmospheric pressure. The idea of correlation between the total gas content and the site formation altitude of high polar ice has thus been suggested. Here we present the results of twenty-five total gas content determinations on apparently unfractured samples taken from the 1,400 m deep core drilling carried out at Camp Century on the North Greenland ice sheet. The total gas content of Wisconsin ice is on average 12.5% lower than that of the

Holocene; and it is concluded that the site formation altitude of Wisconsin ice was higher than that of the present Camp Century, by 1300 m, suggesting a significant increase in the thickness of the ice sheet in this part of Greenland during the last glaciation. (After Author) GA 73A/1721

739. **Reed, J.C., Jr.** 1964. Recent Retreat of the Teton Glacier, Grand Teton National Park, Wyoming. *U.S. Geological Survey Professional Paper 501-C, (pp. C147-C151).*

Comparison of a plane-table map of the Teton Glacier made in 1963 with a map prepared from aerial photographs taken in 1954, and with older maps and photographs, indicates that the rate of retreat of the terminus has decreased, and that the thickness of the upper part of the glacier has increased since 1954. These observations suggest that the terminus of the glacier may begin to advance within the next few years. (Author) GA 65/386

740. **Robbins, R.C., L.A. Cavanagh, L.J. Salas, and E. Robinson.** 1973. Analysis of Ancient Atmospheres. *Journal of Geophysical Research 78(24):5341-5344.*

In 1967 and 1968, ice samples were taken from various depths in the ice caps of Greenland and Antarctica and transported to the Stanford Research Institute laboratories in the frozen state. These samples ranged in age from 100 to 2500 years. After the ice samples had been melted in the laboratory, the air trapped in compressed bubbles in the glacial ice during the transition from firn to ice was collected and removed by a novel technique developed for this specific purpose. Carbon monoxide and methane analyses were made on a large number of samples by using gas chromatography. Major components were also measured in a few samples by mass spectrometry. The measured methane concentrations appear to be about half of present-day concentrations. The measured carbon monoxide concentrations were high in value by severalfold, and initially the validity of the approach was doubted. However, in the light of recent evidence suggesting that the largest global source of carbon monoxide is oxidized methane, our carbon monoxide and methane measurements can be reinterpreted. They suggest that the background Carbon monoxide concentration in the atmosphere has been near current concentrations of about 0.1 ppm for many centuries. It can be inferred, therefore, that no large increase in Carbon monoxide concentration accompanied the advent of the Industrial Revolution. (Auth)

741. **Robin, G. de Q.** 1970. Stability of Ice Sheets as Deduced from Deep Temperature Gradients. *International Association of Scientific Hydrology Publication 86:141-151.*

The major factors affecting deep ice temperatures include: 1) mean surface temperature, 2) mean rate of accumulation of ice, 3) change of surface elevation with time at fixed geographical points, and 4) horizontal velocities of ice movement. Based on these factors, deep temperature profiles from central Greenland and the central area of Bryd Land, Antarctica are analysed as a means of examining the stability and past history of ice sheets. The discussion is based on an equation which shows the tendency of ice to assume a temperature gradient due to changes of surface temperature with time. (from Antarctic Bibliography) GA 71A/1738

742. **Robin, G. de Q.** 1977. Ice Cores and Climatic Change. *Philosophical Transactions of the Royal Society of London, Series B, 280:143-168.*

When determining past climates from the isotopic record, allowances have to be made for changes in the flow and thickness of ice sheets during major glacial periods. These factors are considered in relation to major ice cores from Vostok and Byrd stations in Antarctica and from Camp Century in Greenland. Vostok is the simplest case glaciologically, Camp Century the most complex. On purely glaciological grounds it appears that the ice age gave way to present-day climates some 10,000 + or - 1000 a B.P., the coldest period being 20,000 + or - 3000 a B.P., when the climate in Antarctica was 6-8 C colder than at present. (Auth)(JTA)

743. **Robin, G. de Q., and R.J. Adie.** 1964. The Ice Cover. *Antarctic Research, R. Priestly, R.J. Adie and G. de Q. Robin (Eds.). Butterworths, London, Chapter 8, (pp. 100-117).*

A discussion of the valley glaciers of South Georgia and the problems of determining their budgets. Brief description of the surface form of the ice sheet is followed by more detail on seismic techniques in locating the rock floor. Gravity observations are also discussed. From these results the volume of ice can be estimated ithin + or - 25%. With the potential rise of sea level were this ice to melt, mass balance studies are of importance. Various published budgets are compared. Theoretical calculations are of interest in view of the lack of agreement. (K.M. Clayton) GA 65/90

744. **Rozycki, S.Z.** 1964. The Rhythm of Changes in the Antarctic Ice Cap under the Influence of Climatic Variations. Der Rhythmus der Veranderungen des antarktischen Inlandeises unter dem Einfluss der Klimaschwankungen. *Polarforschung 5(1-2):213-215.*

The East Antarctic ice cap covers a large lowland which is surrounded on three sides by a high mountain chain through which the ice has only a few outlets. In the sector between 68 deg E and 154 deg E, the ice has relatively free movement all the way to the ocean. Almost 40% of the accumulation in this sector of the ice cap develops in the border area which is 10% of the total surface. Ice velocity in this area is 100-130 m/yr. The ice front condition and the expansion of the inland ice is therefore determined by processes in the border area which strongly depend on climatic variations. If the inactive part of the inland ice is excluded from the calculations, it is noticed that, even with an over estimation of the precipitation, the decrease of the inland ice exceeds or at least equals the alimentation of the active border area. The extent of accumulation in the border area is determined by the precipitation and the wind transport of snow. The effect of climatic fluctuation is first noticed by changes in the elevation of the condensation zone. During cooler periods the front of the inland ice moves forward and the ice cap increases, while during warmer periods the surface decreases and the front moves southward. (B.L. Evans from CRREL Bibliography, 19, 1965) GA 67A/141

745. **Sable, E.G.** 1961. Recent Recession and Thinning of the Okpilak Glacier, Northeastern Alaska. *Arctic 14(3):176-187.*

Quantitative values for the amount of recession and thinning of the Okpilak Glacier (lat. 69 deg N) are presented. The evidence is obtained from a comparative study of photographs of the glacier since 1907. The terminus of this five mile long glacier has retreated at a mean rate of some 20 feet per year since 1907 and in its lower section has thinned by some 3 feet per year. The volume of ice lost by thinning is some 25 times greater than that due to recession of the snout. The paper is amply illustrated by photographs including one stereopair dated 1956. (D. Ingle Smith) GA 62/54

746. **Semevskiy, D.V., and Ye.P. Shkatov.** 1965. Present Retreat of the Glaciers of Spitsbergen. Sovremennoye otstupaniye lednikov Zapadnogo Shpitsbergena. Russian.

Glaciologic

Leningrad. N.-issl. inst. geologii Arktiki. Materialy po geologii Shpitsbergena. (pp. 241-245).

With the warming trend in the arctic climate the glaciers are in general retreat. Those on Spitsbergen are analyzed with special attention to the Nordenskiold and Hornsund glaciers. The amount and rate of retreat of Nordenskiold 1898-1963 and of the Hornsund glaciers 1901-64 are calculated. In the 65 yr Nordenskiold retreated 595 m or 91 m/yr. Some other glaciers are also noted. (AB107079) AB107079

747. **Smith, I.N., and W.F. Budd.** 1981. The Derivation of Past Climate Changes from Observed Changes of Glaciers. *International Association of Scientific Hydrology Publication 131:31-52.*

A two dimensional time dependent model of glacier flow has been parameterized to take account of certain three dimensional characteristics of real glaciers in order to match their present flow regimes and to study the glacier reactions to climate change. The effects of climate change on the glacier regimes are examined in terms of the changes in the net balance vs. elevation relations. A balance vs. elevation relation is then prescribed as a function of time and the glacier's reaction studied. The input data required are the glacier bedrock distribution, the ice flow parameters, and the balance-elevation relation. A number of glaciers have been studied for which data exist on the present regime and some past variations. A simple method has been adopted whereby recent climatic trends are simulated by a simple sinusoidal function. By comparing known terminus histories and the reaction of the modelled glaciers to a variety of these functions, an estimate of the difference in conditions between the present and the peak of the Little Ice Age is made. This method has been modified in some cases because of certain limitations, but for the European glaciers so far examined, it is found that the observed retreats over the last century can be matched by similar shifts in the net balance curves. Evidence suggests that these shifts may be the result of similar changes in mean summer temperatures. (Auth)

748. **Soons, J.M.** 1971. Capricious Franz Josef Glacier. *Geographical Magazine 43(7):490-494.*

The positions of the glacier since 1894 can be plotted accurately, and since 1950 the glacier has been photographed at regular intervals. In the early 1960's there was a considerable retreat of the terminal face, but from mid-1965 to late 1967 the glacier advanced 404 metres. At times the measured advance was as much as 7 m a day though 1.7 m was more normal. From 1967 to 1970 the glacier retreated again, leaving a small terminal moraine. (Auth) GA 71A/2180

749. **Soons, J.M.** 1971. Recent Changes in the Franz Josef Glacier. *New Zealand Geographical Society Conference Series, 6. Sixth New Zealand Geography Conference, R.J. Johnston and Jane M. Soons (Eds.), Proceedings 1971. (pp. 195-200).*

The discussion is chiefly concerned to demonstrate how delicately balanced are the factors that control a temperate glacier such as the Franz Josef. This is particularly true of the glacier in its present state, short, fast-flowing, apparently responding rapidly to changes in the neve field. There is some indication that the glacier is poised for a further readvance, but this may not materialise unless the supply of snow at its source is maintained by a series of winters with above-average precipitation which are not counter-balanced by summer ablation. It seems clear that, while a series of wet winters will not guarantee an advance of the glacier, none will occur unless there is such a series. Finally, it may be suggested that there is a need for measurements of climatic variables on the neve of the glacier, so that some precise information is available of the conditions under which accumulation and ablation occur. (Auth) GA 72A/1849

750. **Surova, T.G., and L.S. Troitskii.** 1968. Development of Polar Urals Glaciation in the Holocene from Spore-Pollen Analysis Data. Russian. *Materialy glyatsiol. issled Khronika. Obsuzhd. (Moscow), 14:131-140.*

To ascertain the changes in the Polar Urals during the Holocene, a study was made of sections of coarse hillocky peat bogs, situated at a wide continuous valley (altitude 210-220 m), containing the source of the rivers B. Khadat and Iz'ya Shor (tributary of the river Us). In mountain valleys in the early Holocene tundra associations predominated, average summer temperatures were higher by at least 1.5 - 2 degree, corresponding to increase in ablation of glaciers by 150-200 g/sq cm , so that the glaciers were reduced to the dimensions of their firn basins. In the Middle Holocene (phases 2-4) summer temperatures were up 2-4 deg, and the total ablation by 300-400 g/sq cm. The Urals glaciers disappeared completely at each climatic maximum, since the total ablation at that period must have amounted to 550-700 g/sq cm, 2-3 times greater that is than the snow accumulated in the firn basins of the glaciers. In the late Holocene climate cooling set in, which gave rise to recession of forest vegetation in the south on the plains and from the circum-interfluve part of the Polar Urals up to its present limits. In the first half of the upper Holocene the mean summer temperature was 1-1.5 deg less than at present, the largest glaciers attained a length of 2-4 km, glaciers fillėd almost all the cirques, and many of them moved forward to the first end moraines. (from Ref. Zhurnal, 1969/9G57, trans. F. Hilton) GA 71A/1377

751. **Theakstone, W.H.** 1965. Recent Changes in the Glaciers of Svartisen. *Journal of Glaciology 5(40):411-431.*

Svartisen in north Norway is the second largest ice-cap in Norway and lies on the Arctic Circle. Rapid retreat has been in progress and the ice-covered area is now less than 400 sq km and is in two parts. Some of the glaciers advanced about 1600 A.D. and reached their maxima about 1750. Reports indicate that the glaciers ended near the sea or at lower elevations than their present height in the late nineteenth century. The rapid retreat started in the late 1920s after a period of irregular and fairly slow retreat covering about 50 years, with minor readvances. Detailed accounts of the glaciers in 1910 are reported. In 1941 subglacial draining of a glacial lake dammed by Osterdalsisen, caused serious flooding: this has become an annual event. Osterdalsisen, which has changed most of all the glaciers, has been studied in detail between 1957 and 1963 and has shown a large loss of ice with 250 m thinning of the eastern part of the present snout since 1897. Considerable areas of detached, stagnant ice have formed this century, much bare rock has emerged from the formerly ice-covered area, and marginal lakes are now common. In some years there is no net accumulation on the ice-cap. (C.A.M. King) GA 65/586

752. **Thomas, R.H.** 1976. Thickening of the Ross Ice Shelf and Equilibrium State of the West Antarctic Ice Sheet. *Nature 259(5540):180-183.*

Data from the southeast quadrant of the Ross Ice Shelf indicate that, near the grounding line, the ice shelf is growing thicker by almost 1 m/yr. This thickening rate implies an advance of 1 km/yr of the grounding line between the West Antarctic ice sheet and the Ross Ice Shelf. It can be reconciled with independent evidence for current thinning of the West Antarctic ice sheet if the latter is a delayed response of an earlier retreat of the ice shelf grounding line. The high rates of ice shelf thickening may be due to an increase in the resistance to ice shelf movement caused by localized ice shelf grounding following isostatic uplift of the sea bed. (Auth)

753. **Thomas, R.H.** 1978. The Equilibrium State of the Eastern Half of the Ross Ice Shelf. *Journal of Glaciology 20(84):509-518.*

Measurements of ice thickness, velocity, snow accumulation rates, and surface strain-rates are used to examine the state of equilibrium of three flow bands of the Ross Ice Shelf. The analysis gives the rate of thickening of the ice shelf in terms of the basal freezing rate, which is unknown. However, indirect evidence suggests that the basal flux ranges from a small value of freezing in the south to a melting rate of about one meter of ice per year at the ice front. If these values are correct then the flow band in the south-east corner of the ice shelf appears to be thickening at an average value of (34 + or - 15) cm of ice per year. Persistent thickening at this rate must lead to grounding of large areas of the ice shelf. This would restrict drainage from West Antarctic ice streams which feed this part of the ice shelf and these would tend to thicken and advance their grounding lines into the ice shelf. Further north, near the RISP bore-hole site, the ice shelf is probably in equilibrium. The largest flow band is to the south and east of Roosevelt Island, and this also may be in equilibrium if there is significant bottom melting from ice shelf that is more than 100 km from the ice front. (Auth)

754. **Thomas, R.H.** 1979. West Antarctic Ice Sheet: Present-Day Thinning and Holocene Retreat of the Margins. *Science 205:1257-1258.*

Retreat of margins of the West Antarctic ice sheet associated with rising sea level during the last 15,000 years is the main cause for the thinning of the ice sheet by approximately 300 meters. The West Antarctic ice sheet during the late Wisconsin was at least 30 percent wider than it is today, and Holocene retreat of its margins has added about 6 meters to the world sea level. (Auth)

755. **Thomas, R.H., T.J.O. Sanderson, and K.E. Rose.** 1979. Effect of Climatic Warming on the West Antarctic Ice Sheet. *Nature 277(5695):355-358.*

Climatic warming could cause increased melting from Antarctic ice shelves. Continued weakening of the ice shelves in this way would result in the ultimate collapse of most of the West Antarctic ice sheet. For complete removal of the ice shelves collapse of the ice sheet and a 5 m rise in world sea level could occur in < 100 yr. More realistically, ice-shelf deterioration is likely to be a rather slow process, and even for a major and sustained warming trend ice-sheet collapse would take several hundred years, with most of the associated rise in sea level occurring during the final century. However, little is known about the glaciers that drain the northern part of the ice sheet. These glaciers have little or no protective fringe of ice shelf and, unless they flow over sufficiently high bedrock sills, they may show a more rapid response to increased temperatures. (Auth)

756. **Thompson, L.G.** 1976. Microparticles, Ice Sheets and Climate. *Ph.D. Thesis, Ohio State University, Columbus, Ohio, 216 pp.*

The recent development of ice core drilling techniques has made it possible to recover ice cores to bedrock from Camp Century, Greenland (1966, 1387 meters) and Byrd Station, Antarctica (1968, 2164 meters). Two initial studies of microparticle variation in the Byrd Station and the Camp Century deep ice cores have been conducted to clarify the relationship between atmospheric turbidity and climate by presenting the particle concentration and size distribution from sections of these two ice cores. These measurements have been compared with stable oxygen isotope values for ice from the same depths. This study has provided a comparison of particle concentrations and size distributions in an ice core from the Northern Hemisphere with one from the Southern Hemisphere. In both cores the highest concentrations of particles occur where Oxygen 18/Oxygen 16 ratios exhibit the greatest negative values. During the Wisconsinan Glacial Stage (>10,000 y.B.P.) the concentration of small diameter particles (0.65 to 0.82 micrometers) was as much as 100 times greater than the mean Holocene (<10,000 y.B.P.) concentrations in the Camp Century core and more than 4 times greater than mean Holocene values for the Byrd core. Elemental composition and morphology of the microparticles suggest that most of the particles of Wisconsinan age in the Byrd core are of volcanic origin and in the Camp Century core are of continental (eolian) origin. (Auth)(JTA) Dissertation Abstracts International 37(5):2129B-2130B, Order No. 76-24,699

757. **Thompson, L.G.** 1977. Variations in Microparticle Concentration, Size Distribution and Elemental Composition Found in Camp Century, Greenland, and Byrd Station, Antarctica, Deep Ice Cores. *International Association of Scientific Hydrology Publication 118:351-364.*

The above relationships provide conclusive evidence that the stratigraphic record of microparticle size distributions, concentrations and elemental variations preserved within ice and snow contains a wealth of climatic information especially when coupled with the corresponding stable isotope data. The relatively short time interval involved in the transition from the Wisconsin with high particle content to the Holocene with low particle content is of great importance. In the Camp Century core this transition occurs within less than 10 m of ice encompassing less than 100 years which indicates that climatic transitions may occur rather suddenly. It is necessary to note that recent solid particle deposition in West Antarctica (Figure 1(a)) has not increased significantly over mean Holocene values and thus the natural processes which occurred during the Wisconsin must have been of monumental magnitude. The results of these analyses indicate an urgency for man to investigate the possible causes of climatic change. The continued analysis of microparticle elemental compositions and temporal concentration and size variations will provide more detailed knowledge of their sources and about the atmospheric circulation patterns which existed during the various past climatic regimes. The ultimate goal is to determine precisely the role of microparticles in world climate. (Auth)(JTA)

758. **Thompson, L.G., S. Hastenrath, and B.M. Arnao.** 1979. Climatic Ice Core Records from the Tropical Quelccaya Ice Cap. *Science 203(4386):1240-1243.*

The Quelccaya Ice Cap in the easternmost glaciated mountain chain of the Peruvian Andes has been studied in four recent field seasons. Ice cores to a depth of 15 meters have been retrieved at the summit dome (elevation, 5650 meters) and two other locations and used for microparticle, isotope, and beta radioactivity measurements. A concurrent study of the present climate and the heat and mass budgets is being made to permit a paleoclimatic interpretation of deep core records. The results indicate the need for a revision of the isotope "thermometry" for application in the tropics. However, the seasonality of the beta radioactivity, microparticle content, and isotope ratios offers the prospect of a mass balance chronology. This is important in that precipitation is believed to be a more indicative paleoclimatic parameter than temperature in the tropics. (Auth)

Glaciologic

759. **Trofimov, A.K.** 1969. The Regime of the Pamirs Glaciers in the Holocene. Russian. *Izvestiya, Vsesoyznogo Geograficheskogo Obshchestva, 101(2):118-124.*

In solving a number of questions regarding the palaeography of the Pamirs in the Holocene, and in interpreting ages of moraines of the last phase of the advance of glaciers, great interest attaches to data got in the study of the meso-Neolithic camp sites of Oshkhon (E. Pamirs, valley of the river Uisu), found in 1956. Radiocarbon dating gives the absolute age of the encampment as 9530 + or - 130 years. For the first time a geological-morphological allocation is given for the encampment, and a comparison made between the dated terrace deposits and the moraines of the last phase of advance of the glaciers. The encampment's cultural layers are deposited in an upper part of the section of the terrace, the terrace being 1 - 1.5 m high along the valley of the River Uisu. The terrace is cut into the moraine deposits of the last glaciation. Upwards along the valley of the river Uisu the terrace in whose section the encampment is found, is raised up to 3-4 m and ends 1 km from the end of the glacier of the R. Uisu, abutting the left edge. Here in it are deposited young alluvial fans, which also are put in the young moraine deposited by the Trapetsie glacier (situated in the upper part of the right tributary of the R. Uisu). In the valley of the R. Kara-Dzhilga a terrace, synchronous with the Uisu one, is joined to a young moraine before the end of the Oktyabr'skii glacier, deposited in the last phase of the advance of the glaciers of the E. Pamirs, called the Uisu phase. A hypothesis is put forward about the Holocene age (about 10,000 years) of this phase of glaciation. Uisu-type moraines, widely developed in the E. Pamirs, are compared with the moraines of the Khirsdarinskaya phase of advance. All these results, and those of palynolgical investigations of post-glacial deposits indicate that during the Holocene, the Pamirs had a dry continental climate, closely resembling the present one. (from Ref. Zhurnal, 1969/10G148, trans. F. Hilton) GA 71A/1334

760. **Tze-chu, Hsieh, and Fei Ching-shen.** 1980. Recent Research on the Distribution and Fluctuations of the Glaciers in Chilien Shan. *International Association of Scientific Hydrology Publication 126:117-120.*

The results of glaciological research carried out in the Chilien Shan since 1958 are briefly reported. Recent mass balance measurements show that the retreat of glaciers in the region is slowing down and that a new period of advance can be expected. (Auth)

761. **Veatch, F.M.** 1969. Analysis of a 24-Year Photographic Record of Nisqually Glacier, Mount Rainier National Park, Washington. *U.S. Geological Survey Professional Paper 631, 52 pp.*

Nisqually Glacier in Mount Rainier National Park, Wash., covers 2.5 sq mi (6.5 sq km) (1961) and extends from an altitude of about 14,300 ft (4,400 m) near the top of Mount Rainier down to 4,700 ft (1,400 m), in a horizontal distance of 4.1 mi (6.6 km). Analyses were made of the annual photographs taken by the writer for 24 years from about 20 stations. A number of pictures taken sporadically from 1884 to 1941 by others were also available for use in the study. Where possible, the results obtained from photographs were compared with those from the available engineering surveys. Such detailed analysis of an extensive photographic coverage of a single glacier may be unique.Photographs illustrating the retreat and advance of the glacier's west ice margin in a reach extending for about a mile (1.6 kilometers) downstream from Wilson Glacier show that, by 1965, most of the ice thickness lost in that area between 1890 and 1944 had been recovered. Withering of the stagnant valley tongue down glacier from the nuntak is portrayed, as is its spectacular reactivation in the 1960's by a vigorous advance of fresh ice. Some of the visible characteristics of advancing and receding termini are noted. (Auth)(JTA)

762. **Vincent, C.E., T.D. Davies, and P. Brimblecombe.** 1981. The Lewis Glacier (Mt. Kenya) and Possible Links with Tropical Climate. *International Association of Scientific Hydrology Publication 131:63-77.*

A detailed analysis is made of an ice core (in the frozen state) from the Lewis Glacier (0 deg 09 min S, 37 deg 18 min E) at about 4800 m. The glacier responds to changes in the highland climate of East Africa which reflects the behavior of the atmospheric flow above the 850 mb level. During the last 80 years the glacier volume has decreased by 70% and is presently ablating by about 0.5 m depth per year. The determination of particulate concentrations in the ice allows accumulation and ablation periods to be identified and, alongside other evidence, has enabled a tentative dating of the core and indicated that the oldest ice is of the order of 150-200 years old. The size spectrum of the particulate material between 2 and 40 micrometers for each 2 cm section of the core (11 m long down to the glacier base) shows considerable variation with depth and may be related to changes in the wind regime. The concentrations of cations and cation ratios also show a pronounced stratigraphy and some zones of very high concentrations. These characteristics also help to identify accumulation and ablation zones. The stratigraphy in the core is much more pronounced than in ice cores from temperate zone glaciers. The stratigraphy is interpreted in terms of climate using the present state of knowledge on the Lewis Glacier. The ice core record, and evidence from adjacent lakes with highland catchments, indicate a marked change in East African climate since the last century. (Auth)

763. **Vivian, R.** 1960. The Recent Retreat of the Upper Arc and Upper Isere Glaciers. French. *Revue de Geographie Alpine 48(pt.2):313.*

77 glaciers above Tignes and Lanslebourg have been studied on aerial photographs dated 1953-6 and on the 1:20,000 map of 1927. A steady shrinkage is revealed by comparison of these, and in 1956, there were 47 glaciers with areas below 50 hectares each, compared with 40 in 1927. It is also shown that the mean altitude of the glacier snouts has risen, and that the larger glaciers are less affected in this respect than the smaller ones, since they are thicker and maintain their forward movement better. The relationship between loss of surface area, mean thickness of the glacier snout, altitude, and orientation of the glaciers is discussed. It is demonstrated that important factors in the preservation of glaciers during periods of insufficient accumulation are shade and the amount of surface debris. The second section comprises a discussion of the balance between accumulation and ablation for glaciers in the area, and suggests that the steady diminution of the glaciers since 1927 has recently been checked. (C. Embleton) GA 69

764. **Vivian, R.** 1971. Recent Variations in Glaciers in the French Alps (1900-1970): Possibilities of Forecasting. Les variations recentes des glaciers dans les Alpes francaises (1900-1970): possibilites de prevision. French. *Revue de Geographie Alpine 59(2):229-242.*

Since the beginning of the century more than twenty Alpine glaciers have been investigated by French glaciologists. Every second or third year thorough investigations of their spatial extent and their thickness have been undertaken. French glaciers have been affected by important recessions, though four phases of extension have taken place (late 19th century; 1915-25; 1940; and 1955). The problem of forecasting glacial variations is being studied in detail from data collected from the Mer de Glace. (Auth) GA 72A/0806

765. **Waldrop, H.A.** 1964. Arapaho Glacier a Sixty-Year Record. *University of Colorado Studies, Series in Geology No. 3, 37 pp.*

Arapaho Glacier occupies a cirque just east of the Continental Divide and twenty miles west of Boulder, Colorado. It is the largest glacier in Colorado, and is probably the southernmost active glacier in the Rocky Mountains. Its accumulation basin rises to 13,300 feet, and its front terminates at 12,075 feet in a moraine-dammed lake. In 1960 the glacier covered 62 acres. Average altitude of the firn limit was 12,400 feet. Annual accumulation layers, which originally dipped downslope parallel to the glacier surface, have been rotated by glacier movement until they dip steeply back into the cirque. In places ablation surfaces separating these accumulation layers contain rubble of ancient rockfalls that was incorporated into the glacier beneath firn layers of succeeding years. Ice wastage slowly releases this rubble to the glacier surface, where it forms apron-like patches below outcrops of ablation surfaces. Maximum annual movement has decreased from about 28 feet measured in 1904-05 to about 12 feet measured in 1960-61. The glacier has receded 300 to 900 feet across its front since its Historic stade maximum around 1860, losing 29 acres or 32 percent of its area. Since 1900, when it was first studied, it has receded 250 to 750 feet across its front, losing 22 acres, and has thinned an estimated average of 106 feet, losing 315,412,200 cubic feet or 7,218 acre-feet of water. (Auth)(JTA)

766. **Watanabe, O., K. Kato, K. Satow, and F. Okuhira.** 1978. Stratigraphic Analyses of Firn and Ice at Mizuho Station. *Ice Coring Project at Mizuho Station, East Antarctica, 1970-1975, Memoirs of National Institute of Polar Research Special Issue No. 10, K. Kusunoki and Y. Suzuki (Eds.). National Institute of Polar Research, Tokyo, (pp. 25-47), 172 pp.*

Stratigraphy of the 150 m core from Mizuho Station, Antarctica, is studied with visual observation as well as with analysis of density and oxygen isotope profiles. Stratigraphic structures are well preserved to a depth of 70 m. Considerably deviated values of density from the average depth-density curve serve as one of good indicators of the texture of initially deposited snow. From stratigraphic interpretation about 10.6 g/sq cm is estimated as the mean annual accumulation. With this value the age of the lowermost part of the 150 m core is estimated to be some 1100 years B.P. excluding the periods of hiatus of annual layers. In the delta Oxygen 18 profile to a depth of 60 m, the smallest peak indicating the coldest climate is seen at a depth of 32 m which is dated back to some 200 years B.P. Comparison of the delta Oxygen 18 profile in the Mizuho core with that in the Camp Century core indicates that the period of hiatus of annual layers is about one-third of the real duration of the core formation and the mean annual accumulation is about two-thirds of 10.6 g/sq cm at Mizuho Station in the past 300 years. (Auth)

767. **Weidick, A.** 1972. Holocene Shore-Lines and Glacial Stages in Greenland - An Attempt at Correlation. *Gronlands Geologiske Undersogelse Rapport 41, 39 pp.*

Post-Wisconsinian uplift of West, North and East Greenland has been estimated on the basis of information in current literature and compared to the data collected by the author in central West Greenland. For West and North Greenland the dated uplift allows an estimate to be made of the age of former shore-lines, which in turn have been used to date the stages of the extent of the Inland Ice. The results have been compared with published information of the age of glacial stages in East Greenland. The estimated ages of the ice margin stages imply a history of deglaciation in West (and North?) Greenland comparable to that of North America. In both areas the major deglaciation took place after the Younger Dryas and a marked halt took place in Boreal times. It is possible that the history of East Greenland is more closely related to that of Scandinavia where a widespread deglaciation took place prior to the Younger Dryas. The deglaciation of North Greenland was interrupted by a marked readvance or readvances during the climatic optimum. It is possible that the northward shift of the low pressure centres during this period lead to an increased accumulation on the northern part of the Inland Ice. (Auth)

768. **Wendler, G., C. Fahl, and S. Corbin.** 1972. Mass Balance Studies on McCall Glacier, Brooks Range, Alaska. *Arctic and Alpine Research 4(3):211-222.*

Mass balance results are given for the 1968/69 and 1969/70 hydrological years. The year was arbitrarily divided into winter (October 1 to April 30) and summer (May 1 to September 30). Balances were relatively small: mean winter balances were 152 mm (water equivalent) in 1968/69 and 221 mm in 1969/70, and mean annual balances were -326 mm in 1968/69 and -177 mm in 1969/70. Mean annual balances of Hanging Glacier, a smaller glacier adjacent to McCall Glacier and within the same basin, were -168 mm in 1968/69 and 36 mm in 1969/70. Preliminary analysis shows that the mean balance of McCall for the preceding 11 years was -265 mm yr(E-1). Photographic studies on two other glaciers in the Brooks Range indicate recession for the past 60 years. (Auth) GA 73A/0304

769. **Whillans, I.M.** 1978. Inland Ice Sheet Thinning Due to Holocene Warmth. *Science 201(4360):1014-1016.*

The climatic warming of 10,000 years ago is now affecting the central portions of ice sheets, causing ice-flow acceleration. This process explains the present-day thinning of the ice sheet in West Antarctica. Former ice sheets must have also responded to climatic warming with a delay of thousands of years. This lag in response is important in the climatic interpretation of glacial deposits and of changes in ice volume obtained from deep-sea cores. (Auth mod.) AntB F-20572

770. **Whillans, I.M.** 1979. Ice Flow Along the Byrd Station Strain Network, Antarctica. *Journal of Glaciology 24(90):15-28.*

The flow of the Antarctic ice sheet near Byrd Station is modeled using surface net accumulation-rate data, surface strain-rate data, and core-hole tilting results. The model empirically allows for the progressive development of ice fabric and for values of the vertical strain-rate nearer to zero at depth, and adjusts the strain rates according to the effect of the climatic warming at the beginning of the Holocene. The validity of the model is supported by the agreements between calculated bed form and that measured by radar sounding, and between calculated and measured present-day ice-sheet thinning rates. The ice was about 200 m thicker than before thinning. The depth-age relationship for the Byrd Station ice core shows that the climatic change represented by the oxygen isotopic ratio of the ice began some 5,000 years sooner than in north Greenland (Hammer and others, 1978), but ended at about the same time. (Auth)

771. **Williams, L.D.** 1978. The Little Ice Age Glaciation Level on Baffin Island, Arctic Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology 25:199-207.*

Glaciologic

Mapping of the perennial snow/ice cover which existed on Baffin Island about 300 years ago, by means of light-toned areas of sparse lichen cover visible on satellite photographs, has made it possible to map the Little Ice Age glaciation level (a type of snowline). Comparison with the modern glaciation level (which is 200-300 m higher) is not meaningful, for it is not necessarily in equilibrium with the present climate. However, energy/mass balance modelling gives a 1963-1972 mean "snowline" which roughly approximates the modern glaciation level, and a 1.5 deg C temperature decrease gives a similarly rough approximation to the Little Ice Age glaciation level. A more important observation, perhaps, is that the Little Ice Age glaciation level dipped westward, and in west Baffin Island and the Melville Peninsula it was only 100-200 m higher than extensive plateaus of the central Canadian arctic west of Baffin Island. This suggests that these plateaus would have been glacierized early in a glacial episode, and early glacierization of the central Canadian arctic (by its effect on atmospheric circulation) has been considered to be important for inception of the North American ice sheet. (Auth) BafBib 387

772. **Williams, L.D.** 1979. An Energy Balance Model of Potential Glacierization of Northern Canada. *Arctic and Alpine Research 11(4):443-456.*

The probable sites of Laurentide Ice Sheet inception and the amount of climatic change required are examined by means of a computer model of the energy balance of a snow cover. With various amounts of climatic change, the climatic snowline over northern Canada is computed, and its intersection with the land surface predicts the broad distribution of perennial snow cover. It is found that (1) as expected, Baffin Island is the most probable site of ice sheet initiation, but contrary to previous opinion, Keewatin is just as susceptible to glacierization as Labrador-Ungava; (2) much more climatic change is required for very extensive glacierization of either Keewatin or Labrador-Ungava than has been suggested, equivalent to a 10 to 12 deg C summer temperature decrease; (3) increased winter snow accumulation (the maximum observed at each station) does not greatly increase the area of perennial snow cover, nor does the possible effect of unrecovered glacioisostatic rebound; and (4) an estimate of the local climatic effects of a Northern Hemisphere summer insolation minimum (due to Earth-orbital variations) gives perennial snow cover on Baffin Island and the central Canadian Arctic west of Baffin Island. The probability of ice sheet growth on Keewatin is supported by other evidence. A map of 30 June snowcover probability based on satellite observations is produced; it shows that extensive summer snow cover is more likely on Keewatin than on Labrador-Ungava. Comparison of old glacial striae mapped in Keewatin with computed potential boundaries of perennial snow cover suggests that ice spread south from the central Canadian Arctic, including northern Keewatin, initiated with summer temperatures perhaps 8 deg C lower than at present. (Auth)

773. **Williams, L.D., and T.M.L. Wigley.** 1983. A Comparison of Evidence for Late Holocene Summer Temperature Variations in the Northern Hemisphere. *Quaternary Research 20:286-307.*

Data on glacier, tree-line, tree-ring, pollen, and ice-core variations in North America, Greenland, and Europe during the last 2000 yr (up to A.D. 1800) are compared in detail on the century time scale. Only data that may be indicative of summer temperature changes are included, since these comprise most of the available paleoclimatic information, although some variations (especially of glaciers) may have been in response to precipitation changes instead. Radiocarbon dates and Carbon 14 dated records are converted to calendar (dendrochronological) years using the calibration of M. Stuiver (1982, Radiocarbn 24, 1-26). Despite the basic uncertainties in dating, interpretation, response times, and "noise level" of proxy climatic data, there is at times good agreement among different kinds of evidence from within a region to suggest an episode of generally warmer or cooler summers. Three previously identified episodes find expression in records from all of the regions considered: the "Little Ice Age" of the last few centuries, a "Medieval Warm Period" around the 12th century A.D., and an earlier cold period sometime between the 8th and 10th centuries. However, the timing of minima and maxima within these episodes seems to have varied from region to region (although the evidence is consistent within regions). In the 15th century, summers were warm in the eastern Canadian Arctic and southern Greenland while there was a cold episode in Europe and western North America. (Auth)

774. **Wilson, A.T.** 1970. The McMurdo Dry Valleys. *Antarctic Ecology, M.W. Holdgate (Ed.). Academic Press, London, New York, vol. 1, (pp. 21-30), 604 pp.*

The events of the glacial history of the Ross Dependency area of the Antarctic should be divided into three separate glacial sequences: (1) Glaciers whose extent is controlled by the height of the Polar Plateau have not been of much greater extent than at present for at least 20,000 yr and may be advancing. (2) Alpine glaciers fed from local snowfall occur as far south as the Darwin Glacier; the period from 3000 yr B.P. to 1200 B.P. was a period of glacial recession in the McMurdo oasis region; another advance took place 1200 yr ago and a further very minor advance 100 yr ago. (3) Glaciers from the sea filled McMurdo Sound with an ice sheet which penetrated a short distance into Taylor Valley and produced a large lake. This receded 6000 B.P. and was replaced by open water. (AntB-B-8124) AntB B-8124

775. **Wilson, A.T.** 1978. Past Surges in the West Antarctic Ice Sheet and Their Climatological Significance. *Antarctic Glacial History and World Palaeoenvironments, E.M. van Zinderen Bakker (Ed.), Proceedings of a Symposium held on 17th August, 1977 during the 10th INQUA Congress at Birmingham, U.K. A.A. Balkema, Rotterdam, (pp. 33-39), 172 pp.*

Evidence is presented from both Antarctica and Australia to show that the West Antarctic ice sheet has surged several times in the last 6,000 years. During these surges perhaps up to 300,000 cu km of ice in the form of icebergs are delivered to the Southern Ocean in a period of a few hundred years. The dates of these surges correspond to the post-glacial cold periods and it is suggested that this may be the mechanism for at least some of the post-glacial climate fluctuations. (AntB F-22761) AntB F-22761

776. **Wood, W.A.** 1970. Recent Glacier Fluctuations in the Sierra Nevada de Santa Marta, Colombia. *Geographical Review 60(3):374-392.*

Knowledge of responses of alpine glaciers to tropical environments is sparse. Recently, however, an appraisal of mass change was afforded by comparison of glacier features illustrated in aerial photographs taken thirty years apart over the Sierra Nevada de Santa Marta, Colombia. Conclusions of this appraisal confirm that the rapid wasting of ice reported in 1939 continues today, that such ablation is confined to altitudes below 5300 metres, that glaciers with northern exposures have suffered markedly less than those with other orientations, and that slope and albedo may be more important factors in mass wasting in tropical regions than at higher latitudes. About 33% of the ice present in 1939 had disappeared in 1969, and if this ablation rate continues, deglaciation in the Sierra Nevada will be complete in about a century. (Auth) GA 71A/0194

777. **Yu-feng, Shih, Hsieh Tze-chu, Cheng Pen-hsing, and Li Chi-Chun.** 1980. Distribution, Features and Variations of Glaciers in China. *International Association of Scientific Hydrology Publication 126:111-116.*

Since 1975 a new glacier inventory is being made in China with new aerial and ground stereophotogrammetric maps. In Chilien Shan, Tien Shan, Altai and part of the Chinghai-Tibet Plateau there are 17,123 glaciers covering an area of 22,181 sq km. This represents roughly half of the glaciers in China. The new results show that the previous 1959 survey underestimated the number and the area of glaciers. Analysis of the spatial distribution of the snow line shows clearly the three main sources of precipitation. From the 1950s to 1960s glaciers were retreating but in the 1970s positive mass balances appeared and the snow line descended. Temperature has decreased and precipitation increased since the 1950s and, on the basis of dendroclimatological data, this trend may last until the end of the century with an increase of advancing glaciers. (Auth)

Historic

778. **Bell, W.T., and A.E.J. Ogilvie.** 1978. Weather Compilations as a Source of Data for the Reconstruction of European Climate during the Medieval Period. *Climatic Change 1:331-348.*

Research into the climate of the Middle Ages has relied heavily upon data provided by compilations of references to weather and related phenomena extracted from a variety of historical texts and source documents. These compilations, produced from 1858 onwards, have generally neglected the essential need for source validation. While a considerable amount of reliable and useful information about medieval climate is to be found in documentary sources, it occurs together with material which is spurious, inaccurate, or whose reliability cannot be properly authenicated. Because they were, for the most part, scientists, unfamiliar with historical methodology and techniques of source analysis, the authors of the compilations were either unaware of the problematic character of their sources, or ignorant of the techniques developed by historians for dealing with them. The material included in the compilations must be regarded as suspect until its authenticity has been checked by validating individual sources. Unless this is done, a misleading picture of the climate of the Middle Ages may emerge from uncritical use of the compilations. In particular, the climate may appear to have been more extreme than authentic sources alone would suggest. (Auth)

779. **Beschel, R.E.** 1961. Dating Rock Surfaces by Lichen Growth and its Application to Glaciology and Physiography: Lichenometry. *Geology of the Arctic, G.O. Raasch (Ed.), Proceedings of the First International Symposium on Arctic Geology, Calgary, Alberta, January 11-13, 1960. University of Toronto Press, Toronto, (pp: 1044-1062), 2 vol.*

Compares climatic, geologic, and glaciological conditions in the Alps with those of the Sukkertoppen and Holsteinsborg districts of West Greenland as observed in 1958, in a study of lichen growth. The eleven glaciers studied, eight in West Greenland, have all passed through a period of advance about 1500-1900 A.D., featuring several smaller peaks the latest a minor advance, 1920-1925. (AB70182)(JTA) AB70182

780. **Beschel, R.E., and A. Weidick.** 1973. Geobotanical and Geomorphological Reconnaissance in West Greenland, 1961. *Arctic and Alpine Research 5(4):311-320.*

Lichen growth rates are used to determine glacier behaviour in West Greenland in modern times where no documents are available. During the first seven decades the growth of RHIZOCARPON spp. is slow; maximum size is attained only on moraines exceeding 1000 years. Direct comparison of lichens appearing in photographs taken on Disko Island in 1896 and 1961 show that the majority have not increased measurably in size in the following 63 years. Comparison with photographs taken in 1958 show increases of only 1 to 4 mm for the fastest growing lichens. Photographic records of glacier outlets confirm an advance maximum around 1880-1890. Rapid retreat appears to have commenced shortly before 1961. (Auth)(JTA) GA 74A/1500

781. **Brandt, J., and R. Gutteson.** 1978. Population and Climate in the Development of the Faroese Peasant Society. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 60-67), 259 pp.*

Settlement began on the Faeroe Islands between 600 and 650 A.D. The Norwegian immigration began in 825, and by 1327-28 the population was about 4000. Until the 20th century, agriculture was the dominant industry. Historic evidence is presented that a sea level rise in the last 2000 years of 3-4 m, (2.5-3 m since settlement), has reduced the amount of acreage available. Temperatures are believed to have declined in the 17th and 18th centuries, but socio-economic changes may have been affected as much as by changes in systems of production and settlement as by climatic variations. A graph shows mean temperatures from June 1781 to August 1782, superimposed on mean temperatures between 1873 and 1897. (JTA)

782. **Bray, J.R.** 1980. Alpine Glacial Advance in Relation to a Proxy Summer Temperature Index Based Mainly on Wine Harvest Dates, A.D. 1453-1973. *Boreas 11:1-10.*

A highly significant correlation was calculated between French wine harvest dates and central England summer temperature from 1659 to 1879 which suggested wine harvest dates might be used to approximate western European summer temperatures for the preinstrumental period. A proxy summer temperature index was thereby constructed which combined French and German wine harvest and central England temperature data. This index was significantly correlated with a tree-ring density prealpine Swiss summer temperature index from 1484 to 1973 and also with Northern Hemisphere annual temperatures from 1579 to 1973. Comparison of the proxy index with Alpine glaciation summaries showed highly significant relationships between glacial advance and intervals of below-median proxy temperature for all glacial studies combined and for the two most complete individual studies allowing a seven-year lag between temperature decline and glacial advance. The initial Little Ice Age glacial expansion around A.D. 1600 occurred towards the close of the longest below-median proxy temperature sequence which lasted from A.D. 1569 to 1604. Subsequent to this, glacial readvances were related to summer temperature declines of lesser duration or magnitude. (Auth)

783. **Bryson, R.A.** 1974. A Perspective on Climatic Change. *Science 184:753-760.*

This paper attempts to answer the following questions: 1) How large must a climatic change be to be important? 2) How fast can climate change? 3) What are the causal parameters and how do they change? 4) How sensitive is the climate to small changes in the causal factors? Some answers to these questions are examined by analysis of records extending over different time scales: for example, the last 13,500 years (from pollen and isotope data) and the last 1000 years (from historic data). The author concludes that significant Holocene climatic changes may have occurred in a matter of decades. In addition, the point is made that the estimated mean annual temperature in Iceland between 900AD and the present indicates that the period between 1930-1960AD was characterized by abnormally high temperatures. (JTA)

784. **Burrows, C.J., and D.E. Greenland.** 1979. An Analysis of the Evidence for Climatic Change in New Zealand in the Last Thousand Years: Evidence from Diverse Natural Phenomena and from Instrumental Records. *Journal of the Royal Society of New Zealand 9(3):321-373.*

An analysis is made of the diverse evidence for climatic variation in New Zealand in the last 1000 years. After a brief account of the pressure systems and circulation pattern near New Zealand, indirect evidence from a range of phenomena which have been influenced by climate is discussed. The climatological evidence derived from instrumental records and observations is then considered, with emphasis on precipitation and temperature. Little reliance may be placed on some evidence which is weak, equivocal, difficult to interpret or difficult to place in time. The most reliable evidence is summarized in two overlapping time periods, 1000 A.D. to 1900 A.D. and 1850 A.D. to the present. Dated glacial episodes, speleothem palaeotempertures and tree palaeotemperatures demonstrate that there have been many fluctuations of temperature in the last 1000 years, over a range of not much more than + or - 0.5 deg C. The high temperatures since about 1950 A.D. have probably not been exceeded. Expansion of glaciers in the Southern Alps requires consistent cold airflow from southerly directions onto the western side of the South Island. Iceberg irruptions into unusually low latitudes in the Southern Hemisphere occurred at the same times as glacial advances in New Zealand last century and early this century. Exceptional snowstorms in the South Island were generally most frequent at the same times. Closed basin lakes in the Central North Island were low in the 17th century, 18th century and late 19th century when glaciers were expanded in the Southern Alps. The lakes were high in the 20th century when glaciers were shrunken and temperatures and local precipitation were also high. Consistent warm northerly airflow onto the North Island provides the conditions promoting the high lake levels and other correlated phenomena. (Auth) (JTA)

Data are presented for several proxy and actual climatic records. Each type of evidence is discussed, and some are expanded upon in a commentary section. (JTA)

785. **Burrows, C.J., and J. Lucas.** 1967. Variations in Two New Zealand Glaciers during the Past 800 Years. *Nature 216:467-468.*

Lichenometry is used to study the moraines of the Mueller and Tasman glaciers in the Mount Cook region, Canterbury, New Zealand. Age calibration of the lichen curve is based on historic records and dendrochronology. Maximum ages recorded by two lichen species on Mueller and Tasman moraines (years A.D.) are shown in Table 1. The estimates of the dates of glacial advances determined in this way match those for historically recorded advances of glaciers in the European Alps and glaciers in the Caucasus Mountains from the late sixteenth century onward, and seem to show that most of these glacial events were synchronous in the northern and southern hemispheres. (Auth)(JTA)

786. **Calkin, P.E., and J.M. Ellis.** 1980. A Lichenometric Dating Curve and its Application to Holocene Glacier Studies in the Central Brooks Range, Alaska. *Arctic and Alpine Research 12(3):245-264.*

Lichen growth curves for dating in the central Brooks Range have been developed and applied using RHIZOCARPON GEOGRAPHICUM s.l. and the fast-growing Alectoria minuscula/pubescens. Rhizocarpon eupetraeoides and R. inarense, nearly as common in this region, have a growth pattern which correlates wih that shown by the R. geographicum curve for thallus diameters up to 150 mm. The R. geographicum curve has a great growth period lasting 200 yr based on historic, dendrochronologic, and direct measurement control; this is followed by a linear growth phase of approximately 3 mm per century based on radiocarbon dates. The lichenometric technique has proved successful in developing the first detailed Holocene glacial chronology for the Brooks Range and indicates that major pulsations of cirque glaciers occurred as recently as 350 yr ago. (Auth)

787. **Carrara, P.E., and R.G. McGimsey.** 1981. The Late Neo-Glacial Histories of the Agassiz and Jackson Glaciers, Glacier National Park, Montana. *Arctic and Alpine Research 13(2):183-196.*

Twenty-one tree-ring stations, totaling 116 trees, were sampled at various localities within the forest trimlines fronting the Agassiz and Jackson glaciers, Glacier National Park, Montana. Tree ages within these zones became progressively younger from the region of the maximum late-Neoglacial position to the bases of the bedrock slopes on which these glaciers are now confined. The age of the oldest tree plus 15 yr was used to estimate the date of glacier withdrawal from a given station. It was found that both the Agassiz and Jackson glaciers began to retreat from their maximum late-Neoglacial positions about 1860. Hence, Matthes's (1940) estimate of glacial advances culminating about 1850 to 1855 for many glaciers in the western United States seems reasonable for the Glacier National Park region. Retreat rates, derived from the tree-ring data, appear to have been modest (<7 m yr(E-1)) until about 1910 when they increased reaching more than 40 m yr(E-1) for the Agassiz Glacier between 1917 and 1926. Retreat rates after the late 1920s could not be monitored by tree-ring analysis as both glaciers had retreated onto bare bedrock dip slopes. However, from various literature descriptions and National Park Service records, both glaciers experienced rapid retreat (>100 m yr(E-1)) from this time until 1932. In addition, while the Agassiz Glacier was monitored by the National Park Service (1932 to 1942) retreat continued at a rapid rate (>90 m yr(E-1)). This period of rapid retreat corresponds with a period of above-average summer temperatures and decreased precipitation in the climatic record of the region. Since the mid-1940s the retreat rate of both glaciers has slowed markedly. (Auth)

788. **Catchpole, A.J.W., and T.F. Ball.** 1981. Analysis of Historical Evidence of Climatic Change in Western and Northern Canada. *Climatic Change in Canada - 2, National Museum of Natural Sciences Project on Climatic change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus no. 33, (pp. 48-96), 220 pp.*

The paper presents an analysis of a variety of historical climatic records based upon records of the Hudson's Bay Company. The nature of the records examined included: 1) ice conditions on rivers and seas; 2) dates of first snowfall and first frost; and 3) analysis of phenological indicators. Many records give continuous data coverage between ca 1750 A.D. to 1870 A.D. and some commenced as early as 1715 A.D. The duration of westward voyages through the Hudson Strait by Hudson's Bay Company ships is diagrammed for the period 1750-1870 A.D. The longest voyage within this period was approximately 30 days which occurred in 1815 whereas it took only 10 days in 1832. (JTA)

789. **Catchpole, A.J.W., and M.-A. Faurer.** 1983. Summer Sea Ice Severity in Hudson Strait, 1751-1870. *Climatic Change 5:115-139.*

Annual indices of sea ice severity in Hudson Strait, for the period 1751 to 1870, are derived from written historical evidence contained in ships log-books. These logs were all kept on Hudson's Bay Company ships sailing from London to the Company's trading posts. The log-books are homogeneous in nature and this property facilitates their numerical interpretation. The annual indices are subjected to face validity testing which indicates that they may plausibly be accepted as measures of sea ice severity. The results are examined in relation to the present-day behaviour of sea ice in Hudson Strait and they provide evidence that the summer severity of ice

Historic

conditions is mainly determined by atmospheric circulation conditions. (Auth)

790. **Catchpole, A.J.W., D.W. Moodie, and D. Milton.** 1976. Freeze-up and Break-up of Estuaries on Hudson Bay in the Eighteenth and Nineteenth Centuries. *Canadian Geographer 20(3):279-297.*

This paper analyses changes in dates of freeze-up and break-up at four river estuaries on Hudson Bay in the period 1714-1871. The dates have been reconstructed from daily journals kept by personnel of the Hudson's Bay Company and concern the estuaries of the Moose, Albany, Hayes, and Churchill rivers. The journals are those kept at Moose Factory, Fort Albany, York Factory, Churchill Factory, and Fort Prince of Wales. The locations of the keeping of the journals in both time and space are shown in Figure 1. The first part of the paper is concerned with the origin and nature of these dates as measures of change in the freezing and breaking processes. The second part describes the changes they exhibit. (Auth)

Content analysis, the method used here to derive the dates from mainly qualitative sources, is described. Dates of first partial and first complete freezing and first breaking of the ice are graphed and tabulated. A pronounced period of early first complete freezing occurred between 1805-1810 AD with a peak in the first breaking occurring slightly later between 1810-1820 AD. (JTA)

791. **Corner, R.W.M., and R.I.L. Smith.** 1973. Botanical Evidence of Ice Recession in the Argentine Islands. *British Antarctic Survey Bulletin 35:83-86.*

Botanical evidence is presented which suggests that there has been some degree of ice recession in the Argentine Islands in recent tiems. This tends to contradict the results of recent glaciological investigations in these islands. The observations were made during 1964-65 on an outcrop of rock below an ice cliff on Galindez I. and on a rock exposure on the easternmost of the Corner Is. (Auth mod.) AntB F-13573

792. **Douguedroit, A.** 1978. Timberline Reconstruction in Alpes de Haute Provence and Alpes Maritimes, Southern French Alps. *Arctic and Alpine Research 10(2):505-517.*

Owing to very extensive reafforestation efforts in the middle of the last century, high altitude forests have been reestablished and timberline has been reconstructed in the southern French Alps. The altitudes of the reconstructed timberline and of the natural timberline (where it is still preserved) are found to be comparable. The physical and human conditions affecting timberline are classed according to their relative importance. The main controlling factor is temperature of the growing season. Precipitation, soils, human activity, land ownership, and legal conditions are important secondary factors that influence local variations in timberline. (Auth)

793. **Grove, J.M.** 1972. The Incidence of Landslides, Avalanches, and Floods in Western Norway during the Little Ice Age. *Arctic and Alpine Research 4(2):131-138.*

Land rent assessments from western Norway and documents concerned with applications for their reduction provide detailed information about the incidence of landslides, rockfalls, and avalanches, as well as floods, during the period of the Little Ice Age. The nature and reliability of available data is discussed and is shown to be adequate to demonstrate a much increased incidence of major mass movements and floods which started in the late 17th century and continued into the 19th century in valleys adjacent to Josteldalsbre. This environmental change began abruptly and there was a striking concentration of disastrous incidents between 1650 and 1760 and in certain years during that period, such as 1687, 1693, and 1702. (Auth)

794. **Groveman, B.S., and H.E. Landsberg.** 1979. Reconstruction of Northern Hemisphere Temperature: 1579-1880. *Publication No. 79-181, Meteorology Program, University of Maryland, College Park, MD, 45 pp.*

In the latter part of the 19th century temperature observations were begun over most of the Northern Hemisphere. Before the start of the 18th century only fragments of instrumental information can be found. These data are supplemented by the existence of so called proxy information such as tree rings and river freezings, and historical records. Multiple linear regression equations using long climatological time series from proxy information were used to reconstruct the Northern Hemisphere annual temperature for the period 1579-1880. The entire period was for the most part colder than the period 1881-1975 with the extremely cold period between 1810-1820 being well pronounced. A trend toward abrupt warming occurred 1826-1830. The so-called Maunder Sunspot Minimum from 1645-1715 as a whole does not seem to be appreciably colder than the major portion of the record. A spectral analysis of the reconstructed and calculated values of Northern Hemisphere annual termperatures show significant spectral peaks in the intervals 2.0-2.2, 2.4-2.7, 2.7-3.0, 3.5-4.0 and > 80 years. (Auth)(BJC) ORNL/CDIC

795. **Gunnarrson, G.** 1978. The Limitations of Climatology as Explanatory Factor of Human Institutions. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 27-34), 259 pp.*

The connection between climatic deterioration and economic decline in the late Middle Ages is questioned. Iceland is considered in some detail. From 1600-1800 the colder climate, which was detrimental to marginal farming operations, probably had an insignificant effect on the cod stock. It is the author's opinion that the socio-economic framework of Iceland, i.e., the population's resistance to fishing and opposition to abandoning farming, caused the economic and demographic crises of 18th century Iceland. (MA)

796. **Hillaire-Marcel, C., S. Occhietti, and G. Prichonnet.** 1980. Historical, Hydrological and Physical Evidence of Changing Climate in Eastern Canada. *Climatic Change in Canada, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, 1977-1978, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 26, (pp. 61-72), 246 pp.*

A series of historical records (newspapers, journals, etc.) exist for Quebec that provide information back to 1800 A.D. Figure 2 in this article graphs the dates of the opening and closing of the Port of Montreal between 1870 and 1915 and the number of days the port was closed. The port was closed for nearly 160 days in the middle 1870s and again in 1887 and 1907 A.D. Water level records in eastern Canada are graphed from 1890 to 1980 A.D. Water levels tended to be high near the turn of the century with low levels reached in the decade of the 1930s. (JTA)

797. **Hunter, G.T.** 1970. Postglacial Uplift at Fort Albany, James Bay. *Canadian Journal of Earth Sciences 7(2, Part 1):547-548.*

Historic

Evidence from air-photo interpretation, the Hudson's Bay Company's Fort Albany (established 1674-1679) and Samuel Hearne's map of the mouth of the Albany River (1774) suggests that uplift has occurred at a rate of between 3-4 feet (90-120 cm) per century in the Fort Albany area. (A. Heginbottom) GA 72A/0671

798. **Lamb, H.H.** 1965. The Early Medieval Warm Epoch and Its Sequel. *Palaeogeography, Palaeoclimatology, Palaeoecology 1(1):13-37.*

An attempt is made at quantitative assessment of the warmer period 1000-1200 A.D., and the "Little Ice Age" of 1500-1700 A.D. Earlier workers have used documentary evidence to show that climatic changes have occurred within the historic period in a qualitative sort of way; the main indications being that between 1000 and 1200 A.D. temperatures were 1 deg or 2 deg C warmer in many parts of the world. The author used manuscript evidence (diaries etc.) to find "winter severity" and "summer wetness" indices for particular years within the period. The movements of wet and dry, warm and cool months across continental Europe are suggestive of changes in the track of upper westerlies and associated low-level features. Correlation coefficients based on comparison with instrumental data from 1700 showed that specific temperature and rainfall figures could be associated with these "documentary-anomalous' months, and by the use of regression lines to extend such data, he produces tables and figures to show changes in the 50-year means in the period under discussion. The conclusion is reached that the medieval warm epoch was one of dry summers, and that later epochs up to the present have seen summers which have contributed more and more rain. Autumns have always apparently been wetter than springs. Actual changes have, however, been small - in England, the difference in temperature between the two extreme periods probably amounted to only 1.2 deg or 1.4 deg C, and rainfall varied within 10%. (N.C. Ward) GA 66B/200

799. **Lamb, H.H.** 1965. Britain's Changing Climate. *Biological Significance of Climate Changes in Britain, Symposia of the Institute of Biology, 14, C.G. Johnson and L.P. Smith (Eds.). (pp. 3-31).*

An outline of Britain's climate since about 9000 B.C. is given, compiled from paleo-ecological data, historical records of outstanding climatic events, documentary material and instrumental recordings. Variations in climatic parameters are discussed and the outstanding features of the lesser climatic optimum of A.D. 1000-1300 and the "Little Ice Age" of 1500-1850 presented. Special treatment is given to the effect of changing circulation patterns of climatic variation and to the value of evidence of the form and distribution of vineyards. (Ian Simmons) GA 66B/547

800. **Lamb, H.H.** 1972. Atmospheric Circulation and Climate in the Arctic since the Last Ice Age. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 455-495), 511 pp.*

After a brief review of the types and distribution of data from which the existence and nature of past climatic regimes differing from today's may be construed, the paper illustrates the apparent course of prevailing temperatures in various parts of the northern hemisphere through, and since, the last ice age and the probable character of the atmospheric circulation that prevailed at the surface and in the upper troposphere, summer and winter, in the different climatic regimes. (Auth)

801. **Lamb, H.H.** 1974. The Data Available and Course Established for the Development of the Little Ice Age in Recent Centuries in Europe and Other Parts of the World. *Climatic Research Unit Research Publication No. 2; Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the Time of the Last Glacial Maximum about 17,000 Years Ago, Proceedings of an International Conference, Norwich, May 17-22, 1973. Collected Abstracts. Climatic Research Unit, University of East Anglia, Norwich, England, (pp. 97-100), 123 pp.*

Two maps show the winds, weather, and suggested isobars for July 1956 and July 1695 A.D. In both instances a Low sits off northwest Scotland with additional Lows to the east. (JTA)

802. **Lamb, H.H.** 1974. Contributions to Historical Climatology: the Middle Ages and after; Christmas Weather and Other Aspects. *Bonner Meteorologische Abhandlungen 17:549-568.*

The first section of this paper briefly reviews the types of manuscript information available on European weather over some centuries before the invention of the barometer and thermometer and shows how the wealth of data available may be submitted to meteorological analysis. Numerical indices of the prevailing character of the winters and summers over periods of ten years (or longer) are defined for this purpose. Analysis of the values of these indices, and their sequence through the Middle Ages and since, in different longitudes in Europe is seen to verify the general trustworthiness of the original manuscript information and points to changes in the prevailing values of temperature and rainfall over England, for which first approximation values and estimates of the margin of error can be derived by straight-forward statistical means. Indications are also obtained regarding the probable character of the atmospheric circulation which maintained the different climatic regimes. Thus historical climatology may enhance our knowledge of the behaviours of the atmospheric circulation and the processes that bring about changes of climate. The second section of the paper illustrates what may be learnt from the records of Christmas weather in the London area, which are complete since the year 1660. The result supports indications already reported in the German meteorological literature that the character of the atmospheric circulation prevailing over the four pentads centred about New Year is a sensitive indicator of (i.e. shows an amplified response to) tendencies at any given time affecting the atmospheric circulation and climate over the whole year. (Auth) GA 74B/2468

803. **Lamb, H.H.** 1974. Reconstructing the Climatic Patterns of the Historical Past. *Endeavour 33(118):40-47.*

The long period of ameliorating climate in the first half of this century prompted little interest in climatic change - it is the threat of colder conditions in recent years that has helped to focus attention on the historical record. At the same time, improved worldwide news of droughts and floods, with fears of the long-term global effects of pollution provide a further stimulus. The fragmented early records kept by amateur observers or ship's captains can be used (with suitable care and correction) to compile tentative maps of mean seasonal conditions. Fortunately pressure, a fundamental variable, was accurately measured from about 1750. Some examples based on different sources illustrate this account. A major problem is that the past 200 years so far reconstructed show no period of declining vigour in the global circulation, such as we are now experiencing. There is thus a particular need to extend our reconstructions still further back. (K.M. Clayton) GA 74B/2923

804. **Lawrence, D.B.** 1972. Geographic Distribution of Some Climatic Aberrations. *Sea Ice, T. Karlsson (Ed.), Proceedings of an International Conference, Reykjavik, Iceland, May 10-13, 1971. National Research Council, Reykjavik, (pp. 101-111), 309 pp.*

Following the "little ice age", deglaciation began about 1750 in a periodicity in southeastern Alaska related to the sunspot cycle. Concurrent drying of lakes culminated in the extraordinary drought of the 1930s. Growth of glaciers and lakes began about 1940 with lowering temperature and increasing precipitation. These and more extreme changes have occurred in historic and prehistoric past concurrently in N. and S. hemispheres. Understanding of causes may lie in tracing geographic distribution of past aberrations epecially in the southern hemisphere where such greater proportion of sea to land and symmetrical position of Antarctica greatly simplify operation of climatic processes. Periodic changes in solar activity and barometric pressure initiating storms in the Arctic basin may have caused the regular distribution of raised beaches on emerged Arctic shores; and periodic depression of the earth's crust by abnormal snow loads may have triggered earthquakes and initiated tsunamis breaking off ice shelves and dispersing extraordinary masses of ice in polar seas. (Auth)

805. **Le Roy Ladurie, E.** 1972. Times of Feast, Times of Famine: a History of Climate Since the Year 1000. *George Allen & Unwin, London, 428 pp.*

This translated work examines the climatic variations of the last 1000 years mainly through the evidence of dendrochronology, dates of wine harvests, and glacial advances and retreats. Some other documentary evidence is useful, and while most of the evidence is obtained from Western Europe, supplementary information is gained from such places as America and Japan. The chronology suggested includes: 1) a little optimum about the year 1000; 2) the glacial thrusts of the Little Ice Age culminating first about 1200-1300 and then 1580-1859; 3) the contemporary warming up. The climatological causes are briefly outlined. (Gillian M. Sheail) GA 74B/2476

806. **Lindgren, S., and J. Neumann.** 1982. Crossings of Ice-Bound Sea Surfaces in History. *Climatic Change 4:71-97.*

Seven more-or-less well documentated cases of the use made of ice-bound sea areas in winter for the purposes of warfare are reviewed. The sea-ice crossings took place in 1495, 1577, 1581, 1658, 1809, 1940, and 1943, i.e. the first five occurred during the Little Ice Age. A book authored by a prominent Swedish personality (Archbishop Olaus Magnus) and published in 1555 says that warfare on frozen sea areas in winter by the Muscovites (Russians) and Swedes was as common as warfare by ships on the open seas in summer. There are indications of some crossings of ice-bound seas prior to 1495 and not necessarily for warlike activities. It seems that the Vikings too did some sea-ice crossings. The crossings of 1495, 1577, 1581, and 1940 involved the Gulf of Finland, that of 1809 the Gulf of Bothnia and the Aaland Islands area of the Baltic, that of 1658 the Danish Belts, and that of 1943 the Gulf of Taganrog in the Sea of Azov. In the first three cases the powers were Muscovy (Russia) and Sweden which for centuries were fighting for supremacy in the Baltic and over the routes from the inner Baltic (Gulf of Finland and Bay of Riga) to western Europe. The case of 1809 involved, again, Russia and Sweden, though in the background of the conflict between the two were wider European issues of the Napoleonic wars. The 1658 crossing of the frozen-over Danish Belts was accompanied by the Swedes, forcing the Danes into submission: In the ensuing Peace Treaty Sweden for the first time in her history achieved her present territorial extent in the Scandinavian Peninsula. The case of 1940 was connected with the 1939-40 Winter War of Soviet Russia against Finland. The crossing of 1943 was made by German forces retreating from the Caucasus under the pressure of Soviet forces in World War II. The crossings of 1577, 1581, 1658, 1809, 1940, and 1943 took place between late in January and late in March; the case of 1495 appears to have taken place early in the winter season: probably late in November. Since in the period 1931-60 no part of the Gulf of Finland froze over before about the middle of December, the early date of the crossing of 1495 is possibly one of the many indications of cold winters during the Little Ice Age. (Auth)

807. **Luckman, B.H.** 1977. Lichenometric Dating of Holocene Moraines at Mount Edith Cavell, Jasper, Alberta. *Canadian Journal of Earth Sciences 14(8):1809-1822.*

A preliminary growth curve for the lichen RHIZOCARPON GEOGRAPHICUM over a 250 year period was determined on moraines of quartzite debris at Mount Edith Cavell and Penstock Creek, Jasper National Park, Alberta. The dating control was obtained by dendrochronology and from documentary and photographic sources. Four "Little Ice Age" moraines are identified and dated as 1705 + or - 5, 1720 + or - 5, 1858 + or - 7, and 1888 + or - 7 A.D. at Mount Edith Cavell, and 1765 + or - 5, 1810 + or - 5, 1876 + or - 5, and 1907 + or - 5 A.D. at Penstock Creek. Recession of Cavell Glacier averaged about 16 m/year from 1927-1963 and 6-8 m/year from 1963-1975. Angel Glacier shows a similar pattern but has maintained its frontal position since 1962. Remnants of at least three "pre-Little Ice Age" moraines occur in two small areas at Mount Edith Cavell. The minimum lichenometric age for the oldest moraine is about 1800 B.P. The presence of Bridge River Ash in the soils in front of the 1705 moraine indicates no greater glacial advance in the last 2600 years. Thus although several glacial advances occurred at this site during the Holocene they were of similar or smaller extent than the "Little Ice Age" maximum. (Auth) (JTA)

808. **Matthews, J.A.** 1973. Lichen Growth on an Active Medial Moraine, Jotunheimen, Norway. *Journal of Glaciology 12(65):305-313.*

Abundant specimens of lichens, including RHIZOCARPON GEOGRAPHICUM, are reported from an active medial moraine on Storbreen, southern Norway. The size and distribution of two crustose and two foliose species are described. Inferences are made regarding the age, origin and population dynamics of the lichens. Some implications of the observations for lichenometric dating and use of lichens as indicators of moraine stability are discussed. (Auth)

809. **Matthews, J.A.** 1974. Families of Lichenometric Dating Curves from the Storbreen Gletschervorfeld, Jotunheimen, Norway. *Norsk Geografisk Tidsskrift 28:215-235.*

Lichenometric dating, based on RHIZOCARPON GEOGRAPHICUM, is applied to the establishment of an areal chronology for deglaciation of the Storbreen gletschervorfeld, central southern Norway. A simple approach permitting many lichenometry curves to be constructed in the same area is adopted, each curve differing in the number of sites per surface or the number of lichens per site employed in its construction. Nine lichenometry curves of exponential form are constructed from largest lichens on four past glacier margins of known age, and the age of four margins of unknown age predicted. Median predicted ages are 1811, 1833, 1854 and 1871 and all predictions fall within an overall range of 17 years, 10 years, 10 years and 7 years respectively. (Auth)(JTA)

810. **Matthews, J.A.** 1975. Experiments on the Reproducibility and Reliability of Lichenometric Dates, Storbreen Gletschervorfeld, Jotunheimen, Norway. *Norsk Geografisk Tidsskrift 29:97-109.*

Experiments are made on the reproducibility of lichenometric dates and a method outlined for obtaining reliable lichenometric dates and a measure of their accuracy. The paper is based on field measurements of RHIZOCARPON GEOGRAPHICUM growing on 10 former ice margins, Storbreen gletschervorfeld, Jotunheimen, southern Norway. The "preferred predictions" for the four margins of unknown age are: 1867-71 (M5), 1852-53 (M4), 1824-27 (M3), 1810 (M2). Previously published predicted dates, based on families of lichenometry curves and necessary for the establishment of an areal chronology for the Storbreen gletschervorfeld, are substantiated. Previously published results of lichenometry curves, are criticised and widespread use of the principle of reproducibility is advocated. (Auth)(JTA)

811. **Matthews, J.A.** 1977. A Lichenometric Test of the 1750 End-Moraine Hypothesis: Storbreen Gletschervorfeld, Southern Norway. *Norsk Geografisk Tidsskrift 31:129-136.*

The hypothesis that the outermost end moraine in front of a southern Norwegian glacier dates from 1750 is tested by a lichenometric technique on the Storbreen gletschervorfeld, Jotunheimen. A method of randomized extrapolation involving 300 lichenometry curves is used, whereby predicted dates are obtained from lichenometry curves constructed from well-founded fixed points bsed on surfaces dating from between 1900 and 1951. The mean predicted date based on the use of five largest lichens per surface is 1757 with 95% confidence limits at 1743 and 1770. Mean predicted dates based on the use of single largest or ten largest lichens are 1785 and 1774, respectively, dates which differ significantly from 1750. (Auth)(JTA)

812. **Mayewski, P.A., and P.A. Jeschke.** 1981. Himalayan and Trans-Himalayan Glacier Fluctuations since A.D. 1812. *Arctic and Alpine Research 11(3):267-287.*

Historical records of the fluctuations of glaciers in the Himalayas and Trans-Himalayas date back to the early 19th century. Local and regional syntheses of 112 of these fluctuation records are presented in this study. The local syntheses deal with fluctuations of glaciers in Kanchenjunga-Everest, Garwhal, Lahual-Spiti, Kolahoi, Nanga Parbat, Karakoram (north and south sides), Rakaposhi-Haramosh, Batura Mustagh, and Khunjerab-Ghujerab. Regional syntheses deal with the composite record and the differentiation of records by glacier type (longitudinal versus transverse) and regional setting (Himalayan versus Trans-Himalayan). In a gross regional sense Himalayan and Trans-Himalayan glaciers have been in a general state of retreat since A.D. 1850. Filtering of the fluctuation records with respect to glacier type and regional setting reveals that the period A.D. 1870 to 1940 was characterized by alterations in the dominancy of retreat, advance, and standstill regimes. (Auth)

813. **Messerli, B., P. Messerli, C. Pfister, and H.J. Zumbuhl.** 1978. Fluctuations of Climate and Glaciers in the Bernese Oberland, Switzerland, and Their Geoecological Significance, 1600 to 1975. *Arctic and Alpine Research 10(2):247-260.*

Huge moraine masses and changes in area and volume of ice that have occurred since A.D. 1600 seem to indicate significant climatic fluctuations. On the other hand, the upper timberline, an ecologically sensitive element, appears to show no significant change in altitude over the same period. The extent and mechanisms of long- and short-term climatic fluctuations are assessed and their influence on the geoecological elements of an alpine area are evaluated. Climatic deteriorations during the last three and one-half centuries, including the Little Ice Age, are discussed in relation to glacier advances, historical weather observations, and instrumental measurements from 1755 to 1965. Instrumental records of summer temperature show no trend from the Little Ice Age to the present while spring and autumn have positive trends during the period of major glacier regression since 1860. The long-term climatic fluctuations, shown by the long lasting larger extension of the glaciers during the Little Ice Age, seems to coincide with a somewhat higher snowfall frequency during the summer months and a lower level in seasonal mean temperature (spring, autumn, and winter) during the period of observation. The short-term climatic fluctuations, superimposed upon the long-term effect, show an uninterrupted succession of unfavorable years with cold, wet summers of generally less than a decade. Within this period their effect on the individual elements of the mountain ecosystems were very different: (1) The glaciers reacted in regard to their size and drainage area with strong advances and significant moraine accumulations, and the equilibrium line fell approximately 200 m. (2) The upper timberline was damaged and its regenerating ability reduced, but it appears to have outlasted the critical years without essential altitude changes. (3) Above the timberline on the alpine pasture a few years with catastrophic climatic conditions were sufficient to bring about superficial destruction and soil erosion processes. (4) In alpine agriculture 1 yr with catastrophic weather damaged production heavily; a repetition of such years could lead to famine. It is proposed that the climatic fluctuations of the last 3 centuries were similar for certain periods of the last 10,000 yr, during which time geomorphic and palynologic evidence indicate that glacier fluctuations were comparable. This also throws emphasis on the conditions of the present century, which have so far been extremely favorable to human use of the Alps. It can be inferred that a reversal could occur within a very short period. (Auth)

814. **Miller, G.H., and J.T. Andrews.** 1972. Quaternary History of Northern Cumberland Peninsula, East Baffin Island, N.W.T., Canada. Part VI: Preliminary Lichen Growth Curve for RHIZOCARPON GEOGRAPHICUM. *Geological Society of America Bulletin 83:1133-1138.*

A graph showing the relation between maximum thallus diameter of RHIZOCARPON GEOGRAPHICUM and age of the individual is presented as an aid to detailed chronological studies in this section of the eastern Canadian Arctic. The curve is derived from: (1) historically dated surfaces; (2) measured growth of ALECTORIA MINUSCULA for a two year period; (3) the interspecific ratios of A. MINUSCULA/R. GEOGRAPHICUM; and (4) radiocarbon-dated surfaces associated with lichens. The size/age curve for R. GEOGRAPHICUM shows an initial fast rate of growth of 0.15 mm yr (E-1) which falls off to approximately 0.03 mm yr (E-1) after the passage of 250 to 300 years. Extrapolation of the curve back to about 9,500 B.P., when individual maximum thalli would be 280 mm in diameter, is in accord with independent geological dating. (Auth)(JTA)

This paper forms the basis for much of the neoglacial chronology on Baffin Island post 1972 (e.g. Miller, 1973; Andrews and Barnett, 1979). (JTA)

Historic

815. **Moodie, D.W., and A.J.W. Catchpole.** 1976. Valid Climatological Data from Historical Sources by Content Analysis. *Science 193(4247):51-53.*

Content analysis is used to derive dates of freeze-up and break-up from historical descriptions of river estuaries on Hudson Bay between 1714 and 1871. Validity testing of these dates indicates that they are comparable with modern data. It is thus proposed that the method affords potential for the systematic retrieval of a broad array of environmental data from the historical past. (Auth)

816. **Nazarov, V.S., and E.R. Hope (Translator).** 1969. Historical Variation of Ice-Conditions in the Kara Sea. *Biull. Vses. Geog. Obshch (Bulletin of the All-Union Geographic Society), 1947(6):653-655; Canada. Defence Research Board, T525R:5-9.*

A table and a figure give information on the variation in sea ice cover in the Kara Sea for the 366 year period between 1580-1946AD. Major peaks in ice intensity occur about every 100 years. The last significant peak occurred at 1920-1929AD with earlier peaks at 1820-1829, 1720-1729 and 1620-1629. (JTA)

817. **Pfister, C.** 1978. Fluctuations in the Duration of Snow-Cover in Switzerland since the Late Seventeenth Century. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 1-6), 259 pp.*

Observations on the duration of snow cover in the Zurich area are graphed for the period 1680-1730 and 1880-1950, based on historic records. A high of approx. 70 days snow cover per year in the late seventeenth century, falls rapidly to approx. 45 days in 1705. The lowest number of days with snow cover occurred in the 1940s. The impact of the cold 1680s and 1690s on grain and dairy production is discussed. Slight climatic changes can drastically impact crops. (JTA)

818. **Piuz, A.-M.** 1974. Climate, Harvests and Life at Geneva, Sixteenth to Eighteenth Centuries. Climat, recoltes et vie des hommes a Geneve, XVIe-XVIIIe siecle. *Annales Economies, Societes, Civilisations 29(3):599-618.*

Archival data has been compiled of grape and wheat harvest dates and prices, climate, glacier positions, etc. and the author relates the data and discusses the effect of the relationships on agricultural, social and political life. Economic difficulties resulted from a series of poor harvests leading to high prices and subsistence problems. Conversely good harvests led to easier living and lower prices. A series of graphs shows the relationships in some detail. In the eighteenth century a trend towards a more continental climate - colder winters and hotter summers - is apparent. An appendix gives a summary of the known conditions for individual years, both climatic and crop, e.g. diseases, excessive rain, harvest dates, quality of crop. (M.A. Bass) GA 75B/835

819. **Stork, A.** 1963. Plant Immigration in Front of Retreating Glaciers, with Examples from the Kebnekajse Area, Northern Sweden. *Geografiska Annaler 45(1):1-22.*

Compares results of some botanical and pedologic methods of dating moraines with such obtained in dated areas with similar climate. Studies of plant species and plant communities, measurements of mosses, liverworts and lichens, tree rings, and soil properties were carried out on moraines produced by the Stor, Isfalls, and Tarfala glaciers in the Tarfala valley, 1960-1961. Comparison with lichenometric results obtained in the Alps, Greenland, and northern Canada suggests an ice-free period of 150-200 yrs. in Kebnekaise; similar results are obtained from comparison with Jostedalsbre in south Norway, where moraines exposed for more than 150 yrs. are covered with certain moss and lichen communities. Appended is summary of 39 lichenometrical studies, mainly since the systematic methods introduced by Beschel in 1950. (AB83295) AB83295

820. **Ten Brink, N.W.** 1973. Lichen Growth Rates in West Greenland. *Arctic and Alpine Research 5(4):323-332.*

Photographs of a lichen-measurement station, established by Beschel at Stromfjordshavn, West Greenland, indicate a RHIZOCARPON GEOGRAPHICUM growth rate of 17 to 18 mm 100 years (E-1) between 1958 and 1970. A radiocarbon date of 330 + or - 75 years B.P. for a moraine at the head of Orkendalen, which is 35 km farther east and 125 m higher than Stromfjordshavn, indicates a RHIZOCARPON GEOGRAPHICUM growth rate of about 6 to 7 mm 100 years (E-1). These results support Beschel's previous estimates for lichen growth rates in the very continental inland parts of West Greenland and strongly support his conclusions that lichen growth rates are highly sensitive to local climate and inversely proportional to continentality. (Auth) GA 74A/1501

821. **Vibe, C.** 1978. Arctic Climatic and Ecological Changes, the Spring-Tides, and the Declination of the Sun. (Preliminary Report). *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 154-161), 259 pp.*

Animal numbers in West Greenland fluctuate considerably. Animal population studies have suggested that periodicities exist of 4-5, 9-10, 29, 58, 261, 522 and multiples of these years, apparently coinciding with fluctuations in climate. A cause for these fluctuations is sought in solar/lunar interrelationships. A graph of drift ice north of Iceland and in Davis Strait from 1850-1910 A.D. is discussed in relation to animal population fluctuations. (JTA)

822. **Wigley, T.M.L.** 1979. Climatic Change Since 1000 A.D. *Colloque International/International Conference, Evolution des Atmospheres Planetaires et Climatologie de la Terre/Evolution of Planetary Atmospheres and Climatology of the Earth, Nice, 16-20 Octobre, 1978. Centre National D'Etudes Spatiales, France, (pp. 313-323), 574 pp.*

During the past 1000 years the earth is believed to have experienced significant shifts in climate, the most pronounced of which was the Little Ice Age, a time of severe climate which occurred between approximately 1400 and 1800 A.D. However, our picture of global climatic change is generally based on information from only a few isolated points where long time series of climatic data have been produced. The picture tends to be biased towards events in the North Atlantic-European sector of the Northern Hemisphere. Is this picture truly representative of conditions averaged over the whole globe? In attempting to answer this question we have used a wide spatial coverage of data from different sources. We have reanalysed traditional historical sources and found that much of the material which has been accepted by earlier workers is manifestly unreliable. Based on revised and new historical data, and on proxy data from a wide variety of sources, our results show the uniqueness of the time about the 17th century as a period when the whole Northern Hemisphere was cooler than the present. We have found no other time during the past 1000 years when either warm or cold conditions, or warming or cooling trends were ubiquitous. (Auth)

823. **Worsley, P.** 1973. An Evaluation of the Attempt to Date the Recession of Tunsbergdalsbreen Southern Norway by Lichenometry. *Geografiska Annaler 55A(3-4):137-141.*

Historic

A critical examination of the RHIZOCARPON GEOGRAPHICUM growth curve recently published reveals that it does not appear to have the precise chronological control which is claimed. Consequently on the available evidence it cannot yet be said that an exponential form may be linked to a decelerating phase of growth. The predicted ages of the recessional moraine ridges using the curve appear to be at variance with the historic records. (Auth)

Oceanographic

824. **Aksu, A.E.** 1980. Late Quaternary Stratigraphy, Paleoenvironmentology and Sedimentation History of Baffin Bay and Davis Strait. *Ph.D. Thesis, Dalhousie University, Halifax, N.S., 2 vols.*

The transition from marine isotope stage 2 to stage 1 (approximately Pleistocene to Holocene transition) was marked in Baffin Bay by the widespread deposition of sediments rich in detrital carbonates. Sedimentation of this facies continued until about 6800 yr B.P. (linear extrapolation on the basis of Carbon 14 dates) when the style of sedimentation changed to the deposition of hemipelagic muds with a rich association of fauna and flora. (JTA)

825. **Burckle, L.H.** 1972. Diatom Evidence Bearing on the Holocene in the South Atlantic. *Quaternary Research 2(3):323-326.*

The Pleistocene Holocene boundary is easily recognized in deep-sea cores from the South Atlantic as an upward change from predominantly shelf and meroplanktonic diatoms to holoplanktonic forms. Those cores with high sedimentation rates show several climatic fluctuations during the Holocene. One core (E 7-1) from the Scotia Sea has a sufficiently expanded Holocene to reveal three distinct coolings at approximately 4600 yr B.P., 2800 yr B.P. and 1000 yr B.P. This compares favorably with the results of other workers. (Auth) AntB E-13960

826. **Campbell, I.B., and G.G.C. Claridge.** 1966. Evidence of Former Sea Levels Near Cape Hallett, Antarctica. *New Zealand Journal of Science 9(4):776-781.*

Deposits on a small outwash plain at Redcastle Ridge (Edisto Inlet) show 3 surfaces. The highest deposit is a fan, and the lower deposits appear to be raised beaches. The sediments of the fan and of the upper beach surface probably have similar source and were formed contemporaneously. In contrast to the upper surfaces, the deposits of the lower beach surfaces are not well sorted, and they have a high percentage of boulder-sized rocks. Because no fossils or other organic material suitable for dating have been found in the deposits, no definite age can be assigned to them. However, comparison with other Antarctic beach deposits suggests that the fan and upper terrace deposits could be of last interglacial age and that the lower beach terrace may represent a surface formed during the post-glacial climate optimum dated at about 6000 yr. B.P. (AntB E-5269) AntB E-5269

827. **Cushing, D.H.** 1976. The Impact of Climatic Change on Fish Stocks in the North Atlantic. *Geographical Journal 142(2):216-227.*

Fish stocks are peculiarly responsive to climatic changes, the most recent of which was a period of warming in the twenties and thirties followed by some cooling since 1945. The period of warming was associated with the rise of the West Greenland cod fishery which has now nearly disappeared. During this period subtropical species moved into temperate waters and boreal ones migrated into arctic waters. Some fish stocks rise and fall with a periodicity of about a century; this is governed by the success or failure of the annual year classes, which are very variable. A mechanism is proposed by which the annual year classes may repond to the changes in wind strength and direction and in solar radiation. (Auth) Ecol Abs 77L/2694

828. **Defelice, D.R., and S.W. Wise, Jr.** 1972. Surface Lithofacies, Biofacies, and Diatom Diversity Patterns as Models for Delineation of Climatic Change in the Southeast Atlantic Ocean. *Marine Micropaleontology 6:29-70.*

Distribution of diatom species in surface sediments of the southeast Atlantic Ocean is regulated by present-day oceanographic and hydrodynamic processes. Five assemblages (vectors) defined by factor-vector analysis, reflect different environments and conditions. Assemblage A is a high diversity flora associated with the nutrient-rich, relatively cold waters south of the Polar Front in the diatom ooze belt. Assemblage B is a reworked assemblage that dominates the southern portion of the study area. Productivity there is low, reflecting sea ice cover during most of the year. The area north of the Polar Front is dominated by Assemblage C, whose characteristic species reflect the relatively warm Subantarctic Surface Water. Winnowing and frustule breakage have altered Assemblage D (found in three isolated samples) by removing relatively delicate forms leaving lag deposits of more robust species. Assemblage E is a low diversity stress flora, reflecting unstable, unpredictable environments along the Polar Front, Antarctic Slope, and the northern boundary of winter sea ice. These sites are characterized by the sinking of cold water. Downcore analysis of cores lying adjacent to the Polar Front and the diatom ooze–pelagic clay boundary show evidence for past climatic variation. The low trophic level occupied by diatoms and the subsequent sensitivity of these organisms to abiotic environmental parameters such as light quality, make relative diatom abundance a useful tool for monitoring fluctuations of winter sea ice and the temperature changes responsible for these fluctuations. The position of the Polar Front has migrated at least three times within the last 0.015 m.y. B.P. Within the last 0.3 m.y. B.P. warm maxima have occurred at approximately 0.0, 0.015, 0.125 and 0.3 m.y. B.P. (Auth)

829. **Dunbar, M.** 1972. Increasing Severity of Ice Conditions in Baffin Bay and Davis Strait and its Effect of the Extreme Limits of Ice. *Sea Ice, T. Karlsson (Ed.), Proceedings of an International Conference, Reykjavik, Iceland, May 10-13, 1971. National Research Council, Reykjavik, (pp. 87-93), 309 pp.*

Comparison of maps of sea ice extent for the 1950s and 1960s indicate that significant ice remained in Baffin Bay during the 1960s, whereas during the 1950s ice largely disappeared, on average, in August. Another figure (Figure 4) shows the mean extent of ice in May on the west coast of Greenland by decade between 1900 to 1930 and 1952 to 1970. The mean ice limit lies close to 70 deg N and was least extensive (i.e. furthest north) between 1952-1960 A.D., and most extensive between 1921-1930 A.D. The maximum difference in the mean ice limits was 120 nautical miles. (JTA)

830. **Dunbar, M.J.** 1976. Climatic Change and Northern Development. *Arctic 29(4):183-193.*

The warm decades in the early part of the present century were replaced by a cooling trend from 1940-1970, followed by the suggestion of a reversal in the past 5 yr. In East Greenland and in the Canadian Arctic and Subarctic seaboard, the climate has changed least in the whole of the North Atlantic region. During the recent warming trend, the southern limit of sea ice in the Svalbard - Jan Mayen region retreated 200-300 km northward between 1928 and 1936, and then moved south again during the cooling period. Faunal changes have accompanied these events. Significance of climatic change to agriculture, aquaculture and stock breeding is noted. (David G. Tout) Ecol Abs 78L/2645

831. **Harland, R., D.M. Gregory, M.J. Hughes, and I.P. Wilkinson.** 1978. A Late Quaternary Bio- and Climatostratigraphy for Marine Sediments in the North-Central Part of the North Sea. *Boreas 7(2):91-96.*

Oceanographic

Micropalaeontological studies of three boreholes in the north-central North Sea have led to the erection of a bio- and climatostratigraphy for the area. Palaeoenvironmental interpretations have depended largely upon oceanographic concepts and changes in the micropalaeontological assemblages have been related to postulated alterations in water mass regimes. The biostratigraphy can then be utilized as a climatostratigraphy since such water mass changes are most probably linked to alterations in the circulation of the North Atlantic, and in particular to the positions of the climatically important North Atlantic Current and Polar Front. The North Sea sequences are compared to similar sections in Europe and related to the commonly accepted standard chronostratigraphy. (Auth)

832. **Hattersley-Smith, G.F.** 1973. Ice Shelf and Fiord Ice Problems in Disraeli Fiord, Northern Ellesmere Island, N.W.T. *DREO Technical Note no. 72-34, Defence Research Establishment Ottawa, 12 pp.*

The Ward Hunt Ice Shelf forms a floating barrier across the entrance to Disraeli Fiord, damming the surface water to a 44 m depth. Beneath this, free interchange of water occurs with the Arctic Ocean. Surface water is almost fresh and is derived from melt-water runoff from the fiord's shores. Based on radiocarbon dating of driftwood samples this situation is believed to have existed for not more than 3,000 yr. A systematic search of the fiord shores during the summer of 1972 gathered 27 samples of driftwood. The majority were collected less than 1 m a.s.l. with the remainder from 1 to 23 m a.s.l. Deltas on the east and west shores of the fiord provided 23 of 27 samples. The main conclusions of the significance of these driftwood samples await taxonomic and radiocarbon analysis by the Geological Survey of Canada. South of the Ward Hunt Ice Shelf within Disraeli Fiord, the ice cover is more or less perennial with the characteristics of lake ice. A moat of fresh water, varying in width from a few metres to 1 km, separates the ice shelf from the shore. Seasonal melt occurs in this moat; in cool years different generations of lake ice are distinguishable from the air. Similar moats occur around a small unnamed island in the fiord. Periodic ice calving from the southern front of the ice shelf has occurred. From photographs taken in 1947 and 1959 it is evident that many small ice-bergs calved and disintegrated in the moat between the ice shelf and the shore. Two larger bergs moved slightly but did not disintegrate. Movement of the small bergs implies a short open water or break-up period between 1959 and 1966. Since 1966, summer field parties have not reported such break-up conditions in the fiord. Milne Fiord is the only other northern Ellesmere Island fiord blocked form the ocean by an ocean shelf. Markham, M'Clintock and Ayles Fiords were blocked in a similar manner until the partial disintegration of the Ward Hunt Ice Shelf in 1961-62. (Ecol Can 988) Ecol Can 988

833. **Hays, J.D.** 1978. A Review of the Late Quaternary Climatic History of Antarctic Seas. *Antarctic Glacial History and World Palaeoenvironments, E.M. van Zinderen Bakker (Ed.). Proceedings of a Symposium held on 17th August, 1977 during the 10th INQUA Congress at Birmingham, U.K. A.A. Balkema, Rotterdam, (pp. 57-71), 172 pp.*

Detailed faunal and isotopic studies of Antarctic and sub-Antarctic deep-sea cores indicate that during most of the late Quaternary (last 200,000 years) climatic changes in the area are in phase or nearly in phase with Northern Hemisphere glacial advances and retreats. However, changes in sub-Antarctic sea surface temperatures in much of the record precede slightly (approximately 3,000 years) changes in Northern Hemisphere glaciers. In the Holocene, for example, sub-Antarctic surface waters reached a temperature maximum approximately 9000 years B.P., have been cooling since and are today half way between interglacial maximum and glacial minimum temperatures. This provides strong evidence that Southern Hemisphere climates are not being driven by changes in the volume of Northern Hemisphere ice sheets. Furthermore, changes in aerial extent of Antarctic sea ice, probably the most remarkable Pleistocene changes to occur in Antarctic Seas, also precede changes in Northern Hemisphere ice volume. Power spectrum analysis of the climatic record in sub-Antarctic deep-sea cores shows that the dominant frequencies resolved represent periods of approximately 100, 000 years, 41,000 years and 23,000 years. These are nearly identical to the dominant periods of volume change of Northern Hemisphere glaciers and changes in geometry of the Earth's orbit. This indicates that major climatic changes on the time scales of ice ages are induced by insolation changes in responses to the changing parameters of the Earth's orbit around the sun. (Auth)

834. **Hays, J.D., J. Lozano, and G. Irving.** 1974. High Southern Latitudes Estimated Temperature Changes of the Last 20,000 Years. *Climatic Research Unit Research Publication No. 2; Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the Time of the Last Glacial Maximum about 17,000 Years Ago, Proceedings of an International Conference, Norwich, May 17-22, 1973. Collected Abstracts. Climatic Research Unit, University of East Anglia, Norwich, England, (p. 80), 123 pp.*

The interpretation of radiolarian fossils in sediment cores from the Antarctic sea floor indicates that a pronounced warming occurred over most of the core sites at 10,000 B.P. Since that interval of warmth, temperatures have declined, and in some cores present temperature estimates approximate those at 17,000 to 20, 000 years ago. (JTA)

835. **Herman, Y., J.R. O'Neil, and C.L. Drake.** 1972. Micropaleontology and Paleotemperatures of Postglacial SW Greenland Fjord Cores. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 357-407), 511 pp.*

Faunal analysis accompanied by oxygen isotope paleothermometry and gross sediment characteristics have been utilized to reconstruct Postglacial environments in the Igaliko and Julianehaab fjords, SW Greenland. The time interval represented by the longest core is estimated to be about 5,500 years. Temperature and salinity tolerance, as well as substrate preference appear to be the dominant factors controlling benthonic foraminiferal distribution. A marked degree of similarity between the recent SW Greenland fjord fauna and the benthic assemblages that populated Oslo fjord, SW Greenland, in late Glacial and Early Postglacial time was observed, suggesting similar environments during their deposition. Correlation between paleoclimatic evidence based on our faunal and Oxygen 18/Oxygen 16 data, and Dansgaard's oxygen isotope paleotemperature record of the Greenland Ice Sheet is presented. Oxygen 18/Oxygen 16 measurements on isotopically well-behaved pelecypods and gastropods from the Igaliko and Julianehaab cores and one trawl sample suggest that mean bottom water temperatures have not varied significantly from present-day values in the last 5,500 years. Higher apparent temperatures in the calculated range of 0.2 deg to 2.8 deg are probably the result of admixing of glacial melt water. Other taxa analyzed yield anomalously high temperatures. It is proposed that there is a temperature for each species below which non-equilibrium precipitation of carbonate takes place. All specimens examined had Carbon 13/Carbon 12 ratios typical of normal marine carbonate. In Julianehaab fjord, where thick turbidite, slump and glacial-marine sequences intervene silty lutite deposits, sedimentation rates were much higher than in Igaliko fjord. Concentration of iron sulfides and black plant detritus in lower core sections suggests that deep-water stagnation was more severe during the early phases of the Holocene, than it is today. (Auth)

836. **Hillaire-Marcel, C.** 1981. Isotopic Paleo-Oceanography of the Post-Glacial Marine Basins of Quebec. Paleo-Oceanographie Isotopique des Mers Post-Glaciaires du Quebec. *Palaeogeography, Palaeoclimatology, Palaeoecology 35:63-119.*

It is concluded that the present marine basins of Quebec do not show any large differences in either salinity or temperature from the post-glacial basins. More brackish water has characterized the surficial layers since deglaciation. Shoaling of the basins, due to glacio-isostatic rebound, later induced local variations in the temperature and salinity, the water becoming progressively warmer and more brackish. In these basins, the geochemistry of carbon is more complex. The IN SITU biological production of Carbon Dioxide caused large variations in the Carbon 13 content of the carbonates, independently of any direct continental influence. The observed anomalies in Carbon 14 activity of fossil mollusks are believed to be related to the "old-water" effect and to local influx of "dead" carbon originating from dissolution by ice meltwater of surrounding carbonate-bearing bedrock. (Auth) (JTA)

837. **Jansen, J.H.F., J.W.C. Doppert, K. Hoogendoorn-Toering, J. de Jong, and G. Spaink.** 1979. Late Pleistocene and Holocene Deposits in the Witch and Fladen Ground Area, Northern North Sea. *Netherlands Journal of Sea Research 13(1):1-39.*

Determinations of carbonate, total N, and organic C content, grain size distributions, analyses of Foraminifera, molluscs and pollen, as well as two Carbon 14 data of cores taken in the Witch and Fladen Ground area, were used to supplement earlier interpretations of acoustical reflection records, in an attempt to clarify the Late Pleistocene and Holocene history of the northern North Sea. Starting from below, the lower and Upper Swatchway Beds, containing not only glaciomarine deposits but also temperate marine sediments, are shown to be at least Middle Weichselian and possibly of Eemian age. The overlying Hills Deposits consist of a subglacial till, forming the base of a morainic facies, with arctic glaciomarine sediments above and alongside it. The postglacial rise of the sea level and the increase of seawater temperature were recorded in the glaciomarine Fladen Deposits and marine Lower Witch Deposits. For the greater part sedimentation ended during Boreal times (pollen zone IIa2) with the formation of the Upper Witch Deposits, a veneer of fine sands which is correlated with the development of the East Bank Deposit northeast of Dogger Bank. The succession is correlated with a sequence of deposits in a system of buried channels between Witch Ground and Dogger Bank. A belt of tunnel valleys marks the maximum Weichselian ice extension, which occurred at roughly the time of formation of the Hills Deposits. A Witch Ground shore line, probably of about 15,000 yr B.P., is present at about 110 m below sea level, and is proposed to represent the lowest level of the last Weichselian substage. (Auth)

838. **Kellogg, T.B.** 1975. Late Quaternary Climatic Changes in the Norwegian and Greenland Seas. *Climate of the Arctic, G. Weller and S.A. Bowling (Eds.), Proceedings of the Twenty-Fourth Alaska Science Conference, August 15-17, 1973. Geophysical Institute, University of Alaska, Fairbanks, Alaska, (pp. 3-36), 436 pp.*

Anlyses of total carbonate and coarse fraction content in 29 deep-sea cores provide climatic data for the past 150,000 years in the Norwegian and Greenland Seas. Only during the Eemian interglacial did temperatures moderate to about present levels. Quantitative paleo-temperature estimates, derived by applying the Imbrie & Kipp (1971) technique to seven cores, show that except for the Eemian and Recent interglacials, temperatures less than 0 C in winter and 5 C in summer prevailed throughout the region. This temperature regime is identical to that of the northwestern Greenland Sea today, where sea-ice is present during the winters. For about 100,000 of the past 127,000 years, therefore, ice has probably covered most or all of the Norwegian and Greenland Seas, at least during the winters. The Norwegian Current, a branch of the Gulf Stream, is reponsible for the relatively warm climate of Scandinavia at the same latitude where Greenland supports an ice cap. In addition, the Norwegian Current controls the present distributions of planktonic and benthonic foraminifera and the present extent of sea-ice cover. Based on faunal and sedimentary changes in the deep-sea cores, most of the past 150,000 years (at least) was characterized by a surface water circulation pattern in which the Norwegian Current was either much weaker or absent, thus allowing sea-ice formation throughout the region. The only exception to this observation occurs during the Eemian interglacial when conditions were comparable to those of the present. (Auth)

839. **Kellogg, T.B.** 1976. Late Quaternary Climatic Changes: Evidence from Deep Sea Cores of Norwegian and Greenland Seas. *Investigation of Late Quaternary Paleooceanography and Paleoclimatology, Geological Society of America Memoir 145, R.M. Cline and J.D. Hays (Eds.). Geological Society of America, Boulder, CO, (pp. 77-110), 464 pp.*

The present temperature regime of the Norwegian and Greenland Seas results largely from the warm Norwegian Current. This current is partially responsible for the maritime climates of northern Europe and Scandinavia, and it controls the distribution of planktonic Foraminifera and the extent of sea-ice cover in the Norwegian and Greenland Seas. Analyses of 6 piston cores show that Norwegian Sea temperatures during most of the past 150,000 yr have been much lower than they are now. Only between 127,000 and 110,000 B.P. did temperatures approach or surpass present-day temperatures. For the remaining time, foraminiferal faunas were similar to or even less diverse than those of today in the northern Greenland Sea, where ice cover is present in winter. This suggests that during most of the last 150,000 yr, ice covered all of the Norwegian and Greenland Seas, probably on a year-around basis. As a result, northern Europe and Scandinavia did not receive air warmed by the Norwegian Current as they do now. Additionally, the presence of total sea-ice cover prevented the formation of Norwegian Sea overflow water, thus altering the deep circulation of the Atlantic. (Auth)

840. **Kellogg, T.B.** 1977. Paleoclimatology and Paleo-Oceanography of the Norwegian and Greenland Seas: the Last 450,000 Years. *Marine Micropaleontology 2(3):235-249.*

Planktonic foraminiferal assemblages in Norwegian sea sediment show that during the past 450,000 years a glacial regime, characterized by permanent sea-ice cover and the absence of the Norwegian Current, prevailed in the Norwegian Sea. These extremely cold conditions were interrupted by short, quasi-periodic (period of about 100,000 years) incursions of water warm enough to reduce sea-ice cover on a seasonable basis. Only the 2 most recent incursions were of sufficient intensity to bring relatively warm Norwegian Current waters into the region and thus justify here the name "interglacial": the last interglacial (about 120,000 B.P.) and the Holocene. The absence of the Norwegian Current from the Norwegian Sea for all but about 20,000 of the last 450,000 years had 2 important effects. First, a major source of heat for the Scandinavian land mass was not present except during the Holocene and the last interglacial. Thus, Scandinavia probably enjoyed a climate much like, or more severe than, that of Spitsbergen for most of the last 450, 000 years. Large ice sheets were probably the rule rather than the exception. Second, the sources of saline water for the formation of North Atlantic Deep Water was not present. This fact, together with the prevailing ice cover, prevented formation of a deep-water mass, except during the Holocene and the last interglacial. Deep water in the North Atlantic for all the remainder of the last 450,000 years must have formed elsewhere and by another mechanism. The prevailing ice-covered condition of the Norwegian Sea rules out the possibility of an open surface-water connection between the Arctic and the North Atlantic oceans for all of the last 450,000 years. This is further evidence that the Ewing-Donn theory of an ice-free Arctic Ocean is incorrect. Of all the Pleistocene interglacial events recognized in temperate and low latitudes, only the last interglacial (Eemian) and the Holocene were intense enough to transport warm water into the Norwegian Sea and melt large amounts of sea ice. Further theories to explain climatic change must account for these anomalously warm interglacials as well as the extremely cold average conditions of the Norwegian Sea. (QL/ASFA) QL/ASFA

841. **Kellogg, T.B., L.E. Osterman, and R.S. Truesdale.** 1978. Late Quaternary Paleoecology and Paleoclimatology Inferred from Ross Sea Sediments. *Antarctic Journal of the United States 13(4):124-125.*

We studied microfossis in core-top samples to determine oceanographic, environmental, and sedimentary conditions that control modern faunal and floral distributions. Three sedimentary units were encountered in Ross Sea cores (figure 1). Unit A, consisting of diatom-rich, silty sediment (greater than 90 percent silt-size or smaller), occurs at the tops of most Ross Sea cores. This unit varies systematically in thickness throughout the Ross Sea (figure 2); it is thin or absent near the Ross Ice Shelf but it is about 150 centimeters thick near the continental shelf margin. Foraminifera, Radiolaria, and sponge spicules comprise coarse particles in unit A. We think Unit A is Holocene rather than Brunhes. We obtained a radiocarbon date of 7,360 (+ 3,700– -2,500) years (QL-1125) on a composite sample from the base of unit A from the southern Ross Sea (M. Stuiver, written communication, 1978). Unit A represents postglacial sedimentation just north of and on the continental shelf under conditions similar to those that prevail today. The systematic variation in thickness of unit A is related to the length of time since grounded ice covered each core location and indicates that the base of unit A is time-transgressive. (Auth)(JTA)

842. **Kellogg, T.B., and R.S. Truesdale.** 1979. Late Quaternary Paleoecology and Paleoclimatology of the Ross Sea: the Diatom Record. *Marine Micropaleontology 4:137-158.*

Factor analysis of marine-diatom census data from five Ross Sea piston cores resolved four floral assemblages in Ross Sea core-top samples. All cores examined have three distinct lithologic units. The lowermost, Unit B, is interpreted as till deposited under grounded ice during the last expansion of the West Antarctic Ice Sheet. Unit B is characterized by a diatom flora of reworked species with widely differing stratigraphic ranges. A Transition Zone between Unit B and Unit A consists of well sorted, sandy sediments with a diatom flora dominated by EUCAMPIA BALAUSTIUM. This Transition Zone was probably deposited under a regime of strong bottom currents immediately following retreat of the grounding line past each core location. The uppermost sediment, Unit A, represents a return to marine conditions. In core EL32-8, from the Northwestern Ross Sea, Unit A is 152 cm thick and probably contains a record of Holocene climatic fluctuations. Diatom floras in this core indicate that, immediately following retreat of the grounded ice sheet, the sea surface was somewhat warmer than today during the summers. Diatom floras in the uppermost 72 cm of Unit A in EL32-8 and in Unit A in all of the remaining cores indicate conditions similar to those of today. This paleoclimatic reconstruction appears to support the contention of some glacial geologists that grounded ice extended to the continental shelf margin at the last glacial maximum. (Auth)

843. **Kjemperud, A.** 1981. A Shoreline Displacement Investigation from Frosta in Trondheimsfjorden, Nord-Trondelag, Norway. *Norsk Geologisk Tidsskrift 61(1):1-15.*

Diatom analyses, pollen analyses and radiocarbon dating have been used to establish the Holocene shoreline displacement. Twenty-three radiocarbon dates, together with eight pollen analytical dates, are presented. The hyperbolic form of the shoreline displacement curve, which is based on ten dated marine/lacustrine boundaries, shows a continual regression from Younger Dryas to the present. (from Author) GA 81A/2522

844. **Lamb, H.H.** 1979. Climatic Variation and Changes in the Wind and Ocean Circulation: The Little Ice Age in the Northeast Atlantic. *Quaternary Research 11:1-20.*

Variations must take place in the ocean circulation when the general wind circulation varies. There are hints even within recent years that the variations in the ocean between Iceland and Scotland and Norway can be big: The area has been regarded as the main path of the warm, saline North Atlantic Drift water heading towards the Arctic; but, when the polar water occasionally intrudes from the north, sea-surface temperature is liable to fall by 3 to 5 deg C and presumably by more than this when, as in 1888, the ice advanced to near the Faeroe Islands. The long series of sea surface temperature observations at this point, starting in 1867, and earlier observations covering the area in 1789, are studied. Various kinds of proxy data–notably the CLIMAP Atlantic ocean-bed core analysis results for the last Ice Age climax and cod fishery and sea-ice reports from the Little Ice Age in the 17th century A.D.–are then used to indicate the variability in this part of the ocean on longer time scales. The reconstruction of the situation between A.D. 1675 and 1705 resulting from this study suggests a probable mean departure of the sea surface temperature from modern values between the Faeroes and southeast Iceland amounting to about -5 deg C; and at the climax in 1695 the polar water seems to have spread all around Iceland, across the entire surface of the Norwegian Sea to Norway, and south to near Shetland. Support for this diagnosis is found in a considerable variety of reports of environmental conditions existing at the time in Scotland, south Norway and elsewhere. The enhanced thermal gradient between approximately latitudes 55 and 65 deg N during the Little Ice Age, which this result indicates, offers an explanation for the occurrence in that period of a number of windstorms which changed the coasts in various places and seem to have sur-

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passed in intensity the worst experienced in the region in more recent times. (Auth)

845. **Lamb, H.H., and A.I. Johnson.** 1961. Climatic Variation and Observed Changes in the General Circulation, III; Investigation of Long Series of Observations and Circulation Changes in July. *Geografiska Annaler 43(3-4):363-400.*

Discussion of arctic sea ice charts shows that in summer the extent and distribution of floating ice and cold surface melt water affects the atmospheric circulation much more than the circulation affects the long-term ice situation. Growth or decline of arctic sea ice, however, seems to depend on variations in the direct heating budget, and in the strength of atmospheric circulation, particularly in the colder months. Sea ice extent on nine northern water bodies is tabulated for irregular chronological periods from 1594-97 to 1950-59. Analysis of changes in general atmospheric circulation in July since 1750, also of corresponding changes in rainfall, air and sea temperature, and ice distributions, indicates a period of generally warm climate about 1000-1200, followed approx. 1430-1850 by the "little ice age" cold epoch, which culminated in the 17th century. Slightly reduced effective solar radiation is suggested as a cause of this little ice age; other possible explanations are also noted. (AB73286) AB73286

846. **Maksimov, I.V.** 1972. Causes of the Increase in the World Ocean Level in the 20th Century. *Oceanology 11(3):444-454.*

An analysis of all available data shows that the World Ocean level has risen on the average by 6.10 cm during the last 50 years. It was generally believed that the rise has been associated with the melting of glaciers in Greenland and Antarctica. New hypotheses of the heliogravitational background of the ocean level fluctuations are discussed on the basis of studies of variations in pressure field of the Earth associated with the 11-yr solar activity cycle, annual water temperature variations, and iceberg distributions in the polar regions. (AntB J-10688) AntB J-10688

847. **Malyasova, Ye.S., and M.A. Spiridonov.** 1966. New Data on Holocene Stratigraphy of the Barents Sea. Novyye dannyye po stratigrafii golotsena Barentseva morya. Russian. *Verkniy pleystotsen 1966:106-111.*

Reports a spore-pollen study of bottom sediments from four cores. The data are used to correlate marine and continental deposits and to trace changes in the vegetation during the Holocene. (AB105632) AB105632

848. **Moore, T.C., Jr.** 1973. Late Pleistocene-Holocene Oceanographic Changes in the Northeastern Pacific. *Quaternary Research 3(1):99-109.*

The distributions of the radiolarian assemblages in the northeastern Pacific Ocean were determined and correlated with the average summer temperature of the near surface waters of this region. These assemblages were compared with those in three sediment cores taken beneath the Transition Zone waters. This comparison indicates that the assemblage off Oregon at the last maximum cold interval (24,000 yr B.P.) was like that now found off southern Alaska. The correlation of the radiolarian assemblages with temperature gives an estimate of 11 deg C for the average summer temperature at that time. This is approximately 4 deg C cooler than present day conditions in the area. Superimposed on the general warming trend that began 24,000 B.P., there are minor oscillations in the assemblages which correspond to estimates of temperature change of about 2 deg C in the Pleistocene and about 1 deg C in the Holocene. In the Holocene, these minor warm intervals appear to be approximately synchronous with advances in mountain glaciers. (Auth) GA 74A/0146

849. **Moore, T.C., Jr.** 1974. Late Pleistocene-Holocene Oceanographic Changes in the Northeastern Pacific. *Climatic Research Unit Research Publication No. 2; Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the Time of the Last Glacial Maximum about 17,000 Years Ago. Proceedings of an International Conference, Norwich, May 17-22, 1973. Collected Abstracts. Climatic Research Unit, University of East Anglia, Norwich, England, (pp. 66-80), 123 pp.*

This paper discusses the interpretation of radiolarian asssemblages from three piston cores. Although radiometric dating control is lacking in the upper part of the cores, intervals of higher temperature are estimated to have occurred at about 2500, 4700, 8000, and 10,500 B.P. Dating errors are suggested to be in the range of + or - 1000 years. A table is included which gives calculated minimum and maximum temperatures at 3 core sites. Estimates are included for six intervals within the Holocene. Latitude and longitude readings for the three cores are given in the caption to Fig. 2. (JTA)

850. **Morner, N.-A.** 1971. The Holocene Eustatic Sea Level Problem. *Geologie en Mijnbouw 50(5):699-702.*

As the Holocene climate was oscillating and sea level oscillations are recorded in areas studied in detail, the author considers a low amplitude oscillating eustatic curve will be accepted. High sea level stands about 5,000 and 3,500 B.P. have been recorded in several areas. The main problem however, is that the difference between curves for various parts of the world does not grow bigger back in time (which would have been the case if the cause were different isostatic changes) but that all curves converge at about 4,500-5,000 B.C. One possibility is that the ocean level was different and unequal to that of today. Another is the occurence of reversed isostatic movements during transgression caused by a compensational upheaval changed to hydroisostatic subsidence. (Margaret A. Bass) GA 72A/1760

851. **Morner, N.-A.** 1971. Eustatic and Climatic Oscillations. *Arctic and Alpine Research 3(2):167-171.*

Attention is drawn to the fact that several different methods indicate global climatic oscillations to be well established not only for the Late Glacial period but also for the whole of the Postglacial (Flandrian, Holocene) period. These oscillations were drastic enough to affect the ocean level even during the last 6,000 years when only minor glaciated areas were left after the last ice age. A low amplitude oscillating eustatic curve during the Holocene is in full concordance with the climatic and glacier changes which have been found. Therefore, smooth "eustatic" curves (type Shepard's curve) are considered to be overgeneralized or based on incomplete information. (Auth)

852. **Morner, N.-A.** 1973. Eustatic Changes during the Last 300 Years. *Palaeogeography, Palaeoclimatology, Palaeoecology 13(1):1-14.*

Tide gauges in rising and subsiding areas show a major change in the shore-level displacement at about A.D. 1840, caused by the onset of a rapid eustatic rise. Comparisons between information from Amsterdam, Stockholm and Warnemunde provide material for the reconstruction of the eustatic changes during the last 290 years. Relative uplift data from the Swedish west coast, corrected according to the eustatic curve established here, give the same location of

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the isostatic zero isobase as does the geological material for the last 7,000 years. The eustatic changes closely follow climatic changes. A rapid eustatic rise started about 1840, slowed down about 1930 and ended about 1950. Knowing the eustatic factor, the isostatic (or tectonic) factor is calculated for different areas of importance in the discussion of Holocene eustatic sea-level changes. (Auth) GA 73A/1406

853. **Newell, J.** 1983. Preliminary Analysis of Sea-Ice Conditions in the Labrador Sea during the Nineteenth Century. *Climatic Change in Canada 3, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 49, (pp. 108-129), 343 pp.*

The ice regime of the Labrador Sea consists of the Labrador pack, which is a mixture of ice from Baffin Bay and Hudson Strait, and the Storis, which originates from East Greenland. This paper considers the Labrador pack and not the Storis for the period 1800-1900 A.D. The study shows that during the nineteenth century, ice conditions in the Labrador Sea were more severe than present normals and that for at least 46 percent of the years conditions were more severe than the present extremes. (JTA)

854. **Olausson, E., and U.C. Jonasson.** 1969. The Arctic Ocean during the Wurm and Early Flandrian. *Geologiska Foreningens i Stockholm Forhandlingar 91:185-200.*

The Arctic Ocean has been covered by pack-ice during the last 11,000 years. This situation will prevail until the salinity stratification disapppears. During glacial phases no halocline existed due to the low fresh water supply. The last phase with an open Arctic Ocean was the Upper (Main) Wurm. A salinity discontinuity was established probably at the end of the Allerod subage as a result of high meltwater supply and inflow from the Pacific. The change from open into ice-covered conditions causes a large increase in the albedo of the Arctic Ocean. This caused a great drop in (summer) temperature. This climatic deterioration is supposed to be the Younger Dryas stadial. (Auth)

The idea that the Arctic Ocean was ice-free during the late Wisconsin Glaciation is not generally accepted, but the theory deserves consideration in view of concerns about CO2 effects and disappearance of the Arctic sea-ice cover. (JTA)

855. **Osterman, L.E.** 1982. Late Quaternary History of Southern Baffin Island, Canada: A Study of Foraminifera and Sediments from Frobisher Bay. *Ph.D. Thesis, University of Colorado, Boulder, CO, 380 pp.*

Three piston cores from Frobisher Bay, Baffin Island, Canada, were analysed to determine the glacial and climatic history of the area, and to test the maximum versus minimum model of the 18,000 B.P. Laurentide reconstruction. Radiocarbon dating indicates there is a continuous record from 27,225 + or - 1250 B.P. to the present. There is evidence in the upper part of the cores that the present day Baffin-Labrador Current did not become established until after 5,000 B.P. The initiation of this cold water coastal current may have augmented the climatic deterioration during the period of neoglaciation on Baffin Island. Before 5,000 B.P., the coast of Baffin Island was under the influence of the warmer proto-West Greenland Current. This supports the "cool land/warm ocean" model for glaciation on Baffin Island. The dramatic increase of NONION LABRADORICUM in the upper part of the cores is believed to be related to the reinstitution of the Baffin-Labrador Current. (Auth)(JTA)

856. **Pisias, N.G, J.P. Dauphin, and C. Sancetta.** 1973. Spectral Analysis of Late Pleistocene-Holocene Sediments. *Quaternary Research 3(1):3-9.*

Spectral analysis of deep-sea sediments indicates that the fluctuations in compositional parameters are not random fluctuations with time. Spectra show significant peaks representing periodicities in the data of 380, 1300, and 2600 years. Two of these periods are similar to periods reported in Carbon 14 fluctuations. Analysis of a palaeotemperature curve from the North Atlantic shows that the characteristics of the fluctuations within interglacial and glacial stages of the climate are similar, and that the spectrum has a signifcant peak at 2600 years. (Author) GA 74A/0139

857. **Ruddiman, W.F., and L.K. Glover.** 1975. Subpolar North Atlantic Circulation at 9300 yr B.P.: Faunal Evidence. *Quaternary Research 5:361-389.*

We have examined the circulation of the subpolar North Atlantic at 9300 yr B.P. by using a dispersed layer of silicic volcanic ash as a synchronous horizon. At the level of this datum, we have reconstructed from foraminiferal evidence a geologically synoptic view of seasonal variations in sea-surface temperatures and salinities. The reconstruction defines two oceanic fronts at 9300 yr. B.P.: (1) the meridionally oriented Polar Front bordering the axis of deglacial outflow of Arctic and Laurentide ice and melt-water and (2) a zonal portion of the Subarctic Convergence along 48 deg N, marking a major confluence between the subtropical and subpolar gyres. The 9300-yr configuration primarily differed from the modern pattern in the more easterly position (by 3 deg) of the Polar Front and the more southerly (3 deg) and easterly (5 deg) position of the Subarctic Convergence. (Auth)(JTA)

858. **Ruddiman, W.F., and A. McIntyre.** 1973. Time-Transgressive Deglacial Retreat of Polar Waters from the North Atlantic. *Quaternary Research 3:117-130.*

A 9300 yr-old zone of disseminated volcanic ash in North Atlantic sediments between 45 deg N and 65 deg N provides a time-synchronous reference layer against which we have compared the stratigraphic level of deglacial warming of ocean surface waters. In the Atlantic north of 45 deg N the most prominent feature of this warming is the replacement of low-carbonate glacial marine sediment containing only a single species of polar Foraminifera by calcareous oozes containing a diverse temperate fauna and flora. The local terminations of glacial conditions marked by this change are not synchronous at these latitudes, but range from 13,500 yr B.P. to older in the southeast near Great Britain to 6,500 yr B.P. or younger in the northwest near Greenland. Regionally, these local warmings trace the progressive westward and northward retreat of polar water from the North Atlantic. Since the withdrawal of polar water from the North Atlantic coincides with the northward shrinkage of temperate-latitude continental ice sheets, it is the best oceanic analog to continental deglaciation. Faunal, floral, lithologic, and isotopic parameters showing evidence for a sudden deglacial warming may not be time-synchronous; those parameters are subject to a range of environmental controls and may thus respond differently to the causal mechanism for global warming. (Auth)

859. **Ruddiman, W.F., and A. McIntyre.** 1977. Late Quaternary Surface Ocean Kinematics and Climatic Change in the High-Latitude North Atlantic. *Journal of Geophysical Research 82(27):3877-3887.*

The late Quaternary earth is characterized by quasi-periodic glacial-interglacial cycles. In the higher latitudes of the North Atlantic these have been registered by large-scale surface water mass movements. During major climatic changes the North Atlantic polar front moved as a line hinged in the western Atlantic south-southeast of Newfoundland, sweeping out an arc larger than 45 deg and increasing in angle slightly to the northeast toward the European mainland. Its position is a critical monitor of whether warm saline North Atlantic Drift water flowed into the northeast Atlantic and southeast Norwegian Sea or turned southeastward and was contained within the subtropical gyre. Only during peak interglacial portions of the last 800,000 years (as at present) did North Atlantic water penetrate into the Labrador Sea and west of Iceland. During most of the interglacial isotopic stages, this flow was cut off by a SSW-NNE polar front alignment that intersected Iceland. During main glacial portions of these cycles the average position of the polar front trended WSW-ENE across the subpolar Atlantic, roughly intersecting the Faeroes. This configuration virtually eliminated North Atlantic Drift flow into the Norwegian Sea and west central North Atlantic. (Auth)

860. **Ruddiman, W.F., and A. McIntyre.** 1981. The North Atlantic Ocean during the Last Deglaciation. *Palaeogeography, Palaeoclimatology, Palaeoecology 35(2-4):145-214.*

The last deglacial warming of the high-latitude North Atlantic Ocean (40 degrees - 65 degrees) occurred in three discrete steps: in the southeast and central regions at 13,000 B.P.; in the central and northern sectors at 10,000 B.P.; and in the western (Labrador Sea) sector between 9000 and 6000 B.P. This regionally time-transgressive sequence was punctuated by a major cooling and polar front readvance from 11,000 to 10,000 B.P.; this briefly returned most of the high-latitude North Atlantic to almost full-glacial temperatures. The brief but strong oceanic cooling roughly coincident with the European Younger Dryas (11,000 to 10,000 B.P.) appears to mark a major influx of tabular icebergs from a disintegrating Arctic ice shelf, perhaps enhanced by external forcing at higher frequencies (2500 yr). (Auth)(JTA)

861. **Schell, I.I.** 1961. The Ice off Iceland and the Climates during the Last 1200 Years, Approximately. *Geografiska Annaler 43(3-4):354-362.*

Limited evidence shows that the duration and extent of ice off Iceland, when considered by longer, i.e. 100-year intervals, are indicators of the climate of Iceland, Greenland, Europe, North America and other areas. Such intervals with little ice off Iceland appear to be associated with higher temperatures, generally less precipitation and lower lake level and river discharge; intervals with much ice are associated with lower temperatures, generally more precipitation, etc. Comparison is made with mean annual temperature of Jakobshavn in Greenland, Vardo in Norway, and Arkhangel'sk among other stations. (AB75407) AB75407

862. **Schledermann, P.** 1980. Polynyas and Prehistoric Settlement Patterns. *Arctic 33(2):292-302.*

In traditional Inuit society the availability of game resources must always have been one of the most important criteria for the determination of settlement locations. A number of ecological factors determine the availability of particular game species in the Arctic regions. The presence of open water areas known as polynyas is one of these factors. The relationship between polynya distributions and prehistory settlement patterns in the High Arctic is explored, with particular reference to the Bache Peninsula region on the east coast of Ellesmere Island, N.W.T. (Auth)

863. **Schnitker, D.** 1979. The Deep Waters of the Western North Atlantic during the Past 24,000 Years, and the Re-Initiation of the Western Boundary Undercurrent. *Marine Micropaleontology 4:265-280.*

Changes in composition of benthic foraminiferal faunas in two cores from the North American continental rise (at approximately 3000 m and approximately 4000 m depth) and one core from the center of the North American Basin (at approximately 4600 m depth) reflect changes in the nature of bottom water in the western North Atlantic during the past 24,000 years. During the late glacial times the portion of the basin below 4500 m depth was filled with cold, well oxygenated water, probably of local North Atlantic origin. This water was overlain by more than 1500 m of "old", oxygen-deficient water, of probably southern (Antarctic) origin. A basinwide change of deep water occurred first at about 12,500 yr B.P., which resulted in a strong vertical differentiation of the water masses. As the deepest water became isolated and was losing oxygen, a western boundary undercurrent became established which carried well-oxygenated water at approximately 3000 m depth along the continental rise. "Old" oxygen-deficient water reoccupied the levels between these two. A second basinwide change occurred shortly after 9000 yr B.P., marking the beginning of modern deep-water conditions. The Western Boundary Undercurrent enlarged, moved downslope and flushed out the "old" glacial-age deep water. Norwegian Sea overflow reached its maximum about 4000 years ago. The center of the basin experienced the second change with a delay of about 1000 years, when it filled with Norwegian Sea Overflow Water, and later (after 5000 yr. B.P.) received large proportions of Antarctic Bottom Water. These deep-water events are correlated with the initial retreat of the polar front into the Norwegian Sea, its southward readvance, and the final opening of the Norwegian Sea to the inflow of North Atlantic Drift water. (Auth)

864. **Sejrup, H.-P., H. Holtedahl, O. Norvik, and I. Miljeteig.** 1980. Benthonic Foraminifera as Indicators of the Paleoposition of the Subarctic Convergence in the Norwegian–Greenland Sea. *Boreas 9:203-207.*

A method is presented for correlating benthonic foraminiferal communities in Late Quaternary marine sediments on continental shelves and in coastal areas with the planktonic foraminiferal stratigraphy of the North Atlantic and Norwegian Sea deep-sea sediments. Two radiocarbon dates of marine molluscs from this core (74-A-07-16) indicate that this shift in the benthonic foraminferal fauna occurred around 9810 + or - 280 years B.P. (T-2859), but definitely after 11,060 + or - 210 years B.P. (T-2860). Analyses of core V27-86 from the Norwegian Sea at a depth of 2900 m are also included in Fig. 2. Two pronounced peaks in the percentages of G. PACHYDERMA (right) occur in this core. Kellogg (1976, 1977) concludes that these peaks represent intervals when Atlantic water intruded into the Norwegian Sea during the late Quaternary and displaced the Polar Front. We suggest that the observed change in the benthonic foraminiferal faunas records the same events. The Holocene warm pulse is recorded in cores 361 and 74-A-07-16 on the Norwegian continental shelf and the Eemian warm pulse is recorded in the raised marine sediments at Fjosanger. As the cores are relatively closely spaced, the faunal changes are supposed to have taken place at approximately the same time at both localities as the Polar Front moved towards the Norwegian coast. (Auth)(JTA)

865. **Shaw, D.M., and W.L. Donn.** 1971. A Thermodynamic Study of Arctic Paleoclimatology. *Quaternary Research 1(2):175-187.*

A thermodynamic model of J. Adem has been applied to the determination of Arctic and hemispheric surface temperatures with both ice-covered and ice-free states of the Arctic Ocean. The effect of glaciated and nonglaciated continents is included in the investigation. With an ice cover over the Arctic, as at present, computed temperatures for the polar sea and the Northern Hemisphere correspond closely with present observations. Over a broad range of the critical parameters, removal of the ice cover yields computed temperatures that remain well above freezing level throughout the year. With glaciated continents computed Arctic temperatures are depressed. (Auth)

866. **Smed, J.** 1978. Fluctuations of the Temperature of the Surface Water in Areas of the Northern North Atlantic, 1876-1975. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 154-161), 259 pp.*

Sea surface temperature anomaly graphs for regions in the western and eastern North Atlantic between 1876 and 1977 A.D. are presented, with a gap in the records during World War II. In all areas temperatures decreased to a minimum in the 1880's. Maximum temperatures are recorded in the 1890's, late 1920's-1930's and 1960's. Minimum temperatures are observed in the 1920's, early 1950's, and the early 1970's. Changes in temperature from the long-term mean in the different ocean areas range between -1 and +1 deg C. A change of 1 1/2 deg C in less than 10 years was noted near Greenland. (JTA)

867. **Stewart, T.G., and J.H. England.** 1983. Holocene Sea-Ice Variations and Paleoenvironmental Change, Northernmost Ellesmere Island, N.W.T., Canada. *Arctic and Alpine Research 15(1):1-17.*

More than 70 samples of Holocene driftwood between present sea level and the marine limit are plotted on an emergence curve from Clements Markham Inlet (82 deg 40 min N). Three periods of driftwood abundance and sparsity are recognized. These are interpreted as indications of climatically induced changes in summer sea ice conditions. Period 1 extends from initial driftwood entry ca. 8900 B.P. until ca. 4200 B.P. During this period driftwood penetration increases with greatest abundance (= reduced summer sea ice) ca. 6000 to 4200 B.P. During Period 2 (ca. 4200 to 500 B.P.) driftwood penetration is sparse whereas in Period 3 (<500 B.P.) driftwood bordering the present shoreline exceeds all the samples in the previous periods. Driftwood dates from elsewhere in the Canadian and Greenland High Arctic show similar periods. In Clements Markham Inlet the initiation of abundant driftwood penetration corresponds with the deposition in marine sediments of fossil bryophytes (25 species) dated 6400 B.P. This increased plant productivity is also interpreted as indicating summer warmth/higher precipitation associated with the greater open water. Accompanying these bryophytes is the disjunct marine pelecypod LIMATULA (LIMA) SUBAURICULATA which presently has a subarctic-boreal distribution. This paleoenvironmental information is discussed in relation to Holocene ice core records and the history of Arctic Ocean sea ice stability. (Auth)

868. **Taira, K.** 1979. Holocene Migrations of the Warm-Water Front and Sea-Level Fluctuations in the Northwestern Pacific. *Palaeogeography, Palaeoclimatology, Palaeoecology 28:197-204.*

In eastern Asia there are six complete cycles of ocean surface temperature in postglacial time, and the oscillations since 6000 years B.P. are a result of world-wide climatic change. In general, times of ocean surface warming correspond to periods of transgression, and the time of transgression is variable from south to north on a latitude base. The speed of the latitudinal shift is about 10 deg per 690 years. (Auth)

869. **Teh-Lung Ku, and W.S. Broecker.** 1967. Rates of Sedimentation in the Arctic Ocean. *The Quaternary History of the Ocean Basins, Progress in Oceanography Vol. 4, M. Sears (Ed.). Pergamon Press, New York, (pp. 95-104), 344 pp.*

The sedimentation rate in the Arctic deep-sea over the last 150,000 years has undergone no significant changes. Based on both radiocarbon and uranium series isotope analyses, the deposition rate is estimated to be about 0.2 cm/1000 years. These findings imply that: 1) the observed variations in the Foraminifera abundance in most Arctic cores reflect changes in the biological productivity; 2) the Arctic Foraminifera abundance curves cannot be simply correlated with those observed in the Atlantic deep-sea cores; and 3) the Arctic Ocean has not been open during the last 150,000 years. (Auth) GA 68A/1655

870. **Thomas, C.W.** 1965. Late Pleistocene and Recent Climates as Inferred from Ocean Bottom Cores. *Science in Alaska, Proceedings of the 15th Alaskan Science Conference, College, Alaska, Aug. 31-Sept. 4, 1964. American Association for the Advancement of Science, Alaska Division, College, AK, (pp. 73-82); Geological Society of America Special Paper 82:1-363.*

The paleoclimatic regime of the Arctic and Antarctic is discussed based on the findings of various investigators including the author. Most of the evidence (obtained from ocean bottom cores) indicates that if a "climatic optimum" existed about 6000 yr ago, it was confined to the lower latitudes. The present polar climate is the warmest since the Wisconsin glaciation; however, there must be a "glacial optimum" intermediate between cold temperatures which freeze sea water and temperatures warm enough to melt glaciers at a rate faster than they can accumulate. Evidence that there is a lack of bipolar synchronism is supported by Cromie who says Antarctic ice has been accumulating a million years while the Arctic has been periodically open. Although accumulation is not necessarily a function of low temperature, an ice covered Antarctic continent tends to stabilize the climate. Some investigators suggest that the lack of Permian bi-polar synchronism is evidence that the thermal regime at the opposite poles is not in phase. The modification of the Ewing and Donn theory of glaciation suggested by Colinvaux is supported by the evidence presented in this paper. (AntB I-3443) AntB I-3443

871. **Thomas, C.W.** 1966. The Post-Pleistocene Hypsithermal Interval: Is It Fact or Fiction?. *Sixteenth Alaskan Science Conference, E.G. Viereck (Ed.), Proceedings of Conference, Juneau, August 29-September 1, 1965. American Association for the Advancement of Science, Alaskan Division, College, Alaska, (pp. 138-149), 321 pp.*

Criticizes the concept of the hypsithermal interval or climatic optimum postulated on terrestrial and glaciological evidence as occurring ca 6000 B.P. The case for the optimum is summarized briefly, with references. The evidence for continuous warming since Wisconsin (post-Wurm) time is then reviewed. Marine sediments are considered to provide an ideal temperature recording mechanism. Cores from the Cariaco Trench, the Antarctic, Atlantic and Indian Oceans confirm that today's temperature is higher than any other post-glacial stage. It is concluded that warming was rapid to 6000

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B.P. and has continued more or less gradually since, except possibly in the equatorial plane. (AB92325) AB92325

872. **Turon, J.-L.** 1978. Dinoflagellate Cysts as Indicators of Holocene Paleoenvironments in the North-Western Atlantic Ocean, Paleohydrological and Paleoclimatologic Significance. Les dinoflagelles temoins des paleoenvironnements durant l'Holocene dans l'Atlantique nord-oriental. Signification paleohydrologique et paleoclimatique. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D 286(25):1861-1864.*

The study of four cores located in the Rockall channel proves great changes in dinoflagellate cyst productivity during the Holocene times. This productivity is found to be related to variability of nutrient amount in surface water masses. A general model of variation in anticyclonic regime over British Isles is proposed. (Auth)

873. **Vilks, G.** 1969. Recent Foraminifera in the Canadian Arctic. *Micropaleontology 15(1):35-60.*

Discusses the distribution of forams from cores and grab samples taken in Hecla and Griper Bay and Hazen Strait in 1966, in relation to the local bottom topography and sediments and oceanography and in comparison with other arctic and subarctic shelf faunas. Some 78 foram species belonging to 48 genera and 28 families were studied. These forams from ice-covered seas were distributed in two bathymetric zones, above and below the 200-m isobath. The data are used in support of a theory of a regional sea-level lowering during the Holocene. The sedimentation rate during the past 8000 yr is indicated to be 4.4 cm/1000 yr. (AB108196) AB108196

874. **Vilks, G.** 1977. Trends in the Marine Environment of the Canadian Arctic Archipelago during the Holocene. *Polar Oceans, M.J. Dunbar (Ed.), Proceedings of the Polar Oceans Conference, McGill University, Montreal, May 1974. Arctic Institute of North America, Calgary, (pp. 643-653), 682 pp.*

Changes in marine paleoenvironment in the Canadian Arctic Archipelago are discussed on the basis of foraminiferal assemblages in bottom sediments. In Lancaster Sound during glacial recession (18,000 - 6,000 years BP), bottom waters were less mobile than at present. In the Northwest Passage the present circulation was established at 6,000 BP. In Prince of Wales Strait during the marine maximum the circulation was in the opposite direction to what it is now. In the northwestern Queen Elizabeth Islands the channels have become shallower during the Holocene, while the extent of summer ice has remained close to that found at present. (Auth)

875. **Vilks, G., and P.J. Mudie.** 1983. Evidence for Postglacial Paleoceanographic and Paleoclimatic Changes in Lake Melville, Labrador, Canada. *Arctic and Alpine Research 15(3):307-320.*

Foraminifera, dinoflagellates, and pollen in a radio-carbon dated piston core from Lake Melville have been used to reconstruct a postglacial history of the fiord oceanography and regional climate. Present bottom water salinity in Lake Melville is about 5 0/00 lower than on the inner Labrador Shelf because of a shallow sill in the Narrows at the fiord entrance. Foraminiferal assemblages suggest that about 5000 yr B.P., the fiord salinity was about the same as the inner shelf. The postglacial change in fiord salinity is best explained by a shallowing of the sill, preventing the entry of saline inner shelf bottom water. A model of relative sea-level changes at the Narrows is proposed which shows that at 5000 yr B.P., the sill was about 20 m deeper than present; at 7000 yr B.P. it was 50 m deeper, and it was 90 m deeper until the end of the marine maximum at 7500 yr B.P. Pollen assemblages in the piston core indicate a succession of four major vegetation types in the Lake Melville drainage basin; from ca. 8000 to 7500 yr B.P., low arctic tundra was replaced by shrub tundra; around 6000 yr B.P., shrub tundra gave way to spruce woodland, which was followed by boreal forest around 5000 yr B.P. A decline in absolute pollen concentrations during the past 4000 yr may indicate a recent climatic deterioration. Before forestation of the Lake Melville watershed, sedimentation in the fiord basin was three to four times higher than at present, but the maximum sedimentation rate of 0.26 cm(E-1) is much lower than in other large Canadian fiords, e.g., Knight Inlet. (Auth)

876. **Vilks, G., F.J.E. Wagner, and B.R. Pelletier.** 1979. The Holocene Marine Environment of the Beaufort Shelf. *Geological Survey of Canada Bulletin 303, 43 pp.*

The marine environment on the Canadian continental shelf of the Beaufort Sea is described on the basis of data on foraminifera, molluscs, and sediments. The fauna and sediment were studied in 659 surface samples, 49 sediment cores, and 80 plankton tows, most of which were collected from CSS Hudson during the summer of 1970. Cores taken from the continental shelf contained only Early to Late Holocene sediments, but deposits of one of the glacial periods may have been recovered from the continental slope. On the basis of core recovery, Carbon 14 data, and faunal discontinuities, the rate of sedimentation may be in the order of 3-30 cm /1000 y on the continental shelf, more than 100 cm /1000 y in Mackenzie Canyon, and 20-30 cm/1000 y along the continental margin–upper continental slope at depths greater than 1000 m. The faunal evidence also indicates that along the continental margin to the north of the delta the extent of sediment slumping has increased during the last 5000 years. During the same period the influence of offshore waters in Mackenzie Canyon has also increased. Because one of the causes for the shoreward eddy in the canyon is the eastward migration of the Mackenzie runoff, it is suggested that the present anticlockwise circulation on the continental shelf has existed for at least the last 5000 years. (Auth)(JTA)

Paleobotanic

877. **Aleksandrova, V.D.** 1966. On the Postglacial History of the Vegetation of the New Siberian Islands. K istorii rastitel'nosti Novosibirskikh ostrovov v poslelednikovoe vremia. Russian, English Abstract. *Botanicheskii zhurnal 51(11):1580:-92.*

Study of a fossil peat bog on the Bol'shoy Lyakhovskiy Island revealed its formation under alluvial conditions in a river valley. The islands were at that time fused and part of the mainland, with a warmer climate than today. (AB93494) AB93494

878. **Andrews, J.T., W.N. Mode, P.J. Webber, G.H. Miller, and J.D. Jacobs.** 1980. Report on the Distribution of Dwarf Birches and Present Pollen Rain, Baffin Island, N.W.T., Canada. *Arctic 33(1):50-58.*

A distribution map for the dwarf birches is presented for the region from Frobisher Bay northward to Cumberland Peninsula. These shrubs are restricted to favourable habitats which, at the northern limit of the species (67 deg 40 sec N), are found on south-facing slopes above the immediate local cooling influence of the sea. Pollen studies within the zone of scattered dwarf birch indicate that pollen dispersal from these low, prostrate shrubs is minimal. Samples of moss collected beneath the bushes have 5-36% BETULA pollen; whereas sites more than 50 m away from BETULA shrubs have percentages of less than 2%. These data will be useful in considering the Holocene and Pleistocene histories of these Low Arctic shrubs in the Eastern Canadian Arctic. (Auth)

879. **Andrews, J.T., and P.J. Webber.** 1964. A Lichenometric Study of the Northeastern Margin of the Barnes Ice Cap, a Geomorphologic Technique. *Geographical Bulletin 22:80-104.*

Reviews results of lichen measurements made during 1961-1963 studies by the Canadian Geographical Branch. The seven main species used are described, and their growth rates are calculated on the assumption of a linear retreat of the glacier from the present margin to the first Alectoria minuscula. Growth rate for this species was 0.40 mm/yr, from which growth rates of the other species were calculated. Results were used in studying the recent history of the Lewis Glacier, 70 deg 20 min N 74 deg 50 min W, and that of the icecap margins. Existence is suggested of a major end-moraine system of Sub-Atlantic age and of other important moraines dating back to A.D. 1680, 1790, 1890, and 1920. These moraines are compared in age with others on the southeastern margin of the icecap, which has a different history, and with portions of Greenland. (Auth) AB85078

880. **Bartley, D.D.** 1973. The Stratigraphy and Pollen Analysis of Peat Deposits at Ytri Baegisa near Akureyri, Iceland. *Geologiska Foreningens i Stockholm Forhandlingar 95(4):410-414.*

Radiocarbon dates and tephra layers allow a fairly accurate dating of a sequence of vegetation changes and possible climatic changes. This sequence begins with open woodland and a relatively moist climate at the beginning of the Boreal period (c 9000 B.P.), passes through a long forested interval with two periods when the bog surface was sufficiently dry to be colonized by trees, and ends with a decline of the forest probably coincident with the arrival of the Norse settlers in 1080 B.P. Evidence is given for a glacial advance at about 2500 B.P. (Auth) GA 74A/0997

881. **Beschel, R.E.** 1970. The Diversity of Tundra Vegetation. *IUCN Publications New Series No. 16, Productivity and Conservation in Circumpolar Lands, W.A. Fuller and P.G. Kevan (Eds.), Proceedings of a Conference, Edmonton, Alberta, October 15-17, 1969. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland, (pp. 85-92), 344 pp.*

This paper outlines the major patterns of vegetation at Rens Fiord (extreme polar desert), Middle Fiord (polar desert), Iceberg Glacier (Luzula steppe), Expedition Fiord (CASSIOPE tundra) and Fosheim Peninsula (polar steppe), all on Ellesmere Island. There is also a description of vegetation complexes along a west-east transect across Axel Heiberg Island at latitude 79 30 N. The vegetation patterns of the tundra regions are further varied as a result of earlier environmental fluctuations. The extensive nivation during the "Little Ice Age", roughly from the sixteenth to the nineteenth century, led to a severe alteration and even destruction of the plant cover over wide areas. Aerial photographs of central Baffin Island indicate the extent of these recent nivations as patches with light coloured rock surfaces beside the nearly black area where the epipetric lichen cover could survive. Estimation of the biomass of these areas must consider the discrepancy of the potential vegetation development under present climatic conditions and the actual state of epipetric succession which reflects conditions of about a century ago. From the foregoing it is evident that the tundra is far from uniform. A minute fraction of the Canadian Arctic has so far been mapped for vegetation patterns on a large scale. (Ecol Can 48)(JTA) Ecol Can 48

882. **Birks, H.H., and R.W. Mathewes.** 1978. Studies in the Vegetational History of Scotland. V. Late Devensian and Early Flandrian Pollen and Macrofossil Stratigraphy at Abernethy Forest, Inverness-Shire. *New Phytologist 80:455-484.*

This paper describes palaeoecological studies at Abernethy Forest by means of pollen and macrofossil analysis and radiocarbon dating. It also illustrates the value of stratigraphic macrofossil analysis in conjunction with pollen analysis in increasing the range and detail of palaeoecological reconstruction of past vegetation and environment. A new, large diameter core from Abernethy Forest was radiocarbon dated, and the presence of Late Devensian sediments was confirmed. Clear vegetational changes were recorded. A pioneer grass-sedge vegetation colonized the bare moraine. It developed into a shrub tundra, dominated by EMPETRUM and BETULA NANA as a result of the climatic warming during Allerod time. The Younger Dryas climatic deterioration led to the formation of species-rich open vegetation, in which ARTEMISIA was very abundant. At the opening of the Flandrian, at about 9700 B.P., JUNIPERUS and BETULA NANA scrub developed, which was later colonized by tree BETULA and then CORYLUS. From about 7225 B.P. PINUS dominated the forest. (Auth)

The site lies at 56 deg 14 min N. Seven Carbon 14 dates are used to provide chronological control. The paper concentrates on the late Pleistocene/early Holocene records. (JTA)

883. **Birks, H.J.B., and B.J. Madsen.** 1979. Flandrian Vegetational History of Little Loch Roag, Isle of Lewis, Scotland. *Journal of Ecology 67:825-842.*

The present environment and the treeless landscape of the Isle of Lewis, Outer Hebrides, are described, and the existing data on the vegetational history of the Outer Hebrides are briefly reviewed. (2) The present vegetation, sediment lithology, radiocarbon dating and pollen stratigraphy of a valley mire at the south end of Little Loch Roag, Lewis, are described. The pollen sequence studied extends from the present day to 9140 + or - 140 B.P. Three local pollen zones with three subzones are delimited on the basis of numerical-zonation procedures. (3) The vegetational history of the environs of Little Loch Roag is reconstructed. The most striking feature is the absence of any forest development throughout the Flandrian, presumably as a result of intensive exposure to westerly gales. (4) Prior to 5000 B.P. the vegetation appears to have been a mosaic of grassland, heath, and tall-herb communities with willows and ferns, and with occasional birch and hazel copses in locally favourable situations. In the last 4000 years, human activities appear to have favoured the expansion of heather moor, the reduction of willow scrub and tall-herb communities, and the spread of grassland and pasture.(Auth)

The Little Loch Roag mire is located at 58 deg 8 min N and 6 deg 53 min W at an altitude of 27 m. (JTA)

884. **Brown-MacPherson, J.** 1982. Postglacial Vegetational History of the Eastern Avalon Peninsula, Newfoundland, and Holocene Climatic Change along the Eastern Canadian Seaboard. *Geographie physique et Quaternaire 36(1-2):175-196.*

Two radiocarbon-dated pollen profiles from the eastern Avalon Peninsula suggest late deglaciation (probably no earlier than 9700 B.P. at the coast), followed by a brief period of tundra vegetation. After 9300 B.P. a rich shrub tundra at lower elevations was invaded by spruce, balsam fir and tree birch until at ca 8400 B.P. the vegetation was an open woodland. The forest remained open for the next 3000 years; evidence of fire and the continuous presence of POPULUS suggest drier and warmer conditions than at present. The period of maximum warmth, ca 5400-3200 B.P., saw the closing of the forest cover, a rise in the level of the tree limit in the interior upland and an increase in precipitation. After 3200 B.P. decreasing temperatures resulted in a lowering of the tree limit. The climatic changes inferred for the Avalon Peninsula are compared with those inferred from palaeo-environmental studies along the eastern North American seaboard from Baffin Island to New England. A sequence of changing controls on the regional atmospheric circulation during the Holocene is suggested. (Auth)

885. **Cwynar, L.C.** 1982. A Late-Quaternary Vegetation History from Hanging Lake, Northern Yukon. *Ecological Monographs 52(1):1-24.*

A 403-cm core was recovered from Hanging Lake in unglaciated northern Yukon. Twenty-one radiocarbon dates indicate that the section is at least 25,000 and possibly 33,000 yr old; they permit the calculation of pollen influxes for the full-glacial in eastern Beringia. Numerical methods were used to divide pollen stratigraphy into five zones. From prior to 33,000 to 18,450 B.P., a herb zone was dominant (zone HL 1) with high percentages of Gramineae, ARTEMISIA and Cruciferae. However, the low pollen influx, ranging from 5-100 grains per sq cm per yr, the low organic content of the sediment, and the occurrence of open-ground taxa all indicate that the vegetation cover was sparser than it is today. The arctic-alpine affinities of the herb pollen show that generically the vegetation was akin to modern arctic plant communities. Modern fellfield communities in the northern Yukon and Siberia have a rich and endemic ARTEMISIA flora and they can produce pollen spectra comparable to that of the herb zone. Percent and influx values for spruce, alder and birch increased slightly during subzone H 1B (21,680-18,450 B.P.); this subzone probably represents an interstadial. From 18,450 to 14,600 B.P., a SALIX-Cyperaceae zone (HL 2) occurred, suggesting the development of snowbed and willow scrub communities in sheltered areas. Between 14,600 and 11,100 B.P., BETULA pollen dominated (zone HL 3) indicating the spread of dwarf birches, but the influx data show that this initial increase was modest compared with the subsequent zone and thus dwarf birches were probably restricted at this time to more favorable habitats. The spread of birch together with the increased total pollen influx, the higher organic content of the sediment, and the increased richness of herb pollen indicates that the local flora was more diverse and that the vegetative cover increased. The climate must have warmed. Zone HL 4 (Ericales zone) spanned the period from 11,100 to 8,900 B.P. Wet heath communities became locally abundant, poplar was more abundant at the beginning of this zone than at any subsequent time, the ranges of TYPHA LATIFOLIA and MYRICA GALE were greater than today, and pollen influx and sedimentation rate both increased greatly. Spruce became regionally abundant. These varied changes are probably in response to a warmer and wetter climate; they provide evidence for a late Pleistocene to early Holocene warm interval initially recognized by McCulloch and Hopkins (1966). Zone HL 5 (ALNUS CRISPA zone) has been dated from 8900 B.P. to the present; it reflects the regional expansion of ALNUS CRISPA on organic soils. (Auth)

886. **Denton, G.H., and W. Karlen.** 1973. Lichenometry: Its Application to Holocene Moraine Studies in Southern Alaska and Swedish Lapland. *Arctic and Alpine Research 5(4):347-372.*

In White River Valley and Skolai Pass in the Wrangell and St. Elias mountains of southern Alaska, several well-dated drift surfaces and abandoned alluvial channels covered with numerous lichens served as control points of a growth curve for RHIZOCARPON GEOGRAPHICUM. This curve shows initial rapid increase in thallus diameter, followed after a few centuries by a long interval of nearly linear increase of about 3.4 mm per century. The largest living R. GEOGRAPHICUM thallus in the region is 155 mm in diameter and presumably is about 3700 years old. In the Kebnekaise and Sarek mountains of Swedish Lapland, measurement of maximum thallus diameters of R. GEOGRAPHICUM and R. ALPICOLA on mapped Holocene drift units fronting 40 glaciers afforded consistent results that permitted regional correlation and placement of Holocene moraines into four groups, each representing a broad interval of glacier expansion. Lichen measurements on numerous surfaces of known historical age dispersed through the mountains, first, suggested that growth rates were uniform throughout the area and, second, provided control points for a detailed growth curve through the last several centuries. It is suggested that the largest living R. ALPICOLA thallus in the region, which is 480 mm in diameter, may be as much as 9000 years old. (Auth) GA 74/1478

887. **Detterman, R.L.** 1970. Early Holocene Warm Interval in Northern Alaska. *Arctic 23(2):130-132.*

Reports a radiocarbon date of 8400 + or - 300 B.P. for a poplar log found 6 m below surface near the Sagavanirktok River and close to the Itkillik glaciation type area. This confirms the correlation of dates reported earlier by others in the Seward Peninsula, Pt. Barrow, and along the Anaktuvuk River, with a warm period between the Antler valley and Anivik Lake advances of the Itkillik glaciation. (AB103075) AB103075

888. **Dionne, J.-C.** 1979. Radiocarbon Dates on Peat and Tree Remains from James Bay Area, Subarctic Quebec. *Canadian Journal of Forest Research:125-129.*

Carbon 14 dates on peat and tree remains from the southern part of James Bay Lowlands, subarctic Quebec, indicate that forests and peatland conditions began at least 1000 years after the deglaciation of the area. The oldest age recorded for the beginning of peat deposition is 6890 + or - 120 years before present (BP) at an elevation of 240 m and the youngest age is 3830 + or - 120 years BP at an elevation of 60 m. A delay ranging from 400 to 900 years between forest occupation and the establishment of bog conditions is recorded. (Auth)(JTA)

889. **Dort, E.** 1960. Climatic Changes of the Past and Present. *American Scientist 48(3):341-364.*

Traces climatic changes during the Cenozoic era (mainly on paleobotanic evidence) and considers future trends. Late Eocene fossils indicate: subtropical forests in southeastern Alaska; a warm temperate forest belt from central Alaska to central Greenland, Spitsbergen and Siberia; subarctic, boreal forest on Ellesmere Island (at 82 deg 30 min N.). Pleistocene fossils record northern plants and animals south of present limits, e.g. musk oxen in southern United States. The present interglacial warming trend is expected to continue for two centuries, with probable return to another glacial stage in 10,000 - 15,000 yrs. Indications (several from the Arctic) of warmer climate during the past century are cited. Contrary to the general trend, some areas, e.g., the Hudson Bay region are becoming cooler. (AB64240) AB64240

890. **Elias, S.A.** 1982. Paleoenvironmental Interpretation of Holocene Insect Fossils from Northeastern Labrador, Canada. *Arctic and Alpine Research 14(4):311-319.*

A 2.16 m column of peat from a raised palsa mound near Umiakoviarusek Lake, Okak Bay, Labrador, yielded plant macrofossils and insect fragments ranging in age from 2650 B.P. to the present. The insect fossils included 70 named taxa of 13 beetle families and 14 families of other insects, arachnids, and Cladocera. The assemblages are dominated by aquatic and semiaquatic taxa, indicative of a wet bog environment with open water. A continuous woodland episode is inferred from assemblages from 2650 to 1000 B.P., followed by a possibly colder episode to the present day, as indicated by increases in tundra dwelling taxa. This sequence is in general agreement with the Labrador pollen record from this interval. (Auth)

891. **Elliott-fisk, D.L.** 1983. The Stability of the Northern Canadian Tree Limit. *Annals Association of American Geographers 73(4):560-576.*

This paper presents data on and discusses the degree of postglacial stability of the northern Canadian tree limit. Holocene climatic changes have been both directional and synchronous for this region, though deteriorations/ameliorations either (1) lagged from west to east, (2) were buffered by local geographic factors, or (3) were not registered in the fossil record owing to the inherent persistence of the vegetation at some sites. The present northern tree limit in eastern Canada is in equilibrium with the prevailing climate, with the tree populations successfully regenerating both sexually and vegetatively. These tree stands are still occupying their maximum Hypsithermal positions. In contrast, the tree limit, tree line, and intervening forest-tundra ecotone in central and western Canada are out of equilibrium with today's climate. These populations are not sexually regenerative and apparently became established during warmer climates where the tree line was north of its present position. As such, they are susceptible to destruction by further climatic deteorioration or anthropogenic disruption. (Auth)

892. **Elliott, D.L.** 1979. The Stability of the Northern Canadian Tree Limit: Current Regenerative Capacity. *Ph.D. Thesis, University of Colorado, Boulder, CO, 192 pp.*

The three tree species investigated here were LARIX LARICINA (Du Roi) K. Koch, PICEA GLAUCA (Moench) Voss, and PICEA MARIANA (Mill.) B.S.P. Eleven northern tree sites were investigated across Canada in the summer of 1977 and spring and summer of 1978. Nine of these study sites compose a southwest to northeast transect from the northern boreal forest through the forest-tundra ectone in the Keewatin District of the Northwest Territories (Kasba and Ennadai lakes). The remaining sites are north of the forest limit in eastern Canada above the Koroc River, Quebec, and at Napaktok Bay, the northern tree limit on the Labrador coast. Field work and laboratory determinations of pollen production and viability, female cone production, bisexual cone production, seed production and viability, the presence of seed stores, the occurrence of layering, and the age structure of the tree populations show that the trees from treeline north through the forest-tundra ecotone in Keewatin are not in equilibrium with the present climate. These trees are not sexually active today, instead maintaining their positions through layering. The youngest sexually produced juvenile found here was established in 1938. In contrast, the northern trees in Labrador-Ungava are vigorously reproducing sexually, with viable seeds being produced, a small buried seed store existing, and numerous juveniles present both within and around the stand perimeters. The northern trees in Keewatin are therefore in a very perilous situation, for if destroyed by fire or cutting, they will not regenerate, since these conifers do not have the ability to stump sprout. (Auth)(JTA)

893. **Elliott, D.L., and S.K. Short.** 1979. The Northern Limit of Trees in Labrador: A Discussion. *Arctic 32(3):201-206.*

A map shows the postulated extent of the northern tree limit in Labrador and compares it with the actual distribution of trees based on field studies. The northern limit of trees is now placed at Napatok Bay rather than either Saglek or Hebron fiords. (JTA)

894. **Elven, R.** 1978. Subglacial Plant Remains from the Omnsbreen Glacier Area, South Norway. *Boreas 7:83-89.*

Plant remains have been found on ground recently deglaciated from the Omnsbreen glacier. They consist of SALIX HERBACEA, SALIX spp. SILENE ACAULIS, POLYTRICHUM NORVEGICUM, KIAERIA cf. STARKEI, and some unidentified species. Their age has been determined by the radiocarbon method to approx. 550 years. indicating that the present Omnsbreen glacier emerged as late as the climate deterioration in the late Middle Ages. The past vegetation was similar to the present, but slightly more thermophilous, indicating a rapid climate deterioration in the fourteenth century. (Auth)(JTA)

895. **Eronen, M.** 1979. The Retreat of Pine Forest in Finnish Lapland Since the Holocene Climatic Optimum: A General Discussion with Radiocarbon Evidence from Subfossil Pines. *Fennia 157(2):93-114.*

Literature data on the retreat of the pine forest in Northern Fennoscandia are presented to cover the period from the early 19th century onwards, i.e. since the first reliable observations were made. These data are compared with radiocarbon datings of 44 samples from subfossil pines found at or beyond the present limit of pine forest. The trees had usually been preserved best in moist surroundings, the majority of the trunks and stumps having been recovered from small lakes or wet paludified depressions. Although the dates are scattered over a wide period of time, from about 7000 B.P. up to recent times, there is a concentration around 4000-6000 B.P. sufficient to suggest that pine forest grew beyond the present limit during the Holocene climatic optimum. The most pronounced retreat in the

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forest limit since that time is recorded in Enontekio, in the western part of Finnish Lapland. The results fit well with existing pollen records, which indicate that pine spread to Lapland around 8500-7500 B.P. and achieved its maximum distribution in the period 7500-5000 B.P., gradually retreating since then, due to the deteriorating climate. (Auth)

896. **Eronen, M., and H. Hyvarinen.** 1981. Subfossil Pine Dates and Pollen Diagrams from Northern Fennoscandia. *Geologiska Foreningens i Stockholm Forhandlingar 103(4):437-445.*

As a continuation of earlier work on the Holocene history of the pine forests of northern Fennoscandia, new finds of subfossil pine (PINUS SILVESTRIS) are reported from sites in Enontekio, northwestern Finnish Lapland, and at one location in the Lyngenfjorden area in North Norway. Two pollen diagrams from lake sediments are also presented, one from near Kilpisjarvi in Finland, the other from close to Skibotn in Norway. The megafossil, pollen and radiocarbon data provide a more or less consistent picture of the history of the pine forests of northern Fennoscandia. Pine spread to the Kilpisjarvi and Lyngen area around 7500-7000 B.P., and the pine forests were at their maximum there from about 7000 to 4000 B.P. Their subsequent gradual decline meant a retreat of the pine limit by some 70 km or so. Discussions are provided on climatic variations in the area, and on possible further research into these and other paleoecological changes. (Auth)

897. **Fredskild, B., N. Jacobsen, and U. Roen.** 1975. Remains of Mosses and Freshwater Animals in Some Holocene Lake and Bog Sediments from Greenland. *Meddelelser om Gronland 198(5):1-44.*

Core samples of South Greenland lake sediments have been investigated as regards macroscopical remains of mosses and freshwater animals. Besides many widespread species the deeper samples contained species now occurring only in North Greenland, e.g. BRYUM NEODAMENSE ssp. OVATUM and LEPIDURUS ARCTICUS. During the hypsithermal, CRISTATELLA MUCEDO lived in one of the lakes. The upper samples are poor in species, partly a result of an oligotrophication of the lakes. From Peary Land, North Greenland, remains from one lake and one bog have been determined. The species found all occur in present day Peary Land. (Auth)

898. **Frenzel, B.** 1960. The Vegetation and Landscape Zones of Northern Eurasia during the Last Glaciation and During the Postglacial Warm Period, Part 2: An Attempt at Reconstruction of Northern Eurasia Vegetation in the Last Glaciation and in the Warm Period. Die Vegetations-und Landschaftszonen Nord-Eurasiens wahrend der letzten Eiszeit und wahrend der postglazialen Warmezeit, II. Teil: Rekonstruktionsversuch der letzteiszeitlichen und warmezeitlichen Vegetation Nord-Eurasiens. German. *Akademie der Wissenschaften und Literatur in Mainz. Abhandlungen der mathematischnaturewissenschaftlichen Klasse, Jahrg. 1960, no. 6:5-167.*

Reconstructs from paleogeographic and paleobotanical study, the vegetation- and landscape zones of Europe and the Caucasus, the Urals, West Siberian plain, middle and southern Siberia, northeastern Siberia, and Kamchatka and other adjacent areas. This reconstruction is made for two periods: the highest extent of the last glaciation, and the maximum warm rise during the postglacial period. The last glaciation substantially changed the climate of northern Eurasia, areas of permafrost increased and the zones of forest diminished. Distribution of frost-drift tundra, forest tundra, taiga and other vegetation zones is treated in detail and shown on map. Expansion of vegetation during the postglacial warm period is also demonstrated. (AB71498) AB71498

899. **Gellatly, A.F.** 1982. Lichenometry as a Relative-Age Dating Method in Mount Cook National Park, New Zealand. *New Zealand Journal of Botany 20:343-353.*

A study of the Holocene glacial sequence at Mount Cook National Park, New Zealand lead to revision of proposed chronology and re-examination of lichenometric dates for the area. Glacial deposits were up to one order of magnitude older than was previously thought and the original lichen record has been re-calibrated using the new dates. Additional measurements of lichens were collected from the eastern end of the Park and compared with ages of the moraines. A revised lichen growth curve was produced for glacial deposits formed during the last 1000 years. The rate of lichen growth declined on some older surfaces with increased competition from vascular plants. Calibration of the lichen growth curve was only possible where independent dates were available. Rates of rock weathering rind development, soil development, and plant succession were all useful fo the re-calibration. Many radio-carbon dates greatly aided the construction of the chronology. (Auth)

900. **Gilbert, H., and S. Payette.** 1982. Ecology of the Populations of Green Alder at the Forest Line, Northern Quebec. Ecologie des populations d'aulne vert (ALNUS CRISPA (Ait.) Pursh) a la limite des forets, Quebec nordique. French, English and Russian Abstracts. *Geographie physique et Quaternaire 36(1-2):109-124.*

Populations of green alder (ALNUS CRISPA (Ait.) Pursh) growing on south-facing and well-drained terraces in the Riviere aux Feuilles area (Northern Quebec: 58 deg 15 min N, 72 deg W), located above the local forest line, present a disjunct distribution, isolated from the well-established alder stands found along the river. These populations are the result of an important range expansion of the species in the XXth century, during a warmer period between 1920 and 1960. Similar situations in such alder populations have been observed elsewhere in the Hemi-arctic, and indicate 1) that green alder responds directly to climatic changes in this major biota of the Quebec-Labrador peninsula, and 2) that it represents a general phenomenon for which there is a need for more detailed studies, in particular for paleoecological and palynological purposes. (Auth) (JTA)

901. **Godmaire, A.** 1981. Spatio-Temporal Evolution of a Forest Strip near the Tree Line, Riviere aux Feuilles, Nouveau-Quebec. Dynamique spatio-temporelle d'une bande forestiere pres de la limite des forets, riviere aux Feuilles, Nouveau-Quebec. French, English and German Abstracts. *Geographie physique et Quaternaire 35(1):73-85.*

The spatial distribution of dead or living individuals among larch (LARIX LARICINA (Du Roi) K. Koch) and black spruce (PICEA MARIANA (Mill) B.S.P.) populations within a forest strip has allowed us to reconstruct the forest evolution since 1550 years B.P. The influence of climatic conditions and forest fires on these populations could thus be determined. The fluctuation of success in tree species regeneration and that of the spatial distribution of trees which appeared during the last five decades are ascribed to climatic conditions. Two recent fires (100 and 160 years ago) have in part influenced the distribution pattern as well as the success of colonization of older trees. These fires have restricted the tree populations to a damp depression and have affected their structure. The different soil horizons containing charcoal, detected on the site, (1550 + or - 130 years B.P., 1170 + or - 100 years B.P., 640 + or - 80 years B.P.) and their spatial distribution indicate that forest fires have had an influence on the extent of the forest cover. Prior to 1550 years B.P., the forest strip covered a greater surface than today. After a fire of 1170 years B.P., a change in the number and the dynamic of fires, associated with periglacial activity during that period, suggests a cooler climate. Finally, the spatial fluctuations of the tree populations are associated with the climatic changes that have occurred since 1550 years B.P. and that are brought out by the absence or the success of the tree species regeneration since the larch and the black spruce have burnt. (Auth)

902. **Gray, J.** 1981. The Use of Stable Isotope Data in Climate Reconstructions. *Climate and History, T.M.L. Wigley, M.J. Ingram, and G. Farmer (Eds.). Cambridge University Press, Cambridge, (pp. 53-81), 530 pp.*

This paper discusses, amongst other things, the stable oxygen isotope ratios from a section of peat sampled near Fort Simpson, N.W.T., Canada. The results were obtained on alpha-cellulose extracted from the peat. Peat began to accumulate at the site 10,380 years ago. A maximum variation in delta Oxygen 18 of 3.25 ppt occurred during the Holocene. In an attempt to correlate the delta Oxygen 18 values with mean annual temperature (MAT) a series of mosses were analyzed from across Canada. The relationship between delta Oxygen 18 and MAT is: delta Oxygen 18 = 0.52 MAT + 20.2. Minimum temperatures were reached between 3000 and 4000 B.P. There are peaks in temperature about 5500 and 1000 B.P. and the highest temperature for the Holocene occurs at present on the basis of delta Oxygen 18 values. (JTA)

903. **Harmata, K.** 1969. Materials for the Postglacial History of Vegetation in the West Carpathians. A Peat Bog on Palenica Mt. Materialy do Postglacjalnej historii roslinnosci Karpat Zachodnich. Torfowisko na Palenicy (Porgorze gubalowskie). *Folia Quaternaria 33, 14 pp.*

The object of this paleobotanic study was a small peat-bog filling a depression formed by landslip processes at an altitude of 1130 m in the forest on the northeastern slope of Palenica Mt. (Gubalowka Range). A pollen diagram (Fig. 2) made for this peatbog includes two late periods of the Holocene, the Subboreal, in which spruce forests with an admixture of fir dominated, and the Subatlantic characterized by beech-fir mountain forests. The presence of man in this area can be observed as early as the older part of the Subboreal Period. Distinct changes in the plant composition brought about by pasturage took place in the Subatlantic Period, whereas the first indicators of agriculture occurred in the second half on this period. The high percentage values of herbs in the diagram from Palenica Mt. are caused by huge amounts of pollen of local origin (Ranunculacea, Polypodiaceae, Cyperaceae and Gramineae). For this reason, the curve of total pollen of plants, which probably did not grow at that place, has been plotted against the total pollen curve of herbs. (Auth) GA 71B/1382

904. **Hills, L.V., and E.V. Sangster.** 1980. A Review of Paleobotanical Studies Dealing with the Last 20,000 Years - Alaska, Canada and Greenland. *Climatic Change in Canada, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, 1977-1978, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 26, (pp. 73-224), 246 pp.*

This paper is essentially a catalog of the papers dealing with the vegetational history of northern North America and Greenland over the last 20,000 years. Although it does not offer a synthesis of all the investigations it is an important source. The report discusses a total of 373 sites and lists appropriate Carbon 14 dates. (JTA)

905. **Hopkins, D.M.** 1972. The Paleogeography and Climatic History of Beringia during Late Cenozoic Time. *Inter-Nord 12:121-150.*

A sharp vegetation change records a rapid warming throughout Beringia about 10,000 years ago. In most parts of Beringia, the Holocene warming seems to have peaked in a minor thermal maximum about 5000 years ago, but northwestern Alaska has experienced two climatic optima - one within the interval 10,000 to 8,000 years ago and another during the last three decades - during which forest biota expanded to their furthest limits. (Auth)(JTA) GA 74A/1031

906. **Hopkins, D.M., P.A. Smith, and J.V. Matthews, Jr.** 1981. Dated Wood from Alaska and the Yukon: Implications for Forest Refugia in Beringia. *Quaternary Research 15(3):217-249.*

Postulations on the existence of forest refugia in parts of Beringia during the last glacial have been, in large part, based on ambiguous evidence. Existing data on radiocarbon-dated and indentified fossil wood and macrofossils from Alaska and northwest Canada are synthesized here and are augmented by results of palynological studies in an effort to show the persistence of some, and total extinction of other, tree and large shrub species. Possible dispersal routes taken by species that reinvaded Beringia in postglacial times are also reconstructed from the fossil record. Macrofossil and pollen evidence, when combined with climatic factors, makes cottonwood a good candidate for survival during the last glacial. Larch and aspen are also candidates, though the evidence for them is less positive. Pollen and macrofossils of alder are very scarce in deposits of the last glacial age, and if it survived at all, it was probably in very isolated vegetatively reproducing clones. Shrub birch may have been present in Beringia, but tree birch probably was reintroduced during the Holocene. Spruce also appears to have been absent in Alaska from about 30,000-11,500 yr ago and probably reinvaded Beringia from a refugium south of the Laurentide ice sheet. (Auth)

907. **Hustich, I.** 1966. On the Forest-Tundra and the Northern Tree-Lines. *Annales Universitatis Turkuensis AII 36, Reports from the Kevo Subarctic Research Station 3, (pp. 7-47).*

This paper defines 5 types of forest-limits and tree-lines, namely: 1) economic forest-line; 2) physiognomic forest-line; 3) tree-line; 4) species-line; and 5) historic tree-line. The northern limits of PINUS, PICEA, BETULA, ALNUS and ABIES are mapped at the generic and species level. The limit of the varying tree-lines and forest-lines is most probably associated with climatic factors. Of these, July temperature appears to correlate most closely with the tree-line. (JTA)

908. **Jankovska, V., and L.C. Bliss.** 1972. Pollen and Macroscopic Analysis of a Peat Mound Profile Truelove Lowland. *Devon Island I.B.P. Project High Arctic Ecosystem, Project Report 1970 and 1971, L.C. Bliss (Ed.), (pp. 105-112).*

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A frozen sediment core, 1.7 m in thickness was obtained from the center of a polygon. A Carbon 14 date of 2450 + or - 90 BP is reported as the basal date. Macrofossils and pollen content are analysed and tabulated for 18 different levels. The pollen is dominated by SALIX and Poaceae. (JTA)

909. **Kay, P.A.** 1978. Dendroecology in Canada's Forest-Tundra Transition Zone. *Arctic and Alpine Research 10(1):133-138.*

Black spruce in forest outliers has a slower growth rate, more high frequency variation, and less persistence than at the forest limit. Climate variation accounts for more variance in ring widths at the forest limit than within outliers, which occupy protective sites that mitigate stress. Growth behavior at the forest limit can be interpreted in terms of Arctic Front positions. A two-century long chronology of tree growth is presented. (Auth)

910. **Keatinge, T.H., and J.H. Dickson.** 1979. Mid-Flandrian Changes in Vegetation on Mainland Orkney. *New Phytologist 82:585-612.*

The presence of birch-hazel scrub with a rich ground flora of tall herbs and ferns in the mid-Flandrian on Mainland, Orkney, suggested by Moar (1969), is supported, but no evidence was obtained for PINUS, QUERCUS, ALNUS or other major forest trees as indigenous species. Evidence from lake muds and intertidal peat in the region of the Bay of Skaill suggests an increase in onshore wind speeds with the formation of the Bay of Skaill and the beginning of sand-blow c. 5000 B.P. The birch-hazel scrub declined at this time and the remaining tall herb and fern vegetation was replaced by pasture within c. 200 years under the influence of neolithic man and his grazing animals. At c. 3400 B.P. a combination of increased oceanicity of climate and high grazing pressure appear to have led to the initiation of blanket peat formation on the hills. A contribution to the interpretation of Carbon 14 dates derived from marly sediments is included. (Auth)

911. **Koerner, R.M.** 1980. The Problem of Lichen-Free Zones in Arctic Canada. *Arctic and Alpine Research 12(1):87-94.*

The origin of lichen-free areas in the High Arctic has been attributed to lichen-kill under permanent snowfields developed 300 yr ago during the Little Ice Age. There are inconsistencies in this hypothesis, particularly in regard to the manner of lichen-kill, the mechanism of dead lichen removal once the previously ice-covered ground is exposed again, the period when the lichen-kill occurred, and the form of lichen trimlines. An alternative hypothesis is suggested whereby lichen-free areas occur where seasonal snowfields persist for a much greater part of the summer than elsewere. As a result the lichen growth season is very short. (Auth)

912. **Kuc, M.** 1970. Peat Deposits and Fossil Mosses in the Arctic. *Geological Survey of Canada Paper 70-1A, (pp. 161-162).*

Three locations of peat deposits and fossil mosses are identified on Banks Island. The second peat deposit is part of a postglacial deposit in the Masik River valley where 9 to 18 ft thick peat deposits dominated by willow (SALIX ALAXENSIS) and mosses occur in the valley bottom. The area is significant as the valley bottom appears unglaciated and yet plateau areas adjacent to the Masik River valley were covered by ice caps. This peat deposit is a product of shrub-tundra and is characteristic of the Low Arctic. Three peat zones are distinguished in the valley bottom: deltaic areas of older peat at least 10,000 years old; younger peats that are presently developing; and a marginal zone with glacial land forms. (Ecol Can 1028) (JTA) Ecol Can 1028

913. **Lang, G.** 1962. Late-Glacial and Early Post-Glacial Vegetational History Along the Margin of the Alps. *Eiszeitalter und Gegenwart 12:9-17.*

This primarily botanical article summarizes recent literature on the Late- and Post-Glacial period along the western and northern margins of the Alps, indicating the dominant vegetational characteristics of Zones Ia, Ib (Bolling), Ic, II, III, and IV in these areas. The author then proceeds to consider the results of Zoller (1960) in southern Switzerland and argues that afforestation in the lowlands along the southern border of the Alps probably occurred first in the Bolling rather than the Allerod; accordingly, the "Piottino oscillation" in southern Switzerland can be correlated with the Allerod and is not a newly discovered Pre-boreal climatic oscillation. (R.J. Rice) GA 64/268

914. **Larsen, J.A.** 1964. An Outline of Materials for a Post-glacial Bioclimatic History of Keewatin, Northwest Territories, Canada. *University of Wisconsin, Department of Meteorology, Madison, WI, Technical Report no. 15, 79 pp.*

Reviews current views, not all in agreement, concerning changes in the flora and climate of this district since the Wisconsin glaciation. Using radiocarbon data a chronology of floral recolonization of the glaciated area is considered. Evidence indicates that marked genetic differentiation after the glaciation due to the isolation of populations by the ice was followed by subsequent hybridization and intermingling of species. An altithermal period ending 3500 B.P. is postulated during which the treeline was 175 miles north of that at present. Also 800-900 years ago continuous forest extended 50 or more miles north as indicated by dwarf spruce groves, sphagnum bogs and dated logs. (AB89133) AB89133

915. **Larson, D.D.** 1974. Paleoecological Investigations of Diatoms in a Core from Kerguelen Islands, Southeast Indian Ocean. *Ohio State University, Institute of Polar Studies, Report no. 50, 61 pp.*

Analysis of diatom communities from 20 levels along a sediment core from Kerguelen Island shows a progression from a wet, organically enriched, acid condition to a drier, less organic, alkaline condition at the site during the past 10,000 years since deglaciation. This analysis shows a close correlation between physical stratigraphy of the core and diatom ecology. By analyzing pollen frequencies from the same Kerguelen core material, Young and Schofield (1973) suggest that a transition from a climate warmer and wetter than present to a cold, dry climate began about 5,000 years B.P. Although it is possible to substantiate the transition from a wetter to a drier climate with both diatom and pollen evidence, there does not seem to be a correlation between cooling temperatures in the southern hemisphere and past diatom populations on Kerguelen Island. (Auth)

916. **Lundquist, G.** 1962. Geological Radiocarbon Datings from the Stockholm Station. *Geologiska Undersokning. Avhandlingar och Uppstatser, ser. C, no. 289, 23 pp.*

Summarizes the geological datings carried out 1955-1962 at the Stockholm Natural Radiocarbon Station, including an outline of author's unpublished results. Pine stumps are generally younger in northern than in Southern Sweden; four finds near Abisko are dated from 3900 + or - 80 to 6130 + or - 115 B.P. Northernmost stump in author's material is from Kellottijarvi, northwest of Karesuando, dated 5000 B.P. Carbon 14 determinations of the northward extent of forests in Sweden during Allerod time (approx. 11,000 B.P.) is suggested. Unpublished datings from Mt. Ruoutevre, north of Kvikkjokk, may be extended by the appearance of abundant birch forest

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where almost none existed 50 yrs ago. Immediate problems include: oscillations of tree limits in the mountains , "recurrence surfaces" in peat bogs, and regional dating of iron workings. (AB73627) AB73627

917. **MacDonald, G.M.** 1983. Holocene Vegetation History of the Upper Natla River Area, Northwest Territories, Canada. *Arctic and Alpine Research 15(2):169-180.*

A 2.3 m thick lenticular exposure of autochthonous peat provides a palynological and plant macrofossil record of vegetation development in the central Selwyn Mountains. This record spans at least the last 8640 yr. Interpretation of the fossil pollen profile is aided through numerical comparison with 15 pollen surface samples from the area. From 8640 to 7700 BP the region was dominated by a BETULA tundra. This tundra became increasingly productive during the later stages of this episode. At approximately 7700 BP PICEA expanded into the area. This relatively late rise of PICEA was possibly a result of restricted migration up the mountain valleys. It appears that PICEA was at its greatest dominance in the landscape from 7700 to shortly after 5000 BP and treeline was probably higher than present during this period. (Auth)

918. **Mathewes, R.W., and J.J. Clague.** 1982. Stratigraphic Relations and Paleoecology of a Late-Glacial Peat Bed from the Queen Charlotte Islands, British Columbia. *Canadian Journal of Earth Sciences 19(6):1185-1195.*

The stratigraphic relations of late-glacial and Holocene sediments exposed in sea cliffs at Cape Ball on the Queen Charlotte Islands are summarized, based on section descriptions and 13 radiocarbon dates based on wood, peat, and marine pelecypod shells. One peat bed dated at 12,400 + or - 100 years B.P. (GSC-3112) to 10, 200 + or - 90 B.P. (GSC-3159) was investigated for pollen and plant macrofossils. This study extends the Late Pleistocene vegetation history of the Queen Charlotte Islands by about 1550 years and suggests that the record will date back to before 13,700 + or - 100 B.P. (GSC-3222). Four local pollen zones are described from the 70 cm thick peat, beginning with a 7 cm thick herb dominated zone (CB-1), characterized by up to 60% grass pollen, and including a unique assemblage with abundant Apiaceae, Cyperaceae, EMPETRUM/Ericaceae, POLEMONIUM, PLANTAGO MACROCARPA, FRITILLARIA, and RANUNCULUS. A high diversity of other herbs, including subalpine/alpine species and two taxa presently absent from the Charlottes (ARMERIA MARITIMA and POLEMONIUM CAERULEUM type), suggests that this zone represents an open floodplain vegetation with no modern analog. Zone CB-2 (63-45 cm) is dominated by PINUS CONTORTA type pollen (65-70%) and moderate values for fern spores. Zone CB-3 (45 30 cm) shows a rapid rise of PICEA pollen from 3 to 39%, followed by a drop to about 12%. Fern spores (20-50%) and ALNUS (6%) also reach maximum levels in this zone. Abundant wood fragments and sand inclusions are compatible with an interpretation of a swampy floodplain forest during this interval. The uppermost zone (30-0 cm) exhibits high PINUS CONTORTA (40-60%) and Cyperaceae (12-38%) values, along with a moderate abundance of grasses, ferns and Apiaceae. Estuarine and marine sediments with pelecypod shells, deposited during a marine transgression, overlie the peat bed. Implications for the controversy over the existence of Late Pleistocene refugia in the Charlottes are briefly discussed. (Auth)

919. **Matthews, J.V., Jr.** 1980. Paleoecology of John Klondike Bog, Fisherman Lake Region, Southwest District of Mackenzie. *Geological Survey of Canada Paper 80-22, 12 pp.*

Pollen and macrofossils, the latter including mollusca, insects, as well as fruits and seeds of higher plants, were recovered from the sediments of a 4.7 m core taken at the site of a small bog near Fisherman Lake in southwest District of Mackenzie. The core sequence spans approximately the last 9600 years. Its pollen and macrofossil contents largely portray the change of a small pond or lake into an elevated, frozen bog. Despite the domination of the pollen diagram by local vegetation, two regional trends are evident: the migration into the Fisherman Lake area of alder 8700 years ago and pine 6700 years ago. Apparently none of the pollen and macrofossil data portrays the mid-Holocene Altithermal, and in fact the only indication of climatic change in the entire core sequence may be the indirect evidence of permafrost development at the site during the Little Ice Age 300 to 500 years ago. (Auth)

920. **Maycock, P.F., and B. Matthews.** 1966. An Arctic Forest in the Tundra of Northern Ungava, Quebec. *Arctic 19(2):114-144.*

Willow trees up to 16 ft (4.87 m) occur as a forest 32 miles (51 km) southeast of Deception Bay, Northern Quebec (61 deg 31 min N, 74 deg 05 min W). It is suggested that the forest was first established during the Hypsithermal (9,000 B.P. - 2,600 B.P.) and has survived because of favourable site conditions. Radiocarbon and pollen evidence from nearby sites suggest a more extensive willow forest existed 2000 years ago. A study of growth-rings indicates a marked increase in growth rate during the 1930s and 1940s. The paper also mentions a recent moraine of a cirque "glacierette" which is thought to date from recent centuries based on the presence of only small RHIZOCARPON GEOGRAPHICUM lichens. (JTA)

921. **McCulloch, D.S., and D.M. Hopkins.** 1966. Evidence for an Early Recent Warm Interval in Northwestern Alaska. *Geological Society of America Bulletin 77(10):1089-1107.*

In the coastal tundra covered area of N.W. Alaska, a warm interval that began at least 10,000 years B.P. and lasted until at least 8,300 years ago is recorded by the presence of fossil wood, fossil beaver-gnawed wood found beyond the modern range of beaver, evidence of ice-wedge melting, buried soils and soils that extend below the top of modern permafrost. Dating of the warm interval is based on eight radiocarbon dates. Although these do not provide tight control for either the beginning or the end, they permit the interpretation that the warm event began at the start of the world-wide postglacial warming and ended at the time of the Anvik Lake glacial readvance in the Brooks Range. If this is correct the early Recent warm interval and Livingstone's postglacial thermal maximum in the Brooks Range were separated by a period of cooler climate. It is suggested that the postglacial thermal maximum between 6000 and 3000 B.P. recorded in the Brooks Range is poorly shown in the coastal areas of Northwestern Alaska, because of the lower summer temperatures of accompanying maritime climate. (Auth) GA 67A/1481

922. **McGlone, M.S., and N.T. Moar.** 1977. The ASCARINA Decline and Post-Glacial Climatic Change in New Zealand. *New Zealand Journal of Botany 15(2):485-490.*

ASCARINA LUCIDA was abundant in the west of both North and South Island between c. 10,000 and 5,000 yr B.P. but since then it has been severely and progressively reduced in quantity. It is now common only on the west coast of South Island, and elsewere occurs in scattered localities in northern South Island and

North Island. Because ASCARINA is frost- and drought-sensitive, an increased incidence of these two factors is suggested to be responsible for its elimination from previously suitable areas. (Auth) Ecol Abs 78L/6549

923. **Miller, G.H.** 1973. Variations in Lichen Growth from Direct Measurements: Preliminary Curves for ALECTORIA MINUSCULA from Eastern Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 5(4):333-339.*

Direct measurement of thallus area of the subfruticose lichen ALECTORIA MINUSCULA from eastern Baffin Island allows construction of preliminary lichen growth curves for this area. The tracing method of determining thallus diameters is accurate within + or - 0.5 mm, whereas the photogrammetric method is accurate within + or - 0.1 mm and is capable of even greater precision. The form of the growth curve for A. MINUSCULA is sigmoidal with an average diameter increase ranging from 0.6 to 1.0 mm year(E-1). Previously published curves for this species are similar to the empirically derived curve presented here. There appears to be a decrease in the rate of growth with elevation which underlines the immediate necessity of establishing growth stations in selected localities for areas in which lichenometry is employed. With the accuracy of the photogrammetric technique, growth of even the slowest growing species (i.e. RHIZOCARPON GEOGRAPHICUM) should be detectable within a decade (0.3 mm diameter increase) and within two or three years for faster growing species. (Auth)

924. **Mortenson, M.** 1966. Age Determination of Fossil Fir from Nord-Osterdal. Aldersbestemmelse av "fossil furu" fra Nord-Osterdal. Norwegian. *Norges Geologiske Undersokelse. Arbok 1965(242):135-137.*

Reports on finds of charcoal and trunk of a fir tree at 600-1000 m elevation southwest of Roros, Norway. Carbon 14 determination for the charcoal is 5200 + or - 400 yr, for the trunk 6090 + or - 100 yr. The latter is associated with the top of a morainal and the bottom of a bog deposit. The upland was tree-covered in the early stone age, and further search could enable tree ring analyses and climate determinations of the time to be made. (AB98240) AB98240

925. **Odgen, J.G., III** 1980. Late Quaternary Paleoenvironments of Eastern Canada. *Climatic Change in Canada, National Museum of Natural Sciences Project on Climatic Change in Canada during the Past 20,000 Years, 1977-1978, C.R. Harington (Ed.). National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 26, (pp. 225-246), 246 pp.*

The paper briefly discusses the deglacial history of eastern Canada south of Hudson Strait. Table 1 is an important source of information on available sediment cores from the region. Sites are listed in terms of: 1) latitude and longitude; 2) number of Carbon 14 dates; 3) sedimentation rate; and 4) reference. Table 2 lists radiocarbon dates on sediment cores from eastern Canada. (JTA)

926. **Payette, S., and R. Gagnon.** 1979. Tree-Line Dynamics in Ungava Peninsula, Northern Quebec. *Holarctic Ecology 2:239-248.*

The characteristics of the present tree-line in continental Northern Quebec appear to be related to modern and past ecological conditions. Carbon 14 dating of fossil trees and charcoal, and age structure of tree populations are used as evidence of tree-line dynamics over the last 400 yr. As inferred from the reproductive strategies of the two tree species, black spruce PICEA MARIANA (Mill.) BSP and Tamarack LARIX LARICINA (DuRoi) K. Koch, forming the present tree-line populations, major changes during postglacial time in Northern Quebec are not only concerned with tree-line position, but also with tree-line composition. The present tree-line is made by larch (or tamarack) and corresponds to its natural seed regeneration limit. Black spruce probably reached its northernmost holocene latitudes during a warmer period and it then formed the tree-line. During the Little Ice Age, fires destroyed large tracks of forest and black spruce krummholz (400, and 250-200 yr ago); afterwards, tree species reestablished only in protective sites, and exposed sites were not reseeded. At some places, fires did not burn completely the forest cover, and preserved isolated trees and small groves probably became locus of reafforestation. Differential forest regeneration and tree age structure suggest that fire and climate are intimately associated in controlling tree population dynamics. Favourable and less favourable forest regeneration periods are inferred from these data and it is suggested that tree-line displacements in Northern Quebec during the last 400 yr were less important than in the Northwest Territories. (Auth)

927. **Payette, S., and R. Lajeunesse.** 1980. Snow Patches of the Leaf River (Nouveau-Quebec): Holocene Paleoclimate Indicators. Les combes a neige de la riviere aux Feuilles (Nouveau-Quebec): indicateurs paleoclimatiques Holocenes. French, English and German Summaries. *Geographie physique et Quaternaire 34(2):209-220.*

On the basis of plant macrofossils analysis (charcoals, charred cones of black spruce PICEA MARIANA (Mill.) BSP and LARIX LARICINA (DuRoi) K. Koch, wood fragments) and plant population dynamics the origin and the evolution of the snow-patch environment are correlated with the Neoglacial episode. Data suggest that this peculiar environment has evolved from previously wooded stands. The removal of the forest cover was caused by fires during cold climatic periods that restricted forest regeneration. The snow-patches therefore are thought to be a response to several periods of climatic deterioration around 2600, 2200, 1600-1400, 1000-900 and 500-300 years B.P. Some snowpatches that appeared early during the Neoglacial may have experienced a minor tree invasion around 1300-1200 years B.P., during a warmer climatic interval. The gradual development of snowpatch communities, and the overall regression of the forest cover, since 2600 years B.P., suggest that the climatic deterioration, although persisting, was not of great range; forest fires have played some role in the snow cover expansion, and may have initiated them. Snowpatches located near forest formations have experienced a larch colonization between 1940 and 1970, which seems to be correlated with the twentieth century warming trend. Since 1970, a reversal of this trend has been observed, and it is characterized by at least 17% of larch mortality in the snowpatch population. This mortality appears to be related to the reactivation of periglacial process. Finally, the recent formation of large gelifluction lobes along some snowy slopes had detrimental effects on lowland vegetation, and may eventually produce suitable conditions for new snowpatch initiation. (Auth)

928. **Pears, N.V.** 1975. Radiocarbon Dating of Peat Macrofossils in the Cairngorm Mountains, Scotland. *Transactions Botanical Society of Edinburgh 42(3):255-260.*

Radiocarbon dates for tree strumps at 3 sites in the Cairngorm Mountains are presented. These are considered along with a previous set and the evidence they provide for determining altitudinal limits of forest growth in the Flandrian Period is discussed. They support earlier tentative conclusions that topography and local site hydrology are the key factors in interpreting the macrofossil pattern. (Author) Ecol Abs 76L/3729

Paleobotanic

929. **Petersen, K.L., and P.J. Mehringer, Jr.** 1976. Postglacial Timberline Fluctuations, La Plata Mountains, Southwestern Colorado. *Arctic and Alpine Research 8(3):275-288.*

A paleoecological study of the La Plata Mountains was initiated to develop further a dated and continuous environmental sequence for the San Juan River headwaters to which discontinuous archaeological and alluvial data from the Four Corners region might be compared. Routine pollen analysis of a 4 m core from a subalpine meadow adjacent to Twin Lakes, 3290 m (10,790 ft), including 11 radiocarbon dates and pollen ratios, provides the chronology of climatic change as reflected by postglacial timberline fluctuations. The timberline was lower than that of the present about 9800 B.P., then advanced upward at least twice to higher elevations prior to 6000 B.P. The timberline retreated to lower elevations shortly after 4000 B.P.; this retreat was followed by another significant advance upward about 2500 B.P. Mining, logging, and grazing, which began in the 1870's, may be represented by a sharp decrease in the relative frequencies of PINUS and PICEA pollen, with subsequent secondary succession represented by increased Ranunculaceae and SALIX pollen and then a return to conifer pollen dominance. These changes may also result from a significant lowering of the timberline within the last few hundred years. (Auth)

930. **Pitman, G.T.K.** 1973. A Lichenometrical Study of Snow Patch Variation in the Frederikshab District, South-West Greenland, and Its Implications for Studies of Climatic and Glacial Fluctuations. *Gronlands Geologiske Undersogelse Bulletin 104, (pp. 1-29).*

This report describes firstly the methods used to determine local growth rates of the species RHIZOCARPON GEOGRAPHICUM and the confidence that can be put in such estimates of substrate age based on lichen diameters. Secondly, mean RHIZOCARPON GEOGRAPHICUM diameters in former snow patch zones were sampled and non-random patterns of colonization were observed. Two models were constructed to explain these colonization patterns in terms of the change of the perennial snowline with height against time. Hence mean annual temperatures back to 1680 were predicted from the models for Frederikshab. Lastly a correlation is shown between local mean annual temperature changes in the historical period, glacial fluctuations, and estimates of temperature obtained from the lichen colonization models. (Auth)

931. **Ralska-Jasiewiczowa, M.** 1972. The Forests of the Polish Carpathians in the Late Glacial and Holocene. *Studia Geomorphologica Carpatho-Balcanica 6:5-19.*

To reconstruct the history of forest zones it is necessary to analyse the pollen profiles of small basins at a variety of altitudes. There are few suitable basins in the higher parts of the Carpathians and most of the material comes from the lower slopes and the valleys. Although there is insufficient data for a thorough investigation new evidence does corroborate earlier suppositions. There are about 20 localities of Late Glacial and Holocene floras with good pollen spectra. From the available data the author describes the forest flora of the Older Dryas, the Allerod, Younger Dryas, Preboreal, Boreal, Atlantic, Subboreal, and Subatlantic periods. (Margaret A. Bass) GA 73A/1384

932. **Rampton, V.** 1971. Late Quaternary Vegetational and Climatic History of the Snag-Klutlan Area, Southwestern Yukon Territory, Canada. *Geological Society of America Bulletin 82(4):959-978.*

A pollen diagram from the pond sediments suggests the following vegetational sequence for the last 31,000 yrs.: 31,000 B.P. through 27,000 B.P., fell-field or sedge-moss tundra followed by shrub tundra; 27,000 B.P. through 10,000 B.P., sedge-moss tundra; 10,000 B.P. through 8700 B.P., shrub tundra; 8700 B.P. through 5700 B.P., spruce woodland; 5700 B.P. through present, spruce forest. The diagram also suggests the following negative departures of July temperatures: 31,000 B.P. through 27,000 B.P., at least 8 deg F and possibly as much as 16 deg F; 27,000 B.P. through 13,500 B.P., 13 deg; 13,500 B.P. through 10,000 B.P., 12 deg F; 10,000 B.P. through 8700 B.P., 8 deg F. Precipitation seems to have been lower during cooler intervals than are present levels. Precipitation also seems to have increased over the last 6000 years. Logs above the present tree line imply that summer temperatures have fluctuated above present values between 6000 B.P. and 1220 B.P. Tree-ring studies indicate that temperatures during the 200 years preceding 1940 were as much as 2 deg F cooler than present. (from Author) GA 72A/0251

933. **Rybnickova, E.** 1974. The Development of Vegetation and Flora in the Southern Part of the Bohemian-Moravian Uplands during the Late Glacial and Holocene Periods. Die Entwicklung der Vegetation und Flora im sudlichen Teil der Bohmisch-Marhischen Hohe wahrend des Spatglazials und Holozans. *Vegetace CSSR A7, Academia, Prague, 163 pp.*

Fragmentary evidence suggests that heliophytic herbs and pine were characeristic of this part of Czechoslovakia during the Allerod Period. Heliophilous vegetation also prevailed in the Younger Dryas, with open pine or pine-birch stands, and juniper, the significant woody plants. Pine forest or shrubland developed during the Pre-Boreal (birch being less important here than in other European regions) with trees characteristic of the Quercetum mixtum (QM) entering later. Spruce was dominant on waterlogged sites, a feature which continued into the Boreal. The Boreal was charactetised by the first hazel maximum, though hazel was less well represented here than in western Europe, perhaps because of a more closed forest and greater climatic continentality. Pine was gradually replaced by deciduous QM. The Atlantic demonstrated a maximum development of climax QM forest. A higher frequency of ash, spruce and alder distinguished a younger from an older phase. Vegetation changes in the Sub-Boreal, mainly a gradual retreat of thermophilous QM elements and a replacement by beech, fir and spruce, cannot be linked with human activity. In the older Sub-Atlantic, rapid development of beech-fir forests soon dominated QM elements. The present altitudinal zoning was possibly established at this time. The younger Sub-Atlantic (c. 12th-c. 13th) shows the first signs of permanent human settlement; the original forests became almost completely destroyed. Coniferous plantations, and synantropic herbs and cereals, represent a human-dominated landscape. (P.J. Jarvis) Ecol Abs 76L/1375

934. **Salgado-Labouriau, M.L.** 1980. A Pollen Diagram of the Pleistocene-Holocene Boundary of Lake Valencia Venezuela. *Review of Palaeobotany and Palynology 30(3-4)297-312.*

The deepest part of a core from Lake Valencia (403 m elevation) was studied. Radiocarbon dating shows that the section includes the Pleistocene- Holocene boundary. The pollen analysis indicates that the Pleistocene lake had desiccated, and from 13,400 to approx. 11,500 B.P., the site (today under 40 m water) was a swamp or intermittent lake. The region was covered by semi-arid vegetation. Shortly before 10,700 B.P. precipitation increased but evaporation was probably very high. Around 10,000 B.P., the lake started to form again. Dry or thorn forest and savannas occupied the region around the lake and rain forest covered the mountain top. At that time, the lake was smaller than today. The Valencia dry phase at the end of the Pleistocene corresponds to the end of the Glaciation period in the northern Andes. (Auth)

935. **Sonesson, M.** 1974. Late Quaternary Forest Development of the Tornetrask Area, North Sweden 2. Pollen Analytical Evidence. *Oikos 25(3):288-307.*

The first described vegetational period after deglaciation was the Early Birch period (7000 B.C.). Land at low altitudes was covered with birch forests except at the onset when shrub vegetation with HIPPOPHAE, JUNIPERUS, and SALIX prevailed. During the Birch-Alder period (7000-4700/4500 B.C.) PINUS became established in the birch woods with ALNUS prominent in moist areas. The Pine period (4700/4500-1500 B.C.) was the thermal maximum period for the area, and PINUS and BETULA dominated. The period was possibly delayed about 1000 years in the western part and there is no conclusive evidence of earlier pine growth there. The timbering was higher than today in the central and eastern parts, but similar in the western. The Late Birch period (1500 B.C.-) saw a lowering of the timberline and a successive change towards the present situation where birch dominates and PINUS and ALNUS have restricted distributions. (Auth) Ecol Abs 75L/2634

936. **Sonesson, M., and B. Lundberg.** 1974. Late Quaternary Forest Development of the Tornetrask Area, North Sweden. *Oikos 25(2):121-133.*

Forests were separated into four major heath and two major meadow types, mainly on criteria in the ground vegetation. BETULA PUBESCENS Ehrh. was the main tree species, whereas PINUS SILVESTRIS L. and ALNUS INCANA (L) Moench were infrequent and showed a relic type of distribution. Forest types are related to differences in moisture, nutrient conditions, snow cover, and the biotic influences of the stands. (Auth) Ecol Abs 75L/1354

937. **Spaulding, W.G.** 1981. The Late Quaternary Vegetation of a Southern Nevada Mountain Range. *Ph.D. Thesis, University of Arizona, 307 pp.*

Plant macrofossils from ancient packrat (NEOTOMA spp.) middens preserve a detailed record of past vegetation. They provide a far more informative record on details of upland community composition than has been available to paleoecologists previously. In the Sheep Range of the northern Mojave Desert 30 midden sites that span 900 m of relative relief, from desert scrub vegetation to fir-pine forest, yield 52 radiocarbon dated samples. This data base, encompassing more than 50,000 radiocarbon years, was used to reconstruct the vegetation of the middle Holocene and the dynamics of vegetation change, to test corollaries of the individualistic concept of the plant association, and to verify vegetation reconstructions based on pollen analysis. (Auth)(JTA) Dissertation Abstracts International 42(7):2755-B, Order No. 8200326

938. **Stewart, T.G.** 1981. The Holocene Paleoenvironment of Clements Markham Inlet, Northern Ellesmere Island, N.W.T., Canada. *M.Sc. Thesis, University of Alberta, Edmonton, Alberta, 135 pp.*

Abundant fossil plants were collected from the proximal bottomset beds of a local marine delta graded to a 43 m relative sea level which is dated 6400 B.P. on the provisional emergence curve. The fossil plants also dated 6400 + or - 60 B.P. (SI-4314) and contain a highly diverse bryophyte flora with a minimum of 21 genera and 25 species. LIMATULA (LIMA) SUBAURICULATA, a small marine pelecypod, was collected in deposits laterally continuous with the dated plants. This species' contemporary distribution is predominantly Atlantic-Mediterranean extending to Jan Mayen Island and into the subarctic waters along west Greenland. Its disjunct (?) occurrence here is interpreted as a range extension in reponse to ameliorated (warmer) marine conditions resulting in less abundant summer sea ice and thus more available summer moisture. The abundant fossil plants are therefore interpreted to represent the commencement of increased plant productivity in response to increased summer precipitation in this arid polar environment. This interpretation is consistent with driftwood zonation within inner Clements Markham Inlet. Driftwood penetration or exclusion from Clements Markham Inlet is primarily dependent upon the stability of the landfast sea ice cover at the inlet mouth. Periods of driftwood exclusion indicate warm summers when the landfast sea ice decays. Four postglacial driftwood abundance zones are indicated on emerged shorelines below the local Holocene marine limit: sporadic driftwood ca. 7800 B.P. to 6500 B.P.; abundant driftwood 6500 B.P. to 4500 B.P.; greatly reduced driftwood 4500 B.P. to ca. 500 B.P. (?); and abundant driftwood on the present shoreline with penetration beginning as early as 500 B.P.(?). This zonation is similar to that demonstrated on southern Ellesmere Island and a histogram of driftwood radiocarbon dates from the Canadian and Greenlandic High Arctic indicate that this is likely a regional trend. (Auth)(JTA) SPIRES/BOREAL

939. **Terasmae, J.** 1977. Postglacial History of Canadian Muskeg. *Muskeg and the Northern Environment in Canada, N.W. Radforth and C.O. Brawner (Eds.), Muskeg Research Conference, 15th, Edmonton, Alta., 1973. University of Toronto Press, Toronto and Buffalo, (pp. 9-30), 399 pp.*

The termination of the last glaciation was caused by a significant climatic change that has been substantiated by many different kinds of evidence. A generalized temperature graph for late-Quaternary time is shown on Figure 8. It is also well known that several changes in climate have occurred during the Holocene (Sawyer, 1967). The most important of these changes in terms of muskeg development were those that led to cooler and moister conditions and resulted in an expansion of peatland at the expense of other types of vegetation. One such change occurred some 6,000 to 5,000 years ago and terminated the hypsithermal episode, which was characterized by a generally warmer and drier climate than the present. Another change to cooler and moister conditions occurred about 2,500 to 3,000 years ago, and several other changes of smaller magnitude have occurred since, some of which are documented by historical records. (Auth)(JTA)

940. **Thom, B.G., and J.M. Bowler.** 1982. Chronostratigraphic Subdivision of the Holocene in Australia. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 7-9), 110 pp.*

Highland areas in northeast and southeast Australia and in Tasmania show good evidence for migration of vegetation zones. (Auth)(JTA)

Climatic deterioration over the last 3000 years has been reported from snowline sites in the Snowy Mountains. (JTA)

941. **Vance, R.E., D. Emerson, and T. Habgood.** 1983. A Mid-Holocene Record of Vegetative Change in Central Alberta. *Canadian Journal of Earth Sciences 20:364-376.*

Paleobotanic

Sediments from three lakes in central Alberta, Smallboy Lake (53 deg 35 min N, 114 deg 8 min W), E.I. Pond (53 deg 38 min N, 112 deg 51 min W), and Hastings Lake (53 deg 25 min N, 112 deg 53 min W), have been analyzed for their pollen content, charcoal remains, and (in two lakes) pyrite spherule concentration. The earliest record (radiometrically dated at 7400 years B.P.) indicates the existence of mixed-wood parkland vegetation. By 5000 years B.P. the regional vegetation had a considerably more open structure than now and was subject to frequent fires, presumably a response to the warm, dry Hypsithermal climate of this time. The termination of the Hypsithermal Interval (4000 years B.P.) is recorded in all three lakes by a marked increase in precipitation. The onset of a cooler, moister climatic regime stimulated forest closure and reduced regional fire activity, although the local vegetation of each of the three study sites responded in a unique way to the changing climate. By 3000 years B.P. the vegetation resembled the modern vegetation. Little change is recorded in the sediments from 3000 years B.P. to the present. (Auth)

942. **Viereck, L.A.** 1966. Plant Succession and Soil Development on Gravel Outwash of the Muldrow Glacier, Alaska. *Ecological Monographs 36(3):181-199.*

Plant succession and soil development are described for a series of five stands on glacial outwash adjacent to the McKinley River in an alpine tundra region of the Alaskan Range in Mount McKinley National Park. The ages of the four successional stands are estimated, on the basis of shrub growth, ring counts, and correlation with historical advances of other glaciers, to be approximately I, 25 to 30 years; II, 100 years; III, 150 to 200 years; and IV, 200 to 300 years. Based on estimates of the time of retreat of the ice at the end of the late Wisconsin glaciation, the age of the climax stand is estimated to be 5,000 to 9,000 years. (Auth)(JTA)

943. **Viereck, L.A.** 1968. Botanical Dating in Recent Glacial Activity in Western North America. *Arctic and Alpine Environments, H.E. Wright, Jr. and W.H. Osburn (Eds.), Proceedings of the VII Congress INQUA, Boulder and Denver, Colorado, August 14 - September 19, 1965. Indiana Univ. Press, Bloomington, vol. 10 (pp. 189-204), 308 pp.*

Tree-ring analysis and lichen growth rates provide useful tools for dating glacial events during the past five centuries. From botanical evidence the dates of historical maxima and main advances of 51 glaciers in western North America are given. All areas show a glacial maximum in the past 300 years that was the greatest of the past 500 to 1000 years and probably the greatest since late-glacial time. In most areas there is evidence of advances sometime in the 17th, 18th, and 19th centuries. In British Columbia the glacier maximum was predominantly in the 1700's, with a readvance in the mid-1800's. In Alaska only the glaciers in the Alaskan Range show evidence of a late-1500 and mid-1600 advance. In the vicinity of the Juneau Ice Field and in Glacier Bay the most commonly recorded maximum was the mid-1700's. On the Kenai Peninsula and in the Prince William Sound area a major advance in the late 19th to mid-20th century has destroyed most evidence of earlier advances. (Auth) GA 69A/460

944. **Vilks, G., and P.J. Mudie.** 1978. Early Deglaciation of the Labrador Shelf. *Science 202:1181-1183.*

Data are presented on two marine sediment cores taken from the Cartwright Saddle, Labrador Shelf (54 deg 37.7 min N. and 56 deg 12.6 min W) with basal Carbon 14 dates between 19,000 and 21,000 years old. Seven radiocarbon dates are reported for the two cores. The Holocene boundary occurs at about 4.5 m in both cores. Pollen analysis indicates that a dwarf shrub and herb flora dominated the nearby land area from 21,000 to 8000 B.P. This was followed by a shrub-tundra association between 8000 and 6500 B.P., which in turn was followed by a spruce dominated assemblage. In one core there is evidence for a decrease in the forest assemblage over the last 2000-3000 years. (JTA)

945. **Walker, D., and J.R. Flenley.** 1979. Late Quaternary Vegetational History of the Enga Province of Upland Papua New Guinea. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences 286(1012):265-344.*

Stratigraphies and pollen analyses are reported from three sites within 25 km east and west from Wabag in the highlands of Papua New Guinea, namely: Sirunki, 2500 m above sea level, 32,000 to 1500 yr Inferred Ages; Inim, 2500 m above sea level, 10,000 to 0 yr Inferred Ages; and Birip, 1900 m above sea level, 2300 to 0 yr Inferred Ages. Events evidenced by these data are described against a time scale of Inferred Ages (I.A.) based on radiocarbon dates and stratigraphic considerations. The pollen analytical data from Sirunki are presented in terms of pollen recovery (deposition) rates as grains per square centimetre per year (grains cm(E-2) a(E-1)) and their interpretation controlled by information about total pollen deposition rates and differential pollen production and transport at the present day. Around Sirunki, the composition of the vegetation before 27,500 I.A. is enigmatic, although almost certainly it was treeless. From then until 9000 I.A. subalpine and alpine conditions dominated except during two short periods when forest taxa grew in the catchment. Final afforestation began about 9000 I.A. but the composition of the forest did not stabilize until about 3000 years later. This relative stability was shortlived; soon after 5000 I.A. fluctuations in forest composition began. These fluctuations were associated with periodic changes in the proportion of forested to unforested land. The Inim data lead to conclusions generally compatible with those drawn from Sirunki. However, data from the two areas differ in detail, particularly in the later onset of change in the local forests about 2000 I.A. and its intensification, coeval with a diminution in forest area, after 500 I.A. The short record from Birip is dominated by seral changes on the crater wall itself but the main indicators of forest disturbance and unforested areas were already there at its beginning (2300 I.A.). It seems likely that general forest destruction began, or gained greater impetus, around Birip about 450 I.A. In the most general terms, the forest taxa, recorded by pollen analysis, have behaved consistently with their present distributions and ecological relationships throughout the last 30,000 years. More detailed resolution, however, exposes many deviations from this generalization. The majority of taxa are usually associated in groups which vary in their composition repeatedly during a few thousand years, yet some of the taxa occasionally behave entirely individualistically. Although there is no archaeological evidence, the pollen analytical data suggest human interference with the forests around Sirunki from about 4300 I.A., which for 1300 years involved clearing of the forest and the enhanced growth of ephemerals of forest and open-land. Subsequently, the forest remained generally degenerate and a new wave of clearing began about 2000 I.A. near both Sirunki and Inim which continued and intensified about 500 I.A. At the lower altitude of Birip, forests were already disturbed by the beginning of the pollen analytical record at about 2300 I.A. (Auth)

946. **Wilson, M.A.** 1981. The Climatic and Vegetational History of the Postglacial in Central Saskatchewan. *Ph.D. Thesis, University of Saskatchewan.*

Paleobotanic

Pollen and diatom samples from three lakes in the La Ronge area of central Saskatchewan provide information on the vegetation and climate for a period of time from 9,000 years ago to the present. Pollen stratigraphy can be presented in percentage form and as absolute influx data. Both methods were employed and formed the basis of a numerical stratigraphic zonation and a description of vegetational sequences. From approximately 9,000 to 8,100 years ago the level of Glacial Lake Agassiz dropped from its Campbell Phase level of 423 m to below 370 m above sea level. At this time most presently existing water-bodies became in outline and area much as they are today. The ice retreated from the Cree Lake Moraine close to 9,000 years ago, allowing Glacial Lake Agassiz to drain to the east. It is suggested that before 9,000 years ago the Polar Air Mass dominated the region. This resulted in stagnation of the glacier and stabilization of a zone of treeless vegetation close to the ice front. It also explains why tree pollen are absent from the lake sediments. After 9,000 years ago, the Pacific Air Mass became dominant, causing rapid ice retreat and permitting the northward expansion of spruce forest. Approximately 8,600 years ago, or even earlier, tree pollen became an important component of the pollen assemblage. From approximately 8,000 to 6,700 years ago, first alder and then pine migrated into the La Ronge area. This resulted in a true boreal forest much like the one now growing there. Between approximately 3,500 to 3,000 years ago, the conditions became slightly cooler and/or moister, rather like today's climate. Diatoms, several of which have not been previously recorded from Saskatchewan, reveal little additional information. Lake waters remained relatively unaltered since organic or calcareous sedimentation began 8,000 years ago. Only the southernmost of the three lakes studied, Marl Pond, displays a brief change from its normally slightly basic waters to slightly acidic, approximately 3,500 years ago. A more recent fluctuation to acid conditions is not yet clearly reflected in the diatom flora. (Auth) Dissertation Abstracts International 42(05):1798-B

947. **Worsley, P.** 1974. Absolute Dating of the Sub-Boreal Climatic Deterioration–Fossil Pine Evidence from Strimasund, Vasterbotten County, Sweden. *Geologiska Foreningens i Stockholm Forhandlingar 96:399–403.*

This locality has previously yielded the youngest dated IN SITU fossil pine stump from above the current pine limit in Sweden. A new radiocarbon age determination supports the validity of the original dating as early first millenium B.C. The pine dates, in conjunction with paleosol dates from beneath nearby solifluction lobes, suggest an absolute age of CIRCA 2,800 years B.P. for the local climatic transition to the Sub-Atlantic period. This note forms report no. 18 from the Okstindan Research Project.

948. **Zeist, W. van** 1974. Niederwil, a Palaeobotanical Study of a Swiss Neolithic Lake Shore Settlement. *Geologie en Mijnbouw 53(6):415–428.*

The Neolithic lake shore settlement of Niederwill, northeastern Switzerand, is dated from c. 3700 to c. 3625 B.C. At that time the natural vegetation of the uplands consisted of Carpinion betuli forests, in which with oak and beech were other trees and a number of shrubs. In the river valleys Alno-Padion forests with poplar, ash and elm was present. Cutting and grazing led to open vegetation. Prunetalia shrub expanded along forest edges. The main crops of the Niederwil farmers were bread wheat (TRITICUM AESTIVUM), naked barley (HORDEUM VULGARE var. NUDUM), flax (LINUM USITATISSIMUM), and opium poppy (PAPAVER SOMNIFERUM). Wild plants would have played some part in the diet. (from Authors) Ecol Abs 75L/3402

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949. **Andrews, J.T.** 1972. Recent and Fossil Growth Rates of Marine Bivalves, Canadian Arctic, and Late-Quaternary Arctic Marine Environments. *Palaeogeography, Palaeoclimatology, Palaeoecology 11(3):157-176.*

Growth rates of three marine bivales--MYTILUS EDULIS, SERRIPES GROENLANDICUM and CLINOCARDIUM CILIATUM--are used to elucidate Late-Quaternary marine conditions in the Candian Arctic and Subarctic. Present-day growth rates in Subarctic waters are statistically faster than those for the same species in Arctic waters. Fossil growth rates are analysed for a 6,000- and 8,500-year sequence from central Hudson Bay and east Baffin Island. These data suggest that growth rates and the size of coexistent clams, MYA TRUNCATA and MYA PSEUDOARENARIA, increased to a maximum about 3,500 B.P. and have since declined. Growth rates did not increase to Subarctic values and hence the increase is related to temperature and salinity changes of the surface layer rather than by vertical mixing with the Atlantic water layer at depth. During the period 8,000- 2,500 B.P. M. EDULIS and MACOMA BALTHICA extended up the east coast of Baffin Island and across the entire Arctic mainland coast; CHLAMYS ISLANDICUS does not appear to have been as widespread. In the last 2,500 years or so these species have retreated to the west and south. A comparison of raised, Late-Quaternary marine deposits throughout the North-Atlantic Arctic indicates similar biostratigraphic zones. Warmer conditions than today prevailed between 8,500-2,500 B.P. with an optimum at approximately 3,500 B.P. These dates suggest that marine conditions lagged behind terrestrial climatic changes, thus superimposing (in time) a cool atmosphere/ warm ocean system that might explain the renewed glacierization of Arctic regions in the Neoglacial. (Auth)

950. **Andrews, J.T.** 1973. Late Quaternary Variations in Oxygen and Carbon Isotopic Compositions in Canadian Arctic Marine Bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology 14:187-192.*

The oxygen and carbon isotopic composition of arctic marine bivalves MYA TRUNCATA; HIATELLA ARCTICA, and MYTILUS EDULIS are reported on samples from raised marine deposits in Hudson Bay and eastern Baffin Island. The shells range in age from modern, through the Holocene, to "old" marine units. During the Holocene the Oxygen 18/Oxygen 16 ratio in shells rose to a maximum about 3,500 B.P. which coincides in time with the period of maximum growth rates of bivalves, maximum size and maximum faunal diversity. The change is interpreted to indicate that about 3,500 years ago arctic waters may have reached a salinity of about 1-2% greater than present. (Auth)(JTA) BafBib 335

951. **Betancourt, J., P.S. Martin, and T.R. Van Devender.** 1983. Fossil Packrat Middens from Chaco Canyon, New Mexico: Cultural and Ecological Significance. *Chaco Canyon Country, A Field Guide to the Geomorphology, Quaternary Geology, Paleoecology, and Environmental Geology of Northwestern New Mexico. American Geomorphological Field Group, 1983 Field Trip Guidebook, S.G. Wells, D. Love and T.W. Gardner, (Eds.). (pp. 207-217).*

The packrat midden record from Chaco Canyon has furnished new insights about several research topics, from reconstructing regional biogeography to pinpointing sources of wood used by the pueblos for construction and fuel. The sequence from Atlatl Cave documents a major reshuffling of biotic communities at the end of the Pleistocene Epoch. Subalpine trees such as spruce and limber pine contracted their ranges to refugia well above 2,600 m elevation. The territory they vacated was colonized in part by conifers from the south, mainly ponderosa pine and pinyon. These trees expanded north with Holocene development of monsoonal circulation over the Southwest. Greater effective moisture than today is suggested for at least parts of the middle Holocene. Although we do not challenge the prevailing view that annual temperatures were higher, there is little indication of a major trend in aridity at Chaco Canyon. A hot and dry Altithermal would have been manifested in fluctuations at the lower edge of the pinyon-juniper woodland. Such a marginal woodland was present at Chaco Canyon throughout most of the Holocene. A major reduction in the Chaco woodland is registered only recently, between 1,200 and 500 years ago, and most likely due to human impact rather than climate. (Auth)(JTA)

952. **Blake, W., Jr.** 1979. Age Determinations on Marine and Terrestrial Materials of Holocene Age, Southern Ellesmere Island, Arctic Archipelago. *Geological Survey of Canada Paper 79-1C, (pp. 105-109).*

A series of new age determinations of the pelecypod, MYA TRUNCATA, and SALIX sp, aged close to 8,000 yr old is reported from Swinnerton Peninsula, Ellesmere Island and confirms an earlier age determination of driftwood, whale bones and marine pelecypod shells from Cape Storm (Blake 1975). At Swinnerton Peninsula, the 10 intact pairs of shells and SALIX were extracted from exposed calcareous stony silt at an elevation of 42 m a.s.l. along a stream. The shells were all collected in the position in which they had lived and been buried in deposition of sediment. Similar shells collected 3 km west at 82 m a.s.l. suggest the silt was deposited at a depth of 40 m or more. At Cape Storm, driftwood (mainly PICEA sp and LARIX sp), whalebone and MYA TRUNCATA shells were found in an exceptionally well-developed sequence of raised beaches. Ages of the shells at 100.5 to 101.0 m a.s.l. and of whale bone collected at 118.0 m a.s.l. were very similar, approximately 9,350 and 9,370 years. An additional new age determination on the collagen fraction of a whale bone from this site (approximately 9,340 years) is in good agreement with the ages of the nearby marine mollusc shells. The results from these studies show that in situ Holocene marine mollusc shells yield reliable Carbon 14 age determinations, even where carbonate rocks are widespread, and that the utilization of the organic (collagen) fraction of whale bones for radiocarbon dating gives reliable results. (Ecol Can 3215) Ecol Can 3215

953. **Clark, D.L.** 1969. Paleoecology and Sedimentation in Part of the Arctic Basin. *Arctic 22(3):233-245.*

The paper reviews studies based upon the analysis of the 1,000 or so cores available from the Arctic Ocean including those obtained by Russian workers. Topics dealt with include: magnetic stratigraphy, the physical properties of the cores, micro-fauna and overall accounts of climatic change based upon this work and extending back throughout the Pleistocene. The bibliography is particularly useful for articles published in the last five years. (D. Ingle Smith) GA 70A/1069

954. **Delorme, L.D., S.C. Zoltai, and L.L. Kalas.** 1977. Freshwater Shelled Invertebrate Indicators of Paleoclimate in Northwestern Canada during Late Glacial Times. *Canadian Journal of Earth Sciences 14(9):2029-2046.*

Paleoclimatic interpretations based on shelled invertebrates from four sites in the northwest corner of the Northwest Territories, Canada, during the time interval 14410-6820 years B.P., indicate that the mean annual temperature was about 8.2-11.6 deg C higher than at present, and that the annual precipitation was about 55-234 mm greater than at the present time. Based on potential evapotrans-

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piration, it can be computed that the length of the growing season was about 156 days long as compared to between 90 and 135 growing days at the present time for the same area. (Auth)

955. **Donner, J.J., M. Eronen, and H. Jungner.** 1977. The Dating of the Holocene Relative Sea-Level Changes in Finnmark, North Norway. *Norsk Geografisk Tidsskrift 31:103-128.*

THE Holocene land/sea-level changes in Finnmark, North Norway, were determined with the help of radiocarbon dates of shells from raised beaches. The regression of the sea level below 25 m could be dated in the Varangerfjord area for the time interval 5500-3600 B.P., and below 15 m for the outer coast of the Varanger peninsula after about 4500 B.P. In addition, dates from two lakes and a former dated peat at Tomaselv were used to determine the lowering of the sea level after 9000 B.P. It was shown that radiocarbon dates of charcoal samples from archaeological sites cannot directly be compared with the other dates and also that lichenometry cannot be used in the study of the land/sea-level changes of the area. The influence of corrected radiocarbon ages is also discussed. (Auth)

956. **Elias, S.A.** 1980. Paleoenvironmental Interpretations of Holocene Insect Fossil Assemblages from Three Sites in Arctic Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 331 pp.*

The Ennadai Lake I site consisted of a SPHAGNUM peat monolith which yielded a minimum of 1450 individuals of arthropods. Fifty three taxa were identified (27 to species level), representing 13 families of Coleoptera and seven families of other insect and arachnid orders, including an abundant ant fauna, ranging in age from before 6000 to 630 B.P. The Ennadia Lake II peat monolith produced at least 1368 individuals of 43 beetle taxa (13 families) and 15 taxa in three other insect and arachnid families, ranging in age from 4700 to 870 B.P. The insect assemblages from Ennadai I are predominantly forest taxa from before 6000 to 2300 B.P., with brief climatic changes marked by outbreaks of bark beetles and forest fires at 5800-5600 B.P. The pollen record had registered a conifer pollen decline at 4800-4500 B.P., previously interpreted as a southerly migration or opening up of the forest in response to climatic cooling (Nichols, 1967). The Ennadai beetle record, however, reveals the continued presence of trees, which may suggest a climatic episode which was palynologically "silent", and may have contributed to bark beetle outbreaks. Both assemblages indicate climatic deterioration between 2200 and about 1500 B.P., then a slight recovery before peat deposition ended. The Umiakoviarusek site produced a peat column with a basal charcoal horizon (dated 2650 B.P.), containing numerous conifer macrofossils. The site yielded a minimum of 1033 individuals, including 70 named taxa of 13 beetle families and 14 families of other insects, arachnids and Cladocera. The assemblages are dominated by aquatic and semi-aquatic taxa, indicative of a wet bog environment with open water, in contrast to the terrestrial environment at Ennadai. These fossil assemblages show a continuous woodland episode, from the base (2650 B.P.) to 1000 B.P., followed by colder and drier episodes to the present day, indicated by reduction of aquatic species and increases in tundra dwelling taxa. This sequence is in general agreement with the Ennadai reconstruction for this interval, and the Labrador pollen record. Many of the forest faunal elements from these Holocene sites were present in late glacial sites, over 2500 km to the south. The Ennadai and Umiakoviarusek assemblages document the northward migration of these faunal units, almost intact, after deglaciation. (Auth)(JTA)

957. **Elias, S.A.** 1982. Holocene Insect Fossils from Two Sites at Ennadai Lake, Keewatin, Northwest Territories, Canada. *Quaternary Research 17:371-390.*

Ennadai Lake, in the forest-tundra ecotonal region of Keewatin, Northwest Territories, Canada, has been the subject of several paleoecological investigations (palynology, plant macrofossils, fossil soils). This study concerns Holocene insect fossils at Ennadai, a new approach in a region shown to be sensitive to climatic change. The insect evidence suggests the presence of trees in the Ennadai region from 6000 to 2200 yr as an opening up or retreat of forest in reponse to climatic cooling, but the insect fossils reveal the continued presence of trees during this interval. Both insect assemblages suggest trends of forest retreat and tundra expansion between about 2200 and 1500 yr B.P., presumably due to climatic cooling, with a return of woodland by about 1000 yr B.P. (Auth)

The chronology used in this study is discussed in more detail by Nichols (1975). Pollen diagrams for one site are included in this last mentioned paper. (JTA)

958. **Feyling-Hanssen, R.W.** 1972. The Pleistocene/Holocene Boundary in Marine Deposits from the Oslofjord Area. *Boreas 1:241-246.*

In marine deposits from the southern Oslofjord area in Norway the boundary between Holocene and Pleistocene is found within a formation characterized by Arctic species, the so-called Yoldia Clay or zone A in the foraminiferal stratigraphy. The fossil assemblage on the Holocene side of the boundary is even poorer than that on the Pleistocene side, which is explained by the rapid Preboreal ice recession. The boundary is not conspicuously reflected in the faunas but still discernible and applicable. (Auth)

959. **Forsten, A., and S. Lahti.** 1976. Postglacial Occurrence of the Beaver (CASTOR FIBER L.) in Finland. *Boreas 5:155-161.*

Subfossil finds of the beaver in Finland, both stray finds and bones among refuse at cultural sites are reviewed. The beaver may have arrived in the Preboreal period together with other elements of the taiga fauna; the earliest finds, however, are from the Late Ancylus or Early Litorina phase of the Baltic. The animal's arrival and occurrences in this country since the end of the last glaciation are tentatively discussed. (Auth)

960. **Gaunitz, S.** 1965. A Contribution to the Discussion on the Significance of Climatic Changes in the Northern Scandinavia. Ett bidrag till diskussioner om klimatforandringarnas betydelse i Norden. Swedish. *Ymer 85(1-2):141-44.*

Reports on 1958 observations of birch east and west of the height of land (near 650 m) between headwaters of the Umealv in northern Sweden and those of Ranfjorden in the Atlantic drainage of Norway. Birch were found at greater elevation than indicated on recent maps and the treeline is assumed to have risen, though below that of the warmer period of post-Glacial time. Carbon 14 datings of 5-7000 yr are known for birch stumps above 600 m in the same region. The possibility is advanced that woodland insects and low-growing woodland flora may have survived the glacial period on refuges and wandered eastward over the height of land in the warmer period; several species are identified. The probability that at 5-7000 B.P. the land was less recovered from post-glacial depression and treeline no higher than now, is not considered. (AB87207) AB87207

961. **Harington, C.R.** 1975. A Postglacial Walrus (ODOBENUS ROSMARUS) from Bathurst Island, Northwest Territories. *Canadian Field-Naturalist 89:249-261.*

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The first recorded walrus fossil from the Canadian Arctic Archipelago is represented by a cranial fragment with tusk that was collected from a raised beach deposit 10 mi (16.1 km) west of Goodsir Inlet at an elevation of about 175 ft (53.3 m) above sea level. This record is also the earliest record for walrus for northern Canada. Radiocarbon dating of the specimen indicates an age of 7320 + or - 120 yr B.P. Much of Bathurst Island was ice-free 9000 yr ago. Blake (1970) indicated that a major ice sheet covered the Queen Elizabeth Islands during the last (Wisconsin) glaciation, in which the ice was thickest in the eastern and central part of the archipelago where uplift has been greatest during the last 5000 yr. The same author concluded that much of the island was ice-free by 9000 yr ago. As the area was reinvaded by the sea, marine molluscs such as MYA and HIATELLA returned to the area. These marine molluscs are an important part of the diet of walruses. It is thought that these marine molluscs entered the region by 8400 yr ago, determined from shell fragments found near the fossil walrus. It is presumed that walruses could have survived in the area at this time, provided other habitat factors were suitable, but the evidence is that walrus reached the area about 7300 yr ago based on the cranial fragment of this fossil species. Whales, probably bowheads (BALAENA MYSTICETUS) also lived in the region at the same time as the walruses from evidence of bones recovered at sea level near Resolute on Cornwallis Island with a radiocarbon date of 7380 + or - 140 yr B.P. (Ecol Can 1520)(JTA) Ecol Can 1520

962. **Harington, C.R.** 1980. Radiocarbon Dates on Some Quaternary Mammals and Artifacts from Northern North America. *Arctic 33:815-832.*

Nine radiocarbon dated specimens from five genera of Quaternary mammals from the Yukon, Alaska and Northwest Territories are described and discussed in this article. These include bone specimens, some of them altered by man as artifacts. The list of mammals includes specimens of muskox (OVIBOS MOSCHATUS). Four radiocarbon dates on muskox specimens are from postglacial time, that is within the last 10,000 years. One of the samples was collected 16 km west of Goodsir Inlet, Bathurst Island. Much of Bathurst Island was ice free about 9000 years ago and evidence suggests that both marine mammals and muskoxen had reached the area about 7000 years ago. It is possible that muskoxen could have occupied Bathurst Island continually from 7000 yr B.P. to the present. Perhaps muskoxen survived the Wisconsin glaciation in a refugium on western Banks Island and spread from there to the remainder of the Canadian Arctic Archipelago and Greenland. Evidence from dated muskoxen samples from Banks Island indicates that tundra muskoxen occupied western Banks Island in late Wisconsin time and earlier. Radiocarbon dates from partial muskoxen skulls also indicate that muskoxen survived in the Yukon Territory until about 3000 years ago. (Ecol Can 3871) Ecol Can 3871

963. **Harris, A.H.** 1969. Past Climate of the Navajo Reservoir District. *American Antiquity 35(3):374-377.*

Assuming that yellow-bellied marmots (MARMOTA FLAVIVENTRIS) indicate a minimum of about two inches of winter precipitation, past changes in marmot distribution are used to interpret climatic change in northwestern New Mexico and adjacent Colorado. An early period of high effective moisture is explained by predominant summer rains. At about A.D. 700-800, there occurred a change to dominant winter precipitation that lasted until about A.D. 1000 or later. This model agrees with previous work based on faunal analysis but is exactly counter to that proposed from alluvial and pollen studies. (Harold E. Malde) GA 71B/0210

964. **Hillaire-Marcel, C.** 1980. The Fauna of the Postglacial Seas of Quebec: Some Paleoecological Aspects. Les Faunes des Mers Post-Glaciaires du Quebec: Quelques Considerations Paleoecologiques. French, English Summary. *Geographie physique et Quaternaire 34(1):3-59.*

A paleoecological study of the fossil fauna of the post-glacial seas of Quebec, with special attention on mollusks, permit the delineation of type- communities. These benthonic communities are distributed according to the depth, with small variations from the northern basins to the generally more brackish southern seas. Thus, epibenthonic (epifaunal) communities living on coarse sediments are the intertidal MYTILUS EDULIS community, and the deeper water HIATELLA ARCTICA community which may be subdivided in two sub-communities. The endobenthonic (infaunal) communities living in sandy, silty or clayey shallow water sediments include the MYA ARENARIA and MACOMA BALTHICA communities and the deeper water MACOMA CALCAREA community which may be subdivided in three subcommunities. The PORTLANDIA ARCTICA community deserves a special status because it's mainly associated with glacio-marine muddy environments. These communities which correspond to well-defined lithofacies, very often succeeded each other in relation to the decreasing depth of the basins due to post-glacial rebound. Thus, they do not reflect climatic trends, but simply hydrological changes caused by shoaling of each basin. Occasionally, some "warm" water species migrated northward for a short period of time during the middle or late Holocene. They reflect a slightly delayed climatic optimum in the Arctic. (Auth)

965. **Hjort, C., and S. Funder.** 1974. The Subfossil Occurrence of MYTILUS EDULIS L., in Central East Greenland. *Boreas 3(1):23-33.*

The subfossil occurrence of MYTILUS EDULIS in central East Greenland has been Carbon 14 dated to roughly between 8000 B.P. and 5500 B.P. Its immigration coincides with the final deglaciation of the innermost fjords, and its disappearance is contemporaneous with an increase in cold-climate plants, as shown by pollen spectra. (Auth)(JTA)

966. **Hunkins, K.** 1967. Quaternary Sedimentation in the Arctic Ocean. *The Quaternary History of the Ocean Basins, Progress in Oceanography Vol. 4, M. Sears (Ed.). Pergamon Press, Oxford, UK, (pp. 89-94), 344 pp.*

A distinct boundary between sediment types at a depth of 10 cm in cores from Alpha Rise represents the most recent change in pelagic deposition and must reflect climatic change. Sediment above 10 cm is brown foraminiferal lutite mixed with ice-rafted sand and pebbles; foraminifera from a zone between 7 and 10 cm have been Carbon 14 dated as 25,000 yr B.P., and the 10 cm boundary itself as 70,000 yr B.P. by a uranium series method. If these dates are accepted, a low sedimentation rate of 1.5 to 3 mm/1000 yr is indicated for Alpha Rise and for the whole Arctic Ocean if pelagic sedimentation has been uniform. Cores from the Canada Abyssal Plain are turbidity-current deposits, with a top 3 mm layer, similar to the Alpha Rise upper layer; formanifera in it have been Carbon 14 dated as 700 yr B.P. It is concluded that pelagic sedimentation has continued unchanged in the Arctic Ocean for the past 70,000 years. (from Abstracts N. American Geology) GA 68A/1656

967. **Lyman, R.L., and S.D. Livingston.** 1983. Late Quaternary Mammalian Zoogeography of Eastern Washington. *Quaternary Research 20:360-373.*

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The late Quaternary mammalian zoogeographic history of eastern Washington as revealed by archaeological and paleontological research conforms to a set of past environmental conditions inferred from botanical data. During the relatively cool and moist late Pleistocene and early Holocene, CERVUS Cf. ELAPHUS, OVIS CANADENSIS, VULPES VULPES, MARTES AMERICANA, ALOPEX LAGOPUS, and perhaps RANGIFER sp., taxa with ecological preferences for mesic steppe habitats, were present in the now xeric Columbia Basin. As the climate became progressively warmer and drier during the late Pleistocene and early Holocene, ANTILOCAPRA AMERICANA, ONYCHOMYS LEUCOGASTER, SPERMOPHILUS TOWNSENDII, and NEOTOMA CINEREA, taxa with ecological preferences for xeric steppe habitats, appear in the Columbia Basin. BISON sp. and TAXIDEA TAXUS may have been present in eastern Washington for the last 20,000 yr. Middle and late Holocene records for OREAMNOS AMERICANUS, SPERMOPHILUS COLUMBIANUS, S. TOWNSENDII, LAGURUS CURTATUS, and UROCYON CINEREOARGENTEUS in central eastern Washington suggest fluctuations in the ranges of these taxa that conform to a middle Holocene period of less effective precipitation and a ca. 3500-yr-old period of more effective precipitation before essentially modern environmental conditions prevailed. (Auth)

968. **Matthews, B.** 1967. Late Quaternary Marine Fossils from Frobisher Bay (Baffin Island, N.W.T., Canada). *Palaeogeography, Palaeoclimatology, Palaeoecology 3:243-263.*

Eighteen species of fossil marine pelecypod and eighteen species of Foraminifera collected from raised beach deposits (with strandlines at 27 ft., 48 ft. and 77 ft. above sea-level) at Frobisher Bay, yield possible evidence of postglacial changes in the marine environment. A few of the little-known species of pelecypod are described. Six of the species are recorded for the first time in raised marine deposits of arctic Canada: two are pan-arctic species (i.e. AXINOPSIDA ORBICULATA and YOLDIA FRATERNA) and three species (i.e. VOLSELLA DEMISSA, NUCULA DELPHINODONTA, LYONSIA HYALINA) do not occur in Canadian arctic waters at the present time and suggest more favourable environmental conditions during the Atlantic climatic phase. The present distribution of the other species, YOLDIA SAPOTILLA, is still uncertain. The presence in sediments at 21 ft. above sea level of temperate Foraminifera GLOBUINA INAEQUALIS and the pelagic Foraminifera ORBULINA UNIVERSA may also point to warmer conditions about 6,000-6,500 years ago. Radiocarbon datings of 6,140 + or - 170 and 6,440 + or - 160 years B.P. were determined on shells from 48 ft. and 11 ft. above sea-level respectively. The latter date indicates the upper part of Frobisher Bay was deglaciated at least 6,500 years ago, while the former date suggests an average land emergence of about 1 ft./century in the last 6,000 years. (Auth)

969. **Osborne, P.J.** 1974. An Insect Assemblage of Early Flandrian Age from Lea Marston, Warwickhsire, and its Bearing on the Contemporary Climate and Ecology. *Quaternary Research 4(4):471-486.*

An extensive insect fauna from an organic deposit occurring in a gravel pit at Lee Marston, Warwickshire, England, was indicative of a temperate oceanic climate similar to that found today in southern England or south Sweden and suggested the presence of deciduous woodland. The six radiocarbon dates, however, agreed in giving the deposit an age of c. 9500 yr B.P. which is earlier than the arrival of the principal broad-leaved trees. The pollen assemblage was consistent with the radiocarbon dates in showing, in addition to herbaceous pollen, only the presence of BETULA, SALIX and small amounts of PINUS. As the insect faunas known from midland Britain at the close of the Devensian period, barely 500 yr before, are arctic in aspect and entirely devoid of thermophilous species a very rapid climatic amelioration is postulated which permitted the immigration of the very mobile insect fauna well in advance of the more slowly migrating trees. (Auth) Ecol Abs 75L/4024

970. **Piankov, V.P.** 1965. Mammoths and the Climatic Paradox. Mamonty i zagadka klimata. Russian. *Priroda 54(10):86-94, English translation by E.R. Hope available as Translation T444R, Defence Research Board of Canada.*

Notes the comparatively warm moist climate of the arctic coast for some two thousand years after the last ice age, and the anomalous (south-north) winter migration of mammoths, etc from the colder interior. The change of climate responsible for the disappearance of mammoths is considered: Kanin Peninsula then an island allowed Gulf Stream waters to penetrate into Kara Sea. When the strait between the island and mainland was blocked some 10,000 yr ago, associated changes in currents, anticyclone pattern, and climate ensued. If old Cheshskiy Strait were restored, Gulf Stream waters would again flow along the arctic coast, change the circulation patterns of the Barents and Kara Sea area, and exert an ameliorating influence upon the climate of Eurasia and North America. (AB90777) AB90777

971. **Spjeldnaes, N.** .978. Ecology of Selected Late- and Post-Glacial Marine Faunas in the Oslo Fjord Area. *Geologiska Foreningens i Stockholm Forhandlingar 100(2):189-202.*

In order to enhance the reliability and precision of the ecostratigraphy of the Quaternary of the Oslo Fjord area, an analysis of selected faunas has been made, for the purpose of determining their relationship to Thorson's Arctic-animal communities and their trophic structure, and especially of reconstructing the original biocoenosis from the observed taphocoenosis. The "noise" due to ice-rafted fossils has been estimated, and it is concluded that epifaunas may appear "warmer" than infaunas from the same environment, when interpreted by conventional methods. Discrepancies in the distribution of some species are attributed partly to the comparatively low latitude of the Oslo Fjord area, and partly to our incomplete knowledge of parts of the Recent faunas. The tentative, preliminary model indicates that the hydrological conditions changed from those of an open, ice-margin shelf–up to and during the Younger Dryas time–to those of an Arctic fjord, after the ice had retreated from the Ra line. (Auth)

972. **Tsepkin, Ye.A., and L.I. Sokolov.** 1969. Growth Change of Siberian Sturgeon in Lena River during the Middle and Late Holocene. Ob izmenenii rosta sibirskogo osetra reki Leny v srednem i pozdnem golotsene. Russian. *Nauchnyye doklady vysshey shkoly. Biologicheskiye nauki 12(1):17-19.*

Comparison of the growth of a specimen of ACIPENSER BAERI from a middle Holocene locality in the Lena River region, with that of the present-day sturgeon indicates a more rapid growth of the ancient sturgeon in the formerly warmer climate of Eastern Siberia. There is also geological and paleobotanical evidence of the former climate. (AB107945) AB107945

973. **Young, J.A.T., and R.W. Renaut.** 1979. A Radiocarbon Date from Lake Bogoria, Kenya Rift Valley. *Nature 278(5701):243-245.*

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Radiometric dates from faunal remains deposited in lacustrine and fluvio-lacustrine sediments at numerous locations in and around the lakes of the Kenya Rift Valley confirm a period of extended lake development related to a wetter climatic phase around 10,000 yr B.P. Thereafter, a drier climatic regime has prevailed and the lakes have contracted, although fluctuating in rapid response to sequences of wetter or drier years. Lake Bogoria (Hannington) is the last of the Kenya Rift Valley lakes to yield a radiocarbon date for this early Holocene high stand. Although a general synchronism of maximal lake development has emerged, as we report here, there is considerable variation in the dates obtained from each lake basin. (from Authors) GA 79A/2416

Palynologic

974. **Adam, D.P.** 1967. Late-Pleistocene and Recent Palynology in the Central Sierra Nevada, California. *Quaternary Paleoecology, E.J. Cushing and H.E. Wright, Jr. (Eds.), Proceedings of the VII Congress of the International Association for Quaternary Research. Yale University Press, New Haven and London, Volume 7, (pp. 275-301).*

Pollen analyses of two surface transects across the Sierra Nevada and four stratigraphic sections from the Lake Tahoe and Yosemite areas have yielded a preliminary climatic history for the central Sierra Nevada for the time since the recession of the last Wisconsin (Tioga) glaciers. The transition from a glacial to a modern vegetation occurred about 10,000 radiocarbon years ago, followed by a postglacial climatic optimum in the Sierra, during which two warm periods occurred. The climatic optimum terminated about 2,900 radiocarbon years ago with the beginning of the Little Ice Age. (Auth)

The time control on the Osgood Swamp core is two Carbon 14 dates, whereas three Carbon 14 dates are available for the Crane Flat archeological site. (JTA)

975. **Ager, T.A.** 1982. Quaternary History of Vegetation in the North Alaska Range. *U.S. Geological Survey Circular 844, (pp. 109-111).*

By about 11,000 years ago, summers became sufficiently warm and probably dry enough to permit the rapid spread of poplar trees (POPULUS) in the Tanana Lowland and many other areas of Alaska and Yukon Territory. One of the earliest known appearances of POPULUS in the Alaska Range occurred roughly 10,000 years ago in the Delta River headwaters area (Tangle Lakes area), according to pollen and macrofossil data reported by C.E. Schweger (unpublished data). POPULUS spread from the Tanana Valley-to at least the northern foothills of the Alaskan Range in the Nenana Valley at about the same time. The next significant regional change in vegetation began about 9,500 years ago in the Tanana Valley, when spruce rapidly spread throughout the lowlands (Ager, 1975). The area around Delta River was an early invasion route into the Alaska Range, where spruce are known to have spread to the headwaters of the Delta River at Tangle Lakes by about 9,100 years ago (C.E. Schweger, unpub. data). In the Nenana Valley and areas to the west of that drainage, however, the spruce invasion appears to have been delayed until perhaps 7,500 years ago or later. Spruce and alder invaded almost simultaneously in the Nenana Valley area, whereas spruce preceded alder in the Tanana Valley by about 1,000 years. (Auth) (JTA)

976. **Alley, N.F.** 1976. The Palynology and Palaeoclimatic Significance of a Dated Core of Holocene Peat, Okanagan Valley, Southern British Columbia. *Canadian Journal of Earth Sciences 13(8):1131-1144.*

Holocene vegetation and climatic changes of the Okanagan Valley, British Columbia, are inferred from fossil pollen assemblages recovered from Kelowna bog in the central part of the valley. Broad climatic changes inferred from relict postglacial landforms in the valley are correlated with the above changes. The Okanagan valley was ice-free and Glacial Lake Penticton drained before 8900 yr B.P. A forest consisting mainly of pine (PINUS) and stands of spruce (PICEA) had colonized the valley sides prior to draining of the lake. Soon after 8400 yr B.P., moist conditions gave way to aridity during which grass (Gramineae) and sagebrush (ARTEMISIA) predominated. This warm, dry interval is correlated with the Hypsithermal. Bare areas in the valley bottom were exposed to wind erosion; sand dunes formed in some areas, whereas in others, a veneer of aeolian sediment was laid down. At approximately 6600 yr B.P., the climate became cooler and moister, aeolian activity diminished, and the dunes became stabilized by vegetation. During the ensuing latest climatic interval, three moister phases affected Kelowna Bog and were characterized by large increases in birch (BETULA), alder (ALNUS), and hazel (CORYLUS). These phases, which were related to increased runoff from the adjacent uplands, are tentatively correlated with the stades of the Neoglaciation recognized in southcentral British Columbia and neighbouring United States. (Auth)

977. **Anderson, J.H.** 1970. A Geobotanical Study in the Atlin Region in Northwestern British Columbia. *Ph.D. Thesis, Michigan State University, Department of Botany and Plant Pathology, East Lansing, MI, 380 pp.*

Reports on a vegetation and palynological study conducted in the Atlin Region, Northwestern British Columbia/South-Central Yukon, with emphasis on the glaciated Atlin Lake Valley. Results include a preliminary catalogue of plants, descriptive analysis of upland plant communitites, a discussion of the regional importance of various arboreal species, qualitative descriptions of bog plant communitites, a vegetation-pollen rain comparison, and five radiocarbon-dated pollen and spore diagrams and a late Pleistocene-Holocene geobotanical chronology based upon them. (SPIRES/BOREAL) SPIRES/BOREAL

978. **Anderson, J.H.** 1975. A Palynological Study of Late Holocene Vegetation and Climate in the Healy Lake Area of Alaska. *Arctic 28(1):62-69.*

A preliminary palynological study of the Healy Lake area in east- central Alaska is reported upon. Interpretations extend to 4,600 radiocarbon years B.P. With the minor exception of pine, pollen profiles show no trends that can be interpreted as environmentally-induced departures from modern conditions, percentages at depth being similar to those for surface samples. Therefore it is tentatively concluded that no major changes in vegetation occurred in conjunction with late Thermal Maximum and Neoglacial climatic changes. There is some indication that lodgepole pine has migrated towards the area from the southeast during the Holocene. (Auth)

979. **Anderson, J.H.** 1975. A Palynological Study of Late Holocene Vegetation and Climate in the Healy Lake Area, Alaska. *Climate of the Arctic, G. Weller and S.A. Bowling (Eds.), Proceedings of the Twenty-Fourth Alaska Science Conference, August 15-17, 1973. Geophysical Institute, University of Alaska, Fairbanks, Alaska, (pp. 43-47), 436 pp.*

A preliminary palynological study of the Healy Lake area in southeastern interior Alaska is reported. With the minor exception of pine, pollen profiles show no important trends for the past 4600 radiocarbon years, percentages at depth being similar to surface samples. Therefore it is tentatively concluded that late Thermal Maximum and Neoglacial vegetation changes, if any, were slight. There is some evidence that lodgepole pine has migrated toward the area from the southeast during the Holocene. (Auth)

980. **Andrews, J.T., P.E. Carrara, F.B. King, and R. Stuckenrath.** 1975. Holocene Environmental Changes in the Alpine Zone, Northern San Juan Mountains, Colorado: Evidence from Bog Stratigraphy and Palynology. *Quaternary Research 5:173-197.*

Cores from five high alpine basins in the northern San Juan Mountains show several fluctuations in lithology. Typically, peats are interbedded with coarser clastic sediments or else woody peats alternate with fibrous peat. Twenty Carbon 14 dates provide radiometric control. Sediment rates averaged about 2.5 cm/100 yr but were varied at the different sites between 1.19 and 50 cm/100 yr. Rates were lower during the middle of the Holocene. Basal radiocarbon dates indicate that these high (ca. 3600 m a.s.l.) northeasterly facing cirques were icefree by 9000 B.P. There is some evidence in the cores for a short climatic reversal sometime between 8000 and 7000 B.P. A major change occurred in the high basins very close to 5000 B.P. and thereafter there are several intervals of increased clastic sedimentation which may be related to Neoglacial climatic fluctuations. Analysis of a 2.15 m core near Hurricane Basin indicates significant fluctuation of pollen and macrofossils occurred during the 9000 + or - year record. The PICEA/PINUS ratios are used to delimit changes in the apparent elevation of the site: the ratios indicate that a short drop of "treeline" occurred about 8000 B.P. and then remained near present level until about > or = 1800 B.P. when the apparent elevation of the site rose. Macrofossils indicate that spruce was present in the Hurricane Basin (and others) at specific periods and confirms the general results of the PICEA/PINUS ratios. The San Juan Mountains do not possess a glacial Neoglacial record but the stratigraphy of these high cirque basins can be used to define glacial stades (cf. Jardine, 1972). The interpreted climatic response record on vegetation and sediment flux has both similarities and differences from other records in the western mountains of North America. (Auth)

981. **Andrews, J.T., P.T. Davis, W.N. Mode, H. Nichols, and S.K. Short.** 1981. Relative Departures in July Temperatures in Northern Canada for the Past 6,000 Yr. *Nature 289(5794):164-167.*

There has been concern about recent temperature trends and the future effects of CO2 concentrations in the atmosphere, but instrumental records only cover a few decades to a few centuries and it is essential that proxy data sources, such as pollen spectra from peats and lake sediments, be carefully interpreted as climatic records. Several workers have shown statistically significant associations between the modern pollen rain and climatic parameters, an approach that by-passes the recognition of pollen/vegetation units. Statistically defined equations that associate abiotic and biotic elements are called transfer functions. We report here on the application of transfer function equations to nine middle and late Holocene peat and lake sediment sequences from northern Canada (Fig. 1). (Auth)

982. **Andrews, J.T., W.N. Mode, and P.T. Davis.** 1980. Holocene Climate Based on Pollen Transfer Functions, Eastern Canadian Arctic. *Arctic and Alpine Research 12(1):41-64.*

Transfer functions are developed for a north-south transect in the eastern Canadian Arctic (from Clyde River to Fort Chimo) based on surface pollen samples. The Imbrie Kipp and multiple stepwise linear regression models are used to show the statistical association between percentages of 19 pollen taxa and climatic variables (January, June, July, and summer temperatures, Young's index of summer warmth, and summer (JJA) precipitation). Multiple correlation coefficients are high and standard deviations of temperature estimates are less than + or - 1 deg C and 2.5 cm. The problem of the local variability of pollen in surface mosses is considered through an analysis of the results of the transfer functions on 69 additional modern surface samples from around Fort Chimo, Frobisher Bay, Pangnirtung, Broughton Island, and Clyde River. Good agreement exists between the predicted July temperatures based on the transfer functions and adjacent weather station records. The transfer functions are applied to four fossil peat pollen sequences on Cumberland Peninsula. These spectra provide a nearly continuous record that covers the last 6000 yr. Analysis of the fossil materials provides estimates of July T deg C and summer precipitation (cm). A period of warmer and wetter conditions generally prevailed between 6000 and 4000 B.P. although this climate was punctuated by cooler conditions circa 4800 yr ago. Over the last 3600 yr the pollen record from Windy Lake shows a progressive decline in July temperature. Superimposed on this trend are a number of temperature oscillations which show correspondence with other regional proxy climatic records. (Auth)

983. **Andrews, J.T., and H. Nichols.** 1981. Modern Pollen Deposition and Holocene Paleotemperature Reconstructions, Central Northern Canada. *Arctic and Alpine Research 13(4):387-408.*

Transfer functions are used on four published pollen diagrams (Nichols, 1975) to predict July temperatures. A generalizd reconstruction of the July temperature history of central northern Canada is then made by taking average departures for each of the four sites over the last 6000 yr. This shows (1)temperatures above average between 5500 and 4000 BP; (2)temperatures below average (or average) between 4000 and 3000 BP; (3)temperatures above average between 3000 and 2000 BP; and (4)temperatures below average between 2000 and the last few hundred years. (Auth)(JTA)

The chronologies of the four peat sections are interpreted from nineteen Carbon 14 dates. Sampling intervals for the pollen data vary between 8 and 200 years (Table 10). (JTA)

984. **Andrews, J.T., P.J. Webber, and H. Nichols.** 1979. A Late Holocene Pollen Diagram from Pangnirtung Pass, Baffin Island, N.W.T., Canada. *Review of Palaeobotany and Palynology 27:1-28.*

A 1.2 m section of organic-rich sediment from near Windy Lake, Pangnirtung Pass, Baffin Island, Canada, is dated by twelve radiocarbon assays which indicate that the sediment accumulated at an average rate of 6.5 cm 100 yr (E-1). The base of the studied exposure is about 2500 years old, whereas the sediment at a depth of 4 to 9 cm is dated about 650 years old. Thirteen biozones are recognized primarily from changes in the rates of pollen accumulation and diversity. The broad climatic interpretation of the pollen stratigraphy has similarities and differences from nearby glacial moraine chronologies. Sharp increases in exotic pollen (especially ALNUS) are provisionally associated with major advection of southerly air toward Cumberland Peninsula, southeastern Baffin Island. (Auth)(JTA)

Based on a linear relationship between depth and Carbon 14 age, the average sampling interval for the pollen analysis was 39 years. (JTA)

985. **Anundsen, K.** 1977. Sediments, Pollen and Diatoms from Two Basins in South-Western Norway. *University of Trondheim, The Norwegian Institute of Technology, Reports from the Department of Geology, 1, 43 pp.*

Sediment cores from the bottom-layers of two basins in South-Western Norway are analysed. Three Carbon 14 dates have been obtained from one of the basins, and five dates from the other. The chronostratigraphy, lithostratigraphy and biostratigraphy are described. (Auth)(JTA)

The paper is concerned with the Pleistocene/early Holocene record of events and discussion on Holocene variations is largely confined to the Pre-Boreal interval. It examines in detail the Pleistocene/Holocene transition. (JTA)

Palynologic

986. **Armando, E., G. Charrier, L. Peretti, and G. Piovano.** 1975. Quaternary Evolution of Climate and Environment in the Italian Western Alps. V: The Peat Formation near the Front of Rutor Glacier (Aosta Valley); its Significance for the Reconstruction of Natural Environment in Piedmont, during Middle and Upper Holocene. Richereche Sull'Evoluzione del Clima e Dell'Ambiente durante il Quaternario nel Settore dell Alpi Occidentali Italiane. V–La formazione di torbiera presso la fronte attuale del Ghiacciaio del Rutor (Valle d'Aosta): suo significato per la ricostruzione degli ambienti naturali del Piemonte nell'Olocene medio e superiore. Italian, English Summary. *Bollettino del Comitato Glaciologico Italiano 23:7-25.*

The recent finding of a new portion of the peat lake deposit in the end moraine of Rutor Glacier has been studied from both palinological and paleoglaciological point of view. The palinological study, carried out in parallel with radiometric datations, by Carbon 14 method, has allowed the documentation of vegetational evolution aspects in this area, during Recent Atlantic and Lower Subboreal (5000-2000 B.C.). In particular, a sharp decline of ABIES in Subboreal has been shown, caused by climatic and environmental modifications. Moreover, the results of palinological investigations and of Carbon 14 datations prove that the explored peat formation has been subjected to great dislocations by the glacier advance in Neoglacial; in fact, it has been found in a reversed position. The paleoglaciological investigation, based on the sedimentological features of the finding, has successively proved that, in the climatic period of Atlantic and Lower Subboreal, environmental conditions of the peat basin varied almost rhythmically, with reference to the contemporary oscillations of the glacial front, around a much more backward and elevated position than the present one. Finally, the topographic evolution of axial glacier in the Rutor Valley during Postglacial is summarized, on the ground of the more and more frequent direct observations in the last centuries. (Auth)

987. **Auer, V.** 1965. The Pleistocene of Fuego-Patagonia, Part IV: Bog Profiles. *Annales Academiae Scientiarum Fennicae A, III, Geologica-Geographica, 80, 160 pp.*

A report on peat and bog samples collected from Tierra del Fuego and Patagonia between the years 1928-57. Chronology is based on tephra-chronology and pollen. The bulk of the work consists of descriptions of profiles and there are something like 140 of these. The author is concerned both with the chronological interpretation of the bogs and the information this gives on climatic changes and eustatic changes of sea level, and also on the regional variation of bog type from one part of Tierra del Fuego and Patagonia to another. A detailed zonation of the bogs of Tierra del Fuego is given, based on the very large number of examples taken from the area. This shows the distribution of steppe bogs, transition regions, sphagnum bogs, a second transition region, and the rain region bogs. (K.M. Clayton) GA 72A/0272

988. **Baker, R.G.** 1970. Pollen Sequence from Late Quaternary Sediments in Yellowstone Park. *Science 168:1449-1450.*

A radiocarbon-dated pollen diagram from a depression near the end of the southeast arm of Yellowstone Lake, Wyoming, records the vegetation sequence from the retreat of Late Wisconsin (Pinedale) ice to the present time. The tundra PICEA-ABIES-PINUS ALBICAULIS (spruce-fir-whitebark pine) parkland vegetation inferred during late glacial time changed rapidly to a PINUS CONTORTA (lodgepole pine) forest shortly before 11,550 carbon-14 years ago, suggesting a warming trend at that time. The PINUS CONTORTA forest persisted with minor modification throughout postglacial time. (Auth)

The Holocene covers about 6 m of sediment record. Three Carbon 14 dates control the chronology during this period. Three subzones are defined within the PINUS CONTORTA zone on the basis of minor pollen fluctuations. These subzone dates (interpolated) are: lower–11,550 to 10,160 B.P.; middle–5,000-10,160 B.P.; and upper–the last 5000 years. It is suggested that the climate 1) was about 3 deg F cooler than present at 11,550 B.P.; 2) was at its warmest and driest (Altithermal) in the middle subzone; and 3) was cooler again at 5000 and 2800 years B.P. (JTA)

989. **Barrow, C.J.** 1978. Postglacial Pollen Diagrams from South Georgia (Sub-Antarctic) and West Falkland Island (South Atlantic). *Journal of Biogeography 5(3):251-274.*

Six pollen diagrams are presented, five from South Georgia, and one from near Port Howard, West Falkland Island. These diagrams are the first published for either island. In South Georgia and the Falkland Islands, conditions seem to have ameliorated by c. 10, 000 yr B.P., and peat then began to accumulate. Many elements of the present vascular flora of South Georgia and West Falkland Island were flourishing before 9500 yr B.P., having in South Georgia possibly survived the last glacial (approx. 20,000-10,000 yr B.P.) in low altitude refugia. Post glacial conditions have not prevented South Georgia plants from flowering, and the Neoglacial (c. 5000-4500 yr B.P.) is thus not clearly indicated. Surface litter analyses are related to percentage cover of vegetation. Pollen blown from South America may attain 3.0% of the native pollen in South Georgia peat and up to 2.8% in West Falkland Island deposits. (Auth)(JTA) AntB E-21215

990. **Bartley, D.D., and B. Matthews.** 1969. A Palaeobotanical Investigation of Postglacial Deposits in the Sugluk Area of Northern Ungava, Quebec, Canada. *Review of Palaeobotany and Palynology 9(1-2):45-61.*

Pollen diagrams from peat deposits, mainly associated with raised beaches at the heads of Kugluk Cove, Sugluk Inlet and Deception Bay and at Lac Faucon, indicate that northern Ungava Peninsula has been covered by treeless tundra since 3900 B.P. Peat exposures were in river cut sections comprised of marine sands, peats and eolian sands. A climatic interpretation suggests a warm period with peat deposits approx 4000 and 2800 B.P.; cold period 2800-1600 B.P. with eolian sand at one site; warm, moist period 1600-670 B.P. with peat; and a cold period with cessation of peat growth and development of sand dunes. The development of living SPHAGNUM appears to reflect climatic amelioration in this century. (AB102083) AB102083

991. **Bellair-Roche, N.** 1972. Palynological Study of a Bog in Vallee des Branloires, Ile de la Possession, Iles Crozet. *Antarctic Geology and Geophysics, R.J. Adie (Ed.), Symposium on Antarctic and Solid Earth Geophysics, Oslo, August 6-15, 1970. Universitetsforlaget, Oslo, (pp. 831-833).*

The section studied is situated in Vallee des Branloires, Ile de la Possession (lat. 46 deg 24 min S, long. 51 deg 45 min E). and it seems to be relatively homogeneous. The sample collected was unfortunately insufficient for absolute dating. From previous studies on Iles Kerguelen, however, it is probable that this section represents a relatively short period of time. (Auth) (JTA) AntB E-12643

Palynologic

992. **Bellair-Roche, N.** 1972. Present Knowledge of the Quaternary Flora (Palynology) in the Southern Islands of the Indian Ocean. *Antarctic Geology and Geophysics, R.J. Adie (Ed.), Symposium on Antarctic and Solid Earth Geophysics, Oslo, August 6-15, 1970. Universitetsforlaget, Oslo, (pp. 789-791).*

One of the first palynological notes on the Quaternary was that by Dubois and Dubois (1948), who recognized most of the plants now living on Iles Kerguelen. Few of the papers give absolute dates; the peat bogs of Márion I. are 5,000 years old (van Zinderen Bakker). The peat bog at Port-Christmas, Iles Kerguelen is not older than 800 yr; the "Little Ice Age" (world-wide cooling) can be seen in this section and it can also be recognized in the other peat bogs of the island (Pointe Denis and Molloy). (Auth)(JTA) AntB E-12637

993. **Bent, A.M., and H.E. Wright, Jr.** 1963. Pollen Analyses of Surface Materials and Lake Sediments from the Chuska Mountains, New Mexico. *Geological Society of America Bulletin 74(4):491-500.*

Pollen analyses of 40 samples of tuff and other surface materials from the major forest associations in the Chuska Mountains, New Mexico, show that a reasonably close correspondence exists between modern pollen rain and vegetation. This provides the basis for interpreting pollen diagrams for sediments from three lakes on the mountain crest at about 9,000 feet elevation. The top 15-30 cm of black mud show pollen percentages much like those for the surface samples on the mountain crest; the black mud represents the Holocene. The underlying gray sediment shows pollen spectra (high ARTEMISIA, high PICEA) not matched by any surface samples in the Chuska Mountains but resembling those from above the tree line in the San Juan Mountains 125 miles to the northeast. The inferred Pleistocene age for these sediments is confirmed by three Carbon 14 dates. (Auth) GA 65/776

994. **Berglund, B.E.** 1968. Development of Vegetation in the Scandinavian North after the Ice Age. Vegetations-Utvecklingen i Norden efter Istiden. Swedish. *Sveriges natur. Arsbok 59:31-52.*

Traces invasion of postglacial vegetation cover the entire Scandinavian peninsula. From evidence of forest and other flora, particularly pollen diagrams and Carbon 14 datings, some conclusions are drawn concerning temperature and humidity changes. Recent effects of man in changing the natural flora are noted. (AB102243) AB102243

995. **Bernabo, J.C., and T. Webb, III.** 1977. Changing Patterns in the Holocene Pollen Record of Northeastern North America: a Mapped Summary. *Quaternary Research 8:64-96.*

By mapping the data from 62 radiocarbon-dated pollen diagrams, this paper illustrates the Holocene history of four major vegetational regions in northeastern North America. Isopoll maps, difference maps, and isochrone maps are used in order to examine the changing patterns within the data set and to study broad-scale and long-term vegetational dynamics. Isopoll maps show distributions of spruce (PICEA), pine (PINUS), oak (QUERCUS), herb (nonarboreal pollen groups excluding Cyperaceae), and birch + maple + beech + hemlock (BETULA, ACER, FAGUS, TSUGA) pollen at specified times from 11,000 BP to present. Many of the trends of the early Holocene were reversed after 7000 BP with the prairie retreating westward and the boreal and other zones edging southward. In the last 500 years, man's impact on the vegetation is clearly visible, especially in the greatly expanded region dominated by herb pollen. The large scale changes before 7000 BP probably reflect shifts in the macroclimatic patterns that were themselves being modified by the retreat and disintegration of the Laurentide ice sheet. Subsequent changes in the pollen and vegetation were less dramatic than those of the early Holocene. (Auth)(JTA)

996. **Bick, H.** 1978. A Postglacial Pollen Diagram from Angmagssalik, East Greenland. *Meddelelser om Gronland 204(1):1-22.*

Study of a mire at Angmagssalik yielded six pollen assemblage zones. The lowermost complex of SALIX scrub and CAREX BIGELOWII grass heaths was probably followed by more chionophytic vegetation. At c. 6000 BP peat growth started. After a second extensive zone with willow scrub and grass heaths, a mire vegetation again developed. During the 'climatic optimum' (6000-2200 BP) the climate was presumably more oceanic than in earlier and later periods, in contrast to conditions in South and West Greenland. (from Author) Ecol Abs 80L/8951

997. **Binder, R.** 1978. Stratigraphy and Pollen Analysis of a Peat Deposit; Bunyip Bog, Mt. Buffalo, Victoria. *Monash Publications in Geography 19, 48 pp.*

Analysis of sediment cores from this sub-alpine peat bog together with an investigation of the surrounding vegetation allowed the reconstruction of vegetation and climate changes. Before c. 10, 000 yr B.P., the treeline was much lower than today and an alpine herbfield community existed near the bog. A rise in temperature caused the replacment of an alpine herbfield by wet sclerophyll forest. The climate remained milder than present until c. 2-3000 yr B.P., when changes in the vegetation of the bog surface and surrounding slopes and an increase in the rate of bog growth suggest a fall in temperature and an increase in the rate of bog growth suggest a fall in temperature and an increase in available moisture. (A.P. Kershaw) Ecol Abs 79L/7474

998. **Binder, R., and A.P. Kershaw.** 1978. A Late Quaternary Pollen Diagram from the Southeastern Highlands of Australia. *Search 9(1-2):44-45.*

Evidence for Late-Quaternary changes for the last 12,000 yr is given using an analysis of a sub-alpine peat deposit on Mt. Buffalo, Victoria. Zone I: alpine herbfield up 12,000 yr B.P.; Zone II: woody plants; Zone III: c. 2,000 yr B.P. an increase in effective precipitation. (Stephen Trudgill) Ecol Abs 79L/4462

999. **Birks, H.H.** 1972. Studies in the Vegetational History of Scotland. II. Two Pollen Diagrams from the Galloway Hills, Kirkcudbrightshire. *Journal of Ecology 60(1):183-217.*

Two long pollen diagrams have been constructed from Flandrian deposits at Snibe Bog and Loch Dungeon in the Galloway Hills in southwest Scotland. The local development of Snibe Bog is reconstructed, using evidence from microfossil, macrofossil, and sediment compositon of the profile. The difference between the two diagrams lead to a discussion of pollen deposition processes into a lake and a bog, and show that the two types of deposit contain complementary information about past vegetational changes. After their final deglaciation, the Galloway Hills supported open treeless communities, which were soon reduced by the expansion of JUNIPERUS in response to a climatic amelioration. In turn, BETULA, and CORYLUS immigrated into the area, quickly followed by PINUS, ULMUS, and QUERCUS. Mixed deciduous forest developed and BETULA and PINUS became restricted, possibly through competition. Because of its late arrival, PINUS was never a major forest component, but had a brief period of expansion on dried peat surfaces between about 7400 and 7100 B.P. Meanwhile, ALNUS expanded, and stability was maintained until man made his first appreciable impact on the environment at about 5000 B.P. (Auth) (JTA) GA 72A/2205

1000. **Birks, H.H.** 1972. Studies in the Vegetational History of Scotland. III. A Radiocarbon Dated Pollen Diagram from Loch Maree, Ross and Cromarty. *New Phytologist 71:731-754.*

A pollen diagram is presented from the upper 460 cm of a 542 cm continuous core from Loch Maree. Six radiocarbon age determinations have been made from the sediments in relation to pollen stratigraphical changes. The constant sedimentation rate thus revealed has been used to interpolate ages for other events in the pollen diagram. During the last 9000 years of organic sedimentation in Loch Maree, many changes have occurred in the flora and vegetation of the landscape. After the instablility at the end of the last glaciation, a climatic amelioration allowed juniper scrub colonization and organic soil development. Birchwoods, with some hazel, succeeded juniper, followed by the entry and rapid attainment of dominance by pine on all acidic soils, especially on the south shore of the loch, at about 8250 radiocarbon years ago. Meanwhile oakwoods with some ash and elm, developed in areas of more favorable soil and microclimate on the north shore. Alder immigrated and rapidly occupied all suitable habitats at about 6500 years B.P., and the pine forest began to degenerate. This process culminated in its rather rapid replacement by moorland and bog, perhaps due to climatic changes, at about 4200 radiocarbon years B.P. As the oakwoods declined at the same time, human activity may have been an additional factor. However, there is little evidence for subsequent human interference in the area. The constant sedimentation rate suggests that deforestation was primarily by natural means, rather than by burning, felling, or grazing. (Auth)(JTA)

1001. **Birks, H.H.** 1975. Studies in the Vegetational History of Scotland. IV. Pine Stumps in Scottish Blanket Peats. *Philosophical Transactions of the Royal Society of London, Series B, 270(905):181-226.*

The palaeoecology of six Scottish blanket peat profiles containing pine stumps was investigated by means of peat stratigraphy, pollen analysis, and radiocarbon dating. In addition, several other pine and birch remains from peat in other areas of Scotland were radiocarbon dated. Three peat profiles were selected in each of two contrasting regions. The Cairngorm area is within the distributional area of native pine today and pollen analysis has shown that pine has been a major component of the upland forest since about 7000 B.P. The Galloway region in southwest Scotland is south of the native pine area, and pollen analysis has shown that pine has never been a major component of the upland forest. Despite the limitations of the methods used, it has been established that there were several different circumstances for the growth and death of the pines studied, and that their ages are synchronous within and between the two areas. Thus little regional climatic significance can be assumed from their occurrence, and they cannot be taken as evidence in support of dry Boreal and sub-Boreal periods in the Blytt and Sernander climatic scheme. In the northwest Highlands dates from pine stumps and major declines of PINUS pollen in pollen diagrams are consistently around 4000 B.P. This overall demise of pine may have a regional climatic cause in this area. (Auth)

1002. **Birks, H.J.B.** 1978. Geographic Variation of PICEA-ABIES (L.) Karsten Pollen in Europe. *Grana 17(3):149-160.*

Numerical analyses of six size and five shape measurements on 18 modern samples of PICEA ABIES pollen throughout Europe and on one fossil sample from England are presented. The data were analyzed by principal components analysis and multi-dimensional plotting. Their results indicate that at least three pollen morphological types exist: one mainly in northern Europe, the second in southern and southeastern Europe and the third in the Swiss Alps and southern Poland. Reasons for these patterns of variation relate to different Holocene migration histories of spruce. (Auth)

1003. **Birks, H.J.B., and M. Saarnisto.** 1975. Isopollen Maps and Principal Components Analysis of Finnish Pollen Data for 4000, 6000, and 8000 Years Ago. *Boreas 4:77-96.*

Isopollen maps of BETULA, PINUS, ALNUS, CORYLUS, and ULMUS for 4000, 6000, and 8000 B.P. and of PICEA, TILIA, and QUERCUS for 4000 and 6000 B.P. are presented for Finland. The maps show the major geographical patterns in pollen composition for these three time intervals. (Auth)(JTA)

The sites used in this paper lie between 60 and 69 deg N. The method of selecting the points from the pollen diagrams is outlined and consists of the use of Carbon 14 dates in conjunction with specific features of the pollen record. The three periods represent 1) a time of great regional change (8000 B.P.); 2) a time of vegetational stability (6000 B.P.), and 3) a time of vegetation regression (4000 B.P.) (JTA)

1004. **Bortenschlager, S., and G. Patzelt.** 1969. Interglacial Climate and Glacier Oscillations in the Pollen Profile of a High Altitude Bog (2270 m) of the Venedig Group. Warmezeitliche Klima- und Gletscherschwankungen im Pollenprofil eines hochgelegenen Moores (2270 m) der Venedigergruppe. *Eiszeitalter und Gegenwart 20:116-122.*

The development of the peat, which is nowadays 225 cm thick, has been investigated by palynologic methods. The moor is situated in an altitude of about 2300 m near the Rostocker Hut in the Hohe Tauern, Austrian Alps. The peat began to grow about 6800 B.C. By means of comparisons with independently dated moraines of the neighbouring glaciers Simonykees and Maurerkees, as well as by using the Carbon 14-method, three periods of glacier advances could be proved in postglacial times. These periods have been denoted with local names: "Venediger- oscillation" (about 6700-6000 B.C.), "Frosnitz-oscillation" (about 4400-4200 B.C.), "Lobben-oscillation" (1500-1300 B.C.). (D. Havlik) GA 71B/1689

1005. **Bowler, J.M.** 1975. Late Quaternary Climates of Australia and New Guinea: A Summary. *WMO No. 421, Proceedings of the WMO/IAMAP Symposium on Long-Term Climatic Fluctuations, Norwich, 18-23 August, 1975. Secretariat of the World Meteorological Organization, Geneva, Switzerland, (pp. 43-46), 503 pp.*

Disappearance of glaciers in Tasmania occurred early in the Holocene. In the Snowy Mountains treeline expanded to its present limit, although there was slight periglacial activity between 3000 and 2000 B.P. Warming of temperatures in the Pleistocene/Holocene transition may have begun earlier in Australia than in equivalent latitudes in the Northern Hemisphere. (JTA)

1006. **Brant, L.A.** 1980. A Palynological Investigation of Postglacial Sediments at Two Locations along the Continental Divide Near Helena, Montana. *Ph.D. Thesis, Pennsylvania State University, 172 pp.*

Cores of sediments from two marshes in the mountains along the continental divide near Helena, Montana, were obtained with a piston corer. Closely spaced subsamples were processed and analyzed for pollen in an effort to decipher postglacial vegetational history, long-term effects of the Mazama ash fall, and the history of the two sites. The marshes were once ponds which filled with glacial rock flour and other terrigenous sediment, diatom frustules, organic material, and volcanic ash. Two volcanic events recorded in the sediment are presumably, the Glacier Peak eruption of about 12,000 years B.P. and the Mazama eruption of about 6600 years B.P. The relationship of the top of the rock flour to the older ash suggests the region was deglaciated shortly after the Glacier Peak event. Alpine tundra, which occupied the mountains shortly after deglaciation, was replaced, first, by transitional vegetation, then by the extant coniferous forest. Pollen data do not show the warmer Hypsithermal of about 7000 to 4000 years B.P. found in pollen records of other parts of the world. No long-term effects of the Mazama ash fall were detected either in the regional vegetation or in the aquatic environments of the pond/marsh systems. Palynological diversity and palynomorph concentration were used to distinguish five successive sedimentary environments which produced the different kinds of sediment filling one of the original ponds. (Auth) Dissertation Abstracts International 41(10):3720-B, Order No. 8107544

1007. **Brubaker, L.B., H.L. Garfinkel, and M.E. Edwards.** 1983. A Late Wisconsin and Holocene Vegetation History from the Central Brooks Range: Implications for Alaskan Palaeoecology. *Quaternary Research 20:194-214.*

Five pollen diagrams reveal late Wisconsin and Holocene vegetation changes in the Walker Lake/Alatna Valley region of the central Brooks Range. Several striking vegetation changes occurred between ca. 10,000 and 7000 yr B.P. Between ca. 11,000 and 10,000 yr B.P., POPULUS BALSAMIFERA pollen percentages as great as 30% indicate that this species was present at low-elevation sites near Walker lake. These populations declined abruptly ca. 10,000 yr ago and have never regained prominence. About 8500 yr B.P., PICEA GLAUCA pollen reached 10-15%, indicating the arrival of P. GLAUCA in or near the study area. P. GLAUCA populations evidently decreased ca. 8000 yr ago, when PICEA pollen percentages and influx fell to low values. About 7000 yr B.P., ALNUS pollen percentages and influx rose sharply as alder shrubs became established widely. PICEA once more expanded ca. 5000 yr ago, but these populations were dominated by P. MARIANA rather than P. GLAUCA, which increased slowly at this time and may still be advancing northward. Some vegetation changes have been remarkably synchronous over the wide areas of interior Alaska, and probably reflect responses of in situ vegetation to environmental changes, but others may reflect the lagged responses of species migrating into new areas. (Auth)(JTA)

1008. **Burga, C.A.** 1982. Pollen Analytical Research in the Grisons (Switzerland). *Vegetatio 49:173-186.*

In the first part, an overview of the history of palynological research in Switzerland and particularly in the Grisons is given, with a map showing all investigated areas in the Grisons. The second part deals with the significance of the pollen analytical research in the Grisons, namely, the history of vegetation during the Late and Post Glacial, climatic fluctuations and applications in geomorphology, archaeology and forestry research. Finally, some results concerning the history of vegetation during the Late and Post Glacial are discussed. (Auth)

1009. **Coetzee, J.A.** 1967. Pollen Analytical Studies in East and Southern Africa. *Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Volume III, E.M. van Zinderen Bakker (Ed.). A.A. Balkema, Cape Town/ Amsterdam, 146 pp.*

The first amelioration of the climate in East Africa after the Mount Kenya Hypothermal is suggested, by the pollen diagrams, to have started in the vicinity of 14,000 B.P. This corresponds very well with the beginning of the Susaca Interstadial which has recently been recognized in some parts of Europe and Colombia and which gives a more definite time for the beginning of the Late Glacial. In East Africa the fluctuations of temperature found for the Late Glacial in Europe are not reflected in the pollen diagrams unless the sites are critically situated. The period in East Africa between 14,050 + or - 360 B.P. and 10,560 + or - 65 B.P. showing some of these fluctuations is named POLLEN ZONE I. The gradual increase in temperature in East Africa becomes evident in the pollen diagrams after 10,560 + or - 65 B.P. and is coeval with the Preboreal and Boreal of Europe. A similar trend in temperature-increase during this time has been found in the equatorial Andes. For East Africa this phase is named POLLEN ZONE II. The further increase in temperature in East Africa parallels that of the European Atlanticum except that in East Africa a cooler interval is recorded at a time corresponding with the end of the Atlanticum. It is remarkable that in the equatorial Andes, van der Hammen has independently also recorded a cooler phase at the same time. For East Africa this warmer phase and cool interval are named POLLEN ZONES IIIa and IIIb respectively. The maximum development of forest at Sacred Lake on Mt. Kenya and at the site of Cherangani suggests that the temperature maximum must have occurred at about 4000 B.P. This time corresponds very well with the Post Glacial Climatic Optimum in the Subboreal of Europe. In the equatorial Andes the temperature maximum is also recorded at about this time. For East Africa this period of maximum temperature is designated POLLEN ZONE IV. A subsequent period of decrease in temperature is reflected in the pollen diagrams of East Africa from the time of about 2090 + or - 215 B.P. which is coeval with the Subatlanticum of Europe. In the equatorial Andes a deterioration of climate from this time onwards has also been recorded. This climatic phase in East Africa is named POLLEN ZONE V. (Auth)(JTA)

1010. **Colinvaux, P.A.** 1964. Origin of Ice Ages: Pollen Evidence from Arctic Alaska. *Science 145(3633):707-708.*

Pollen analysis of radiocarbon-dated samples from the arctic coastal plain of Alaska shows that vegetation of 14,000 years ago reflected a climate colder than the present, and that there has been a progressive warming, culminating in the present cold arctic climate. The record indicated that the Arctic Ocean has been covered with ice since the time of the Wisconsin glacial maximum, suggesting that the essential condition of the Ewing and Donn hypothesis for the origin of ice ages, that the Arctic Ocean be ice-free up to 11, 000 years ago, cannot be met. (Auth)

1011. **Colinvaux, P.A.** 1967. Bering Land Bridge: Evidence of Spruce in Late-Wisconsin Times. *Science 156(3773):380-383.*

A 14-meter core from a crater lake on Saint Paul Island in the Pribilofs has been examined by pollen analysis. Radiocarbon dating indicates that the core spans more than 10,000 years and probably more than 18,000 years. A spruce-pollen maximum about 10,000 years ago suggests that spruce advanced to the flanks of the southern coast of the Bering land bridge toward the close of the land-bridge period. The forests of Alaska and Siberia did not merge, however, and the environment of the southern coast of the land bridge remained cold. (Auth)

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1012. **Colinvaux, P.A.** 1967. A Long Pollen Record from St. Lawrence Island, Bering Sea (Alaska). *Palaeogeography, Palaeoclimatology, Palaeoecology 3:29-48.*

A core of lake sediments from St. Lawrence Island in the Bering Sea has been examined by means of pollen analysis as part of an investigation into the environmental history of Arctic Alaska. A three-zone pollen sequence is compared with the three pollen zones at Imuruk Lake which span the Wisconsin Glaciation and the Postglacial period. The St. Lawrence Island record is thought to go back at least until the Late Glacial period, though an absolute chronology by radiocarbon is only available to 6,000 years ago. The pollen suggests a cold arctic tundra on the land bridge, a conclusion which is in accordance with records from other sites adjacent to the Bering Sea. Sands of a marine transgression, thought to be of Sangamon Interglacial age contain pollen suggesting a tundra similar to that of modern times. (Auth)

1013. **Colinvaux, P.A.** 1967. Quaternary Vegetational History of Arctic Canada. *The Bering Land Bridge, D.M. Hopkins (Ed.). Stanford University Press, Stanford, CA, (pp. 207-231), 495 pp.*

From late Wisconsin time to the present, pollen diagrams from many parts of arctic Alaska record parallel developments of vegetation. In glacial times, spruce, alder, and dwarf birch were all far to the south or east of their present limits. At each site, the vegetation was comparable to that now found several hundred kilometers farther north. With the end of the Wisconsin Glaciation, there was an advance of trees and shrubs, with dwarf birches always well in front of the alder and spruce lines. This advance was completed some 10, 000 years ago on Seward Peninsula, when the tree line had reached or slightly surpassed its present limits. The rise of the sea to within a few meters of its present level then brought a maritime climate to what is now the Alaskan coastal strip, and local adjustments were made to the tree line, which now brought it back to about its present position. In mountainous regions, the development of modern vegetation was delayed by the presence of mountain glaciers. There were local small advances of alder during the hypsithermal period. (Auth) (JTA)

1014. **Comtois, P.** 1982. Holocene History of Climate and Vegetation at Lanoraie (Quebec). Histoire holocene du climat et de la vegetation a Lanoraie (Quebec). French, English Abstract. *Canadian Journal of Earth Sciences 19:1938-1952.*

Four different cores were recovered from the same peat complex at Lanoraie (Quebec), and have been used to evaluate, by pollen analysis, possible differences in the representation of the vegetational history. The isotopic ratio of oxygen has been used to indicate climatic variations involved in these processes. This method was first tested and calibrated with modern moss samples. A transect of 15 samples, from the temperate forest to the tundra, indicates that annual mean temperatures and evapotranspiration rates have a predominant influence on oxygen isotopic ratios. A sequence of fossil sediments, interpreted in terms of these results, shows a climatic maximum at 3500 B.P. and a reduction of temperature since 1500 B.P. in the Lanoraie region. The history of the regional vegetation shows the following succession of stages: (1) establishment of pioneer tree vegetation of pine, oak, elm, and walnut; (2) buildup of a sugar maple forest, contemporaneous with the migration of beech and correlated with a maximum pollen influx and a climatic optimum at about 3500 B.P.; (3) increase of the representation of spruce and fir after 1500 B.P., related to a climatic cooling. Paleobotanical data–the recurrence of ruderal spectra and the presence of IVA XANTHIFOLIA–suggest the occurrence of two prehistoric anthropic periods, one before 3500 B.P. and the other at ca. 1500 B.P. (Auth)

1015. **Davis, P.T.** 1980. Late Holocene Glacial, Vegetational, and Climatic History of Pangnirtung and Kingnait Fiord Area, Baffin Island, N.W.T., Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 378 pp.*

A Neoglacial chronology is derived from detailed lichenometric studies on over 85 moraines fronting 27 glaciers in three separate study areas on southern Cumberland Peninsula. Six radiocarbon assays date the growth curve for RHIZOCARPON GEOGRAPHICUM sensu lato on Baffin Island. Major periods of moraine stabilization (still-stand or retreat) occurred on southern Cumberland Peninsula less than 100, 200-400 and 500-650 yrs B.P. (C[illegible]mberland Advances), 900-1150 yrs B.P. (Pangnirtung Advance), 19[illegible]-2000 and 2200-2400 yrs B.P. (Kingnait Advances), and 2900-3100 yrs B.P. (Snow Creek Advance). Broad synchrony for moraine stabilization in three regions of Baffin Island and one area in northern Labrador is now recognized, although the moraine evidence for the Dorset Advance (1500-1600 yrs B.P.) was not observed on southern Cumberland Peninsula. Pollen diagrams from the Windy Lake peat are dominated by Gramineae throughout its 3700-yr record except for a short-lived SALIX peak about 2400 yrs B.P. Three sand layers and the cessation of peat growth about 2050-1950, 1700-1450, and 600-0 yrs B.P. probably indicate greater cold, but transfer functions suggest that the sand layers may not reflect extremely dry conditions. The dominant pollen taxa from Iglutalik Lake during the last 4000 years fluctuate synchronously and exhibit six peaks at 3950, 3550-3450, 2650, 1800, 1200-1100, and 550 years B.P., roughly correlating with periods of glacier retreat. This may have been due to warmer climatic effects. Exotic ALNUS pollen decreased as exotic PICEA and PINUS increased between 4000 and 3300 yrs B.P. at Iglutalik Lake due to warm, southerly, summer winds passing over advancing forests in central Labrador. (Ecol Can 3780)(JTA) Ecol Can 3780

1016. **De Beaulieu, J.-L.** 1969. Pollen Analyses in the Espinouse Herault. Analyses Polliniques dans les Monts de l'Espinouse (Herault). French, English Summary. *Pollen et Spores 11(1):83-96.*

Five peats have been analysed in the mounts of the Espinouse. They indicated a recent past (Sub-Atlantic) except the peat of Baisse-cure the bottom of which is dated from -6000 + or - 150 by the Carbon 14. That peat shows the complex evolution of a vegetal landscape composed of beechgrove and deciduous oakgrove. (from English summary)(JTA) GA 71B/0988

1017. **De Beaulieu, J.-L.** 1974. Evolution of the Vegetation on the Cevennes Mountain Border in the Postglacial Period, Based on Pollen Analysis. Evolution de la vegetation sur la bordure montagneuse cevenole au postglaciare, d'apres les pollens. *Societe Languedocienne de Geographie, Bulletin 8(3-4):347-358.*

During Atlantic A PINUS keeps a relative importance on Mont Lozere, but its representation is feebler towards the west. Except for that difference, the vegetation has an homogeneous history in the whole area considered. Everywhere CORYLUS, predominant during the Boreal, is still very important during Atlantic B where it constitutes a population at the upper limit of the Quercetum mixtum. Beech forest had a continuous extension from 5000 B.P. to 3800 B.P. The extension of ABIES is parallel but much feebler except on the Mont de Lacaune where a well-balanced Abieto-Fagetum has developed. The Fagetum optimum is reached at the beginning of the Subatlantic, a period corresponding to a cold and damp maximum. Details are given concerning the clearing phases, which do not appear clearly during Atlantic B but are well defined during Sub-boreal and drastic from the beginning of our era. (from English Summary) Ecol Abs 75L/4028

1018. **De Beaulieu, J.-L., and J. Evin.** 1972. Pollen Analyses and Carbon 14 Dating in the Lacaune Mountains, Tarn. Analyse Polliniques et Datages Carbon 14 dans les Monts de Lacaune (Tarn). French. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D, 274(26):3531-3534.*

A pollen diagram from the Lacaune Mountains on the western edge of the Southern Cevennnes shows, through three Carbon 14 dates, that at the end of Atlantic B the mixed oak forests retreated and a progressive diminution of Corylus gave way to beech and fir. This result coincides with that obtained on Mont Lozere, where the spread of Fagus is dated as 3590 + or - 140 years B.P. The degradation of the vegetation cover by man is apparent from the beginning of the Sub-Atlantic. (Authors, trans. Ian Douglas) GA 74A/0529

1019. **De Beaulieu, J.-L., and E. Gilot.** 1971. New Data on the Forest History of the Maritime Alps Based on Pollen Analysis. Donnees nouvelles concernant l'histoire forestiere des Alpes-Maritimes, d'apres l'analyse pollinique. French. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D, Nature 273(25):2489-2492.*

Pollen analysis of sediments from Lac Long Inferieur (Alpes-Maritimes) makes plant succession since the Younger Dryas period obvious. The fir forest that appeared first during the late glacial expanded significantly after 7410 + or - 120 yr B.P. (radiocarbon date). For the first time in the French Alps, a continuous occurrence of LARIX is described, from Atlantic time to the present. The results indicate the existence of an indigenous forest in the Alpes-Maritimes. (trans. from French abstract, MA)

1020. **Digerfeldt, G.** 1974. The Post-Glacial Development of the Ranviken Bay in Lake Immeln. *Geologiska Foreningens i Stockholm Forhandlingar 96:3-32.*

The investigation of the history of the regional vegetation is based on pollen analysis of a main profile from the central part of the bay and also of a shorter complementary profile. An attempt has been made to apply the principles of dynamic plant sociology in the interpretation of the vegetational history. The human influence on the vegetation is considered. However, as concerns settlement, the Ranviken area has always constituted a marginal region, and the human influence indicated in the pollen diagrams is throughout rather slight. The chronology is based on Carbon 14 dating. Thanks to the large number of datings, it has been possible to determine also the rate of sediment deposition. The investigation of the water-level changes is based on macrofossil analysis and pollen analysis of three profiles situated in a section outwards from the shore. An early lowering, culminating during the earlier part of the Early Boreal period, and a later lowering, culminating around the boundary between the Early and Late Sub-Boreal periods, have been established. Each lowering was succeeded by a rise of the water level. (Auth)(JTA)

1021. **Dodson, J.R.** 1978. A Vegetation History from North-East Nelson, New Zealand. *New Zealand Journal of Botany 16(3):371-378.*

A mixed NOTHOFAGUS-podocarp forest has existed in the area for the last 10,500 yr B.P. The major change in the forest taxa has been a continuing rise in NOTHOFAGUS which probably began before 10,500 yr B.P. and peaked at 4,800 yr B.P. PODOCARPUS FERRUGINEUS and DACRYDIUM CUPRESSINUM were present in relatively constant amounts but the NOTHOFAGUS rise was accompanied by a decrease in other PODOCARPUS spp. and shrub taxa. A second major change was a clearance phase and the appearance of PINUS pollen coincident with the arrival of European man. Initially a shallow swamp existed at the site; this became a lake between 8500 yr B.P. and 100 yr B.P., suggesting a wetter climate since 8500 yr than earlier. (from Author) Ecol Abs 79L/5951

1022. **Donner, J.J.** 1963. The Zoning of the Post-Glacial Pollen Diagrams in Finland and the Main Changes in the Forest Composition. *Acta Botanica Fennica 65, 40 pp.*

Reviews established concepts of post-glacial time divisions and correlative vegetation zones based on tree-pollen analysis at 25 sites in Finland. Lack of correlation between these and proved presence of a tree species in any region at a given time is due to the delay factor in species migration, variations in tree establishment, and sites of pollen samples. In the North however, zones are still tentative and lacking in time correlation with those farther south. More detailed diagrams derived from larger counts and including non-tree species are required. (AB86588) AB86588

1023. **Donner, J.J.** 1966. The Late-Glacial and Early Post-Glacial Pollen Stratigraphy of Southern and Eastern Finland. *Commentationes Biologicae, Societas Scientiarum Fennica 29(9):1-24.*

Four sites were investigated. Eight Carbon 14 dates allow the sedimentation rate at the Varrassuo bog to be calculated. Table 1 compares the early to middle Holocene pollen stratigraphy in Scania and that from southern and eastern Finland determined in this study. A major pollen zone occurs within the Boreal in Scania and is dated in southern Finland at 8800 BP. The Boreal/Atlantic boundary in Scania and the VI/V pollen boundary in southern Finland are closely associated in time (8000 BP versus 7800 BP). (JTA)

1024. **Donner, J.J.** 1972. Pollen Frequencies in the Flandrian Sediments of Lake Vakojarvi, South Finland. *Commentationes Biologicae 53:3-19.*

A relative pollen diagram of Flandrian organic sediments in Lake Vakojarvi, north-west of Helsinki, was compared with a diagram of pollen frequencies, showing both number of pollen per cubic cm and annual sedimentation per sq cm. The figures for yearly pollen deposition on the basis of seven radiocarbon dates. An interpretation of the changes in forest composition based on a relative pollen diagram, does not essentially change by using a frequency diagram. The use of R values for corrections of the relative diagrams as well as frequency diagrams, however, probably gives more correct results about the changes in the percentage composition of the trees than uncorrected diagrams. (Auth)

1025. **Donner, J.J., P. Alhonen, M. Eronen, H. Jungner, and I. Vuorela.** 1978. Biostratigraphy and Radiocarbon Dating of the Holocene Lake Sediments of Tyotjarvi and the Peats in the Adjoining Bog Varrassuo West of Lahti in Southern Finland. *Annales Botanici Fennici 15(4):258-280.*

A comparison was made between both percentage and pollen influx diagrams of the raised bog Varrassuo and the adjoining lake, Tyotjarvi on Salpausselka west of Lahti with the help of a number of radiocarbon dates. In addition, the diatoms and Cladocera were studied in the lake deposits. The peats in Varrassuo and the muds in Tyotjarvi represent almost the whole Flandrian history. The dating of the rational limits for PINUS, ALNUS and PICEA gave almost identical results from both profiles, being about 8900-9000 B.P., 8600 B.P. and 4200 B.P. respectively. The rate of sedimentation in the lake was rather uniform but the diatoms and Cladocera show that the lake level was low until about 8000 B.P. and then rose. At the beginning of the Subatlantic Chronozone eutrophication of the lake started, probably at least partly as a result of the activities of the Iron Age Settlement in the area. Varrassuo started as a minerotrophic mire but ombrotrophic peat started to form at about 8000 B.P. at a relatively dry phase. Later the rate of peat growth increased but was interrupted by retardations or standstills in peat growth. The pollen diagrams from Tyotjarvi are more suitable for studies of the vegetational history than those from Varrassuo where there is a strong influence from the local vegetation as well as fluctuations in pollen concentration. (Auth)

1026. **Eicher, U., and U. Siegenthaler.** 1976. Palynological and Oxygen Isotope Investigations on Late-Glacial Sediment Cores from Swiss Lakes. *Boreas 5:109-117.*

Results from detailed pollen and Oxygen 18/Oxygen 16 studies on two sediment profiles from small Swiss lakes are reported. Oxygen 18/Oxygen 16 records in lacustrine carbonate contain paleoclimatic information because they reflect mainly the isotope ratio in rain and snow which is correlated to temperature. Several transitions between different climatic periods determined palynologically are also indicated by marked changes in the isotope ratios in both profiles, namely the transitions Oldest Dryas – Bolling and Allerod – Younger Dryas – Preboreal. Oxygen 18/Oxygen 16 was 2 to 3 ppt lower during the Younger Dryas than during the adjacent periods, corresponding to a temperature drop of a few degrees Centigrade according to a tentative estimate. (Auth)

1027. **Faegri, K.** 1970. A Pollen Diagram from Voss , W. Norway. *Colloquium Geographicum 12:125-131.*

The pollen diagram is from a large gravel terrace (110 m). All the diagram has much tree pollen. Faegri describes the pre-Boreal-Boreal, the Atlantic-Sub-Boreal, the Sub-Atlantic in which clearing for agriculture occurs.. "the pine forest is removed, a sub-climax birch forest established itself in response to the existing extensive methods of agriculture and husbandry". A landnam had occurred (the final clearing of the area took place c.300 A.D.). Later BETULA was replaced by PINUS perhaps 200 years ago. (D.J. Davis) Ecol Abs 74L/0491

1028. **Firsov, L.V., T.P. Levina, and S.L. Troitskiy.** 1972. Holocene Climatic Changes in Northern Siberia. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 341-349), 511 pp.*

The paper discusses the palynology and radiocarbon dating of a peat section on the Jenissey River 1.2 km south of Karginsky Point. Fourteen radiocarbon dates were obtained from the 2 m thick peat. The basal date is 9540 + or - 50 whereas the date between 0 - 23 cm is 2420 + or - 15 B.P. Peat accumulation continued during the 6000 years from the beginning of the Atlantic period until the end of the Sub-Boreal. Around 3600 B.P. the forest was replaced by tundra although 1000 years earlier the birch forest had been replced by a birch forest-tundra ecotone. Periods of rapid peat accumulation are correlated with warm climate – two intervals are recognized of rapid peat accumulation, the first during the Atlantic whereas the second was during the early part of the Sub-Boreal. (JTA)

1029. **Fredskild, B.** 1967. Postglacial Plant Succession and Climatic Changes in a West Greenland Bog. *Review of Palaeobotany and Palynology 4:113-127.*

Sections and profiles investigated at Sermermiut, western Greenland (69 deg 12 min N, 51 deg 08 min W) illustrate the plant succession during the last 3,000 years. By means of palynoloyg and determination of macrofossils the following succession is deduced: a seashore with ELYMUS and STELLARIA HUMIFUSA; a grass-mat dominated by ALOPECURUS ALPINUS; a BETULA NANA heath; a SALIX GLAUCA scrub; a SPHAGNUM SQUARROSUM bog with a number of hydrophilous species; a grass-mat with dwarf shrubs; a SPHAGNUM SQUARROSUM bog; and, after a lacuna, the present moss-carpet. A series of radiocarbon datings has shown that the humid conditions responsible for the change into the first SPHAGNUM bog was contemporaneous with RYIII in northwestern Europe (about 600 B.C.), while the second growth of SPHAGNUM starts about A.D. 400 (RYII). (Auth)

Ten Carbon 14 dates provide control. Influx of far travelled exotic pollen shows peaks at about 2400 and 1400 B.P. The two Sphagnum intervals are associated with cooler climatic conditions. (JTA)

1030. **Fredskild, B.** 1967. Palaeobotanical Investigations at Sermermiut Jakobshavn, West Greenland. *Meddelelser om Gronland 178(4):1-54.*

Two transects in a bog were investigated, pollen diagrams from three profiles worked out, a series of macrofossil samples examined, and samples from one profile were dated by the radiocarbon method (1560 B.C. to A.D. 400). Data were compared with comprehensive reference material of recent pollen from Greenland. The most important features is the twice occurring change from a dwarf shrub heath to a SPHAGNUM bog. The radiocarbon datings of these events show close agreement with the re-growth of the European raised bogs at about 700-500 B.C. and A.D. 400 respectively. (from Abstracts N. American Geology) GA 68B/581

1031. **Fredskild, B.** 1968. An Investigation of the Former Settlement of Sermermiut Near Jakobshavn from the Natural Sciences Viewpoint. En naturvidenskabelig undersogelse af den tidligere boplads Sermermiut ved Jakobshavn. *Gronland 1968, no. 1:23-32.*

Outlines the 1953 and 1955 excavations by Danish Nationalmuseet at this West Greenland settlement, abandoned at the beginning of the 19th century. The vegetational character of the different peat layers is described and analyses of 22 pollen samples given. The sand and gravel that appeared when the land rose above sea level about 3500 years ago became covered by grasses. The first settlement was by the Sarqaq people about 1500-1400 B.C., and those remains represent the oldest in West Greenland. Crowberry and marsh tea spread over the grassy plain, supplanted in turn by dwarf birch and willow, finally the site became a bog. The grasses eventually reappeared and the Dorset people settled about 2000 yr ago. The vegetation cycle was repeated and bog developed again about 400 A.D. The Thule Eskimo probably settled at Sermermiut between 1000 and 1200 A.D. (AB103516) AB103516

1032. **Fredskild, B.** 1969. Postglacial Standard Pollendiagram from Peary Land, North Greenland. *Pollen et Spores 11(3):573-583.*

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Presents a conventional and a standard diagram giving results of analyses of the upper 30 cm of marine clay and overlying clayey chalk guttja which comprise the bottom sediments of Klareso lake bored during the second Peary Land Expedition in 1963 under Eigil Knuth. An uplift curve of the Jorgen Bronlund Fjord area is based on Carbon 14 datings of charcoal in paleo-Eskimo dwellings on raised beaches. The lake was isolated from this fiord approx 5000 B.P., shortly after retreat of the glacier named for the fiord. A few centuries later long fiords were open during summmers, the climate was fairly rich in individuals; driftwood washed ashore and paleo-eskimos hunted musk oxen. Approx. 2500 B.P. the climate deteriorated, turned more arid and the vegetation changed into the the present high-arctic desert. This lecture was given at the Eighth Congress of the International Association for Quaternary Research, Paris, 1969. (AB103518) AB103518

1033. **Fredskild, B.** 1972. Palynological Evidence for Holocene Climatic Changes in Greenland. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 277-306), 511 pp.*

This paper reviews seven previously published pollen diagrams and includes summaries of seven new but unpublished sites, discussed by area– South, Middle West, and North Greenland. Materials examined include peats and lake sediments. In Middle West and South Greenland between 8000 and 7000 B.P. the vegetation changed from an open pioneer community to a willow-juniper scrub which was later mixed with birch and alder shrubs. Important climatic events include two periods of climatic deterioration which are dated at 2500 and 600 B.P. In North Greenland there is evidence for a relatively rich vegetation prior to 2500 B.P. followed by the rapid development of today's Polar Desert. (JTA)

1034. **Fredskild, B.** 1973. Studies in the Vegetational History of Greenland. Palaeobotanical Investigations of Some Holocene Lake and Bog Deposits. *Meddelelser om Gronland 198(4):1-245.*

The content of pollen in Holocene, organic sediments in some Greenland lakes and bogs has been analyzed. The results are presented in relative and absolute diagrams. Furthermore, radiocarbon datings and macrofossil determinations are included in the description of the vegetational history. For the outer coast at Kap Farvel the first vegetation after the deglaciation around or shortly after 10, 000 Carbon 14 years B.P. was an open pioneer vegetation of widely distributed arctic plants. No southern species are proved. Snowpatches seem to have been frequent until ca. 7200 B.P., when SALIX and JUNIPERUS immigrated. A further amelioration is indicated around 5300 B.P. BETUAL GLANDULOSA immigrates ca. 3800 B.P. The hypsithermal falls within 5300-2200 B.P. In the interior the sedimentation starts later. The vegetation is somewhat different due to more continental climate, but the trend of the diagrams is parallel. SALIX immigrates ca. 8000 B.P., JUNIPERUS ca. 7000, BETULA GLANDULOSA between 4500 and 4000, and B. PUBESCENS ca. 3600 B.P. At the head of Godthabsfjord, West Greenland, the vegetational development is parallel and presumably synchronous to that in the interior of South Greenland. In North Greenland the composition of the vegetation seems to have changed little in the past 5000 years, but in a period roughly between 4000-2100 B.P. and again between 1500 and 900 B.P. the climate seems to have been less arid. Exotic and long distance pollen is important in South Greenland sediments. (Auth)(JTA)

1035. **Fredskild, B.** 1975. A Late-Glacial and Early Post-Glacial Pollen-Concentration Diagram from Langeland, Denmark. *Geologiska Foreningens i Stockholm Forhandlingar 97:151-161.*

A pollen-concentration diagram covering the period between the Allerod oscillation and early Atlantic time, derived from a former lake on the island of Langeland, southern Denmark, is presented. Average pollen-deposition rates for the different pollen zones are calculated and discussed. A comparison is made with past and present deposition rates from other parts of Europe and North America. (Auth)

1036. **Fredskild, B.** 1981. The Natural Environment of the Norse Settlers in Greenland. *Proceedings of the International Symposium Early European Exploitation of the Northern Atlantic 800-1700, Arctic Center, University of Groningen, Netherlands, 1981, (pp. 27-42).*

Analysis of pollen profiles collected from sites close to the Eastern and Western Greenland settlements, inhabited by Noresemen prior to 1400, suggests the disappearance of the settlers coincided with a marked climatic deterioration. In the ice core record from Crete on the center of the Greenland Inland Ice, the "...fourteenth century (was) the coldest in historic time." (p. 38). (JTA)

1037. **Fredskild, B.** 1983. The Holocene Vegetational Development of the Godthabsfjord Area, West Greenland. *Meddelelser om Gronland, Geoscience 10:1-28.*

Holocene pollen and macrofossil diagrams from four low arctic lakes at Godthabsfjord are presented. Each core has been divided into radiocarbon-dated palaeovegetation zones, based on remnants of terrestric plants. The PV zones are physiognomically similar, but differences as to the composition and frequency of species can be seen between the two lakes in the interior and the two lakes from the outer coast area. The vegetation which invaded the deglaciated soil was open but rich in species, and 64 species or genera have been determined from the pioneer stage (c. 9400-8000 B.P.). Open soil plants were dominating, but dwarf shrubs entered the vegetation, with species from snow-patches and snow-covered heaths dominating in the beginning. By c. 8000 B.P. SALIX GLAUCA and S. HERBACEA immigrated, and gradually the pioneer plants and and chionophilous dwarf-shrubs were decimated. This SALIX-Cyperaceae stage lasted until c. 6300 B.P., when BETULA NANA spread all over the area within a few centuries. A BETULA NANA-JUNIPERUS stage lasted until c. 3500 B.P. In the subcontinental interior this was followed by an ALNUS CRISPA-BETULA NANA stage, which in turn was replaced by a BETULA NANA-Ericales stage around 1800 B.P. ALNUS has never been able to grow at the maritime outer coast, where BETULA, Cyperaceae, EMPETRUM, and other Ericales dominated after c. 3500 B.P. Later on, EMPETRUM, Cyperaceae and snowbed plants gradually spread at the expense of BETULA NANA. After the deglaciation the temperature increased, reaching today's values between 8000 and 7500 B.P. At which time during the coming millennia the temperature curve peak is not known, but it may have been fairly late, presumably during the BETULA NANA-JUNIPERUS stage. Major climatic changes are registered in the interior at 3900-3600 and 1800 B.P., and at the outer coast at c. 3600 and 2500-2000 B.P. From around 8000 B.P. the development of the lakes is fairly independent of the physical conditions of the surroundings, being dependent mainly on the trophic stages of the lakes. These pass through a succession: highly productive, eutrophic - less productive, mesotrophic - very poor, oligotrophic. As well as in the flora and fauna, these stages are reflected in the sediment, which at the beginning was a clay gyttja followed by a jelly-like gyttja and, finally, by a loose, watery gyttja consisting mainly of precipitated humus. Chemical analyses of one of the cores confirm the oligotrophication. The pollen influx in the pioneer stage is less than 100 grains per sq cm per year, increasing during the Hypsithermal to c. 300 in three of the lakes and c. 1000 in the richest one, but since then the influx decreases somewhat upwards. A survey of the immigration or first appearance of some species palynologically important to South and West Greenland shows big time lags in the spreading of some species, e.g. THALICTRUM and ANGELICA, whereas others, like EMPETRUM and JUNIPERUS, have a more effective dispersal capacity. (Auth)

1038. **Fredskild, B.** 1983. The Holocene Development of Some Low and High Arctic Greenland Lakes. *Hydrobiologia 103:217-224.*

During the Holocene most West Greenland lakes passed from an early eutrophic stage, rich in both flora and fauna, through a mesotrophic to an oligotrophic stage with very low productivity. Temperature conditions were limiting factors only in the very beginning, whereas chemical factors alone were decisive later on. (Auth)

1039. **Frenzel, B.** 1966. Climatic Change in the Atlantic/Sub-Boreal Transition on the Northern Hemisphere: Botanical Evidence. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 99-123), 229 pp.*

Recent palynological investigations have shown that a short-term cold spell occurred in the Northern Hemisphere at the very end of the Atlantic period, i.e. between about 3400 to 3000 B.C. Later, continentality of climate increased in various regions of the world, interrupted by several minor oscillations. At about 1500 B.C., but especially since about 900 B.C., deterioration of climate within the recent zone of temperate climates began. Mean temperatures of summer and winter were lowered, and rainfall during the growing season seems to have increased in Central Europe. This deterioration of climate was modified by several minor climatic fluctuations too. The intensity of the said climatic changes and oscillations was rather weak. Consequently the tendency to climatically induced changes in the vegetation in the Atlantic/sub-Boreal and sub-Boreal/sub-Atlantic transitions were sometimes suppressed, camouflaged, enhanced or retarded by local conditions, and by the activity of man. (Auth)

1040. **Funder, S.** 1978. Holocene (10,000 - 0 Years B.P.) Climates in Greenland, and North Atlantic Circulation. *Proceedings of the Nordic Symposium on Climatic Changes and Related Problems, Copenhagen, 24-28 April, 1978. Det Danske Meteorologiske Institut, Klimatologiske Meddelelser No. 4, (pp. 175-180), 259 pp.*

Studies in East Greenland on plants and marine molluscs suggest that temperatures were similar to present between 10,000 and 9,000 B.P. In East Greenland the local thermal maximum occurred between 8500 and 8000 B.P. whereas in West Greenland the local thermal maximum was delayed to 7000 B.P. in terms of plant evidence and between 7000 and 5000 B.P. based on the migration of marine molluscs. Large sectors of the West Greenland ice sheet readvanced or stood still ca 8000 B.P. A similar diachrony marks the onset of middle to late Holocene climatic deterioration. In East Greenland the Betula nana heath gave way to high arctic plants by 5000 B.P. whereas in West Greenland deterioration of climate was not noted in the pollen records until 3000-2000 B.P. Differences in climatic development may be explained by the changing atmospheric circulation over the North Atlantic. (JTA)

1041. **Funder, S.** 1979. Ice-Age Plant Refugia in East Greenland. *Palaeogeography, Palaeoclimatology, Palaeoecology 28:279-295.*

Carbon 14 dates and amino acid age estimates of marine sediments show that lowland areas of the East Greenland coast have been ice free for more than 40,000 years. Pollen diagrams from East Greenland extending back to 10,000 B.P. indicate that many species immigrated to East Greenland during the Holocene. A map shows the first arrival dates of BETULA NANA into Greenland and arctic North America during the early Holocene. (JTA)

1042. **Graf, K.** 1981. Palynological Investigations of Two Post-Glacial Peat Bogs near the Boundary of Bolivia and Peru. *Journal of Biogeography 8:353-368.*

We explored peat bogs of the northern Andes of Bolivia to analyse post-glacial variations of vegetation and climate. Pollen diagrams show that the post-glacial period began at about 10,000 B.P. with a relatively cold, dry phase. However, the main climatic changes since the last ice age took place immediately before that time. About 7500-5500 B.P. there was probably a moderately humid and dry period. Then moisture increased till approx. 3500 B.P. Since then, a period of quite humid high mountain steppe conditions has developed. (Auth)

1043. **Hafsten, U., and P.A. Tallantire.** 1978. Palaeoecology and Post-Weichselian Shore-Level Changes on the Coast of More, Western Norway. *Boreas 7(2):109-122.*

Pollen analysis, macrosubfossil determinations and radiocarbon datings reveal changes in the local vegetation and in the groundwater level of the landward lagoon-like area, considered to reflect the relative shore-level changes between late Preboreal and early Atlantic times. The spread of alder within the area may have been delayed by a thousand years compared with other regions in south Norway. (Auth) Ecol Abs 79L/2925

1044. **Heusser, C.J.** 1960. Late-Pleistocene Environments of North Pacific North America; Elaboration of Late-Glacial and Postglacial Climatic, Physiographic, and Biotic Changes. *American Geographical Society, Special Publication No. 35, 308 pp.*

Detailed treatment of the peat and pollen stratigraphy of the sections (Alaska, pp. 99-123) is presented. Conclusions are based on 114 sections, of which 78, fifty of them in Alaska, are discussed and diagrammed. Postglacial (from ca. 10,000 B.P.) vegetation in southeastern Alaska included lodgeppole pine and alder; with firn and sedge to the north and west. A gradual rise of conifer forest throughout the Hypsithermal (time when mean annual temperatures exceeded the present) occurred southeast of Prince William Sound; to the southwest, alder and birch appeared. A GRENZHORIZONT marks the boundary between the Hypsithermal and late Postglacial in many sections; in southeastern Alaska, it is radiocarbon dated at ca. 3500 B.P. Other features of the Alaskan Postglacial include at least five major volcanic eruptions and a brackish-water phase of coastal lakes. (AB65144)(JTA) AB65144

1045. **Heusser, C.J.** 1963. Pollen Diagrams from Ogotoruk Creek. Cape Thompson, Alaska. *Grana Palynologica 4(1):149-159.*

Palynologic

Discusses the significance of these diagrams in the postglacial vegetational history at Cape Thompson and in relation to pollen diagrams from other places in arctic Alaska. ERIOPHORUM or cotton-grass-tussock-type vegetation occupies nearly 40% of the Ogotoruk Creek drainage system; the DRYAS- fellfield-type over 30% and the ERIOPHORUM-CAREX-wet-meadow-type about 12%. Sites investigated are in an eroding or thermokarst area between Ogotoruk Creek and Kukpuk River at approx. 75 m elevation. Samples were collected from fresh cuts in the north side of frozen mounds; most samples were found barren of microfossils. Pollen diagrams of the three main sections indicate prominent profiles for birch, sedge, willow, and grass species. Profile fluctuations in the lower two zones are interpreted as a result of major climatic and edaphic changes; in the upper two zones changes were minor. Spectra in the lowest zone appear closely identified with two vegetation types occupying the terrain at present. The increase and dominance of BETULA in the uppermost zone is thought to indicate increased stabilization and amelioration. From correlation with Nome and Umiat (radiocarbon-dated) sites, the lowest zone is dated as before 13,000 to 10,000 yrs B.P. The overlying zone endured until about 6,000 B.P., the middle sub-zone where evident dates from about 8,000 B.P. (AB79369) AB79369

1046. **Heusser, C.J.** 1963. Postglacial Palynology and Archaeology in the Naknek River Drainage Area, Alaska. *American Antiquity 29(1):74-81.*

Analysis of samples aimed at reconstructing environment sequences. Birch and alder were principal arboreal types for muskeg: alder predominated during a late interval of hypsithermal time, about 5,500 B.P.; birch gained thereafter attaining its maximum 5,000-2,500 B.P. Spruce migrated from the interior within recent centuries. A cooler and drier climate than at present existed from about 4,000 (earliest culture phase) to 2,500 B.P., turning gradually warmer and more humid. At first however, temperature remained lower and precipitation was greater than now, causing presumably heavy snow accumulations in the Aleutian Range which resulted in glacial advances during recent centuries. (AB79370) AB79370

1047. **Heusser, C.J.** 1965. A Pleistocene Phytogeographical Sketch of the Pacific Northwest and Alaska. *Quaternary of the United States, A Review Volume for the VII Congress of the International Association for Quaternary Research, H.E. Wright, Jr. and David G. Frey (Eds.). Princeton University Press, Princeton, NJ, (pp. 469-483), 922 pp.*

In Pacific coastal Alaska, early pine parkland in the southeasten sector was subsequently given over largely to hemlock-spruce forest; toward the west as far as Kodiak Island conifer forest developed from an initial tundra of sedge and shrubs. Unglaciated coastal refugia may have served as centra for plant invasion of deglaciated terrain, in addition to the area south of the glacier boundary in Washington. Unglaciated interior Alaska was an extensive refugium for the major forest trees, spruce and birch, as well as for herbs and shrubs of the arctic tundra. Records of late-glacial and early postglacial arctic vegetation show herbaceous tundra in the beginning, later invaded by birch and more recently by alder. Arctic tundra has prevailed in Alaska, much in the same manner as it does at present, through at least the latter part of the Pleistocene. (Auth)(JTA)

Late-glacial vegetation has been reconstructed palynologically.(JTA)

1048. **Heusser, C.J.** 1966. Polar Hemispheric Correlation: Palynological Evidence from Chile and the Pacific North-West of America. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 124-141), 229 pp.*

Pollen diagrams and peat stratigraphy of sections from north Pacific America (46 deg - 59 deg N) and southern Chile (41 deg 30 min - 46 deg 40 min S) are brought together for the purpose of constructing a working model to serve as the basis for comparing the climates of temperate latitudes in the polar hemispheres during the late-glacial and post-glacial. The model, thus far developed, shows a general parallelism for the climatic trends in these regions, and within the limits of the radiocarbon chronological control available, the times of change appear to run in harmony. The late-glacial which dates from 15,000 - 16,000 B.P. consists of three zones, partitioned on the basis of western European stratigraphy. Average summer temperature in zone I (= Older Dryas) was c. 11 deg C, being depressed c. 5 deg compared with the present; in zone II (= Allerod) it increased 3-4 deg; and in zone III (= Younger Dryas) it fell again c. 11 deg C. Humidity, however, was contrasted between the regions during the late-glacial. Zones I and II which were wetter compared to zone II in Chile were drier in north Pacific America by comparison to zone II. The post-glacial begins 10,000 - 10,500 B.P. and its five zones follow the stratigraphic scheme proposed by Blytt and Sernander for southern Scandinavia. The climate of zone IV (= Pre-Boreal) was cool and moist with temperatures 3-5 deg colder than the present, but warmer conditions ensued, reaching maxima of 1-2 deg warmer than today in zone V (= Boreal). Sites of greater continentality appear to have had less humid climate whereas oceanic sites continued to be wet. Zone VI (= Atlantic) was wetter and cooler than the previous interval by 2-3 deg except at low elevations near the ocean where temperature changes were not recognisable. A uniformly drier climate which was also somewhat warmer prevailed in zone VII (= sub-Boreal) but changed rather abruptly at the opening of zone VIII (= sub-Atlantic), at about 2500-3000 B.P., becoming generally wet and on the order of 2-3 deg cooler. (Auth) GA 69B/1037

1049. **Heusser, C.J.** 1972. Additional Postglacial Pollen Diagram from Patagonia Occidental. *Pollen et Spores 14(2):157-167.*

Pollen analyses from a section of cushion bog located at Puerto Eden on Isla Wellington in the Chilean Province of Magallanes show the following zonal sequence: (1) a beech maximum preceded by Empetrum predominance, (2) secondary EMPETRUM predominance. (3) a maximum of DACRYDIUM and PODOCARPUS, and (4) beech predominance. At the beginning of peat deposition at the site, 9670 radiocarbon years ago, vegetation appears to have been treeless, for the most part, and dominated by EMPETRUM. The southward migration of DACRYDIUM and PODOCARPUS to Isla Wellington and the subsequent expanse of these genera there constitute late-postglacial events. The zone II prominence of EMPETRUM, interpreted to result from the advance of this montane plant at low elevations at the expense of beech forest, is suggestive of a cooler climate with greater frequency of storms. It may represent palynological evidence for the climatic change that gave rise to extensive glacier advance in the Patagonian Andes about 5000 years ago. (Auth) AntB E-20905

1050. **Heusser, C.J.** 1973. Postglacial Vegetation on Umnak Island, Aleutian Islands, Alaska. *Review of Palaeobotany and Palynology 15:277-285.*

Pollen analyses of a peat section, 9,945 + or - 320 radiocarbon years of age from Umnak Island in the eastern Aleutians, point to a tripartite sequence of postglacial plant communities beginning with a sedge-grass tundra, followed by an interval of willow dominance (8,500-3,500 years ago), and ending with a grass-sedge tundra. (Auth)

1051. **Heusser, C.J.** 1974. Vegetation and Climate of the Southern Chilean Lake District During and Since the Last Interglaciation. *Quaternary Research 4:290-315.*

During Llanquihue Glaciation, average January temperature is estimated to have been about 8 C colder than today at 19,450 BP, some 5 deg colder shortly before 36,300 BP, and around 4 deg colder at 10,000 BP. Antarctic-alpine tundra or parkland, under colder, drier climate, is mostly in evidence in the vicinity of the study sites before about 12,000 BP. During the postglacial, forest communities occupied the lake district, and temperatures there were probably 1-2 C above (by 6500 BP) and as much as 2 deg below (4500-0 BP) the present-day average of about 16 deg. (Auth)(JTA)

1052. **Heusser, C.J.** 1974. Quaternary Vegetation, Climate, and Glaciation of the Hoh River Valley, Washington. *Geological Society of America Bulletin 85:1547-1560.*

Modern vegetation in the valley is predominantly of the rain forest type, divisible into Pacific coastal and subalpine communities. Coastal forest is established at elevations below 500 to 600 m, subalpine forest continues to the tree limit near 1,700 m, and alpine tundra occurs only on the heights in the interior. A winter-wet, cool, temperate climate prevails in the rainforest. Annual precipitation is greater than 3,000 mm, and the average July temperature lies between 12 deg and 15 deg C. In the alpine zone, temperatures are a few degrees lower and precipitation reaches an estimated 5,000 mm or more. Holocene vegetation is portrayed by three pollen assemblages: PINUS-ALNUS-PICEA- PSEUDOTSUGA-PTERIDIUM (10,000 to 8,000 yr B.P.), PICEA-TSUGA-ALNUS-PSEUDOTSUGA- PTERIDIUM (8,000 to 3,000 yr B.P.), and TSUGA-THUJA-ABIES (3,000 to 0 yr B.P.). The sequence implies a climatic trend from a cool and relatively humid climate in the beginning, to increasing warmth, then maximum warmth and lower humidity, and finally to a cooler and quite humid climate at the close. The sequence also reflects the gradual replacement of open, successional forest communities by a late Holocene-age closed rain forest. Pollen influx is low, generally less than 1,500 grains cm(E-2) yr(E-1), except around 8,000 yr B.P., when values exceeded 5,000 cm(E-2) yr(E-1). (Auth)(JTA)

1053. **Heusser, C.J.** 1977. Quaternary Palynology of the Pacific Slope of Washington. *Quaternary Research 8(3):282-306.*

Holocene vegetation consisted first of open communities of Douglas fir and alder; later, closed forests succeeded, formed principally of western hemlock on the Olympic Peninsula and of western hemlock and Douglas fir in the Puget Lowland. Over the length of the reconstructed environmental record, climate shifted between cool and humid or relatively warm, semihumid forest types and cold, relatively dry tundra or park tundra types. During times of glaciation, average July temperatures are estimated to have been at least 7 degree C lower than today. Only during the Alderton Interglaciation and during the Holocene were temperatures higher for protracted periods than at present. (Auth)(JTA)

1054. **Heusser, C.J.** 1978. Postglacial Vegetation on Adak Island, Aleutian Islands, Alaska. *Bulletin of the Torrey Botanical Club 105(1):18-23.*

Thirty stratigraphic samples from a 2.75-m section of sedge peat located on northern Adak were studied for their pollen and spore content. The section is approximately 10,250 radiocarbon years in age and contains numerous volcanic ash horizons. Three major pollen assemblages indicative of the postglacial vegetation sequence are (1) Cyperaceae-SALIX-EMPETRUM-LYCOPODIUM in the beginning, (2) Cyperaceae and Gramineae between about 10,000 and 3,000 years aggo, and (3) subsequently EMPETRUM. Climate, cold and windy during the early and late postglacial and warmer midway, is interpreted to be primarily responsible for the vegetation changes. The effect of ashfalls on the vegetation appears to have been only transitory. (Auth)

1055. **Heusser, C.J.** 1978. Palynology of Quaternary Deposits of the Lower Bogachiel River Area, Olympic Peninsula, Washington. *Canadian Journal of Earth Sciences 15(10):1568-1578.*

The palynology and radiocarbon chronology of an interstadial peat exposure and a bog located in the lower Bogachiel River drainage area provide further basis for the reconstruction of Quaternary vegetation and environments of the western Olympic Peninsula. After about 10,000 a B.P., alder reaches peak proportions and is followed by a succession of lowland arboreal species characterized chiefly by western hemlock. The pollen stratigraphy of these deposits correlates with a previously established biostratigraphic scheme for Quaternary deposits in western Washington. (Auth)(JTA)

1056. **Heusser, C.J.** 1981. Palynology of the Last Interglacial–Glacial Cycle in Midlatitudes of Southern Chile. *Quaternary Research 16(3):293-321.*

Pollen and spores in stratigraphic sections located between 40 and 42 degree S range in age from the Holocene, through much of the Llanquihue Glaciation, to the last interglaciation. Chronology of the stratigraphy derives from some 35 Carbon 14 ages and the age relations of Llanquihue Drift and related deposits. Q-Mode, rotated, principal-components analysis of four key pollen records covering the last interglacial-glacial cycle resulted in four leading components: NOTHOFAGUS DOMBEYI type, Gramineae, WEINMANNIA-FITZROYA type, and Myrtaceae. Analysis emphasizes interaction between the first two components. Loadings of Gramineae during the interglaciation are high, unlike the Holocene; WEINMANNIA-FITZROYA-type loadings, prominent in the Holocene, are negligible during the interglaciation. N. DOMBEYI type is the primary component during Llanquihue Glaciation; it becomes modified by increases of Gramineae sometime after 31, 000 and before 14,000 yr B.P. Fluctuations in the belt of westerly winds, reflecting changing meteorological conditions in polar latitudes, are suggested by these data. With the belt located farther south than it is today, interglacial climate was much drier and warmer than during the Holocene; more northerly displacement of the belt obtained when climate was colder during Llanquihue Glaciation. Evidence from comparable latitudes in the Southern Hemisphere points toward a synchrony of major climatic events indicating harmonious fluctuations in the position of the westerlies. (Auth)

1057. **Heusser, C.J.** 1982. Palynology of Cushion Bogs of the Cordillera Pelada, Province of Valdivia, Chile. *Quaternary Research 17(1):71-92.*

Fossil pollen identified in the earliest sediments of three cushion bogs in the Cordillera Pelada (40 degrees 10 minutes S, 73 degrees 30 minutes W) dated 10,425 Carbon 14 yr B.P. includes the subantarctic species DACRYDIUM FONCKII, TETRONCIUM MAGELLANICUM, ASTELIA PUMILA, GAIMARDIA AUSTRALIS, DONATIA FASCICULARIS and DROSERA

UNIFLORA. All grow today in the Cordillera Pelada and range poleward to the southernmost Province of Magallanes; one species, DRAPETES MUSCOSA, included with the pollen of these plants in the earliest record, is no longer a constituent of the flora but is limited only to subantarctic Chile. Available evidence indicates that plants survived the last glaciation north of the glacial border with the course of postglacial migration southward following the wastage of the glacier complex. Holocene climatic and vegetational changes in the Cordillera Pelada are interpreted in the context of regional reconstructions which show maximum warmth about 9000 yr ago with a pronounced dry period lasting from 9000-6500 yr B.P. Maximum precipitation was later reached around 4000 yr ago but has decreased overall since then. The regional decline of the endemic gymnosperm FITZROYA CUPRESSOIDES, which today is extensively destroyed in the Cordillera Pelada, follows this decrease in precipitation. These climatic data suggest a net southward shift in the zone of westerly winds that bring rainfall to the region over the past 4000 yr. (Auth)

1058. **Heusser, C.J.** 1983. Holocene Vegetation History of Prince William Sound Region, South-Central Alaska. *Quaternary Research 19:337-355.*

Vegetation history during the Holocene is interpreted from the pollen and sedimentary records of nine sections of peat deposits located in sedge tundra at sites in the northern and northwestern parts of the Prince William Sound region. Basal radiocarbon ages of the deposits are between 10,015 and 580 yr B.P. Modern surface pollen data from these and 25 additional sites, ranging from lowlands to an altitude of 675 m in the alpine tundra, were used to aid in the interpretation of the fossil records. Both frequency and influx pollen diagrams of the oldest section disclose a sequence of communities beginning with sedge tundra, containing thickets of willow and alder, followed by alder, which became predominant at about 8300 yr B.P. Later, alder declined, and an inferred growth of sedge tundra and the establishment of colonies of mountain hemlock and Sitka spruce with some western hemlock occurred about 2680 yr B.P. Finally, regrowth of sedge tundra accompanied by the development of forest communities took place over the past 2000 yr. The influence of glacier advances on the vegetation in the fjords occurred during Neoglacial episodes dated at 3200-2500 yr B.P. and during recent centuries. Regional Holocene tectonic activity was also an influential factor, especially at the time of the 1964 earthquake. (Auth)

1059. **Heusser, C.J., and L.E. Heusser.** 1981. Palynology and Paleotemperature Analysis of the Whidbey Formation, Puget Lowland, Washington. *Canadian Journal of Earth Sciences 18(1):136-149.*

Vegetation of the Puget Lowland is designated as a subdivision of the coastal TSUGA HETEROPHYLLA forest (Franklin and Dyrness 1973), which owing to human interference, has been replaced to a very great extent by sucessional communities of PSEUDOTSUGA and ALNUS. Present-day pollen rain predominantly of ALNUS reflects this change (Heusser 1978a). In a study of surface samples from 30 stands of PSEUDOTSUGA, ALNUS contributed 78% and PSEUDOTSUGA only 9% of the total pollen. ALNUS, strongly overrepresented, formed only 2% of the basal area of all trees in the stands whereas PSEUDOTSUGA, strongly underrepresented, formed 73%. During the early Holocene, before the ashfall from Mt. Mazama about 6700 years B.P., the average maximum of PSEUDOTSUGA pollen in Puget Lowland bogs was 51% and of ALNUS 41%. This change is attributed to structural differences in the forest communities of the early Holocene when climate was apparently warmer and drier than the present. (Auth)

1060. **Heusser, C.J., L.E. Heusser, and S.S. Streeter.** 1980. Quaternary Temperatures and Precipitation for the North-West Coast of North America. *Nature 286(5774):702-704.*

For interpreting climatic parameters from Quaternary pollen in land and marine cores, we calculated a pair of regression equations relating modern pollen rain from the Pacific coastal forest and tundra to mean July temperture and mean annual precipitation at a series of sites from the Aleutian Islands to northern California. We describe here how application of these equations to Quaternary pollen profiles from Western Washington enabled us to quantify temperature and precipitation over the past approximately 80,000 yr. (Auth)(JTA)

1061. **Heusser, C.J., and S.S. Streeter.** 1980. A Temperature and Precipitation Record of the Past 16,000 Years in Southern Chile. *Science 210(4476):1345-1347.*

Regression equations relating pollen taxa from surface samples to temperature and precipitation are applied to a radiocarbon-dated pollen sequence in a lake core from Alerce. The resulting curves are a measure of the fluctuations of these climatic variables and show similarities to other late Quaternary records from the Southern Hemisphere. (Auth)

1062. **Hibbert, F.A., V.R. Switsur, and R.G. West.** 1971. Radiocarbon Dating of Flandrian Pollen Zones at Red Moss, Lancashire. *Proceedings of the Royal Society of London, B 177:161-176.*

A pollen diagram from Flandrian (post-glacial) organic deposits at Red Moss, Lancashire, has been constructed and six pollen assemblage zones defined. Radiocargon dating, using equipment described in outline, has been applied to sixteen horizons within this sequence, so that boundaries of the pollen assemblage zones, and significant changes within them, have been dated. The sixteen dates fall between 9798 + or - 200 BP and 4370 + or - 80 BP, and form a consistent series, apart from the basal date, which lies near the Late Weichselian-Flandrian boundary. The sequence of assemblage zones has been assigned to three major chronozones of the Flandrian: FI, corresponding to the first four assemblage zones, covering the period of time before the clear establishment of mixed oak forest; FII, corresponding to the mixed oak forest zone (QUERCUS-ULMUS-ALNUS) starting at 7107 + or - 120 BP, and FIII, corresponding to the QUERCUS-ALNUS zone, starting at 5010 + or - 80 BP. Many more dated profiles are required before interpretation of differences can be made in terms of migration, succession or climatic change. (Auth)(JTA)

1063. **Hope, G.S.** 1976. The Vegetational History of Mt. Wilhelm, Papua, New Guinea. *Journal of Ecology 64(2):627-664.*

Five new pollen diagrams from 4420 m, 3910 m, 3550 m, 3500 m, and 2740 m on Mt. Wilhelm, Papua, New Guinea, are presented. Altitudinal sequence and extensive Carbon 14 dating allows determination of the position of vegetation zones through time. Present subalpine communities of Mt. Wilhelm have developed partly by selection of high altitude components of the montane forest flora over the last 10,000 yr and partly by the recent spread of elements of the Pleistocene subalpine grasslands as a result of forest clearance. (Auth) Ecol Abs 77L/4675

1064. **Hope, G.S.** 1978. The Late Pleistocene and Holocene Vegetational History of Hunter Island, North-Western Tasmania. *Australian Journal of Botany 26(4):493-514.*

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Cave Bay Cave contains pollen-bearing sediments which span the periods c. 28,000-14,000 B.P. and c. 8000 B.P. to the present. Pollen analysis of the Pleistocene sediments indicates that an initial open shrubland was followed by grassland which became increasingly open with abundant composites. Eucalypts occurred in the area but were probably very sparse. The Holocene section records a coastal shrubland like that at present in the area. Intervals of occupation had little effect on vegetation recorded at the cave, fires occurred in the vegetation during the unoccupied as well as occupied phases. Comparison of the Pleistocene spectra with those from sites in near-coastal Tasmania and south-eastern Australia suggest that an open grassland with scattered trees was extensive from the Adelaide region down to the Bassian Plain. Some components of this cold steppe formation may occur today in the tree line woodlands on the driest parts of the Tasmanian mountains, but there may also be floristic affinities with arid steppe. The grassland probably reflects conditions colder, drier and possibly windier than any represented in the area today. (Auth) Ecol Abs 79L/7475

1065. **Hope, G.S., and J.A. Peterson.** 1976. Palaeoenvironments. *The Equatorial Glaciers of New Guinea, Results of the 1971-1973 Australian Universities' Expeditions to Irian Jaya: Survey, Glaciology, Meteorology, Biology and Palaeoenvironments, G.S. Hope, J.A. Peterson, U. Radok, and I. Allison (Eds.). A.A. Balkema, Rotterdam, (pp. 173-206), 244 pp.*

Table 9.6, vegetation and temperature–results from Mt. Jaya, integrates the results from the well dated sections of all sites and provides for each section a tentative range within which the temperature of the time probably differed from that experienced by the site today. Where vegetation formations with wide ecological tolerances are present, the range given is also necessarily wide. Where available, estimates of the altitudinal position of the regional tree line and snowline are also given. The general picture provided by Table 9.6 is of rising temperatures after 15,000 years ago, but the maintenance of conditions substantially cooler than present until after 11,000 B.P. The period since then has had substantially similar temperatures to the present day. However there must have been minor oscillations in at least the last 3,500 years. The ice readvances recorded at Ertsberg and Yellow Valley reflect short-term climatic deteriorations from the general trend. Evidently these were not great enough to reverse the continuing vegetation development near Ijomba. The disturbance to the lower subalpine forest after 5,500 B.P. can be attributed to burning by man, and this disturbance could have masked the effects of possible cooler climates on the vegetation. The climatic changes postulated here can be compared to those found in the central mountains of Papua New Guinea (Bowler et al. 1976), particularly Mt. Wilhelm (Hope 1976). On Mt. Wilhelm, deglaciation was followed by colder than present climates until about 10,000 B.P. and the tree line did not reach 2,600 m until after 11,000 B.P. By 8,500 B.P. however the tree line was above its present limit, and slightly warmer conditions than present are indicated. The tree line assumed its present position at 4,900 B.P. and a record of minor climatic oscillations seems to have prevailed since then. At Sirunki pollen analysis site at 2,500 m altitude to the west of Wabag, the maximum depression of vegetation zones and temperatures occurred from 18,500 to 16,000 B.P., and this was followed by a slow rise in temperature until 14,000 B.P. The conditions oscillated, but remained 1.5-2.5 deg C below present until about 9,000 B.P. when forests similar to those in the area today were progressively established. These records parallel the inferred changes in temperature on Mt. Jaya except that too little is known of the period from 10,000-3,500 B.P. to say whether conditions were warmer than present there during part of this time. (Auth)(JTA)

1066. **Hyvarinen, H.** 1970. Flandrian Pollen Diagrams from Svalbard. *Geografiska Annaler 52A(3-4):213-222.*

Five Flandrian lake sediment cores from Bjornoya, northern Vestspitsbergen and Nordaustlandet were analysed for pollen, and radiocarbon dates have been obtained on several samples. The composition of the pollen rain shows apparently regular variations over the last 10,000 years, mainly in terms of long-distance/local pollen (AP/NAP) ratio. (Auth)

1067. **Hyvarinen, H.** 1972. Pollen-Analytic Evidence for Flandrian Climatic Change in Svalbard. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 225-237), 511 pp.*

Pollen diagrams from five Flandrian lake sediment cores from different parts of Svalbard are discussed. The oldest organic material in the cores has been dated to between 10,000 and 11,000 BP. Regular changes in the AP/NAP ratio are recorded and are interpreted in terms of changes in the ratio between local pollen production and the supply of long-distance pollen. A peak in local (NAP) production around 5,000 BP is suggested to represent the optimal development of vegetation at the sites. (Auth)

1068. **Hyvarinen, H.** 1972. Flandrian Regional Pollen Assemblage Zones in Eastern Finland. *Commentationes Biologicae, Societas Scientiarum Fennica 59:1-25.*

Regional pollen assemblage zones for the different parts of eastern Finland are described and are correlated by means of radiocarbon dating. The early Flandrian sequence, a birch maximum followed by the rise of the pine, is clearly time-transgressive, being oldest in SE Finland and becoming consecutively younger towards the north. A retrogressive change, marked by the beginning of the uppermost coniferous zone in the diagrams, occurs at about 5000 BP. (Auth)

1069. **Hyvarinen, H.** 1975. Absolute and Relative Pollen Diagrams from Northernmost Fennoscandia. *Fennia 142:1-23.*

Absolute and relative pollen diagrams from three radiocarbon-dated lake sediment cores were used to illustrate the Flandrian vegetation history of an area between Lake Inari and Varangerfjorden in northern most Fennoscandia. The area is traversed by the modern pine forest limit and by the Main sub-stage (Younger Dryas) end-moraines. After an early Flandrian birch phase, pine immigrated around 8500 B.P., spreading already at that time into areas beyond its present range. Pine invasion was completed by 7500 B.P. The retreat of pine started around 5000 B.P. and continued until 3000-2500 B.P., after which little further change is evident. The pine invasion is considered mainly a migration event, while the retreat was probably climatically determined. (Auth)(JTA)

1070. **Hyvarinen, H.** 1975. Pollen Stratigraphy of Mackenzie Pingo Sediments, N.W.T., Canada. *Arctic and Alpine Research 7(3):261-272.*

Two eroded pingos, of the closed system type abundant in the uplands east of the Mackenzie Delta, yielded sections of pond sediment of Holocene age. Pollen stratigraphy of both sections confirms the general sequence established earlier by Ritchie (1972): Zone I dominated by BETULA GLANDULOSA associated with low frequencies of SALIX and ARTEMISIA; Zone II dominated by PICEA (20 to 40%) and BETULA (50%) and Zone III showing roughly equal representation of ALNUS, BETULA, and PICEA. Zone IV is represented only at Hendrickson Island site and is distinguished from Zone III by the increases in BETULA, ericads, and sedges, and a decline of ALNUS. Radiocarbon analyses suggest that the growth of the two pingos was initiated at least 2,500 years ago. The Zone I assemblage, which has been widely reported in the northwest Arctic-Subarctic of North America, was replaced by Zone II about 9,000 B.P.; at Eskimo Lakes it represents a migration of spruce into birch-dominated tundra, but it is unlikely that spruce actually grew at Hendrickson Island. The Zone III to IV changes confirm the proposition (Ritchie and Hare, 1972) that the tree line has retreated to its present position during the post-glacial. (Auth)

1071. **Hyvarinen, H.** 1976. Flandrian Pollen Deposition Rates and Tree-Line History in Northern Fènnoscandia. *Boreas 5:163-175.*

Previous absolute pollen diagrams from northern Fennoscandia yielded evidence for a retreat of the pine limit from an earlier extended position to a position near the modern one between about 5000 and 3000 BP. New absolute pollen data from the sediment core of Domsvatnet, a small tundra lake near the eastern coast of Varanger Peninsula, are used to demonstrate a parallel retreat in the birch limit. Areas outside the modern birch limit were colonized by early Flandrian pioneer birch woods between 9500 and 9000 BP and remained as birch woodland through middle Flandrian times until a retreat started around 5000 BP leading to the present tundra situation. (Auth)(JTA)

1072. **Jalut, G.** 1973. Evolution of the Climate and Vegetation of the Eastern End of the Pyrenees in the Lateglacial and Postglacial Periods, Based on Pollen Analysis. Evolution du Climat et de la Vegetation de l'extremite Orientale des Pyrenees au Tardiglaciaire et du Postglaciaire, d'apres l'analyse Pollinique. *Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D 276(19):2653-2656.*

Vegetation spread from the glacial refuges progressively to the beginning of the Allerod. At the end of the Preboreal and in the Boreal the regular and simultaneous increase in temperature and humidity favoured confiers above 1,400 m, extending to lower altitudes in the Atlantic period. Beech developed since this phase in the Donezan area and spread generally at about 1,700 B.C. (Margaret A. Bass (after French summary)) GA 74A/0528

1073. **Jalut, G.** 1973. Evolution of the Vegetation and Climate of the Eastern End of the Pyrenees during the Late Glacial and Postglacial. Evolution de la Vegetation et du Climat de l'extremite Orientale des Pyrenees pendant le Tardiglaciaire et le Postglaciaire. *Bulletin de l'Association francaise pour l'etude du Quaternaire 35:55-68.*

The palynological studies realised in Aude, Tet and Tech river basin at the eastern part of Pyrenean chain, prove the existence of glacial refuges as well as cornering of vegetation zones during late glacial times, especially in the middle Aude river-basin. Preboreal and Boreal, in eastern part of the Pyrenean chain are corresponding to a period of simultaneous increase of temperature and humidity. During Atlantic and the two first parts of the Subboreal period occur a decrease of temperature and an increase of cloudiness. FAGUS, developed in Donezan from the beginning of Atlantic period, appears everywhere during the Subboreal period but spread strongly in Aude river-basin only about 1700 B.C. (English summary) GA 74A/0472

1074. **Jankovska, V.** 1977. Palynological Analysis of a Peat from Truelove Lowland. *Truelove Lowland, Devon Island, Canada: a High Arctic Ecosystem, L.C. Bliss (Ed.), University of Alberta Press, Edmonton, (pp. 139-142).*

Peat depths in most high arctic sedge-moss lowlands are only 10 to 50 cm and in upland areas are 1 to 3 cm approximately. The shallow nature of peats makes interpretation of the recent history of vegetation in the High Arctic difficult. In this study core samples at one of these locations, an ice-centre polygon 1 km southwest of the Base Camp, were obtained and analysed. Pollen in the core averaged only 54 grains per three 20 x 20 mm sample areas which corresponds to low pollen production by high arctic plants, making interpretation of past vegetational patterns difficult. Only 16 groups of plants occurred in the pollen spectrum, with SALIX ARCTICA and POACEAE accounting for most. Small amounts of BETULA, PINUS and ALNUS pollen were present as a result of distant transport. The slow accumulation of peat on Truelove Lowland agrees with several reports from Greenland that a cold dry climate has prevailed for the past 1,000 or more years. A report of a peat profile from Axel Heiberg Island (Hegg 1963), which consisted of CAREX and DREPANOCLADUS peat interspersed with waterlain sand, suggested that between 4,000 and 3,000 B.P. the local climate was more favourable than today. CAREX pollen, mostly of local origin, predominated in this Axel Heiberg profile. (Ecol Can 1972)(JTA) Ecol Can 1972

Peat was cored at the center of an ice-center polygon. The base of the 1.7 m stratum was radiocarbon dated to 2450 + or - 90 B.P. (JTA)

1075. **Johansen, J.** 1975. Pollen Diagrams from the Shetland and Faroe Islands. *New Phytologist 75(2):369-387.*

Two pollen diagrams are presented, one from Murraster, Shetland Mainland, and one from Hoydalar, Streymoy, Faroe Islands. Both localities are former lakes, now filled up, and in both places the sedimentation started about 10,000 years ago. In the Faroese diagram herbs are dominant throughout, while it can be seen that JUNIPERUS and SALIX have been of considerable significance and BETULA NANA has had a wide distribution in early Flandrian time. In the Shetland diagram large-leaved BETULA and CORYLUS are also present, even though herbs were also dominant. (Auth)

1076. **Johns, W.H.** 1981. The Vegetation History and Paleoclimatology for the Late Quaternary of Isla de los Estados, Argentina. *M.S. Thesis, Michigan State University, 121 pp.*

Pollen has been analyzed from three cores retrieved from the peat of Isla de los Estados, just east of Isla Grande, Tierra del Fuego. The three resulting pollen diagrams indicate paleoecological and paleoclimatological trends over the past several thousand years in the southeastern-most extension of the Magellanic rain forest. Arboreal pollen is almost exclusively from the southern beech (NOTHOFAGUS). A computer program was devised in attempting to differentiate mathematically from the two main components of the island's NOTHOFAGUS flora, N. BETULOIDES from N. ANTARCTICA, based upon the relative number of apertures of the pollen grains. Four full major vegetational cycles are detected from the pollen spectrum of the 9.6 m Bahia Crossley core, and these may indicate the effects of long-term paleoclimatological and paleoecological trends upon the local flora. (Auth) Masters Abstracts vol. 20, no. 3, September, 1982, p. 280, Order No. 1318218

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1077. **Kay, P.A.** 1979. Multivariate Statistical Estimates of Holocene Vegetation and Climate Change, Forest-Tundra Transition Zone, N.W.T., Canada. *Quaternary Research 11:125-140.*

Newly derived fossil pollen data were obtained from four sites along a transect from the boreal forest limit into tundra in the eastern Northwest Territories. Multivariate statistical analyses were employed to interpret the pollen assemblages. Transfer functions were constructed between the pollen data and climatic data, and the paleoclimatic estimates were derived. The objective nature of the reconstructions provides an independent verification of the general outlines of the chronology of tree-line movements during the mid- and late- Holocene as established in previous paleosol and pollen studies. Boreal forest extended to approximately 62 deg N, associated with mean July temperatures 1 to 3 deg C above modern means, from at least 5500 to 3700 yr B.P. Although a major episode of southward displacement of tree line at about 3700 yr B.P. is recorded, later events are not clearly represented. Considerations of the statistics, the time scales, and the nature of the pollen rain suggest only conservative interpretations of the results are possible. It is suggested that the pollen sites may have been sensitive recorders of regional vegetation change only when they were near the ecotone, corresponding to a climatic threshold. (Auth)

1078. **Kay, P.A., and J.T. Andrews.** 1983. Re-evaluation of Pollen-Climate Transfer Functions in Keewatin, Northern Canada. *Annals Association of American Geographers 73(4):550-559.*

Multivariate statistical analyses allow specification of pollen-climate transfer functions useful in studies of paleoclimate. Two previously published models, when applied to two documented sites in Canada's District of Keewatin, produce inconsistent reconstructions of mean July temperatures for the mid- to late-Holocene (approximately the past 5,000 years). The discrepancy between the results arises from differences in the construction of the functions. Of particular importance are the choice of pollen taxa included, and the sample provenances and the geographical range of the modern pollen data. A new model is developed with all possible subsets regression, with due regard to the assumptions of the general linear model. Linear relationships between taxa abundances and summer temperature are specified, and multivariate outliers are removed. The paleotemperature records produced by the model for the two sites are consistent with the general features of previously reported work, and are more nearly similar to each other than reconstructions produced by the earlier, less sophisticated, models. (Auth)

1079. **Kearney, M.S.** 1981. Late Quaternary Vegetational and Environmental History of Jasper National Park, Alberta. *Ph.D. Thesis, The University of Western Ontario.*

This study examines the late Quaternary vegetational and environmental history of Jasper National Park, Alberta. The record of vegetational/ environmental changes in this area is compared to those of other sites in the Western Cordillera. Palynological investigations of five sites spanning a broad spectrum of environments and elevation provide a consistent picture of postglacial environmental change in Jasper National Park. The earliest available record (c. 9700 yr B.P.) is from a subalpine site (Tonquin Creek), and depicts a PINUS CONTORTA forest which suggests warmer conditions. The succeeding zone (c. 9000-8000 yr B.P.) was characterized by a mosaic of PINUS ALBICAULIS–ABIES LASIOCARPA–PICEA ENGELMANNII, implying cooler conditions than at present. The last c. 8500-8000 years are covered by the pollen records of all sites. The Hypsithermal Interval in this area is dated c. 8500-5900 yr B.P., and was characterized by major advances of timberline and widespread dessication of meadows and fens at lower elevations. Comparative evidence from the sites suggests that the Hypsithermal was complex, with two major warm phases punctuated by a cool episode between c. 8000-7500 yr B.P. The warmest phase (c. 7500-5900 yr B.P.) culminated shortly before c. 6600 yr B.P., and was perhaps drier than the earlier phase (c. 8500-8000 yr B.P.). After c. 5900 yr B.P., the sharp retreat in timberline recorded in the alpine sites and indications of expansion of wet areas at the other sites suggest the onset of cooler, moister conditions associated with Neoglaciation. The timberline record indicates that summer temperatures were similar overall to the present c. 5900-1610 yr B.P. Since c. 1700-1610 yr B.P., depending upon the resolution afforded by individual sites, climates appear to have become cooler as suggested by the continued retreat of the timberline and the increased representation of arctic-alpine taxa in all upper elevation sites. The last c. 500 years, characterized by the lowest timberline in the record, have witnessed particularly severe climates. Although cool, moist conditions have generally prevailed during the Neoglacial, synthesis of the available pollen records indicates that this period has been marked by several warmer episodes: c. 4870 yr B.P., 4110-2950 yr B.P., 1060 yr B.P., and 520 yr B.P. Oxygen isotope and mollusc evidence from an upper montane forest site (Malign Lake) suggest that the prolonged episode c. 4110-2950 yr B.P. may have been as much as 2-3 deg C warmer than present at its peak. (Auth)(JTA) Dissertation Abstracts International 42(6):2209-B

1080. **Kearney, M.S., and B.H. Luckman.** 1981?. Evidence for Late Wisconsin-Early Holocene Climatic/Vegetational Change in Jasper National Park, Alberta. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 85-105), 464 pp.*

Basal Carbon 14 dates of 9660 and 9600 yr. B.P. from two sites close to the Continental Divide indicate late-Wisconsin glaciers had receded to positions at or close to their present limits prior to 10,000 yr. B.P. The deposits of two subsequent glacial advances have been recognized by Luckman and Osborn (1979). The older advance (Crowfoot) is represented by moraines and rock glacier development. Intermediate-age advances may occur on some rock glaciers, but no absolute dating control is available for these features. Preliminary pollen diagrams are presented for the early Holocene period (c. 9700-5000 yr. B.P.) for 3 sites in different ecological environments: Excelsior Basin (2150 m, above treeline), Tonquin Creek (1935 m, subalpine) and Maligne Lake (1675 m, montane forest). Three major vegetation/climatic zones are recognized but the two oldest are present only in the Tonquin diagram and have no contemporary analogues in pollen rain data from the area. The earliest zone (9700-9200 yr. B.P.) dominated by the pollen of PINUS CONTORTA and Polypodiaceae may be largely seral in nature or indicate slightly warmer conditions than present. The succeeding PINUS-ALBICAULIS-ABIES LASIOCARPA-PICEA-ENGELMANNII zone (9200-8500 yr B.P.) suggests slightly cooler conditions. The Hypsithermal Interval (8500-5500) is present at all three sites and has two warmer phases separated by a cooler period between 8000-7500 yr B.P. Palynological and macrofossil evidence indicates that during the warmer periods valley floor sites dried out and treeline advanced at upper elevations. Dated tree remains from sites above present treelines confirm the occurrence of higher treelines than at present c. 980, 5920 and 8060 yr. B.P. The available pollen data suggest that the Crowfoot Advance occurred between 9200-8500 yr. B.P. or predates 9700 yr. B.P. (Auth)

1081. **Kearney, M.S., and B.H. Luckman.** 1983. Postglacial Vegetational History of Tonquin Pass, British Columbia. *Canadian Journal of Earth Sciences 20:776-786.*

A pollen and macrofossil study of peat sediments in Tonquin Pass, British Columbia provides the oldest dated record of vegetational and climatic changes in the middle Canadian Rockies. Paleoecological interpretation of these events dated by tephrochronology and radiocarbon dating is facilitated by comparisons with other regional pollen profiles. Late Wisconsin ice receded from Tonquin Pass prior to 10,000 years B.P. By 9700 years B.P. a PINUS CONTORTA forest with an understory dominated by ferns had colonized the area. The climate of this period was cool and moist. Following this interval was a brief episode (9000-8040 years B.P.) of haploxylon pine dominance during which the climate became colder. A long warm period beginning by 8040 years B.P. was characterized by desiccation of local meadows and fens and invasions of these areas by trees, principally PICEA. Dated fossil PICEA and ABIES logs from alpine bogs within Jasper National Park document that timberlines had advanced beyond present limits by 8770 years B.P. These data indicate a considerable lag in the registration of this interval in the Tonquin record. During the last 4300 years the retreat of trees from meadows and increases in the representation of several alpine taxa indicate that generally moist and cool conditions have prevailed. Evidence for Holocene timberline fluctuations in the Jasper area suggests an overall lowering in timberline elevation and further cooling since 1700 years B.P. (Auth)

1082. **Kelly, M.** 1980. The Status of the Neoglacial in Western Greenland. *Gronlands Geologiske Undersogelse Rapport 96, (pp. 1-24).*

The existence of a deterioration in climate after the mid-Holocene climatic optimum has been recognised widely in the northern hemisphere; and because of the consequent increase in glacierisation this period has become known as the Neoglacial. This paper reviews the current state of knowledge about the Neoglacial behaviour of a major part of the largest ice mass then, and now, existing in the northern hemisphere--the Greenland Ice Sheet and its peripheral local gaciers. The area covered includes the western half of Greenland, from 59 deg--78 deg N. For convenience the recent period for which there is unequivocal evidene of glacier advance is designated the late Neoglacial, with the division from the early Neoglacial, with its advances of more uncertain status, placed around the turn of the last millenium (approximately 1000 BP). This date also falls within, or at the termination of a major mild interval in the Neoglacial according to the palynological and cultural evidence cited by Fredskild (1973) and the Oxygen 18 data of Dansgaard et al., (1975). (Auth)(JTA)

1083. **Kelly, M., and S. Funder.** 1974. The Pollen Stratigraphy of Late Quaternary Lake Sediments of South-West Greenland. *Gronlands Geologiske Undersogelse Rapport 64, 26 pp.*

Pollen analysis and radiocarbon dating of lake sediment cores from four localities in the Frederikshab district, South-West Greenland, provide a chronology of vegetation changes in the area since c. 10000 B.P. An initial pioneer phase with the early development of some heath communities is followed by a mid postglacial phase in which there is the successive appearance of woody scrub species. A final phase shows the decline of some of these. This is interpreted as a general response to a broad amplitude fluctuation in climate, with its optimal period lying between c. 7600 and 3200 B.P. The detailed composition of the vegetation however is influenced by immigration phenomena, with the appearance of many species lagging behind the attainment of their climatic thresholds. Detailed consideration is given to the possibiity of ALNUS CRISPA being present as a scrub component during the climatic optimum. (Auth)

1084. **Kind, N.V.** 1975. Glaciations in the Verkhoyansk Mountains and Their Place in the Radiocarbon Geochronology of the Siberian Late Anthropogene. *Biuletyn Perglacjalny 24:41-54.*

Radiocarbon dating of a number of palynologically investigated sections in Siberia indicates that the sudden transition to warmer climates in the Pleistocene/Holocene transition occurred about 10,300 years ago. There is pollen evidence for a short, sharp climatic reversal between 9700-9500 years ago and the regional climatic optimum is dated as occurring between 8500 and 4500 B.P. (JTA)

1085. **Lamb, H.F.** 1980. Late Quaternary Vegetational History of Southeastern Labrador. *Arctic and Alpine Research 12(2):117-135.*

Pollen percentage and influx diagrams for three lake-sediment cores from southeastern Labrador are subdivided into three regional pollen asssemblage zones: (I) BETULA-SALIX-Cyperaceae zone, 10,500 to 9000 Carbon 14 years B.P.; (II) ALNUS-ABIES-PICEA zone, 9000 to 5000 B.P.; (III) PICEA zone, 5000 B.P. to present. Pollen influx was low in zone I, rose in zone II, and then abruptly increased in the upper part of zone II when tree pollen was first deposited in significant amounts. Influx reached a maximum about 4000 yr ago and declined substantially after 2500 B.P. An early phase of tundra was succeeded 9000 yr ago by BETULA-ALNUS shrub-tundra as the climate warmed. Trees then colonized the shrub-tundra at 6000 B.P. arriving late relative to sites farther south and west. The initial forest community is interpreted as a park-tundra of PICEA GLAUCA with abundant ABIES BALSAMEA and probably with some BETULA PAPYRIFERA. After a period of about 700 yr, ABIES declined in favor of PICEA MARIANA as soil conditions began to deteriorate. The formation of peat was probably accelerated at this time. The pollen record from a site on the south coast shows that the coastal region was never forested. The pollen influx record shows distinct similarities to that of the inland sites, suggesting that climate was most temperate about 4000 yr ago and that a deterioration took place about 2500 B.P. (Auth)

1086. **Lappalainen, V.** 1965. The ULMUS Decline in Postglacial Pollen Diagrams from Southeastern Finland. *International Studies on the Quaternary, Geological Society of America Special Paper no. 84, H.E. Wright, Jr. and D.G. Frey (Eds.). Geological Society of America, New York, (pp. 79-94), 565 pp.*

This study discusses four pollen diagrams from the area of southern Lake Saimaa, southeastern Finland. In the interpretation of these diagrams, attention is drawn to the decline of the ULMUS curve at the end of the Atlantic period (zones VI and VII of the Postglacial pollen sequence). This decline is not final, and it may be only a local phenomenon, but the author believes that it reflects a general climatic change. The ULMUS decline at these sites may be contemporaneous with that described by many scientists in Scandinavia. Nothing indicates that human activity might have induced this phenomenon of forest history. (Auth) GA 66B/271

1087. **Lichti-Federovich, S.** 1973. Palynology of Six Sections of Late Quaternary Sediments from the Old Crow River, Yukon Territory. *Canadian Journal of Botany 51(3):553-564.*

Steep scarps have been exposed by the downcutting of the Old Crow River in these basin-fill sediments, and good exposures of Late Quaternary sediments are available for investigation. Samples from six of these exposures were analysed for pollen. Although many parts of the sections were barren, it has been possible to derive pollen diagrams with discrete pollen zones for the six sections, and four pollen assemblage types have been identified. Their occurrence in the stratigraphic sequence suggests the following pattern of pollen stratigraphy: the lowermost sedimentary units, probably deposited early in the interstadial following an Early Wisconsin glaciation, are of pollen assemblage types III (Glumiflorae-herb) or IV (BETULA-herb), both indicative of tundra vegetation; the middle levels of the sediment show, consistently, pollen spectra of type II (PICEA-BETULA-glumiflorae-herb), indicating forest groves with tundra, quite similar to the modern vegetation. The sediment underlying the Upper Glaciolacustrine Unit (correlative with the Classical Wisconsin) yields pollen assemblage type III (Glumiflorae-herb), which is interpreted as indicating a rich and varied tundra. These vegetation reconstructions are consonant with a tentative palaeoclimatic interpretation in terms of a tripartite interstadial climate showing severe tundra climate - milder forest or forest-tundra climate - severe tundra climate. (from Author) GA 73A/1725

1088. **Lichti-Federovich, S.** 1975. Pollen Analysis of Ice Core Samples from the Devon Island Ice Cap. *Geological Survey of Canada Paper 75-1A, (pp. 441-444).*

Filtered meltwater from an ice coring operation on the Devon Island Ice Cap produced samples which were counted for pollen. Two sections lie within the Holocene and they are bracketed by estimated dates of 2900-3100 B.P. and 6000-8000 B.P. The spectra are dominated by ALNUS and BETULA pollen with smaller amounts of PICEA, PINUS, and ARTEMISIA. Other taxa are present. The 2900-3100 B.P. sample has a richer pollen assemblage than the earlier Holocene interval. Absolute pollen numbers are given. (JTA)

1089. **Lichti-Federovich, S., and J.C. Ritchie.** 1968. Recent Pollen Assemblages from the Western Interior of Canada. *Review of Palaeobotany and Palynology 7:297-345.*

Pollen spectra have been compiled for samples of surficial mud from over one hundred lakes in the Western Interior of Canada. The area of the survey extends from the low-arctic tundras of Keewatin to the grasslands of southern Manitoba and Saskatchewan, including all the major landform-vegetation types. The purpose of the investigation is to provide a basis for the method of direct comparison in the interpretation of Holocene pollen spectra recovered from sites in mid-western North America. The pollen data are accompanied by qualitative and quantitative accounts of the vegetation of the several zones in the region. Spectra from arctic and subarctic zones include substantial fractions of arboreal pollen of southern origin. Tundra specta are distinctive, showing high relative amounts of pollen of dwarf birch and sedges, as well as consistent but low frequencies of ericoid and graminoid pollen. Forest-tundra assemblages are not always clearly distinguishable from those of adjacent zones, but they show substantial proportions of pollen grains of alder, dwarf and arboreal birch, spruce and sedges. The continuous boreal forest region shows in general a predominance of conifer pollen in the spectra. Broad-leaved deciduous forests, represented very poorly in this region, are distinguished by the high values of pollen grains of oak, birch elm and ash. The pollen of poplar, which is the dominant tree of the parkland of the nemoral zone, is absent or very poorly represented in lake mud samples. Grasslands show spectra dominated by pollen of grasses and herbs. (Auth)

1090. **Livingstone, D.A.** 1967. Postglacial Vegetation of the Ruwenzori Mountains in Equatorial Africa. *Ecological Monographs 37(1):25-52.*

Pollen deposits in the mud of glacial lakes in the Ruwenzori Range were studied for age and changes in plant species. These lakes appeared after glacial retreat of about 15,000 years ago. The earliest part of the record includes some taxa now found in the alpine belt of much higher elevation today but the pollen diagram is dominated by grasses and other herbs and heliophytic trees suggesting a relatively open vegetation. The sharpest change occurred about 12,700 years ago with the advent of montane forest taxa while some of the earlier plants are not found in the Ruwenzori Mountains at all today. The whole picture, though incomplete, suggests more than a simple upward movement of zones. Moisture changes, migration, and cultural influences have probably also been involved. (David J. de Laubenfels)(JTA) GA 69B/626

1091. **Lozhkin, A.V.** 1963. Recent Palynological Data on Vegetation Development in Northeastern USSR in the Quaternary. Novye palinologicheskie dannye o razvitii rastitel'nosti Severo-Vostoka SSSR v antropogene. Russian. *Akademiia Nauk SSSR, Doklady 152(4):949-952.*

Reports spore-pollen diagrams of Quaternary deposits on Promezhutochnyy Creek in the upper Indigirka. The deposits are described, prevailing plants reported, and climate conditions interpreted. Comparisons are made with the upper Nera depression. The stratigraphic position of these deposits is discussed. The present stratigraphic division of the Quaternary in the Northeast is found imperfect and further studies are suggested. (AB80830) AB80830

1092. **Lozhkin, A.V.** 1967. New Palynological Data on Vegetation Development in the Northeast of the USSR in the Holocene. Novye palinologicheskie dannye o razvitii rastitel'nosti Severo-Vostoka SSSR v golotsene. Russian. *Akademiia Nauk SSSR, Doklady 172(4):924-927.*

Reports palynologic study of the alluvium in the Bol'shoy Kuobakh-Bagi River basin, a right tributary of upper Indigirka. Spore-pollen diagrams are presented and the Holocene flora is characterized. These data indicate a more complicated development history in the region than hitherto presumed. Comparison is made with western Chukotka. Possibly the Holocene began with a moist cold climate, and a warmer climate prevailed in the middle of the epoch, then cold again as the present climate. (AB97654) AB97654

1093. **MacDonald, G.M.** 1982. Late Quaternary Paleoenvironments of the Morley Flats and Kananaskis Valley of Southwestern Alberta. *Canadian Journal of Earth Sciences 19:23-25.*

A 3.1 m section of limnic sediment and peat from a bog on the Morley Flats and a 2.8 m section of limnic sediment from Wedge Lake in the Kananaskis Valley have yielded the first comprehensive late Quaternary biostratigraphic record from southwestern Alberta. Both sections were analyzed for subfossil pollen, molluscs, and several sedimentary indices. Two distinct pollen zones were recognised. The basal zone, characterized by high relative abundancy of ARTEMISIA-SALIX-JUNIPERUS, suggests that the Morley Flats were dominated by a sparse vegetation composed of aggressive pioneer species following deglaciation until prior to approximately 10,000 B.P. Similarly, the mollusc fauna from this zone is dominated by northern ranging species. The second zone is typified by a predominance of PINUS and PICEA. This reflects the expansion of coniferous forest into the region. Both the relative abundance of southern ranging mollusc species and the total carbonate concentration in the sediment increase in this zone. The vegetation of the region has remained generally stable since at least 9395 B.P. However, increases in the abundance of PINUS relative to PICEA and ABIES in the mid-Holocene suggest that this period experienced an increase in fire frequency, possibly generated by climatic amelioration. (Auth)

1094. **Mack, R.N., N.W. Rutter, V.M. Bryant, Jr., and S. Valastro.** 1978. Reexamination of Postglacial Vegetation History in Northern Idaho: Hager Pond, Bonner Co. *Quaternary Research 10:241-255.*

Hager Pond, a mire in northern Idaho, reveals at least five pollen zones since sediments formed after the last recession of continental ice (>9500 yr B.P.). Zone I (>9500-8300 yr B.P.) consists mainly of diploxylon pine, plus low percentages of ABIES, ARTEMISIA, and PICEA. SEM examination of conifer pollen at selected levels in the zone reveals that PINUS ALBICAULIS, P. MONTICOLA, and P. CONTORTA are present in unknown proportions. The zone resembles modern pollen spectra from the ABIES LASIOCARPA-P. ALBICAULIS association found locally today only at high elevation. Presence of whitebark pine indicates a cooler, moister climate than at present, but one which was rapidly replaced in Zone II (8300-7600 yr B.P.) by warmer, drier conditions as inferred by prominence of grass with diploxylon pine. Zone III (7600-3000 yr B.P.) was probably dominated by PSEUDOTSUGA MENZIESII, plus diploxylon pine and prominent ARTEMISIA and denotes a change in vegetation but continuation of the warmer drier conditions. Beginning at approximately 3000 yr B.P. PICEA ENGELMANNII, ABIES LASIOCARPA, and/or A. GRANDIS and diploxylon pine were dominants and the inferred climate became cooler and moister concomitant with Neoglaciation. The modern climatic climax (Zone V), with TSUGA HETEROPHYLLA as dominant, has emerged in approximately the last 1500 yr. (Auth)

1095. **Mack, R.N., N.W. Rutter, and S. Valastro.** 1979. Holocene Vegetation History of the Okanogan Valley, Washington. *Quaternary Research 12:212-225.*

Haploxylon pine(s) and ARTEMISIA dominated the initial vegetation in front of the receding Okanogan Lobe until ca. 10,000 yr B.P., as revealed by two pollen records in north-central Washington. After 10,000 yr B.P. the macroclimate became warmer throughout the Okanogan drainage as diploxylon pines and ARTEMISIA increased. The Mount Mazama eruption at ca. 6700 yr B.P. is recorded as two stratigraphically separate and petrographically distinct tephra units at Bonaparte Meadows. While there are apparent short-term changes in the vegetation coincident with the ashfall(s), ARTEMISIA continues to dominate the Okanogan Valley until ca. 5000 yr B.P. By 4700 yr B.P. the modern vegetation, dominated by PSEUDOTSUGA MENZIESII, had become established around Bonaparte Meadows. (Auth)

1096. **Mack, R.N., N.W. Rutter, S. Valastro, and V.M. Bryant, Jr.** 1978. Late Quaternary Vegetation History at Waits Lake, Colville River Valley, Washington. *Botanical Gazette 139(4):499-506.*

A 10.6 m section of mostly calcareous sediments at Waits Lake, Washington, reveals a multizoned history of vegetation change since recession of Pinedale (P-2) glacial ice from the Colville River Valley. The oldest unit with high percentages of ARTEMISIA, Gramineae, and SHEPHERDIA CANADENSIS-type pollen characterizes vegetation in which trees were not major components and the climate was cooler and moister than today. Pollen Zone II (ca. 10,000-6,700 yr before present (B.P.)) records a warmer period in which diploxylon pine was prominent. Concomitant with the Mazama ash fall (6,700 B.P.), ARTEMISIA became particularly prominent (Pollen Zone II); but by about 5,000 yr B.P., diploxylon wine was conspicuous. This comparitively short-term vegetation change probably indicates the advance of drought-tolerant ARTEMISIA-dominated steppe northward in the Colville River Valley. The modern climax vegetaton in the vicinity of Waits Lake (PSEUDOTSUGA-dominated forest) appears to have emerged around 2,300 yr B.P., although more detailed documentation of this event is hampered by the low pollen production of PSEUDOTSUGA MENZIESII. (Auth)(JTA)

The site lies close to 2000 feet above sea level. Nearby peaks rise to 3400 feet. (JTA)

1097. **Mackay, J.R., and J. Terasmae.** 1963. Pollen Diagrams in the Mackenzie Delta Area, N.W.T. *Arctic 16(4):228-38.*

Considers postglacial climatic changes in northern Mackenzie District, from palynological and other evidence. Peat from exposures in two areas, also alluvial sediments from a drill hole were analyzed; pollen diagrams with radiocarbon control are presented for the peat. From these investigations and geomorphic interpretation of the exposures, fossil evidence, etc., a tentative climatic sequence is proposed; deglaciation about 12,000 yrs. ago, a cool-dry climate 8500-7500 B.P., a warmer and drier period, and increased moisture and cooling climate in late postglacial time. The last changes are indicated by increases in alder and Ericaceae and the formation of pingos. (AB80944) AB80944

1098. **Macphail, M.K.** 1979. Vegetation and Climates in Southern Tasmania since the Last Glaciation. *Quaternary Research 11(3):306-341.*

Enclosed basins (glacial and nonglacial) of Tasmania contain the most comprehensive record in Australia of trends in a regional vegetation and climate since the late Pleistocene. Seven pollen sequences, each continuous and extending back at least 10,000 years, are used to reconstruct the history of postglacial vegetation and climate in Southern Tasmania (42 degrees S - 43 degrees 30 minutes S). Interpretations are supported by a study of the modern pollen rain. Postglacial climates in Tasmania were characterized by a strong west-to-east decrease in precipitation. During the late Pleistocene, climates were markedly colder and drier than at present, and the vegetation was largely devoid of trees. A major rise in temperature between ca. 11,500 and 9500 yr B.P., accompanied by rising effective precipitation, resulted in the expansion of EUCALYPTUS, then other trees, across Tasmania. This warming trend may have been temporarily reversed during the early postglacial. Dry climates delayed the development of forest in inland eastern Tasmania until after ca. 9500 yr B.P. There is no evidence for a major change in climate since this temperature rise. Two broad phases of development have occurred within the postglacial forests. The first was an early Holocene phase during which NOTHOFAGUS CUNNINGHAMII cool temperate rain forest developed in western Tasmania and on the slopes of mountains in central and southeastern Tasmania. EUCALYPTUS sclerophyll forests developed in eastern Tasmania have remained dominant there since. By ca. 7800 yr B.P. rainforest communities were established beyond present-day limits. The second phase was a mid to late Holocene phase during which forests and alpine vegetation became more open in structure, leading to the re-expansion of EUCALYPTUS and shade-intolerant species. During the early to mid-Holocene, climates in Southern Tasmania were wetter and (?then) warmer than at present. Maximum and minimum dates for this "optimum" are 8000 and 5000 yr B.P. Since then, climates have become increasingly rigorous, possibly through an increased incidence of inequable "weather" types leading to an increase in the frequency of drought and frost. Structural changes in the postglacial vegetation of Southern Tasmania closely parallel those at equivalent latitudes in New Zealand and Chilean South America, hence are likely to reflect the same primary cause. (Auth)

1099. **Macphail, M.K.** 1979. Holocene Climatic Change and Aboriginal Food Economy in Tasmania. *Search 10(1-2):11-12.*

Pollen analyses from the southern half of Tasmania (Macphail, 1976) indicate that closed vegetation reached its maximum extent shortly after 8000 B.P. Since ca. 6-5000 B.P., the vegetation has become increasingly open in structure, resulting in the expansion of EUCALYPTUS and other sclerophyll species at the expense of the rainforest. Climates in this period were more drought- and frost-prone than in the early Holocene, as occurred elsewhere in southeastern Australia (e.g. Raine, 1974; Williams, 1978). Whereas Aboriginal fires were ineffective in preventing the spread of closed vegetation in the early and (?) mid-Holocene, this has not been the case since. (Auth)(JTA)

1100. **Macphail, M.K., and W.D. Jackson.** 1978. The Late Pleistocene and Holocene History of the Midlands of Tasmania Australia: Pollen Evidence from Lake Tiberias. *Royal Society of Victoria Proceedings 90(1-2):287-300.*

During the late Pleistocene, markedly cold and dry climates in the Tasmanian central midlands limited vegetation to sparse, treeless grasslands or possibly a chenopod steppe. Increases in temperature and effective precipitation between c. 11,000-9000 B.P. resulted in the replacement of much of this vegetation with EUCALYPTUS-dominated formations. The ensuing vegetation, probably a mosaic of dry sclerophyll forest, woodland and grassland, has remained characteristic of the region up to the present. Changes in the understory flora of EUCALYPTUS forests believed to be some distance from Lake Tiberias, imply climates in the early to mid-Holocene slightly wetter than at present. This phase was followed by a reversion towards drier conditions leading to the modern sub-humid climate. The pollen evidence is against previous concepts of mid-Holocene aridity in eastern Tasmania. (Auth)

1101. **Madole, R.F.** 1976. Bog Stratigraphy, Radiocarbon Dates, and Pinedale to Holocene Glacial History in the Front Range, Colorado. *Journal of Research, U.S. Geological Survey 4(2):163-169.*

Radiocarbon dates and stratigraphic cores from bogs, kettle ponds, and former ice marginal lakes on the east and west sides of the Front Range, Colo., between lat 40 deg and 40 deg 24 min North, suggest that (1) valley glaciers of Pinedale age began to recede from their terminal positions between about 14,600 and 13,000 yr ago, (2) revegetation of glaciated areas at altitudes of 2,600-2,900 m (8,600-9,500 ft) was complete by 11,000-10,000 yr ago, (3) at one site, 3,500 + or - 1,000 yr elapsed before peat began to form after deglaciation, (4) the formation of bogs within the glaciated areas kept pace with glacier recession in a general way, beginning at progressively later times as deglaciation proceeded upward, (5) Pinedale glaciers had disappeared or were reduced to small remnants by about 8,000 yr ago, (6) moraines that have been mapped as belonging to the early stade of Pinedale Glaciation are no younger than 13,000 yr B.P.and may be older than 14,600 yr, and those delimiting what has been mapped as late stade are no younger than about 7,600 yr B.P. and are probably older than 7,800 yr., and (7) most of the till mapped as Pinedale was deposited between about 14,600 and 8,000 yr ago. (Auth)

1102. **Maher, L.J., Jr.** 1972. Absolute Pollen Diagram of Redrock Lake, Boulder County, Colorado. *Quaternary Research 2(4):531-553.*

Bedrock Lake is situated at 3,095 m in the subalpine zone on the east flank of the Front Range, Boulder County, Colorado. The lake lies on Pinedale moraine, and it contains 170 cm of organic sediments that overlie 10 cm of silty clay. The oldest of seven Carbon 14 dates from the organic sediment is 9,490 + or - 150 yr B.P., a minimum estimate of the time since Middle Pinedale ice receded from the lake basin. The silty clay contains a peculiar Artemisia-dominated pollen assemblage with very low pollen influx rates, which suggests the lake was receiving large volumes of glacial meltwater during its early history. The overlying organic sediments are characterized by pollen deposition rates of Pinus and total anemophilous pollen increase upward in the core; this evidence for a general upward shift in the region's vegetation zones during Postglacial time is supported by pollen trends from modern surface samples. (Auth) (JTA)

The ratio of pine/spruce pollen throughout the core is used to estimate changes in the apparent elevation of Redrock Lake over the last 10,000 years. The suggested changes in climate are antiphase with other reconstructions and possible explanations presented by Nichols (1982; INSTAAR Occasional Paper). (JTA)

1103. **Maher, L.J., Jr.** 1973. Pollen Evidence Suggests that Climatic Changes in the Colorado Rockies during the Last 500 Years Were Out of Phase with Those in the Northeastern United States. *IX INQUA Congress, Christchurch, New Zealand, December 2-10, 1973. Abstracts. (pp. 227-228).*

The boundaries of the Hypsithermal have been variously placed in the range of time from 9000 to 1500 years ago based on evidence from organisms, soils, and geomorphology. The consensus seems to be that temperatures were relatively high 5000 years ago, and that they have decreased toward the present. However, pollen evidence from two mountain areas in Colorado imply conditions were cooler and/or wetter 5000 years ago than now. Pollen data from both the San Juan Mountains and the Front Range of Colorado suggest that conditions became warmer and/or drier between 3000 to 1500 years ago resulting in an upward displacement of timberline by several hundred meters. (Fig. 1). This evidence suggests that the climate changes of the past 5000 years in the northeastern United States were not in phase with those in Colorado, and that the onset of the Neoglacial interval in the Colorado Rockies may date from 5000 or more years ago. (Auth)(JTA)

1104. **Makovskiy, V.I.** 1966. The Age of Peat Bogs and the Development of Forest Vegetation in the Northern Taiga Subzone, Loz'va-Pelym Interfluve. O vozraste torfyanikov i formirovanii lesnoy rastitel'nosti v podzone severnoy taygi; mezhdurech'ye Loz'vy i Pelyma. Russian. *Vses. botanicheskoye ovo. Sverdlovskoye otd-iye. Zapiski, no. 4, (pp. 53-63).*

Presents spore-pollen spectra for the Chernyy Yar, Kershal'skoye and Lavdinskoye bogs. The Chernyy Yar bog is dated as latest lower or earliest middle Holocene, the Kershal'skoye upland bog as latest middle Holocene, and the Lavdinskoye upland bog as late Holocene. Various stages in the development of these bogs and of the forest landscape are discussed. The present forest landscape apparently developed after late Holocene climatic cooling. (AB105598) AB105598

1105. **Malaurie, J.** 1972. Preliminary Remarks on Holocene Paleoclimates in the Regions of Thule and Inglefield Land, Above All Since the Beginning of Our Own Era. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 105-136), 511 pp.*

Pollen-analytical studies have been undertaken on peat samples from four sites in the Thule district (N.W. Greenland). According to radiocarbon determinations the period covered is the past 2,000 years. The results are compared with geomorphological, glaciological and ethnogenetic studies in the area. In many respects each site appears to have its own profile. Palaeoclimatical and methodological observations are made. The profiles are still under observation. (Auth)

1106. **Maloney, B.K.** 1980. Pollen Analytical Evidence for Early Forest Clearance in North Sumatra. *Nature 287(5780):324-326.*

Pollen analysis of sediments from the Toba Highlands of North Sumatra, Indonesia reported here suggests strongly that forest clearance by man began approximately 7,500 yr B.P. Less convincing evidence suggests that man may have been disturbing the vegetation perhaps from 17,800 yr B.P., but climate has also changed and isolation of causal factors is, therefore, difficult. No Sumatran archaeological sites have yet been scientifically excavated, nor are Carbon 14 dates available. However, megaliths possibly 2,000 yr old occur in the study area and Hindu-Buddhist remains occur further south. Lowland shell-middens may be much older. Forest clearance may have begun by 11,000 yr B.P. in Taiwan and agriculture between 14,000 and 8,000 yr B.P. in Thailand but these conclusions have been disputed. Archaeological evidence for agriculture dating from 9,000 yr B.P. onwards has been found in Papua, New Guinea while rice may have been cultivated in Sulawesi by 6,000 yr B.P. (Auth) ORNL/CDIC

1107. **Markgraf, V.** 1974. Paleoclimatic Evidence Derived from Timberline Fluctuations. *Colloques Internationaux du Centre National de la Recherche Scientifique, no. 219, Les Methodes Quantitatives d'Etude des Variations du Climat au Cours du Pleistocene, Gif-Sur-Yvette, France, 5-9 juin 1973. (pp. 67-77).*

Several different approaches to the quantitative determination of paleotemperature by palynologic investigation are discussed. From timberline fluctuations in the Alps and the Arctic, a temperature curve in deg C is established since the last glaciation. Contrary to the general interpretation of vegetational changes in pollen diagrams, the main temperature amelioration after the ice age occurred already at the beginning of the Lateglacial, i.e. before the Allerod period. Later, during the younger Late - and the Postglacial period, the total temperature fluctuated only between 2 to 4 deg C. Fluctuations of the dryness timberline indicate changes in humidity, which up to today are rarely quantitative. (Auth)

1108. **Markgraf, V.** 1980. New Data on the Late and Postglacial Vegetational History of "La Mision", Tierra del Fuego, Argentina. *Proceedings IV International Palynological Conference, Lucknow, 1976-77. (pp. 68-74).*

This paper presents new palynologic and radiocarbon data on a 9.5 m core from Tierra del Fuego, ("La Mision", Rio Grande, 52 deg S lat S), the site of Auer's original pollen profile (1958, 1970) which I record in 1975. The main conclusions are: 1) Prior to 9500 B.P. the climate of this southern most part of South America was cold and slightly humid, as indicated by a treeless, depauperate grassland vegetation with a very low pollen concentration and only a few steppe indicators like Chenopodiaceae and EPHEDRA. 2) Around 9000 B.P., the climate was still too cold to allow the forest to expand to the eastern lowlands of Tierra del Fuego, but the humidity evidently increased as evidenced by a rich herbaceous vegetation with high percentages of sedges and grasses and by a high pollen concentration (20 times that of the older phase). 3) Only at ca. 8000 B.P., did the climate warm enough to cause the forest to spread across the lowlands. The humidity and temperature presumably were higher than at present, as reflected by the density and composition of the forest. The main tree components were NOTHOFAGUS (N. PUMILIO and N. ANTARCTICA) and PODOCARPUS in the ratio of 1:3, respectively. This forest type corresponds to the Valdivian rain-forest, presently situated on the rain-side of the Andes, PODOCARPUS even being restricted to the northwest corner of Tierra del Fuego. The percentage of tree pollen, however, indicates that this postglacial forest of the lowlands never represented a dense rain-forest, but presumably a parkland vegetation with rainforest islands interspersed in an open grassland. 4) The described climatic change at ca. 8000 B.P. to warmer conditions is nearly contemporaneous with the eustatic sea level rise in Tierra del Fuego, suggested by a sedimentation change from terrestrial organic material to marine clay. This date corresponds to a radiocarbon date in a profile near Ushuaia (southern part of Tierra del Fuego) where a similar sedimentation change from peat to marine clay has been dated at 7500 B.P. (Auth)(JTA)

1109. **Markgraf, V.** 1980. Paleoclimatic Reconstructions of the Last 15,000 Years in Subantarctic and Temperate Regions of Argentina. *Memoires du Museum National d'Histoire Naturelle, n.s., B Botanique, 27:87-97.*

Palynologic investigation of sediments from previously glaciated regions in subantarctic latitudes (Tierra del Fuego, 52 deg S) and temperate latitudes (Rio Negro Province, 42 deg S) are analysed to show the contemporaneity of paleoclimatic changes in corresponding latitudes in both hemispheres, which then would lead to better understanding of the causes of climatic changes. Two dated sections from Tierra del Fuego revealed as the major paleoenvironmental event occurring during the last 15,000 years the transition from grassland to NOTHOFAGUS parkland taking place at 8500 B.P. and not as hitherto believed at 12,000 B.P. Several possible explanations are dismissed by the author. However, weather data analysis of temperature and precipitation (Pittock, in preparation) of southern South America stations suggests another approach to interpret climatic changes. The weather data analysis shows principal temperature and precipitation patterns and their correlation with the major pressure anomalies and indicates that at different latitudes opposing climatic trends exist. Such opposition is exactly the picture emerging from the pollen diagrams, not only for the above mentioned period of the principal temperature change at the end of the last glaciation, but also during the more recent phases. Whereas in the temperate region a more arid phase (suggested by increased steppe and decreased NOTHOFAGUS pollen influx values) is recorded between 7000 and 6000 B.P., in the subantarctic region such increased aridity does not show before 6000 B.P. In addition to this latitudinal opposition of climatic and paleoclimatic trends, an opposition is suggested by the comparison of palynologic and glaciologic data between both sides of the Andes, the western, Chilean slope and the eastern, Argentine slope. (Auth)(JTA)

1110. **Markgraf, V.** 1983. Late and Postglacial Vegetational and Paleoclimatic Changes in Subantarctic, Temperate, and Arid Environments in Argentina. *Palynology 7:43-70.*

A paleoclimatic chronology for southern South America is suggested by comparison of dated pollen records from Argentina (lat 32 deg to 34 deg S, 41 deg S and 51 deg to 54 deg S). The paleoenvironmental phases distinguished for the last 13,000 years are interpreted as paleoclimatic phases and explained as latitudinal shifts of atmospheric circulation anomalies by using the correlation of modern precipitation patterns with atmospheric circulation anomaly patterns over Argentina and Chile. The lateglacial type environment is characterized at all sites in the high southern latitudes by pollen assemblages of grasses, composites, sedges, and heath, suggesting climates as cold and wet as the Modern Magellanic Moorland uniformly throughout Tierra del Fuego and southern Patagonia. At latitude 41 deg S the lateglacial pollen assemblages are dominated by rainforest types west of the Andes, suggesting cold and wet conditions, while east of the Andes grasses and herb pollen dominated the assemblages, suggesting conditons colder and drier than today. Lateglacial pollen assemblages at altitude 32 deg S are dominated by grasses, composites, and desert shrub pollen, suggesting colder and wetter climates than today. Postglacial type environments replaced the lateglacial ones at 12,000 yr B.P. at latitudes 32 deg and 41 deg S, but only at 8,500 yr B.P. at latitudes 51 deg to 54 deg S. The postglacial environments at all-latitudes resemble the modern environments, with NOTHOFAGUS pollen dominating at high southern latitudes and latitude 41 deg S and desert scrub pollen at latitude 32 deg S suggesting precipitation and temperature values similar to the modern ones. Environmental changes during the Holocene occurred at 8,500 yr B.P., 6,000 yr B.P., 5,000 yr B.P., and 3,000 yr B.P., but are of much smaller amplitude than the change from lateglacial to postglacial environments. (Auth)

1111. **Markgraf, V., and L. Scott.** 1981. Lower Timberline in Central Colorado during the Past 15,000 Yr. *Geology 9:231-234.*

A 15,000 yr paleoenvironmental record at the elevation of lower timberline in central Colorado suggests two major paleoclimatic changes during that interval: (1) at 10,000 yr B.P., from cool-moist conditions to warm-moist conditions and (2) at 4,000 yr B.P., to warm-dry conditions. This sequence can be interpreted as a shift from precipitation predominantly originating from Pacific winter storms (before 10,000 yr B.P.) to a predominantly monsoonal-type regime (lasting until 4,000 yr B.P.) to the present pattern. Contemporaneity of higher upper timberline and lower lower timberline during the 10,000 to 4,000 yr B.P. interval is not contradictory but a result of changes in those circulation patterns. (Auth)

1112. **Mathewes, R.W.** 1973. A Palynological Study of Postglacial Vegetation Changes in the University Research Forest, Southwestern British Columbia. *Canadian Journal of Botany 51(11):2085-2103.*

The postglacial vegetation history of the University of British Columbia Research Forest was investigated using percentage and absolute pollen analysis, macrofossil analysis, and radiocarbon dating. A marine silty clay deposit records the oldest (12,690 + or - 190 years before present (B.P.)) assemblage of terrestrial plant remains so far recovered from the postglacial of south-coastal British Columbia. Lodgepole pine (PINUS CONTORTA) dominated this early vegetation, although some ABIES, PICEA, ALNUS, and herbs were also present. Sediment cores from two lakes were also studied. The older is Marion Lake, where five pollen assemblage zones are recognized, beginning with a previously undescribed assemblage of PINUS CONTORTA, SALIX, and SHEPHERDIA in clay older than 12,350 + or - 190 B.P. The pollen diagram from Surprise Lake (11, 230 + or - 230 B.P.) is divided into three pollen zones which show the same major trends of vegetation change as the Marion Lake diagram. The first report of the postglacial vegetation history of cedar (THUJA and perhaps CHAMAECYPARIS) in southwestern British Columbia is presented from pollen and macrofossil analyses. At about 10,500 B.P. in both lakes, pollen of Douglas fir (PSEUDOTSUGA MENZIESII) began a rapid increase, probably in response to climatic amelioration. The palynological evidence, supported by well-preserved bryophyte subfossils, suggests that humid coastal conditions have prevailed in the study area since about 10,500 B.P., with virtually no evidence for a classical Hypsithermal interval between 8500 B.P. and 3000 B.P. (Auth)

1113. **Mathewes, R.W., and L.E. Heusser.** 1981. A 12,000 Year Palynological Record of Temperature and Precipitation Trends in Southwestern British Columbia. *Canadian Journal of Botany 59(5):707-710.*

Transfer functions for converting pollen frequencies to estimates of mean July temperature and mean annual precipitation were applied to fossil pollen data from a sediment core in Marion Lake. The paleotemperature curve shows low July temperatures near 14 degrees C at the base of the core at about 12,000 before present (B. P.), rising rapidly between 10,400 B.P. and 10,000 B.P. to maximum values slightly above 16 degrees C. Maximum temperatures cluster between 10,000 B.P. and approximately 7500 B.P., declining steadily thereafter until 6000 B.P. Little change is apparent from 6000 B.P. to the present. The reconstructed precipitation curve also shows a three-part zonation, with moderately high values between 12,000 and 10,400 B.P. dropping rapidly to minimum Holocene values between 10,000 and 7500 B.P. Precipitation rises to modern levels near the Mazama ash bed. The informal term "early Holocene xerothermic interval" is applied to the pre-Mazama interval of maximum temperatures and minimum precipitation. The late-glacial age at the base of the core is confirmed by a new radiocarbon date of 11,920 + or - 245 years B.P. (I-6857) on lodgepole pine needles screened from the basal clays. (Auth)

1114. **Mathewes, R.W., and G.E. Rouse.** 1975. Palynology and Paleoecology of Postglacial Sediments from the Lower Fraser River Canyon of British Columbia. *Canadian Journal of Earth Sciences 12:745-756.*

The postglacial history of vegetation in the Yale area of the lower Fraser River Canyon is described from sediments of two lakes using percentage pollen analysis supplemented with macrofossil evidence and radiocarbon dating. Deposition of postglacial sediments, ranging from basal clays to gyttjas, began about 11,500 yr B.P. Three distinct pollen assemblage zones are distinguished, reflecting in part the main climatic conditions for the intervals. The oldest zone, with high percentages of pine (PINUS) and alder (ALNUS) pollen, suggests cool and moist conditions following withdrawal of glacial ice. This is followed by marked increases in Douglas-fir (PSEUDOTSUGA), grasses and other nonarboreal pollen, suggesting in part, warmer and drier conditions. The third zone, ranging from about the Mt. Mazama ash at 6600 yr B.P. to the present, is marked by high alder and Douglas-fir, and increasing cedar (THUJA-CHAMAECYPARIS type), western hemlock (TSUGA HETEROPHYLLA), fir (ABIES) and birch; an assemblage indicating a return to wetter conditions. This sequence contrasts with previously described sucessions that recognized the classical Hypsithermal in adjacent areas. The sequence of inferred vegetational changes, although similar to those described for the Haney area to the west, suggests that the Yale area has been a biogeoclimatically transitional area for much of postglacial time. (Auth)

1115. **Matthews, J.V., Jr.** 1975. Incongruence of Macrofossil and Pollen Evidence: A Case from the Late Pleistocene of the Northern Yukon Coast. *Geological Survey of Canada Paper 75-1B, (pp. 139-146).*

This paper deals with a small assemblage of plant and animal macrofossils and pollen from a coastal Yukon site near the Alaska border (Fig. 1). The fossils indicate a tundra environment. Dwarf birches were growing at the site, yet this fact is not clearly indicated by the pollen evidence. A similar .ase of incongruent pollen and macrofossil evidence from a site near Inuvik, N.W.T. is cited to illustrate a potential danger of relying on pollen evidence alone to plot the dispersal history of plants. The low percentage of PICEA pollen in the pollen spectrum combined with the presence of macrofossils of BETULA GLANDULOSA, DRYAS INTEGRIFOLIA, and TRICHOCELLUS MANNERHEIMI suggest that the fossil locality was within a region of tundra 10,900 years ago. Alder pollen is also very rare in the pollen spectrum; however, in view of the anomalous situation presented by birch macrofossils and pollen, it seems best not to consider this as evidence of the regional absence of alder. The most that can be said is that ALNUS was probably rare, and if any grew near the site they produced very little pollen. The stratigraphic context of the peat (i.e., its occurrence in a sequence of inorganic, sandy gravels) and the fact that it continued fossils of T. MANNERHEIMI, LEPIDOPHORUS LINEATICOLLIS, and DRYAS INTEGRIFOLIA indicate a fell-field type of local environment, with only patchy vegetation. The peat itself may represent one such vegetated site. Birches are known to produce abundant quantities of pollen (like alders), thus it is strange, even in the face of sedge pollen overrepresentation, that the percent of birch pollen in the sample is not higher, for it seems certain in view of the macrofossil evidence that BETULA GLANDULOSA was growing at the site. A similar incongruence of pollen and macrofossil data occurs at Twin Lakes, near Inuvik (Fig. 1). There, the rise of alder percentages from about 3 to approximately 35 percent (Fig. 3) occurred between ca. 5840 and 5420 years B.P., at least 2000 years after the first appearance of ALNUS macrofossils at the lake (Fig. 3). At other Mackenzie Delta sites the alder pollen curves rise at about 5500 years B.P. (Ritchie, 1972) which is also well after the earliest appearance of Twin Lakes alder macrofossils. Such discrepancies between pollen and macrofossil evidence may be due to reduced pollen production by plants growing under climatic conditions inimical to sexual reproduction (Matthews, 1974a, 1974b). Whatever the cause or causes, cases such as these indicate the need for caution in reconstructing the dispersal history of a plant taxon on the basis of the earliest appearance of its pollen. (Auth)(JTA)

1116. **McAndrews, J.H.** 1981?. Late Quaternary Climate of Ontario: Temperature Trends from the Fossil Pollen Record. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 319-333), 464 pp.*

In eastern Ontario zonal vegetation boundaries parallel isotherms of mean annual temperatures. Because modern pollen rain reflects zonal vegetation one can trace zonal vegetation and temperature trends with critical pollen diagrams from the time of deglaciation (14,000 B.P.). Immediately after deglaciation temperature was -2 deg C or lower. It rose to the modern value of +9 deg C by 8000 years ago in southern Ontario. In northern Ontario a modern temperature of +1 deg C was reached about 6500 years ago – this was followed during the next millenium by a Hypsithermal of +2 deg C to +3 deg C. However, there is no indication of a mid-Holocene in southern Ontario. (Auth)

1117. **McAndrews, J.H., J.L. Riley, and A.M. Davis.** 1982. Vegetation History of the Hudson Bay Lowland: A Postglacial Pollen Diagram from the Sutton Ridge. *Naturaliste Canadien 109(3):597-608.*

A 450 cm long core was sampled in R Lake (informal name) at 54 deg 19 min 20 sec N, 84 deg 33 min 30 sec W, elevation 145-148 m a.s.l., in the Hudson Bay lowland. Sand with marine mollusks is successively overlain by clay, marl and gyttja. A sedimentation rate based on two radiocarbon dates and the modern sediment surface provide an estimate of 8,200 years B.P. for the lake emergence from the sea in response to isostatic rebound. Fossil pollen and macrofossils show a succession from sparse coastal tundra to shrub tundra to the modern spruce woodland between 8,200 and 6,500 years ago. This succession was a response to the decreasing influence of marine climate as Hudson Bay retreated. (Auth)

1118. **McAndrews, J.H., and G. Samson.** 1977. Pollen Analysis and Archeological and Geomorphological Implications, Indian House Lake (Mushuau Nipi) Nouveau-Quebec. Analyse pollinique et implications archeologiques et geomorphologiques, lac de la Hutte Sauvage (Mushuau Nipi), Nouveau-Quebec. French, English and Russian Abstracts. *Geographie physique et Quaternaire 31(1-2):177-183.*

Two pollen cores were collected in the northern section of Indian House Lake and pollen analysis revealed a 4-phase vegetation history of 4,100 years: 1) herb tundra (4,700-4,100 B.P.); 2) shrub tundra (4,100-3,700 B.P.); 3) rich forest-tundra (3,700-2,500 B.P.); 4) present forest-tundra (2,500-0 B.P.). Pollen influx analysis indicates that the shrub-tundra was rather rich. Trees began to colonize the area about 4,000 years B.P. and reached a climax ca. 3,000 B.P. From 2,700 B.P., the vegetation becomes impoverished and at about 2,500 B.P. a climatic change caused the lowering of the tree limit and the thinning of the taiga patches. Pollen data allows the reconstruction of the vegetative environment in which the prehistoric populations of the Mushuau Nipi evolved. Also, we suggest a direct effect of the major vegetative and climatic changes in the ecosystem. Finally, the Carbon 14 dating of the pollen cores (4,100 B.P. and 3,700 B.P.) introduces certain problems concerning the post-glacial lake stages at Indian House Lake. The lower terrace system (0-35 m above lake level) on which all the archaeological sites were found did not begin to form earlier than about 4,000 B.P. (Auth)

1119. **McIntyre, D.J., and I.C. McKellar.** 1970. A Radiocarbon Dated Post Glacial Pollen Profile from Swampy Hill, Dunedin, New Zealand. *New Zealand Journal of Geology and Geophysics 13(2):346-349.*

Study of a peat section 360 cm thick on Swampy Hill near the Otago east coast confirms the three-fold pollen zonation of Cranwell and von Post. The basal Zone I contains mainly herbaceous plants, especially COPROSMA, Zone II starts with a rapid rise of PODO-

CARPUS pollen, and Zone III with a rise of DACRYDIUM CUPRESSINUM. Radiocarbon dates for the base of the peat average 11,600 yr B.P. Despite conflicting dates, Zone II most probably began between 11,200 and 9,700 yr B.P., and Zone III began 6,000 yr ago. Near surface peat is over 3,000 yr old. (Auth) GA 71A/0277

1120. **Mehringer, P.J., Jr., S.F. Arno, and K.L. Petersen.** 1977. Postglacial History of Lost Trail Pass Bog, Bitterroot Mountains, Montana. *Arctic and Alpine Research 9(4):345-368.*

Studies of sediment, chronology, fossil pollen and charcoal from Lost Trail Pass Bog (2152 m) provide the first postglacial bog, forest, and fire history for the Bitterroot Mountains. The 6.27 m of sediment, dated by 16 radiocarbon dates and two volcanic ashes, represent lake, fen and bog deposition spanning the last 12,000 yr. LYCOPODIUM spores were introduced as tracers into the 81 constant-volume samples to estimate pollen and charcoal influx. Because of considerable variation between samples, pollen and charcoal estimates were averaged by pollen zones. Glacial ice withdrew leaving a lake by 12,000 yr ago and sagebrush steppe dominated the landscape for the next 400 to 500 yr. If lodgepole and whitebark pine are the diploxylon and haploxylon pine pollen in the record, then by 11, 500 yr ago whitebark pine forests replaced the steppe and persisted for the next 3000 to 4000 yr under climatic conditions that were probably cooler than present. Two falls of Glacier Peak volcanic ash, separated by less than 25 yr, occurred about 11,250 B.P. By 7000 yr ago, under warmer but not necessarily drier climatic conditions, Douglas-fir and lodgepole pine replaced whitebark pine and charcoal influx increased. The fall of Mazama volcanic ash was dated at about 6700 yr ago. By 5000 yr ago aquatic, fen and bog microfossils became important. With the return to cooler climates, about 4000 yr ago, Douglas-fir was no longer common in the pine forest. Little vegetational change is indicated after 4000 years ago. However, more charcoal was deposited during the last 2000 yr than during the previous 9500 yr. (Auth)

1121. **Mildenhall, D.C.** 1975. Palynology of the ACACIA-Bearing Beds in the Komako District, Pohangina Valley, North Island, New Zealand. *New Zealand Journal of Geology and Geophysics 18(2):209-220.*

In the Pohangina Valley, north of Ashhurst, the pollen assemblages consist of coastal swamp sedges together with scrub and grassland species. Trees may have been restricted to the surrounding hills. The presence of ACACIA and the paucity of tree pollen indicate dry, cool to mild conditions. Such conditions probably extended well north of the study area during late Nukumaruan-Okehuan time. ACACIA may form a stratigraphically useful index fossil of dry, cool to mild coastal environments for the northern part of North Island. ACACIA probably migrated to New Zealand from Australia by chance transoceanic dispersal, not via land bridges. (from Author) Ecol Abs 76L/1372

1122. **Mildenhall, D.C.** 1979. Holocene Pollen Diagrams from Pauatahanui Inlet, Porirua New Zealand. *New Zealand Journal of Geology and Geophysics 22(5):585-592.*

Pollen analysis of two radiocarbon-dated sequences in Pauatahanui Basin, on the west coast of southern North Island, shows that for the last 8000 years or more a DACRYDIUM CUPRESSINUM-dominant broadleaf-podocarp forest existed in the area. During this period, D. CUPRESSINUM has slowly declined in favor of PODOCARPUS, NOTHOFAGUS FUSCA beech and METROSIDEROS. ASCARINA LUCIDA also slowly declined. This suggests a slow deterioration of the climate, particularly from about 5000 years ago, probably due to increased frost and summer droughts. (from Author) GA 81A/253

1123. **Miller, M.M., and J.H. Anderson.** 1974. Pleistocene-Holocene Sequences in the Alaska-Canada Boundary Range, Alaskan Glacier Commemorative Project, Phase IV. *National Geographic Society Research Reports, 1967 Projects, (pp. 197-223).*

Summaries are presented of two pollen diagrams from the Atlin Lake region, British Columbia. The results are compared with earlier palynological studies (Heusser, 1952, 1965) from the Taku region, near Juneau, Alaska. Seven "Time Intervals" are recognized and dated on the basis of seven radiocarbon dates. Fig. 10 presents a summary of the Atlin and Taku data with climatic inferences characterized as "warm or cold" and "wet or dry." There are antiphase relations between the Pacific coastal area (Taku) and the drier interior region (Atlin), especially between 8000 and 3000 B.P. The thermal maximum is dated between 8000 and 2500 B.P. in the Atlin District. A graph of estimated mean July temperatures (deg F) shows temperature 2 deg F above present in the middle of the thermal maximum falling to 4 deg F below present during the first two-thirds of the neoglaciation. Present temperatures were estimated to have been attained by 8000 B.P. Present glaciers are close to the early neoglacial maximum of 2000 B.P. (JTA)

1124. **Millington, A.C.** 1977. Late Quaternary Paleoenvironmental History of the Mary Jane Creek Valley, Grand County, Colorado. *M.A. Thesis, University of Colorado, Boulder, CO, 193 pp.*

After the first mid-Pinedale advance the interstadial culminated in peat growth from 13,740 + or - 160 B.P. to 12,380 + or - 180 B.P. (DIC-516). During this time the climate became warmer than present and the upper Montane Parkland covered the site, at the end of the interstadial the climate cooled; ice advanced over the site at 12,380 + or - 180 B.P. (DIC-516) - this is the ice of the Winter Park Advance. Evidence of a late Pinedale advance is seen upvalley of the site. The late Pinedale and early Holocene sediments are missing from the section, they appear to have been eroded by a flood episode. After 4,260 B.P. subalpine forest reestablished around the site, but was being constantly burnt by forest fires until about 4,000 B.P. After this time it began to regenerate itself but productivity fell off at about 1,400 B.P. (Auth)(JTA)

1125. **Miura, O., and M. Yamanaka.** 1975. Palynological Study of Late Pleistocene Deposits on the Hakkoda Mountains. *Ecological Review 18(2):127-132.*

Pollen analysis suggests that the dominant vegetation of the Hakkoda Mountains during the Pleistocene to Early Holocene was coniferous forest consisting mainly of PINUS, ABIES and PICEA. The pollen frequencies of BETULA pollen suggest periods of mass-movement associated with volcanic activity. PICEA pollen is often found as fossil pollen, although spruce does not live in the Hakkoda Mountains at present; this supports ideas on climatic oscillation. (from Authors) Ecol Abs 76L/4563

1126. **Moar, N.T.** 1966. Post-Glacial Vegetation and Climate in New Zealand. *World Climate from 8000 to 0 B.C., Proceedings of the International Symposium, Imperial College, London, April 18-19, 1966. Royal Meteorological Society, London, (pp. 155-156), 229 pp.*

Pollen studies indicate that changes in the forest communities of New Zealand have occurred during the last 10,000 years. Wetter conditions than today have been postulated for the eastern coast of

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South Island about 1000 years ago. Across New Zealand the change from PODOCARPUS to NOTHOFAGUS dominance was time transgressive, but Carbon 14 dates suggest it occurred within the last 3000 years. The change is attributed to a trend toward a cooler and drier climate. (JTA)

1127. **Mode, W.N.** 1980. Quaternary Stratigraphy and Palynology of the Clyde Foreland, Baffin Island, N.W.T., Canada. *Ph.D. Thesis, University of Colorado, Boulder, CO, 233 pp.*

Pollen analysis of surface samples from a north-southern transect of the eastern Canadian Arctic provides a major addition of knowledge of modern pollen rain in arctic regions. These data suggest that low-, middle-, and high-Arctic floristic zones are palynologically distinguishable and may be recognizable in fossil pollen sequences. Pollen analysis of Holocene materials covering the last 7000 years B.P. and the period 8000-6000 B.P. yields terrestrial proxy data for paleoclimate for time spans previously unexplored in Baffin Island. The 7000 year record reflects a fourfold sequence of climatic change beginning with a climatic optimum ca. 7000-5300 B.P., followed by cooling, a secondary warming, and finally cooling to present. The sequence is, as yet, not well dated. Comparison of this chronology with the Holocene marine chronology of eastern Baffin Island shows that the post-optimum cooling on land preceded that in the marine realm. (Dissertation Abstracts International 41B:2941-2942 (1981))(JTA) Ecol Can 4002

1128. **Moe, D.** 1970. Post-Glacial Immigration of PICEA ABIES into Fennoscandia. *Botaniska Notiser 123(1):61-66.*

Evaluates the use of spruce pollen finds in determining climatic conditions in particular locations. The continuous immigration of PICEA ABIES is shown to have been not synchronous in Norway and Sweden around 500 B.C. This conclusion is drawn from a distribution map made with the aid of chronological datings. It modifies northern Fennoscandian post-glacial vegetational history. (AB105933) AB105933

1129. **Moe, D.** 1970. Pollen Analysis of an Occurrence of Elm in Beiarn, Nordland County, Northern Norway. *Arbok for Universitetet i Bergen, Matematisk-Naturvitenskapelig Serie 2:1-21.*

Reports on study of pollen profiles from Beiarn and Skjerstad in Nordland, northern Norway. The profiles are tentatively correlated with postglacial climatic regimes and with zoning systems of other authors. The geologic settings, elevations, hydrological conditions, climate and dominant plant assemblages of sites are described and comparisons are drawn with present conditions. The rare occurrence of ULMUS GLABRA pollen is believed to be accidental and due to long distance wind transport. The elm, which still grows in Beiarn, may have been introduced in the late 16th or 17th century. (AB105932) AB105932

1130. **Morrison, A.** 1970. Pollen Diagrams from Interior Labrador. *Canadian Journal of Botany 48:1957-1975.*

Six pollen zones are delimited for the last 5800 years. The sites lie within the boreal forest in an open/closed woodland setting. Spruce occurs locally but pine is located 450 km southwest of Churchill Falls. The four basal zones are dated at between 5800 and 5200 B.P. Zone 2 is dated between 5200 and 2500 B.P. whereas Zone I dates from the last 2500 years. In Zone 2, spruce no longer increased rapidly and fir decreased. The present vegetational character was thus established within this interval. In the last 2500 years there are no marked changes that could be ascribed to climate. The changes that occurred could be caused by either small climatic shifts or the effects of forest fires. (JTA)

1131. **Morrison, M.E.S., and A.C. Hamilton.** 1974. Vegetation and Climate in the Uplands of South-Western Uganda during the Later Pleistocene Period. *Journal of Ecology 62(1):1-31.*

Three new pollen diagrams from the Rukiga Highlands in south-western Uganda are presented. These are from Butongo Swamp (site 6; 1 deg 15 min S, 29 deg 47 min E) at 2025 m, Katenga Swamp (site 4; 1 deg 12 min S, 29 deg 49 min E) at 1980 m and Lake Bunyonyi (site 10; 1 deg 18 min S, 29 deg 55 min E) at 1950 m. They are interpreted in the light of recent studies into pollen deposition in highland East Africa and into the relationships between major environmental factors and the distribution of vegetation. Comparison of the pollen diagrams with one another and with the previously published Muchoya pollen diagram allows more confident interpretation than would otherwise be possible. Each of the pollen diagrams is divided into pollen assemblage zones. Comparison with each other and with that for Muchoya suggests that these can be readily correlated with each other. It is concluded that Zones III, IV and V which have been previously established for the Muchoya pollen diagram are each recorded from at least two of the new sites. Zone III is characterized by abundance of HAGENIA ABYSSINICA, Zone IV by abundance of a variety of broad-leaved trees found today in the PRUNUS (PYGEUM) Zone and Zone V by forest clearance. It is inferred that moisture conditions have remained approximately the same as today throughout the time period recorded, but with the possibility of slightly increased rainfall in the central part of Zone IV (centered around 3000 B.P.). Temperatures, however, are estimated to have been c. 2 deg C lower during the upper part of Zone III (c. 8000-6000 B.P.) than they are at present and to have increased rather rapidly by c. 2 deg C over the Zone III/IV boundary. Temperature differences between Zones IV (c. 6000-1000 B.P.) and V (c. 1000-0 B.P.) are difficult to determine because of the over-riding effects of man on the vegetation during the latter zone. Climatic and cultural changes deduced from these diagrams are compared with other evidence from Uganda. Climatic changes inferred are broadly in agreement with evidence from elsewhere, but with some discrepancies. Further data are required. (Auth)(JTA)

1132. **Mott, R.J.** 1973. Palynological Studies in Central Saskatchewan: Pollen Stratigraphy from Lake Sediment Sequences. *Geological Survey of Canada Paper 72-49, 18 pp.*

Lake sediment sequences from four sites in central Saskatchewan were studied as part of a project to determine the late-glacial and postglacial vegetational and climatic history of the area. Several radiocarbon dates help to outline chronology. Boreal vegetation dominated by PICEA invaded the area as the ice retreated northward. Progressively younger radiocarbon dates on the PICEA zones, 11,560 + or - 640 (GSC-648) at Prince Albert, 10,260 + or - 170 (GSC-647) within Prince Albert National Park, and 8,520 + or - 170 (GSC-643) near La Ronge, mark the migration northward. About 10,000 years B.P. a warmer and less humid climate caused grasslands to replace the boreal vegetation in the south and grasslands prevailed to the present in the Clearwater Lake area and, although open grasslands did not extend as far north as the study site within Prince Albert National Park, a parkland type of environment may have existed for a short time. The grasslands retreated with the return of a cooler and more humid climate and a mixed wood forest developed in the Prince Albert Naitonal Park areas. In the La Ronge area the PICEA-dominated vegetation gave way to a mixed wood

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forest and then, after about 6000 + or - 170 years B.P. (GSC-1335), a coniferous forest gradually developed. (Auth)

1133. **Nichols, H.** 1967. The Post-Glacial History of Vegetation and Climate at Ennadai Lake, Keewatin, and Lynn Lake, Manitoba (Canada). *Eiszeitalter und Gegenwart 18:176-197.*

Peat from Keewatin and Manitoba contained macrofossil and palynological evidence of former latitudinal movements of the forest–tundra boundary probably in response to the changing locations of the mean summer position of the Arctic front. There was very rapid melting of the large late-Wisconsin icesheet between 8000 and 6000 years B.P., and swift immigration of Picea, with no evidence of tundra vegetation after deglaciation. From 6000 to 3500 years B.P. the Boreal forest extended far north of its present limit, with a short-lived cooler phase about 5000 years ago. This generally warm period was followed by cooler and variable climatic episodes after 3500 B.P. and by a climatic deterioration about 2600 years ago. There was an amelioration between 1500 and 600 B.P., followed by a prolonged cold episode which terminated peat growth in the tundra. The approximate mean summer temperatures at Ennadai Lake have been estimated from the changing location of the northern limit of forest. The radiocarbon dates for these climatic events coincide with a number of changes recorded in the climatic history of northwest Europe. (Auth)

1134. **Nichols, H.** 1967. Central Canadian Palynology and Its Relevance to Northwestern Europe in the Late Quaternary Period. *Review of Palaeobotany and Palynology 2:231-243.*

Discusses analyses of pollen and macrofossil plant remains from peat of Ennadai Lake, Keewatin, in the tundra, and Lynn Lake, Manitoba, at the northern edge of the forest. Organic accumulation began immediately after very rapid deglaciation of the region 8000-6500 yr B.P. There is evidence that the forest extended north of its present range by about 300 km 6000-3500 yr B.P. Movements of the forest limit are interpreted as reflecting climatic change, in particular the latitudinal movement of the Arctic airmass in summer. Radiocarbon ages of significant zones in the pollen diagrams make it appear that the climatic histories of central Canada and northwest Europe were parallel for the past 6000 yr. (AB98433) AB98433

1135. **Nichols, H.** 1967. Pollen Diagrams from Sub-Arctic Central Canada. *Science 155:1665-1668.*

Vegetation changes registered in pollen diagrams from Ennadai Lake and Lynn Lake at the tundra edge and in the northern part of the Boreal forest, respectively, are used to reconstruct past changes in the climatic boundary between Arctic and Pacific air masses. Peat at Ennadai is composed primarily of SPHAGNUM bog mosses, the growth and humification of which indicate wetter and drier episodes. From ca 5700-3600 yr ago appears to have been a warm period, with a cool episode ca 5000 yr ago. From 3650-2600 yr ago the arctic front shifted to the north. The period 2600-1500 was marked by a drier, colder climate, retreat of the spruce forest, and return of the tundra around Ennadai Lake. The forest moved 40 km north of Ennadai in the final shift, recorded by an age of 1140 yr for a burned forest zone at Dimma Lake. Peat became very humidified and stopped growing about 600 yr ago. These vegetation changes with dates registered in the pollen diagrams correspond to climatic changes in northwestern Europe, and make it possible to use palynological evidence from central Canada to study climatic changes in northern Europe where the fossil pollen record has been affected by anthropogenic factors. (AB98436) AB98436

1136. **Nichols, H.** 1969. Chronology of Peat Growth in Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology 6:61-65.*

Published and unpublished radiocarbon dates from immediately above the unconformable mineral bases of ombrogenous peat bogs are compared with the climatic history of Canada during the last 4,000 years. Most of the determinations group around a few periods of established climatic deterioration (such as 3,500 and 2,400 B.P.) which suggests that large tracts of Canadian peat originated almost simultaneously under the stimulus of climatic change. (Auth)

1137. **Nichols, H.** 1969. The Late Quaternary History of Vegetation and Climate at Porcupine Mountain and Clearwater Bog, Manitoba. *Arctic and Alpine Research 1(3):155-167.*

Radiocarbon dated pollen diagrams from two sites in the southern Boreal forest of Canada have reflected aspects of the local and regional environments since 6,700 and 1,000 B.P., respectively. Spruce forest near Porcupine Mountain was replaced by grassland ca. 6,700 B.P., with a maximum of prairie taxa occurring just before 5,140 B.P. and a short-lived reduction of grass and herb pollen shortly after that date. The grassland episode ended at 4,200 B.P. when spruce forest dominated Porcupine Mountain. The site experienced very rapid SPHAGNUM peat growth and increased sporogenesis after 2,450 B.P. A tentative climatic interpretation is supplied which suggests that 6,700 to 4,200 B.P. experienced generally dry, warm summers, with a maximum of this effect just prior to 5,140 B.P. and a cooler spell following; after 4,200 B.P. the summer climate was cooler and moister, especially from 2,450 to 2,000 B.P. The possibility of a regional increase in soil erosion and sheet flooding prior to 6,700 B.P. is examined. Clearwater Bog is underlain by a spruce forest horizon dated 1,200 B.P. which was established at a time of reduced water level in Clearwater Lake; the PICEA timbers were overlain by very humified peat dated 900 B.P. Unhumified SPHAGNUM peat later formed and continued to the modern bog surface. The climatic interpretation is that the summer climate was warm and dry at 1,200 and 900 B.P., and that cooler, wetter summers characterized the period since then to the present day. The suggested climatic sequences are synchronous at many points with the scheme previously developed for southern Keewatin and northern Manitoba, and some of the vegetational changes are provisionally interpreted as the movement of the southern limit of the Boreal forest in phase with the shifts of the Keewatin forest-tundra boundary described earlier. This correlation encourages comparison with other sites in the Northern Hemisphere. (Auth)

1138. **Nichols, H.** 1970. Late Quaternary Pollen Diagrams from the Canadian Arctic Barren Grounds at Pelly Lake, Northern Keewatin, N.W.T. *Arctic and Alpine Research 2(1):43-61.*

Two peat monololiths were recovered from the high Arctic tundra, now too dry and cold to permit peat growth, near Pelly Lake (66 deg N, 101 deg W). The organic materials began to accumulate at 3,400 and 1,100 B.P. respectively, and both ceased shortly after 900 B.P. Absolute pollen counts, based on numbers of pollen grains per gram (oven-dry weight), revealed parallel changes in representation of PINUS and PICEA pollen which were windblown into the tundra from the Boreal conifer forest 400 to 500 km to the south and west. The absolute numbers of pine and spruce pollen declined after 3,360 + or - 70 B.P. to joint minima at about 2,080 + or - 60 B.P., then rose and culminated in joint maxima at 900 + or - 75 B.P., and then decreased. These variations in PINUS and PICEA counts were probably due to the previously established quasi-latitudinal movements of the forest-tundra ecotone described from Ennadai Lake (500 km south), with which they were synchronous and parallel. The local tundra taxa provided little palynological evidence of climatic changes. The suggested climatic history is that a period of cold summers followed 3,400 B.P., with an episode of maximum severity at ca. 2,100 B.P., then a period of warmer summers occurred which culminated about 900 B.P., and a subsequent cold dry phase, which extended to the present, stopped peat growth in this area. The PINUS and PICEA maxima coincided with the shortlived growth of a local peat bank from 1,060 + or - 55 to 940 + or - 60 B.P. which was sychronous with the Scandinavian exploration and colonization of the North Atlantic. The detailed correlation of these pollen diagrams with that from Ennadai Lake further encourages the comparison of the late Quaternary climatic history of northern Canada with that of northwest Europe. (Auth)

1139. **Nichols, H.** 1971. Late Quaternary Palynological History of Arctic Vegetation and Climate at Pelly Lake, N. Keewatin, Canada. *Etudes sur le Quaternaire dans le Monde, M. Ters (Comp.), VIII Congres INQUA, Paris, 1969. Supplement au Bulletin de l'Association francaise pour l'etude du Quaternaire 4, (pp. 209-215), 1053 pp.*

Peat samples for pollen analysis have been recovered from the Canadian Arctic tundra to allow further reconstruction of the forest-tundra boundary which has already been described from Ennadai Lake, S. Keewatin. At present this ecotone coincides in summer with the southern limit of the dry cold Arctic airmass which occupies the tundra; past movements of the northern edge of the forest have previously been ascribed to prolonged changes in the area dominated by Arctic air during the growing season. There is evidence from Pelly Lake, N. Keewatin (66 deg N, 101 deg W), of changes in representation of PICEA and PINUS pollen which was windblown into the tundra from the conifers of the Boreal forest 500 km to the South and West. The absolute numbers of spruce and pine pollen declined after 3,360 + or - 70 B.P. (the base of the deposit) to minima at 2,080 + or - 60 B.P., then rose to joint maximum values at 900 + or - 75 B.P., and then decreased. A major factor was the associated prolonged changes in the occurrence during the summer of winds from the South and/or West (which transported pollen from Boreal forest) as contrasted with winds from the North which contributed primarily tundra pollen. The local tundra taxa provided little palynological evidence of climatic changes. (Auth) GA 73A/0242

1140. **Nichols, H.** 1972. Summary of the Palynological Evidence for Late-Quaternary Vegetational and Climatic Change in the Central and Eastern Canadian Arctic. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 309-339), 511 pp.*

This paper illustrates the pollen spectra from nine sites in northern Canada from Colville Lake in the west to Sugluk in the east, and from Axel Heiberg in the north to Ennadai Lake in the south. Five major periods are recognized: 1) Prior to 6000 B.P.: evidence suggests that the climate was warmer than present; 2) 6000-5000 B.P.: during this interval the Boreal Forest was north of its present position. The climate is inferred to have been warmer than present with temperatures 2-2.5 deg C warmer than today during the summer months; 3) 5000-3500 B.P.: climate was cooler prior to 4800 B.P. but this event was short lived and by 4500 B.P. the climate was substantially warmer than present until 3500 B.P. During this interval the forest migrated 250 km north of its present limit and summer temperatures were 3 deg above modern values; 4) 3500-2000 B.P.: the climate cooled during this interval and the forest retreated southward; and 5) 2000 to present: the forest was able to migrate northward again due to increasing summer temperatures. Temperatures in summer were 1.5 deg C warmer than present at the height of this warming in 1000 B.P. Cooler summers followed and by 600 B.P. peat growth had ceased at several sites. (JTA)

1141. **Nichols, H.** 1974. Arctic North American Palaeoecology: The Recent History of Vegetation and Climate Deduced from Pollen Analysis. *Arctic and Alpine Environments, J.D. Ives and R.G. Barry (Eds.). Methuen, London, (pp. 637-667), 999 pp.*

The differences in the sensitivity of the palaeoenvironmental records summarized presumably reflect distance of the studied sites from vegetational and climatic boundaries; these variations and the usually inadequate degree of radiocarbon dating control does not obscure the fundamental broad similarity of the circumboreal climatic sequences for the Late Quaternary period. The following summary is based on the literature and the author's research. The evidence for the Early and Middle Holocene or Flandrian indicates relatively warm climates (warmer than present) with spruce forest ranging north of its modern limit in Arctic Alaska (10,000 to 8,300 B.P.), the Yukon, in the Mackenzie Delta and at Colville Lake before 6,000 B.P., with very rapid peat growth under mild Pacific airmass dominance at that latter site, and with extremely quick melting of the Late Wisconsin ice sheet in the Ennadai Lake area due to climatic warming prior to 6000 B.P. 6,000-5,000 B.P.–The evidence for a climate warmer than the present continues throughout this period, with the boreal forest limit lying north of its present location at Colville Lake and Ennadai Lake and in Alaska. This and the above episode fall within the 'Climatic Optimum' and particularly within the period of the Atlantic pollen zone of northern Europe (c 8000 or 7500 to c 5000 B.P.). 5,000-3,500 B.P.–There was a short episode of summer climatic cooling at Ennadai Lake just before 4,800 + or - 90 B.P. (WIS-166) which was estimated to have lasted until maybe 4,500 B.P. and probably did not descend to modern Arctic temperatures. At the same time in the Canadian Arctic and in Europe and elsewhere there were glacial advances and evidence of treeline lowering to suggest climatic cooling. Some centuries after this cooling in Northern Canada there was a recovery to a climate warmer than now beginning at Ennadai Lake at 4,500 B.P. which continued to 3,500 B.P. and allowed forest migration 250 km beyond its present limit with estimated summer temperatures c. 3 deg C above modern values. Treeline was further north at one site in Alaska at 3,600 B.P. 3,500 or 3,300-2,000 B.P.–There is a good deal of agreement on the reality of the cooling of the arctic climates in the last few thousand years. The similarities in the Canadian and Greenland sequences are very marked for this episode, and they have been compared with the similar climatic cooling in Northern Europe which marked the start of the Sub-Atlantic period at 2,500 B.P. 2,000 B.P.-Present–Recovery from this severe climatic cooling seems to have begun by 2,000 B.P. (Pelly Lake, Peary Land) but not to have warmed sufficiently to be registered at most sites until 1800 B.P. (Colville), or 1600 B.P. (Sugluk) or 1400 B.P. (Ennadai). This warm episode, estimated at Ennadai to be c. 1.5 deg C above present summer temperatures, culminated in a maximum of summer warmth c. 1000 B.P. at Pelly Lake, when at the same time the forest limit had again moved north (100 km from modern treeline). Cooler summers followed 900 B.P. at Pelly Lake, and Ennadai Lake became dominated by tundra, while shortly afterwards there was a very widespread cessation of peat growth due to colder, drier (arctic airmass) summers at Pelly (900 B.P.), at Ennadai (630 B.P.) and Sugluk (670 B.P.). Peat growth has not resumed at these sites since due presumably to continued cold dryness. This part of the sequence matches the timing and direction of climatic changes in medieval northern Europe and Greenland. Thus it is possible to argue that the Late Quaternary climatic histories of those Alaskan and Canadian Arctic sites summarized above exhibit a common timing and direction of climatic change, which is comparable to those seen in Greenland and northern Europe, and which in turn have points of similarity with the north Russian sequences which are beyond the scope of this article. (Auth)(JTA)

1142. **Nichols, H.** 1975. Palynological and Paleoclimatic Study of the Late Quaternary Displacement of the Boreal Forest-Tundra Ecotone in Keewatin and Mackenzie, N.W.T., Canada. *University of Colorado, Institute of Arctic and Alpine Research, Occasional Paper 15, 87 pp.*

A series of six pollen diagrams was prepared from peat profiles from four sites along the Canadian boreal forest-tundra ecotone to detect ecotonal displacements due to climatic changes. Two additional short profiles from the High Arctic tundra were prepared to examine the sensitivity of such analyses to influx of exotic forest pollen due to paleowind shifts and forest displacements. The broad outline of the climatic changes is as follows: The oldest sediments dated back to 6200 B.P. in an area deglaciated about 8000 B.P. (Bryson et al., 1969) and represented a spruce forest environment substantially warmer in summer than now. This hypsithermal warmth continued until 4800 B.P., with possible evidence of cooling at 5600 to 5500 B.P. and a maximum of summer warmth from 5300/5200 B.P. to 4800 B.P. A cold summer episode from 4800 B.P. for several centuries expanded tundra almost down to its modern limit, and recovery took place between 4500 and 4250 B.P., depending on lag in plant colonization. At 4200 B.P. there was a brief cooling, followed by a peak of summer warmth around 4000 to 3900 B.P. From about 4000 to 3000 B.P. there were frequent forest fires throughout the northern forest. The forest was able to recover from these until 3500 B.P. when widespread and broadly synchronous fires swept the ecotone from one end to the other over a period of 100 or 200 years. This was due to summer expansion of cold dry arctic air masses over the northernmost forest, which then changed to tundra until 3300 B.P. By 3200 B.P. some woodland regeneration registered milder summers, but by 3000 B.P. tundra expanded southwards in a prolonged episode of colder summers. Further cooling at 2500 B.P. forced another southward ecotonal retreat and damaged the tundra plant cover so that windblown sand was incorporated in peat. Maximum cooling occurred at 2200 to 2100 B.P. When warming followed, vegetational recovery was registered at several dates between 2000 and 1500 B.P., due probably to plant migrational lag. Brief cooling occurred at 1400 B.P. Warming around 1200 to 1000 B.P. allowed a minor woodland advance, followed by a major cooling after 800 to 600 B.P. which caused a major forest retreat. Many peat profiles ceased growth and have not regenerated since. Some minor warming may have been registered within the last 150 years at a minority of sites. (Auth)(JTA)

1143. **Nichols, H.** 1975. The Time Perspective in Northern Ecology: Palynology and the History of the Canadian Boreal Forest. *Circumpolar Conference on Northern Ecology, Proceedings, Ottawa, September 15-18, 1975. National Research Council of Canada, Ottawa, (pp. I-155 - I-166), various pagings.*

Vegetational histories derived from palynological data are presented from sites spaced along 1400 km of the modern forest-tundra ecotone. During the last 7000 years they recorded latitudinal displacements of the ecotone up to 400 km, when estimated mean summer temperatures were +4 deg C above modern. The amplitude of ecotonal displacement was greater in central Mackenzie and Keewatin than in the northwest. This paleoclimatic scheme shows that much of the northernmost forest has undergone parallel and synchronous paleo-climatic changes, and that the last 2000-3000 years has seen massive forest retreat southwards after the mid-postglacial maximum of warmth. This establishes the probable timing of spruce clone growth in the modern tundra. Major forest fire episodes resulting from summer expansion of the Arctic Front were broadly synchronous along the entire ecotone. Fire has been a normal frequent component of northern forest history throughout the record, with substantial recoveries taking less than fifty years under favourable climate. It is tentatively suggested that woodlands are not fully in equilibrium with modern climate but owe their survival to historical climatic factors; if burned they might not regenerate. (Auth)

1144. **Nichols, H.** 1976. Historical Aspects of the Northern Canadian Treeline. *Arctic 29(1):38-47.*

From palynological studies it appears that northernmost dwarf spruces of the tundra and parts of the forest-tundra boundary may be relicts from times of prior warmth, and if felled might not regenerate. This disequilibrium may help explain the partial incongruence of modern climatic limits with the present forest edge. Seedlings established as a result of recent warming should therefore be found within the northernmost woodlands rather than in the southern tundra. (Auth)

1145. **Nichols, H.** 1982. Review of Late Quaternary History of Vegetation and Climate in the Mountains of Colorado. *University of Colorado, Institute of Arctic and Alpine Research, Occasional Paper 37, Ecological Studies in the Colorado Alpine, a Festschrift for John w. Marr, J.C. Halfpenny (Ed.), (pp. 27-33), 147 pp.*

Data on Colorado's vegetational climatic history is surveyed, emphasizing the potential usefulness of such studies in, e.g. forest management. Three major palynological studies of Holocene upper treeline movements from the Front Range and the San Juans are reviewed, and the disagreements between them are shown to be more apparent than real. The pollen diagrams in these studies demonstrated higher alpine treelines during the Holocene, up to 300 m above present forest limits. The revised climatic scheme deduced from palynology shows that in recent millennia alpine treelines have been falling due to colder climate, with further elevational reductions in the past few centuries. This implies that damage to the upper subalpine forest may be irreversible, since the climatic limits for seedling regeneration may be below the present treeline. A palynological study of the lower timberline-grassland ecotone near Crested Butte reflected several elevational changes during the last 15,000 yr. At Winter Park, a five-part till and organic sequence recorded late Pinedale glacier activity, back to 30,500 B.P. At Devlins Park a detailed palynological study from 22,000 to 12,000 B.P. recorded a lower tree line and a climate 4 to 8 deg C colder than now. (Auth)

1146. **Nichols, H., P.M. Kelly, and J.T. Andrews.** 1978. Holocene Palaeo-Wind Evidence from Palynology in Baffin Island. *Nature 273:140-141.*

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Trace amounts of wind-blown tree pollen from boreal coniferous forests and found in late-Holocene sediments on the Cumberland Peninsula, Baffin Island can be used as indicators of palaeo-winds which may be associated with periodic shifts of a trough in the atmosphere. Both productivity of the latter forests and wind shifts over eastern Baffin Island could be common responses to altered strength of the circumpolar vortex. A clear relationship was found between numbers of tree pollen in Holocene tundra peats and the climatic history of the arctic tree-line to the south. The influx of exotic pollen was due to winds of southerly origin passing over the boreal forest during the growth season. Exotic pollen peaks involve ALNUS, PICEA, and PINUS, with alder usually an order of magnitude greater than pine. Distance from the source in northeast Labrador - Ungava to Cumberland Peninsula is approximately 1,200 km. Profiles of pollen from Windy Lake and Maktak Fiord exhibit peaks with intervals of about 200 yr for all taxa. Alder, the most numerous of the exotic pollen taxa, exhibits nine maxima in a 2,000 yr record at Windy Lake with average intervals of 200 to 250 yr. Such incursions of southerly air in summer into eastern Baffin Island at approximately 200 yr intervals during the past 2,500 yr correlates with the history of glaciation on northern Cumberland Peninsula but is insufficiently established for use in long-term forecasting. The Cumberland Peninsula lies below a major atmospheric standing (Rossby) wave formed by the northern hemispheric circulation, with an average trough position at 75 deg W longitude. Shift of the trough to east or west of this position acts as a switching mechanism for air mass trajectories. A westward shift increases southerly air flow and an eastward shift increases northerly air flow. The position of the trough has significant consequences both past and present for climate, ice cover, vegetation, wildlife and human occupation in eastern Baffin Island. These findings will be further tested by collection of lake sediments and peats on Baffin Island and from the believed source region of exotic tree pollen in Labrador-Ungava. (Ecol Can 3024) Ecol Can 3024

1147. **Orlova, Z.V.** 1964. Spore-Pollen Spectra of Alluvium of Present Floodplains of Rivers in Western Chukotka and Their Stratigraphic Importance. Sporovo-pyl'tsevye spektry alliuviia sovremennykh rechnykh polm Zapadnoi Chukotki i ikh stratigrafischeskoe znachenie. Russian. *Akademiia Nauk SSSR, Doklady 154(2):344-47.*

Reports results on 12 sections of deposits in the Ichuveyem, Keveyem, Rauchuvan (Rauchua) and other river valleys. The six kinds of spore-pollen spectra found are described, and the predominant plants noted. Two specta represent a warmer climate than the present, two others a colder and humid climate, and two a cold dry climate. Holocene deposits therefore can be divided according to climatic conditions into three different horizons, as has been done already by others for this area, using different approaches. (AB90495) AB90495

1148. **Parrish, L.L.** 1980. A Record of Holocene Climatic Changes from St. George Island, Pribilof Islands, Alaska. *Ohio State University, Institute of Polar Studies, Report No. 75, 45 pp.*

A suite of lake and bog cores from St. George Island, Pribilofs, Alaska, were analyzed for pollen and stratigraphic changes. The lakes studied appear to have formed well before 5000 B.P. Their formation appears to be a result of a major climatic change, and is perhaps related to the flooding of the Bering Land Bridge. A second episode of climatic change is suggested by a change in the nature of the lake sediments. Just prior to 4845 B.P., the grey clay which had accumulated during the early part of the Holocene was replaced by a more organic brown clay. The higher organic content of the brown clay may be the result of an increase in lake productivity reflecting the warmer temperature of the Hypsithermal. The formation of two bogs between 6800 B.P. and 5500 B.P. is consistent with a hypothesis of change at this time. An indication of more recent climatic change is found in the three pollen diagrams from the St. George lake cores. At approximately 3000 B.P., an increase in Umbelliferae pollen and a decrease in ARTEMISIA pollen are evident, reflecting a change in the local vegetation. The date of this vegetation change is similar to the date of 2980 B.P. for the second episode of bog formation on the island. Both of these dates are comparable to the dates of 3000 to 3500 B.P. associated with the Neoglaciation. Thus, a correlation is suggested between these events and the inferred regional cooling which initiated the Neoglacial advance. (Auth)

1149. **Pennington, W.** 1980. Modern Pollen Samples from West Greenland and the Interpretation of Pollen Data from the British Late-Glacial (Late Devensian). *New Phytologist 84:171-201.*

Samples of the modern pollen rain, some from lake sediment and some from moss polsters, were taken in two regions of West Greenland in which the climate is respectively low arctic continental and low arctic oceanic: (1) round the head of Sondre Stromfjord at 67 deg N; and (2) the south-west of Disko Island at 70 deg N. The vegetation has been described and analysed by Bocher (1954, 1959, 1963). These findings can be used in interpretation of Late Devensian pollen spectra which lack arboreal pollen, and make it probable that: (i) samples from the earliest Late Devensian pollen zones represent an oceanic dwarf-shrub vegetation in which there was more SALIX HERBACEA and fewer sedges than pollen values suggest; (ii) BETULA NANA did not at any time form an appreciable part of the vegetation cover; and (iii) ARTEMISIA pollen values provide an index to local vegetation cover, which implies a vegetation mosaic correlated with snow cover during the period of the Loch Lomond Advance (c. 11,000 to 10,500 B.P.). (Auth)(JTA)

1150. **Pennington, W., E.Y. Haworth, A.P. Bonny, and J.P. Lishman.** 1972. Lake Sediments in Northern Scotland. *Philosophical Transactions of the Royal Society of London, Series B, 264(861):191-294.*

A survey of deep-water sediments in 11 lakes in northern Scotland showed that only under certain conditions does a complete and conformable series of deposits accumulate. In lochs exposed to strong winds there may be no permanent settling of organic sediments in water depths up to 50 m. Three lake cores (representive of three regions of northern Scotland), which proved to be complete and conformable profiles, were analysed in detail for pollen and certain chemical elements; one was also analysed for diatoms. A series of Carbon 14 dates was obtained for two of these profiles. Post-glacial pollen diagrams are divided into a series of Regional Pollen Zones for northern Scotland; in northwest Scotland the boundaries of these zones have been dated by Carbon 14 at two sites and the pollen zones correlated with chronozones. Early post-glacial EMPETRUM and juniper zones are followed by a birch-hazel zone; from ca. 6000 B.C. onwards the birch-hazel pollen assemblage is replaced progressively by pine-birch. Surviving birch and birch-hazel woods around Loch Sionascaig are interpreted as the relics, on dry flush slopes, of a forest type which was widespread there before 6000 B.C. Chemical evidence suggests that between ca. 6000 and 4400 B.C. pine and pine-birch woods were growing on comparatively dry mineral soils, but from ca. 4400 B.C. the appearance of alder pol-

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len is accompanied by evidence for solutional transport of iron and manganese from increasingly waterlogged soils. By 3000 B.C. formation of blanket peat must have begun on the Sionascaig catchment. For about another 1000 years pines and birches continued to grow on a peaty substratum. In Region 1 the pine forest ended suddenly at about 2000 B.C.; alternative hypotheses to account for this are examined. In Region 2 the Loch Clair profile shows the continuity of pine-birch forest with the existing Coulin Forest on that catchment. Steeper slopes than in Region 1 must have prevented the general formation of blanket peat, and the poor siliceous soils did not attract prehistoric settlement, so there was no forest clearance, though traces of human influence appear in the pollen spectra from ca. 3400 B.C. In Region 3 the sediments of Loch Tarff show a sequence of post-glacial pollen zones which can be related both to the northern Scotland series outlined here and to the Godwin series of zones which has been widely applied in more southern parts of Britain. This is interpreted as the result of the position of Loch Tarff on the margin of an area of natural mixed-oak forest in the Great Glen; its pollen diagram records the expansion of this forest type in the mid-post-glacial period on which the Godwin zonation is based. (Auth)(JTA)

1151. **Petersen, K.L.** 1981. 10,000 Years of Climatic Change Reconstructed from Fossil Pollen, La Plata Mountains, Southwestern Colorado. *Ph.D. Thesis, Washington State University, 211 pp.*

Tree-ring cores from spruce trees growing between timberline and the upper krummholz limit and pollen and charcoal from sediment cores collectd from two localities within the spruce-fir forest of La Plata Mountains were used to develop a 10,000 year environmental sequence for the headwaters of the San Juan and Dolores rivers, southwestern Colorado. Changes in pollen spectra from a 4 m core from Twin Lakes (3290 m) reflect the upward advance in the latter half of the 1800s) of the Engelmann spruce timberline in response to warming summer temperatures. Three other advances to elevations higher then both the present timberline and the average conditions of the last 10,000 years occurred from 8600 to 8300, 6700 to 5900, and 4300 to 4000 B.P. During these periods the spruce zone was also much broader than now due to warmer and wetter conditions accompanying the northward extension of summer monsoons. Within a fourth period (2500-1500 B.P.) timberlines reached elevations similar to the present but the summers were drier. Timberlines as low as those of the early 1800s occurred from 10,000 to 8600, 8000 to 6900, and about 5600, 4500, 3600, 2800, 1400, and 750-150 B.P. These timberline retreats downward were the result of cool summers. During Pueblo occupation (A.D. 500s to 1100s) of the Four Corners region, warming temperatures fostered an advance upward of timberline that culminated in the 1100s. Pinyon forest began expanding about A.D. 700 to 900 as moonson rainfall increased. Between A.D. 1050 and 1150 annual precipitation was similar to that of the early 20th century with increased precipitation during both summer and winter. Soon after A.D. 1150 there was a dramatic reduction in summer rainfall, a lowering of summer temperature, and a shortening of the growing season. These changes resulted in a shrinking woodland and a narrowing spruce forest zone and conditions comparable to those of the 1850s when summers were favorable for persistent snowbeds and unfavorable for aboriginal corn agriculture. These cool and dry summers undoubtedly contributed to the abandonment of the Four Corners region by the corn growing Anasazi. Dissertation Abstracts International 42(5):1799B-1800B, Order No. 8122434

1152. **Piavchenko, N.I.** 1963. On Methods of Interpreting of Spore-Pollen Spectra of the Holocene. K metodike interpretatsii sporovo-pyl'tsevykh spektrov golotsena. Russian. *Akademiia Nauk SSSR. Sibirskoe otd-ie. Izvestiia 8:25-33.*

Reviews the use of spore-pollen analyses for geobotanic and paleogeographic investigations of the Quaternary period by giving examples from Arkhangel'sk Province, Podkamennaya Tunguska and other arctic regions. It is emphasized that this method should not be overestimated, and it should be correlated with others. Suggestions are offered in regard to interpretation of analyses, such as to give attention to the different pollen productivity in various plants, possible transport and preservation; not to try classifying variation of plants by climatic causes alone, but keep in mind that variation of soils and other local factors may cause changes as well. (AB82079) AB82079

1153. **Puminov, A.P.** 1964. Late Glacial and Holocene Epochs in the Northeast of the Middle Siberian. Pozdneled-nikovaia i golotsenovaia epokhi na severovostoke Sredne-Sibirskogo ploskogor'ia po sporovo-pyl'tsevym dannym. Russian. *Akademiia Nauk SSSR. Sibirskoe otd-ie. Inst. geologii i geofiziki. Trudy 9:20-47.*

Reviews vegetion landscapes from the end of the Zyryanka glaciation to the present between 66 deg and 72 deg N, approx in the Anabar and Olenek basins and the upper Markha. From numerous spore-pollen analyses, changes in the vegetation cover and climate since the Zyryanka are registered north and south of 69 deg N. Degradation of this glaciation is explained. Latterly three warm periods and three cold are indicated. Paleogeographic history, development of river terraces and other events are evaluated. (AB99268) AB99268

1154. **Richard, P.** 1970. Palynology in Quebec: Observations on its Development and Present Trends. L'analyse pollinique au Quebec. Mise au point et tendances actuelles. *Revue de Geographie de Montreal 24(2):189-197.*

Pollen spectra are percentage counts of different plant pollen within a given stratum of a deposit. A vertical graphic representation of all the spectra of a deposit constitutes a pollen diagram. Nevertheless these data must be interpreted in connection with precise knowledge of plant behaviour and conditions of the environment. The author reviews the publications dealing with pollen analyses in Quebec. The article assesses the mass of these studies from the point of view of new notions in palynology as well as of new techniques and methods of interpretation. Careful identification of pollens is still the best means of getting detailed palaeobiogeographical data and information. The author presents an interpretation methodology based on an analytical use of sub-present time pollen rain data by vegetation unit. (from English Summary) GA 72A/2226

1155. **Richard, P.** 1981. Postglacial Paleo-Phytogeography in Ungava from Pollen Analysis. Paleophytogeographie postglaciare en Ungava par l'analyse pollinique. French, English Abstract. *Paleo-Quebec 13:1-153.*

The postglacial vegetational history of the area between the Ungava Bay and the 72nd meridian west has been reconstructed by means of pollen analysis. A study of the pollen representation of the present-day forest-tundra and tundra has been conducted as an aid to the interpretation of the pollen diagrams. 20 moss samples and 21 lake samples were included in this study. Eleven pollen diagrams were made, out of lake sediments (7), peats (3) and an archaeological soil. Five diagrams are located along a 180 km transect on both sides of riviere aux Feuilles, near the 72nd meridian west; the others come from the Diana Bay area. At Diana, around 7,000 B.P., the initial vegetation type was a rich herb tundra. By 6,200 B.P., it has been replaced by a dense shrub tundra with abundant ALNUS CRISPA and BETULA GLANDULOSA. Around 3,500 B.P., the shrubs became sparse and the landscape progressively developed into the depauperate present-day tundra. In the riviere aux Feuilles area, the tree species were already present around 5,300 B.P. although the landscape was initially very open. A dense shrubby forest tundra rapidly developed and was maintained until 4,000 B.P. It was then replaced by a very dense forest tundra until 2,500 B.P., when the trees became progressively less abundant near the valley. The opening of the tree coverage happened earlier on the plateaus (3,200 and 3,600 B.P.). This opening process was accelerated around 2,000 B.P. and lead to the present-day landscapes. Evidences have been found of a single northward treeline movement of about 40 km, around 3,600 B.P. The study shows the metachronous character of the plant migrations and of their reaction to the environmental changes (soils, climate). The present-day landscapes in the tundra and forest-tundra of Ungava are unique: comparable vegetation complexes have never existed since the last ice retreat. (Auth)

1156. **Richard, P., A. Larouche, and M.A. Bouchard.** 1982. Age of Final Deglaciation and Reconstruction of Postglacial Vegetational History in Central Nouveau-Quebec. Age de la deglaciation finale et histoire postglaciaire de la vegetation dans la partie centrale du Nouveau-Quebec. *Geographie physique et Quaternaire 36(1-2):63-90.*

Pollen and macrofossil analyses, as well as radiocarbon dating, of four cores of postglacial lake sediments collected from central Nouveau-Quebec, provide an estimate of the minimum age for the disappearance of some of the last remnants of the Wisconsinan ice in Quebec, and allow a reconstruction of the postglacial history of the vegetation. The final stages of deglaciation span from about 6200 to about 5600 years B.P. The first date marks the time of inception of the final stagnation of the ice southwest of the terminal ice-divide and the second gives the minimum age of the final melting of the ice on the uplands north of the divide. The time which elapsed between the uncovering of the cored lake basins by the ice and the accumulation of datable organic matter in these was short due to the rapid colonisation of the newly uncovered land by trees, shrubs and herbs. Green alder (ALNUS CRISPA) and larch (LARIX LARICINA) dominated the landscape at first, but all the other species of trees and shrubs were already present. From ca. 5500 to 4400 years B.P., the region supported a dense black spruce (PICEA MARIANA) taiga. The main feature of the subsequent postglacial history of the vegetation is the opening of the arboreal cover around 4700 to 4400 years B.P. reflecting the cooling of the regional climate. The only indication of possible postglacial climatic fluctuations other than the general cooling trend are represented by two pollen influx pulses of white birch (BETULA PAPYRIFERA) between 5760 and 4750 years B.P. and between 3600 and 2500 years B.P., recorded at one of the sites. (Auth)

1157. **Richard, P., and P. Poulin.** 1976. A Pollen Diagram from Mont des Eboulements, Charlevoix, Quebec. Un diagramme pollinique au Mont des Eboulements, region de Charlevoix, Quebec. French, English Summary. *Canadian Journal of Earth Sciences 13(1):145-156.*

The history of vegetation has been registered in the sediments of Lake Mimi since c. 11,000 B.P. The initial vegetation was tundra which, under severe climatic conditions, lasted for c. 1,000 yr. The herb tundra was progressively replaced by shrub tundra; a willow phase (SALIX), followed by a dwarf birch phase (BETULA bf. GLANDULOSA) have been traced. These were followed by an afforestation phase characterized by an aspen community (POPULUS TREMULOIDES) at c. 10,000 B.P. Spruce succeeded the aspen community, probably as an open black spruce (PICEA MARIANA) community with some dwarf birch and green alder (ALNUS CRISPA). An outstanding ALNUS pollen peak (48%) at the end of this spruce phase could be interpreted as a return of colder climate that favored the expansion of this shrub over forest. This event would date at 9750 B.P. An open fir (ABIES BALSAMEA) forest followed, and changed to the balsam fir - white birch (BETULA PAPYRIFERA) forest which prevailed until now. Richer sites supported sugar maple (ACER SACCHARUM) - yellow birch (BETULA ALLEGHANIENSIS) community and fir - yellow birch stands since 6200 B.P. (from English summary) Ecol Abs 76L/3723

1158. **Ritchie, J.C.** 1967. Holocene Vegetation of the Northwestern Precincts of the Glacial Lake Agassiz Basin. *Life, Land and Water, W.J. Mayer-Oakes (Ed.), Proceedings of a Conference on Environmental Studies of the Glacial Lake Aggassiz Region, University of Manitoba, 1966. University of Manitoba Press, Winnipeg, (pp. 217-229), 414 pp.*

Studies of the pollen spectra in Manitoba and Saskatchewan have shown the following pattern of plant development in the area since the evacuation by the ice. From 12,500 to 10,500 years ago, most of the area was occupied by a spruce soapberry forest on mesic sites, poplar and willow stands as seral communities on younger sites, and treeless areas by sage, grass, and locally juniper on the most xeric sites. At about 10,500 years ago, all the area was treeless and was a grassland. At about 3,500 to 4,000 years ago, the grassland was invaded from the north and the south by present day forests. (from Abstracts N. American Geology) GA 69B/1195

1159. **Ritchie, J.C.** 1969. Absolute Pollen Frequencies and Carbon 14 Age of a Section of Holocene Lake Sediment from the Riding Mountain Area of Manitoba. *Canadian Journal of Botany 47(9):1345-1349.*

A section of Holocene lake sediment in the Southern Boreal Forest of Manitoba was re-sampled, and the sedimentation rate (0. 039 cm per annum) calculated from eight Carbon 14 age determinations. Pollen accumulation rates were computed, and an absolute pollen frequency diagram constructed. It suggests modifications of an earlier reconstruction of vegetation, based on relative pollen frequencies. A spruce-dominated assemblage occurred from about 11, 500 to 10,000 B.P., when there was a change to a treeless vegetation of a grassland type. This persisted until aobut 2500 B.P. with the possible interpolation of an aspen parkland phase from 6500 to 2500 B.P. The boreal forest in its present form (dominated by spruce, birch, and aspen, with local occurrences of pine, fir, larch, and oak) returned at 2500 B.P., presumably in response to a deterioration in climate (cooler and/or wetter). (from Abstracts of N. American Geology) GA 72A/0735

1160. **Ritchie, J.C.** 197. The Modern and Late Quaternary Vegetation of the Campbell-Dolomite Uplands, Near Inuvik, N.W.T. Canada. *Ecological Monographs 47:401-423.*

The Campbell-Dolomite uplands comprise a small area (140 sq km) of outcropping, faulted dolomite, limestone, and shale east of the Mackenzie Delta, approximately 40 km south of the northern limit of trees. The major landforms are bedrock ridges and plateaux, steep colluvium, stable slopes, shorelines, and depressions. A principal component analysis of vegetation-cover data from 150 stands suggest that much of the variation within the heterogeneous vegetation is correlated with these broad habitat categories. Stable surfaces bear an open spruce woodland with alder, tree and dwarf birch, and a varied lichen-heath-DRYAS ground vegetation. A glacially modified karstic (solution) depression contains a small (8 ha), relatively deep (22 m), apparently meromictic lake, which yielded a 12,000-yr core of sediment. A conventional percentage diagram, an influx diagram and numerical analysis (principal components) suggest a sequence of pollen assemblage zones as follows: (1) SALIX-Gramineae-ARTEMISIA: 13,000 to 11,300 radiocarbon yr ago, (2) BETULA (shrub)-SALIX-Gramineae-ARTEMISIA: 11, 300 to 10,300, (3) BETULA-POPULUS: 10,300 to 9,700, (4) BETULA-POPULUS-JUNIPERUS: 9,700 to 8,900, (5) PICEA-BETULA (tree and shrub)-JUNIPERUS: 8,900 to 6,500, and (6) PICEA-BETULA-ALNUS: 6,500 to present. Both percentage data and numerical analyses show that none of the pollen assemblage zones 1 to 5 has a modern analogue. With 1 exception, these patterns of change in pollen spectra can be interpreted parsimoniously without reference to regional environmental change. They suggest an initial phase of migration of willow and herbs from adjacent unglaciated Megaberingia (North Yukon and Alaska), followed rapidly by dwarf birch and later poplar. Megaberingian floristic elements (e. g., PLANTAGO CANESCENS, SELAGINELLA SIBIRICA) reached the area during this early phase of migration. Subsequently arriving from the south along the Mackenzie valley were juniper, ericads, spruce, and finally alder, which intensified competition and restricted the early Megaberingian herb types to open, unstable habitats where they persist today. Slow soil development (humus accumulation, rising permafrost table) probably favored the spread of the palynologically "silent" elements–lichens, ericads, and DRYAS (the dominants of the modern ground vegetation). Changes in the influx values of PICEA suggest a climatically induced increase in tree density and/or pollen production during the period 9,000-7,000 B.P. (Zone 5). (Auth)

1161. **Ritchie, J.C.** 1972. Pollen Analysis of Late-Quaternary Sediments from the Arctic Treeline of Mackenzie River Delta Region, Northwest Territories. *Mackenzie Delta Area Monograph, D.E. Kerfoot (Ed.). Brock University, St. Catherines, Ontario, (pp. 29-50).*

Describes the modern pollen spectra and the climatic control over the forest-tundra boundary. Four diagrams are presented from lakes at about 69 deg N. The sequence of vegetation is: 1) 12,900 - 11,500 B.P., tundra, dominated by dwarf birch, with open sites occupied by grass - ARTEMISIA communities, 2) 11,500 - 8,500, invasion by spruce, forming a forest tundra, 3) 8,500-4000, development of a closed crown spruce forest with white birch; alder invasion of the area about 5500 B.P., 4) 4000 - present, retreat of spruce tree-line to present position: Tuktoyaktuk Peninsula; Richards Island and adjacent area occupied by shrub tundra with local abundance of alder. (K.M. Clayton) GA 74A/1905

1162. **Ritchie, J.C.** 1972. Pollen Analysis of Late-Quaternary Sediments from the Arctic Treeline of the Mackenzie River Delta Region, Northwest Territories, Canada. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 253-271), 511 pp.*

Analysis of two lake cores and two exposed pond deposits in the region resulted in a vegetation history that spans the last 12,900 years. During early Holocene time the region was invaded by spruce to form a forest-tundra ecotone. After 8500 B.P. and prior to 4000 B.P. the vegetation developed into a closed crown spruce forest with white birch. Alder invaded the area about 5500 B.P. Between 4000 and present the spruce tree-line retreated to its present position. Areas that were once within the forest limit are now sites of shrub tundra with a local abundance of alder. The expansion of the continuous spruce forest between 8500 and 4000 B.P. suggests that the mean daily temperature for the warmest months was about 5 deg C warmer than present and that the growing season was approximately 30 days longer. These data imply that the median position of the Arctic Front was displaced northward about 350 km from its present position. (JTA)

1163. **Ritchie, J.C.** 1980. Towards a Late-Quaternary Palaeoecology of the Ice-Free Corridor. *Canadian Journal of Anthropology 1(1):15-28.*

The palaeoecology of the area known as the ice-free corridor is as poorly understood and documented as the geological evidence that there was in fact such an area. In the north, Beringian portion the full-glacial (maximum 18,000 B.P.) was characterized by impoverished, tundra communities reflecting an environment colder, drier and less productive than during the Holocene and present-day. Most sites of greater apparent age (Middle Wisconsin), while they have yielded large numbers of vertebrate fossils, either lack stratigraphic context entirely or have stratigraphy of uncertain age and provenance. There is fragmentary evidence for Middle Wisconsin interstadial episodes that supported productive boreal woodland ecosystems. (Auth)

1164. **Ritchie, J.C.** 1981?. Problems of Interpretation of the Pollen Stratigraphy of Northwest North America. *Quaternary Paleoclimate, W.C. Mahaney (Ed.). Geo Abstracts Ltd., University of East Anglia, Norwich, England, (pp. 377-391), 464 pp.*

Pollen diagrams (relative and concentration diagrams) are presented from Lateral Pond, in the Richardson Mountains, Yukon Territory, Canada. The base of lake sediment is dated at 15,200 + or - 230 B.P. and the Holocene record occupies the upper 1.5 m of the core, and takes in pollen zones 5 and 6. Spruce was present at the site by 10,000 to 11,000 B.P. The change from pollen zone 5 to 6 occurs close to 6800 B.P. and is marked by a sharp decrease in the percentage of birch pollen and a rise in alder pollen. (JTA)

1165. **Ritchie, J.C.** 1982. The Modern and Late Quaternary Vegetation of the Doll Creek Area, North Yukon, Canada. *New Phytologist 90(3):563-603.*

The modern vegetation of the mountainous Doll Creek region consists of tundra on surfaces above 700 m elevation and spruce woodlands on lower slopes and valleys. Tundra on noncalcareous parent materials is distinctive, dominated by BETULA GLANDULOSA, ARCTOSTAPHYLOS ALPINA, LEDUM DECUMBENS and SALIX ARCTICA. Limestone ridge surfaces support a tundra dominated by DRYAS INTEGRIFOLIA, CAREX SCIRPOIDEA and CETRARIA species; lower slopes on limestone are dominated by a DRYAS-CASSIOPE-TOMENTHYPNUM cover which also characterizes the ground vegetation of PICEA GLAUCA woodlands on lower surfaces. Bottomland mires are dominated by PICEA-SPHAGNUM woodlands and moraines support a P. MARIANA-B. GLANDULOSA-ericad community. LARIX LARICINA shares dominance with P.

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GLAUCA at treeline on NW-facing gulley surfaces where deep and persistent snow appears to be important. A detailed pollen analysis of one site reveals that immediately following the maximum of the latest glacial cycle (18,000 B.P.), the area supported a sparse, unproductive herb tundra on the lower montane slopes and a sedge-grass marsh complex in poorly drained sites. Between 16,000-12,500 Carbon 14 years rapid changes in the plant populations occurred, particularly involving species of willow, grass, sedge and herbs. By 12,500 the entire area was occupied by a mosaic of treeless communities in response to a slow amelioration of the climate. At 12,000 a rapid transition from a warming glacial to a non-glacial climate stimulated the spread of dwarf shrubs (ericads and birch), increased organic sedimentation, soil humification, and paludification and a gradual increase in spruce until the modern extent and structure of woodland complexes was reached at c. 7500 B.P. Slight changes did occur later (6000 B.P.) as alder and tree birch expanded to their modern modest status in the vegetation. (from Author) Ecol Abs 82L/8084

1166. **Ritchie, J.C., and F.K. Hare.** 1971. Late Quaternary Vegetation and Climate near the Arctic Tree Line of Northwestern North America. *Quaternary Research 1(3):331-342.*

Earlier studies in Alaska and northwest Canada have shown inconsistent evidence for the expected northward extension of the Arctic tree line during the Hypsithermal Interval. Only megafossil evidence has supported this suggestion; the palynological findings have been inconclusive. The Tuktoyaktuk Peninsula, in the Northwest Territories of Canada, offers critical sites for studies of late-Pleistocene ecology, because of its geological, biotic, and climatological features. Palynological and megafossil evidence is presented from sites on the Tuktoyaktuk Peninsula, indicating northward advance of the Arctic tree line during the period 8500-5500 B.P. Relative pollen frequencies of a core of lake sediments suggest a late-Pleistocene sequence as follows: 12,900-11,600 dwarf birch tundra; 11,600-8500 forest tundra; 8500-5500 closed-crown spruce-birch forest; 5500-4000 tall shrub tundra; 4000-present dwarf birch heath tundra. These results suggest that during the Hypsithermal Interval the Arctic Front (July position) was further north, over the Beaufort Sea, a displacement from its present position of about 350 km. The Tuktoyaktuk Peninsula, presently occupied by tundra, and dominated by the Arctic airstream in July, was apparently under forest, with warm, moist Pacific air during the Hypsithermal Interval. (Auth) GA 73A/0182

1167. **Ritchie, J.C., and G.A. Yarranton.** 1978. Patterns of Change in the Late-Quaternary Vegetation of the Western Interior of Canada. *Canadian Journal of Botany 56:2177-2183.*

Principal components analysis (PCA) of pollen data from 14 sites reveals five types of sequence. All begin from an early spruce-dominated assemblage, now apparently extinct, with subsequent differentiation into patterns of forested and grassland vegetation. A comparison of the PCA ordinations of these subfossil zones with those of modern pollen samples illustrates the uniqueness of the early spruce zone and the similarities between subsequent zones and modern spectra. The technique demonstrates the time transgressive nature of the early spruce forest assemblage in this region. (Auth)

1168. **Ritchie, J.C., and G.A. Yarranton.** 1978. The Late-Quaternary History of the Boreal Forest of Central Canada, Based on Standard Pollen Stratigraphy and Principal Components Analysis. *Journal of Ecology 66:199-212.*

Pollen stratigraphic data from four Carbon 14 dated sections of Holocene sediment at sites in the boreal forest region of central Canada were analysed by standard relative frequency pollen diagrams and by principal components analysis (PCA). Ordination of the 173 pollen samples on the second and third components of the PCA facilitated comparison between zones and sites. (2) Modern pollen samples from 110 sites throughout the modern vegetation zones of the Western Interior of Canada were ordinated onto the same principal component axes as the sub-fossil data, to provide a further comparative, graphical description of the data. (3) The two northern sites revealed a stratigraphical sequence from a treeless ARTEMISIA-willow-sedge zone, through a PICEA-JUNIPERUS-ARTEMISIA zone, to zones dominated by mixtures of pine, spruce, birch and alder. (4) At the two southern sites, by contrast, an early treeless zone was lacking; there were comparable early spruce and final mixed-forest zones, but the intermediate zones were dominated by herb and non-coniferous tree types. (Auth)

1169. **Roche-Bellair, N.** 1976. Holocene in Betsy Cove (Kerguelen Islands). L'Holocene de l'Anse Betsy (Ile Kerguelen). French; English summary. *Comptes Rendus Hebdomadaires des Seances, de l'Academie des Sciences, Serie D, 282(14):1347-1349.*

This palynological section is 3 m high and is situated to the northeast of Kerguelen. Carbon 14 dating gives an age of 4,300 B.P. at the bottom. This section shows alternation of cold with mild periods and states the position of climatic optimum between 5,500 B.P. and the present. There are also indications of a "little ice age." (Auth) AntB E-16952

1170. **Ruuhijarvi, R.** 1962. On Palsa Bogs and their Morphology in the Light of Pollen Analysis. Palsasoista ja niiden morfologiasta siite polyanalayysin valossa. Finnish, German Summary. *Terra 74(2):58-68.*

Describes a palsa bog near Petsikko, 69 deg 27 min N 27 deg 20 min E, northern Finland, the center of which had sunk 2.5 m. Pollen diagrams of exposed wall and of a 0.5 m deep cavity beneath it are presented; evidence of the recent climatic warming is shown. Comparison is made with descriptions of other palsa bogs in northern Europe. (AB75280) AB75280

1171. **Salgado-Labouriau, M.L., and C. Schubert.** 1976. Palynology of Holocene Peat Bogs from the Central Venezuelan Andes. *Palaeogeography, Palaeoclimatology, Palaeoecology 19:147-156.*

A sequence of six Holocene peats in a river terrace in Paramo de La Culata was studied and compared with present-day peat deposits. The pollen analysis has shown that this region has been a humid paramo since about 7500 years B.P. At about 6000 years ago, pollen-rain input greatly decreased, reflecting poor local and adjacent vegetation. This is interpreted as representing a lowering of the average temperature of the region during a short time. (Auth)

1172. **Savoie, L., and P. Gangloff.** 1980. Pollen Analysis of a Palsa at the Archaeological Site of Killiniq, N.W.T. Analyse Pollinique d'une Palse au Site Archeologique de Vieux-Port-Burwell (Killiniq), Territoires du Nord-Ouest. *Geographie physique et Quaternaire 34(3):301-320.*

Two pollen diagrams, one located at the summit (A) and the other at the foot (B) of the palsa, 3 m from each other, reflect the geomorphological evolution of the site in a fen at Killniq. Between 5000 and 580 BP, the same evolution is registered by the two diagrams, i.e. the progressive development of the fen. The pollinic

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zonations which mark this period of time are imputed to paleoclimatic variations. The important low in local pollen representation which appears around 3700 BP shows that difficult conditions for plant growth prevailed at that time. Around 2430 BP a break in pollinic zonations IV and III correlates in diagram C, taken at 300 m from the studied site, to the outcome of minerotrophic peat, which probably points out to an aggradation of the permafrost. Temperatures begin to get warmer around 1430 BP. Starting from 580 BP, a divergent evolution is recorded by the two pollen diagrams. (Auth) (JTA)

Five Carbon 14 dates were obtained from the 3 sites. Three dates at one site are used to estimate sedimentation rates at the other two sites where only a single radiocarbon date is available for each. (JTA)

1173. **Schalke, H.J.W.G., and E.M. van Zinderen Bakker.** 1967. A Preliminary Report on Palynological Research on Marion Island (Sub-Antarctic). *South African Journal of Science 63(6):254-259.*

The pollen diagram of a boring made in a swamp shows that, during the peak of the last glaciation (about 16,000 yr B.P.), an upland flora of AZORELLA existed in coastal oases on the partly glaciated island. The melting of the glaciers probably began at the same time as did the melting of the glaciers on the high mountains in East Africa, Europe, and North America. In Late Glacial times, AZORELLA was replaced by lowland ACAENA. As the upland glaciers continued to melt and more water became available, conditions were favorable for the formation of a mire. This apparently occurred about 11,000 to 12,000 yr B.P. Carbon 14 determination of a sample from a black lava flow yielded an age of 3180 + or - 120 yr B.P., indicating that the flow must be of postglacial age. Because all fossil spores are similar to those of the present flora, it is concluded that no enrichment of species has occurred during the past 16,000 to 17,000 yr. (AntB E-5482) AntB E-5482

1174. **Schalke, H.J.W.G., and E.M. van Zinderen Bakker, Sr.** 1971. History of the Vegetation, Marion and Prince Edward Islands. *Report on the South African Biological and Geological Expedition, 1965-1966, Balkema, Cape Town, (pp. 89-97).*

The peaty deposits found on subantarctic islands are of great value in pollen analytical studies on Quaternary climatic changes. The following problems are discussed in this connection: the dampening effect of the hyper-oceanic climate on climatic changes, the possible former shifts in the position of the Polar Front, the scarcity of plant species as climatic indicators and the possibilities of dispersal of pollen grains and spores over long distances. Two cores from Marion I. and one from Prince Edward have been analyzed. The oldest core covers about 16,000 yr (Marion) and the diagram indicates: colder conditions prior to 14,000 B.P., climatic amelioration between 14,000 and about 11,500 B.P. and conditions resembling present day climate during the last 10,000 yr. A decrease in temperature of 2 to 3 deg C during the cold phase can be inferred from the pollen results. During this cold phase extensive parts of the island Marion must have been covered by glaciers as is also indicated by geological evidence. The postglacial black lava which covers extensive areas of the islands must have a minimum age of about 2,700 to 4,000 years according to Carbon 14 age determinations of superimposed peat deposits. (AntB B-11111) AntB B-11111

1175. **Schreve-Brinkman, E.J.** 1978. A Palynological Study of the Upper Quaternary Sequence in the El Abra Corridor and Rock Shelters (Colombia). *Palaeogeography, Palaeoclimatology, Palaeoecology 25(1-2):1-109.*

This palynological study is a contribution to the reconstruction of the vegetational, climatological and stratigraphical sequence in the El Abra corridor principally during the Last Glacial and the Holocene. At the beginning of the Holocene (El Abra zones VI, VII, VIII), the more definite amelioration of the climate took place. The El Abra corridor formed part of the Andean forest belt. Several species, representative of the Andean forest, reappear after a long absence or occur for the first time in the diagram. The sediment consists of a partly homogenized "soily" material. During the upper part of the Holocene, human influence on the vegetation is apparent. Apart from the pollen analysis, opaline silica bodies were studied. These bodies (=phytoliths) are remnants of plants. The main contributors are grasses. Each genus may have its own characteristic types. It appeared that the opaline silica oodies may provide very useful information in two ways. A quantitative analysis offers methods for correlation. A qualitative analysis offers the possibility to identify various taxa within the Gramineae, which is otherwise impossible on the basis of pollen grains. (Auth)(JTA)

1176. **Sercelj, A., and D.P. Adam.** 1975. A Late Holocene Pollen Diagram from near Lake Tahoe, El Dorado County, California. *Journal of Research, U.S. Geological Survey 3(6):737-745.*

A 2,500-yr pollen record from an alpine meadow in the central Sierra Nevada shows a general agreement with other more detailed pollen records from the late Holocene of California. Tree roots from the site suggest dry conditions at about 1150 and 1350 radiocarbon yr B.P. (Auth)

1177. **Short, S.K.** 1978. Holocene Palynology in Labrador-Ungava: Climatic History and Culture Change on the Central Coast. *Ph.D. Thesis, University of Colorado, Boulder, CO, 231 pp.*

Thirty-eight Carbon 14 dates provide chronological control and show that after deglaciation the earliest organic records began at 10,300 B.P. Initially, at the older sites, there was a prolonged tundra episode lasting up to 2000 or more years, followed synchronously by low arctic shrub communities of dwarf birch and alder which dominated the landscape until open spruce woodland arrived about 5500 B.P. in central Labrador-Ungava, 5000 B.P. in the Hamilton Inlet area, and about 4500 to 4000 B.P. in northern Labrador. Spruce values declined after about 3000 B.P. and spread into former woodland areas. There is some evidence for short, warm episodes until ca. 5000 B.P. when colder, drier conditions were initiated. It is hypothesised that settlement pattern change in Hamilton Inlet can be related to climatic change because of the effect of climate on the subsistence activities of human groups. (Auth)(JTA)

1178. **Short, S.K.** 1978. Palynology: A Holocene Environmental Perspective for Archaeology in Labrador-Ungava. *Arctic Anthropology 15(2):9-35.*

A series of six pollen diagrams has been prepared for lakes in northeastern Labrador-Ungava to investigate the chronology of deglaciation, the rate of plant colonization, and episodes of climatic change, and to provide a palaeoenvironmental perspective for archeological research in the area. Thirty-eight Carbon 14 dates provide the chronological control, and show that the earliest organic records began at 10,500 B.P. There was a prolonged tundra episode at all the older sites, lasting from 2000 years up to 4000 years. This was followed around 6700-6500 B.P. by low-arctic shrub communities of dwarf birch and alder dominating the landscape for up to 2000 years until open spruce woodland arrived, generally between 4500 and 4000 B.P. Spruce numbers declined after about 3000 B.P., and tundra has spread into former woodland since that time. This last period of colder climate has also seen a marked decline in lake productivity, as measured radiometrically by the rate of sediment accumulation. Thus, recent vegetational changes are difficult to analyze. The prolonged episodes of tundra and shrub tundra development suggest that the early Archaic occupations of the Labrador coast preceded the arrival of spruce. Colder climatic conditions are correlated with the expansion of Dorset Eskimo into Labrador-Ungava. (Auth)

1179. **Short, S.K., and J.T. Andrews.** 1980. Palynology of Six Middle and Late Holocene Peat Sections, Baffin Island. *Geographie physique et Quaternaire 34(1):61-75.*

Palynological investigations were undertaken at six sites on the northern Cumberland Peninsula, Baffin Island. Pollen assemblages from the Canadian High Arctic are rare, and the purpose of this paper is to expand this record. Twelve pollen diagrams from the six sites are presented. They suggest that over the last 1000 years, the pollen rain has been dominated by pollen of the graminoid group. This contrasts with earlier pollen assemblages between 2500 and 2000 years B.P. and between 5000 and 4000 B.P. which were typically more diverse and included significant quantities of heath and shrub (willow) pollen. A pronounced willow peak is evident on the diagrams and dates from ca. 2500 B.P. (Auth)

1180. **Short, S.K., and J.D. Jacobs.** 1982. A 1100 Year Paleoclimatic Record from Burton Bay - Tarr Inlet, Baffin Island. *Canadian Journal of Earth Sciences 19:398-409.*

Pollen studies were carried out in the upper Frobisher Bay area, Baffin Island, as part of joint paleoenvironmental-archeological investigations in the area. Pollen data from southern Baffin Island are rare, and this paper expands this record. A shallow peat section and several recent pollen records are presented. They suggest a contrast between an earlier assemblage, dated 2000-1650 B.P., which was characterized by a rich, diverse flora, especially birch shrubs, and a subsequent pollen assemblage dominated by grass pollen and interpreted as representing colder and drier conditions to 900 B.P. (Auth)

1181. **Short, S.K., and H. Nichols.** 1977. Holocene Pollen Diagrams from Subarctic Labrador-Ungava: Vegetational History and Climatic Change. *Arctic and Alpine Research 9(3):265-290.*

Six pollen diagrams have been prepared for lakes in northeastern Labrador-Ungava in order to investigate the chronology of deglaciation, the rate of plant colonization of the new landscape, and the climatic changes affecting the arctic tree line, as compared to northwest Canada. Thirty-eight Carbon 14 dates provide the chronological control, and show that the earliest organic records began at 10,300 B.P. Initially, at all the older sites, there was a prolonged tundra episode, lasting up to 1000-2000 or more years. This was followed synchronously by low-arctic shrub communities of dwarf birch and alder, dominating the landscape for many centuries until open spruce woodland arrived, generally about 4000 B.P. Prior to the spruce arrival, there were long "tails" of low PICEA numbers. Spruce numbers declined after about 3000 B.P., and tundra has spread into former woodland since that time. The northward spruce migration was delayed relative to western arctic Canada, possibly due to marine influence on climate, but the subsequent southward expansion of tundra was broadly synchronous in both regions. The last 3000 years of colder climate have also seen a very marked decline in lake productivity, as measured radiometrically by the rate of sediment accumulation. Thus, the topmost decimeters of these lake sediments date back several millennia, and should be used with great caution in comparing modern vegetation with "recent" pollen sedimentation. (Auth)

1182. **Simmons, I.G., and P.R. Cundill.** 1974. Late Quaternary Vegetational History of the North York Moors. I. Pollen Analyses of Blanket Peats. *Journal of Biogeography 1(3):159-169.*

Even within a limited area of the North York Moors, chosen for an intensive pollen and stratigraphic study of the blanket peat, there are marked variations from site to site in the rate of peat accumulation and in the pollen record. The influence of man on the area is apparent throughout the period of blanket peat accumulation. Initially this influence is not strongly marked, but after the ULMUS decline two major periods of woodland destruction can be identified. On the basis of archaeological and historical evidence these periods are tentatively assigned to the Bronze Age and Medieval times. (from Authors) Ecol Abs 75L/4023

1183. **Simonarson, L.A.** 1979. On Climatic Changes in Iceland. *Jokull 29:44-46.*

Holocene climatic changes are mainly reflected by changes in the vegetation, recorded in bog and lake deposits. The dating of the changes is greatly facilitated by numerous tephra layers that serve as good time markers, as their chronology is fairly well known. In early Holocene, 10,000-9000 B.P., there was a small BETULA maximum in North Iceland, whereas South Iceland seems to have been BETULA-free. This may support the theory that a part of the Icelandic flora has survived the last glaciation in ice-free refugia in northern Iceland. About 9000 B.P. BETULA immigrated rapidly into southern Iceland as indicated by the first great BETULA maximum in the pollen diagrams. During this maximum, correlated with the Boreal and lower Atlantic in continental Europe, annual mean temperature may have been about 2 deg C higher than today and the precipitation was somewhat lower. A BETULA minimum equated with the wet Atlantic of continental Europe started about 6500 B.C. The BETULA receded and bogs became wide-spread as the precipitation increased. The temperature must have been somewhat higher than the present one, as this interval shows a distinct SPHAGNUM maximum, but this plant is not spore-producing now in Iceland. Between 5000 and 2500 B.P. the second great BETULA maximum occurred and BETULA vegetation covered at least 50% of the country. This time is correlated with the Subboreal of continental Europe. The anual mean temperature was probably 2-3 deg C higher than today, the precipitation was somewhat lower and the winters were rather mild. Deposits from the NUCELLA transgression in Subboreal time, when sea-level apparently rose about 3 m, are known from Northwest Iceland. A climatic deterioration took place about 2500 B.P. The BETULA vegetation declined somewhat and bogs became widespread again. After the beginning of settlement in Iceland, i.e. about 870 A.D., the BETULA vegetation decreased rapidly. There is a sharp increase of grasses, and cultural indicators appeared. A rapid soil erosion began. This reflects the devastating influence of the settlement on the vegetation of Iceland. (Auth)

1184. **Sorsa, P.** 1965. Pollen-Analysis Investigations of Late Quaternary Vegetation and Climatic Development in Northeast Finland. . Pollenanalytische Untersuchungen zur spatquartaren Vegetations- und Klimaentwicklung im ostlichen Nordfinnland. German. *Annales Botanici Fennici 2(4):301-413.*

Comprehensive study of this largely arctic area (incl spore analysis), covering the late and postglacial. Following introductory review of the area, its physiography, climate and vegetation as well as methods of study, pollen diagrams from three locations sampled are described and analyzed. From these data, the floristic history of the area is traced and five major climatic-vegetational periods described in detail. Two of them are late glacial, with three postglacial following. Of the latter the second, about 5700-2500 B.C., represents the climatic optimum with pine-birch forests predominant. (AB91991) AB91991

1185. **Spear, R.W.** 1981. The History of High-Elevation Vegetation in the White Mountains of New Hampshire. *Ph.D. Thesis, University of Minnesota, 257 pp.*

Pollen and macrofossil analyses of lake and bog sediment provide a paleoecological record for high elevations in the White Mountains since deglaciation. Two pollen types characteristic of disturbed sites, ARTEMISIA and Caryophyllaceae, indicate that periglacial conditions persisted on the summits until 10,300 years B.P. Spruce (PICEA) krummholz arrived at Deer Lake Bog and Lake of the Clouds 10,300 years B.P. Although the patches of spruce krummholz were more extensive than any found today, the fossil record indicates that open patches of vegetation existed. Subalpine fir forests developed around the three lower elevation sites around 9000 years B.P. and have remained essentially unchanged since then. At Lake of the Clouds the numbers of fir needles preserved in the sediments indicate that fir krummholz was more widespread during the first half of the Holocene. After 5000 years B.P. the doubling of pollen percentages of alpine indicators signifies more open conditions. The barren summits were subjected to intense periglacial activity from 13,000 to 11,750 years B.P. Mean annual temperatures between 5 to 10 deg C colder than those of today helped to shatter the bedrock of the summits. By 11,750 years B.P. the climate had moderated, and the peaks had become vegetated. Periglacial activity continued, so the mean annual temperature must have been around 5 deg C colder than today. By 10,300 years B.P. periglacial activity ceased. Temperatures were similar to or possibly a little warmer than those of today. During the first half of the Holocene extensive fir krummholz at Lake of the Clouds indicates that the mean annual temperature may have been as much as 2 deg C higher than at the present. (Auth)(JTA) Dissertation Abstracts International 42(6) :2215-B - 2216-B, Order No. 8126025

1186. **Stravers, L.K.S.** 1981. Palynology and Deglaciation History of the Central Labrador-Ungava Peninsula. *M.Sc. Thesis, University of Colorado, Boulder, CO, 171 pp.*

A three phase history of vegetation has been documented through pollen analysis of lake sediment cores from three sites near the town of Schefferville in the central Labrador-Ungava peninsula. Following deglaciation, an initial tundra phase is proposed for a brief period, lasting approximately 7700-7400 B.P. However, the dating control of this phase is uncertain; these dates are based on extrapolation, assuming linear sedimentation rates, and are maximum estimates. The tundra period of low pollen production is succeeded by a shrub tundra phase which dominated the vegetation from approximately 7400 B.P. to 4900 B.P. The pollen spectrum during this period was characterized by alder and birch pollen. Development of the shrub tundra is illustrated through three subzones recognized from the pollen diagrams. The spruce lichen woodland was solidly established by 4800 years B.P., the result of a major, synchronous warming trend. Spruce pollen is overwhelmingly dominant throughout this final zone. The only vegetational change observed during the last 5000 years since the establishment of the spruce woodland is a reduction in the absolute pollen production, coupled with a drop in spruce pollen percentages and organic sedimentation rate. This reduction, dated here as beginning between 3050 and 2100 B.P., is recognized in many other pollen profiles from across the peninsula. (Auth)(JTA)

1187. **Surova, T.G.** 1967. Development of Plant Life in the Polar Urals during the Holocene. O razvitii rastitel'nosti Poliarnogo Urala v golotsene. Russian. *Moskva. Univ. Vestnik 22 ser. 6: biol., pochvovedenie, no. 2:66-74.*

Distinguishes five phases in the Holocene vegetational history of the Polar Urals, based on a 1964 palynologic and macrofloral study of relict hummocky bogs in the tundra zone of the Malaya Khadata lake region at ca 67 deg N: dwarf birch, pine, mixed pine birch, 2d pine and scrub birch. Indicated climatic fluctuations are noted. Section logs, pollen diagrams, the present-day vertical distribution of plants and maps of plant zones during the postglacial climatic optimum and at present are included. (AB100490) AB100490

1188. **Szczepanek, K.** 1982. Development of the Peat-Bog at Slopiec and the Vegetational History of the Swietokrzyskie (Holy Cross) Mountains in the Last 10,000 Years, Preliminary Results. Historia roslinnosci Gor Swietokrzyskich w ciagu ostatnich 10,000 lat na podstawie badan torfowiska w Slopeu Doniesienie wstepne. *Acta Palaeobotanica 22(1):117-130.*

The preliminary results of pollen analytical studies at Slopiec, in the southern part of the Swietokrzyskie (Holy Cross) Mts. are presented. A profile, 5.25 m long, was obtained from the peat bog, and twelve samples were radiocarbon dated. The oldest sample gave the age of 10,280 + or - 210 B.P. On the basis of pollen analysis the regional history of vegetation and the main outlines of peat-bog development are reconstructed. The comparison of pollen analytical results obtained in 1961 and in 1979/80 showed their close similarity, concerning all phenomena of stratigraphical and successional significance. The radiocarbon datings revealed gaps or considerable changes in the rate of sediment accumulation in two time intervals. (Auth)

1189. **Tallantire, P.A.** 1972. Spread of Spruce (PICEA ABIES (L.) Karst) in Fennoscandia and Possible Climatic Implications. *Nature 236(5341):64-65.*

Radiocarbon dated pollen horizons throughout Fennoscandia suggest climatic periods favourable for the migration of spruce (PICEA) occurred at about 900 year intervals between about 5500 B.P. and the present. These episodes appear to correlate with a "high index"/atmospheric circulation pattern. (JTA)

1190. **Terasmae, J.** 1967. Recent Pollen Deposition in the Northeastern District of Mackenzie (Northwest Territories, Canada). *Palaeogeography, Palaeoclimatology, Palaeoecology 3:17-27.*

Surface samples of peat, soil, and lake sediments collected by W. Blake in the Bathurst Inlet-MacAlpine Lake area while studying glacial history were examined for pollen grains and spores. The pollen-and-spore assemblages obtained reflect the characteristics of local vegetation and contain a significant component of pine and spruce pollen from a distant source area. The area studied lies 200-250 miles north of the tree-line. A study of peat deposits has indicated that the meteorological factors influencing long-distance dispersal of pollen have remained essentially unchanged for the last 2,000 years. This study also suggests that peat deposition has been extensive only in Late Postglacial time, and commonly an important

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discontinuity separates the surface peats from the underlying inorganic deposits in the MacAlpine Lake area. (Auth)

1191. **Terasmae, J.** 1973. Notes on Late Wisconsin and Early Holocene History of Vegetation in Canada. *Arctic and Alpine Research 5(3, Part 1):201-222.*

The ice sheets (Laurentide and Cordilleran) completely disturbed the vegetation in Canada. As deglaciation occurred in response to a significant change in climate at the end of the Pleistocene (about 10,000 years ago), recolonisation of Canada by vegetation proceeded from the refugia and a northward migration of biota from the southern peripheral region of glaciation. The late glacial episode differed from any subsequent Holocene time episode in terms of the availability of large areas of "raw" soils, the very large volume of meltwater runoff, and the presence of numerous large glacial lakes that at least locally affected the climate. Genetic mixing occurred during recolonisation when the populations from different refugia met after having been isolated for several thousand years. The studies of the fossil record are seriously hindered by the lack of basic palynological data (pollen deposition and dispersal in relation to the modern vegetation) and the ecology, phytogeography and genetics of Canadian vegetation and flora, as well as the relationships between vegetation and the climate in particular. (from Author) GA 74A/0133

1192. **Terasmae, J., and T.W. Anderson.** 1970. Hypsithermal Range Extension of White Pine (PINUS STROBUS L.) in Quebec, Canada. *Canadian Journal of Earth Sciences 7:406-413.*

Fossil wood, cones, and leaves of white pine (PINUS STROBUS L.) were discovered at Val St. Gilles, Quebec, some 60 miles (approximately 96.6 km) north of the present distribution limit of this species. The fossils were buried under several feet of peat, and were dated at 5030 + or - 130 (GSC-585) radiocarbon years before the present. In the pollen diagram from this peat exposure a white pine pollen maximum coincides with the stratigraphic unit in which the fossil pine wood was found. This discovery indicates that white pine was growing well north of its present distribution limit during the Holocene hypsithermal interval, when climatic conditions were more favorable in this region than at present. (Auth)

1193. **Terasmae, J., and O.L. Hughes.** 1966. Late-Wisconsinan Chronology and History of Vegetation in the Ogilvie Mountains, Yukon Territory, Canada. *Palaeobotanist 15(1-2):235-242.*

Palynology and radiocarbon dating have been used to interpret the chronology of the complex moraine sequence representing three major glacial episodes in the western Ogilvie Mountains, characterised by successive advances and retreats of valley glaciers; the youngest episode probably culminated 10,000 to 12,900 years ago. Pollen diagrams of the Gill Lake core, dated at 12,550 + or - 190 years at a depth of 9 feet, show vegetational trends suggesting a late-glacial dispersal of birch, alder, willow and spruce from refugia in the unglaciated plateaus of Yukon and Alaska bordering the Ogilvie Mountain on the west, in addition to later migrations from the south and southeast. Glacial and vegetational successions in the Ogilvie Mountains can be correlated with those of the north-central Brooks Range, Alaska. (from Abstracts N. American Geology) GA 68A/816

1194. **Van Campo, M., and G. Jalut.** 1969. Pollen Analysis of the Sediments of the Eastern Pyrenees: Lac de Balcere, 1764 m. Analyse pollinique de sediments des Pyrenees orientales: Lac de Balcere (1764 m). French. *Pollen et Spores 11(1):117-126.*

Pollen-analysis facilitated a study of the evolution of flora, without interruption, from Early Dryas to Sub-Atlantic period. The Allerod oscillation is shown for the first time in Pyrenees Orientales. The beginning and extension of ABIES are dated by Carbon 14 from Pre-Boreal period. Its importance, at 1764 m altitude for a long time, gives some paleoclimatological data. (English Summary) GA 71B/0993

1195. **Van der Hammen, T.** 1962. Palynology of the Region of "Laguna de los Bobos", History of its Climate, Vegetation and Agriculture during the last 5,000 Years. Palinologia de la region de "Laguna de los Bobos", Historia de su clima, vegetacion y agricultura durante los ultimos 5.000 anos. Spanish, English Summary. *Revista de la Academia Colombiana de Ciencias 11(44):359-361.*

The present article deals with the pollen analysis of a section from a lake (Laguna de los Bobos) at an elevation of 3800 metres in the region of Oak-forests near the limit of the departments of Boyaca and Santander (Cordillera Oriental, Colombia). The diagram shows two more important changes of "treeline", a rise between samples 21 and 20 and a fall between samples 13 and 12. According to the Carbon 14 dates, the second one should correspond to the Subboreal-Subatlantic transition in Europe. Comparison with other diagrams from Colombia shows that the first should correspond approximately to the Atlantic-Subboreal transition. The fall of ALNUS and the rise of QUERCUS between samples 16 and 15 is another change of vegetation, also recognizable in other Colombian diagrams. A curve for ZEA MAYS (maize, corn) and the Carbon 14 dates indicate that agriculture was of importance in the lower valleys from approximately 300 (-600) B.C. until 1200 A.D. (Auth)

1196. **Van der Hammen, T., J. Barelds, H. De Jong, and A.A. De Veer.** 1981. Glacial Sequence and Environmental History in the Sierra Nevada del Cocuy (Colombia). *Palaeogeography, Palaeoclimatology, Palaeoecology 32(3-4):247-340.*

The glacial sequence in the area of the Sierra Nevada del Cocuy (Cordillera Oriental, Colombia) was studied in the field and by means of aerial photographs in relation to the environmental history, which was studied by means of pollen analysis and radiocarbon dating. At least five (possibly six) glacial drift bodies could be recognized, and on the basis of the (groups of) bordering moraines about six main glacial stades were defined and named. Drifts 2, 3, 4 and 5 are presumably all of Fuquenian (Last Glacial) age, whereas Drift 6 is of Holocene (Neoglacial) age. There are very clear signs of a late medieval neoglaciation; glaciers started to retire from the outermost Neoglacial bordering moraines probably after 1850 A.D. and are still decreasing. (Auth)(JTA)

1197. **Van der Hammen, T., and E. Gonzalez.** 1960. Upper Pleistocene and Holocene Climate and Vegetation of the "Sabana de Bogota" (Colombia, South America). *Leidse Geologische Mededelingen 25:261-315.*

The uppermost 32 metres of a 266 metre core principally of lake sediments, Pleistocene and Holocene in age from the Sabana de Bogota were analysed for its pollen content, at intervals of 10-15 cm. About seventy species, genera of families could be recognized, many of them for the first time. The rest of the core is being analysed and the results will be published later. The Sabana de Bogota lies at an altitude of approximately 2560 metres above sea level, 4 1/2 deg - 5 deg North of the equator, and 74 deg - 74 1/2 deg West of Greenwich. From the diagram it may be deduced that glacial and interglacial periods affected the tropics equally as Europe and North America. It also shows that the glacial periods were at the same time pluvials, and the interglacial interpluvials. Curves for the real fluctuations of the treeline, changes of annual precipitation and changes of temperature have been calculated (fig. 5). Temperatures dating the high glacial phases of the Wurm glacial were + or - 8 deg C lower than today, the altitude of the tree line was some 1300 metres less than now and the snow-line showed an even greater difference (fig. 5). Radiocarbon dates prove that the parts of the sections considered to be respectively Holocene and later Wurm-glacial really correspond to those ages. Moreover the temperature curve for the upper Pleistocene of the Sabana de Bogota corresponds surprisingly well with that published by Emiliani for surface ocean water and by Gross for Europe (fig. 6). With this knowledge it seemed fully justified to correlate also the older phases with the glacials and interglacials of Europe and North America using principally the alpine nomenclature. The lowest part of the diagram seems to correspond to the end of Riss I (= Drenthe stadial), followed by the Riss I-II interstadial and the Riss II (= Warthe stadial). Then follows the Riss-Wurm interglacial, the Wurm-glacial (subdivided by two long interstadials, together called Interpleniglacial), and the Holocene. (Auth)

1198. **Van der Hammen, T., and E. Gonzalez.** 1960. Holocene and Late Glacial Climate and Vegetation of Paramo de Palacio (Eastern Cordillera, Colombia, South America). *Geologie en Mijnbouw 39:737-746.*

The present article deals with the results of pollen analyses and radiocarbon age determinations of two lake sections and two peat-bog sections from Paramo de Palacio, a high area between 3200 and 3900 metres above sea level in the Eastern Cordillera of Colombia, equatorial South America. It is shown that the climatic phases here of the Late Glacial and the Holocene are perfectly synchronous with the European phases. Maximal average annual temperatures during the climatic optima of the "hypsothermal interval" of the Holocene, were 2 deg - 3 deg C higher than today. (Auth)

1199. **Van der Hammen, T., and E. Gonzalez.** 1965. A Late-Glacial and Holocene Pollen Diagram from Cienaga Del Visitador (Dept. Boyaca, Colombia). *Leidse Geologische Mededelingen 32:193-201.*

In a Carbon 14 dated pollen diagram from "Cienaga del Visitador" ca 6 deg 8 min N; 72 deg 47 min W) in the Colombian Eastern Cordillera the zones Ib - Ic - II including the Allerod and Bolling interstadials form one fluctuation in the diagram, as the short cold zone Ic is not reflected. An earlier Late-glacial interstadial is recognized and is called Susaca-interstadial. It probably lasted from about 13900 to 13100 B.P., was colder than the Bolling-interstadial and is probably reflected in pollen diagrams from other parts of the world. The Holocene part of the diagram shows very high Gramineae-percentages, apparently due to a considerable lowering of the "tree-line". This must have been caused by the fact that the Holocene local climate has been much drier than the Late-Glacial, even dominating the effect of the increase of temperature on the tree-line. The pollen zonation is nevertheless rather clear, and directly comparable with that from the Sierra Nevada del Cocuy and other areas. The contemporaneity of the Colombian and European pollen zones, strongly suggested or proved by earlier partly-dated diagrams, seems to be fully confirmed by the present one. (Auth)

1200. **Van Geel, B., and T. Van der Hammen.** 1973. Upper Quaternary Vegetational and Climatic Sequence of the Fuquene Area (Eastern Cordillera, Colombia). Spanish Abstract. *Palaeogeography, Palaeoclimatology, Palaeoecology 14:9-92.*

In this paper the results of a pollen-analytical study of three bore holes of lake deposits in the Fuquene-Valle de Ubate area, Colombian Cordillera Oriental (5 deg N; elev. 2,580 m) are given. By means of Carbon 14 dates and comparison with other pollen diagrams and dates from the Eastern Cordillera, it was possible to correlate the local pollen zones and chronostratigraphical units with the European chronostratigraphical sequence. The longest diagram (Fuquene II) represents some 30,000 years, including part of the Middle Pleniglacial, the Upper Pleniglacial, the Late Glacial and the Holocene. During the Middle Pleniglacial, POLYLEPIS wood was an important constituent of the vegetation. During the climatic extremes of the Upper Pleniglacial an open paramo vegetation existed. During the main part of the Upper Pleniglacial (from ca. 21,000 to ca. 13,000 B.P.) the lake level was low and the climate dry. The lake level rose again in the beginning of the Late Glacial, and the area around the lake became forested. At the beginning of the El Abra Stadial (Late Dryas Stadial) there was a marked cooling and the lake became lower once more; this had a great impact on the vegetation which became partly open again. The beginning of the Holocene is marked by a gradual increase of forest elements, especially of QUERCUS (oak). Oak forests dominated the area during the greater part of the Holocene. During the "hypsithermal", elements growing today at a lower level, such as CECROPIA, ACALYPHA (and possibly ALCHORNEA), must have been growing in the area, intermixed with the oak forests. At the same time there was a considerable increase of Urticaceae in the undergrowth of these forests. The vegetation zones were probably situated several hundreds of meters higher than they are at the present time. (Auth) (JTA)

1201. **Vasari, Y.** 1962. A Study of the Vegetational History of the Kuusamo District, North East Finland, during the Late-Quaternary Period. *Suomalainen elain- ja kasvitieteellinen Seura Vanamo. Kasvitieteellisia julkaisuja: Annales botanici, v. 33, no. 1, 140 pp.*

Describes the grass-herb forest center of this upland and part of the more sterile area to the south and west. Bedrock is of granite, gneiss, and the intervening highly variable Karelian schists. Surface deposits consist mainly of till. Soil is rich. Mean elevation exceeds 300 m in places, parts of the area are above the tree limit, and bog of various types covers more than a third. Mean annual temperature is + or - 0 to + 1 deg C., and precipitation 550 mm or less. Climate is continental in temperature conditions but oceanic in humidity, a combination found within coniferous forest belts on eastern edges of great continents. Differences in microclimate are pronounced. The author's 1951-1959 collections from shallow water deposits of former lakes provided for analysis 85 general samples for macrosubfossils, 22 macrosubfossil series with pollen profiles for dating, and two pollen series. Present types of field and plant assemblages are described. Cross-sections of Paleo-, Eo-, Meso-, and Neoholocene flora of the region are explained. Each stage is divided into two parts on the basis of pollen analysis. In its nomenclature the author's system follows that formulated by M.I. Neishtadt, and his phases resemble those defined for eastern Karelia by Russian scientists. Summary includes some key words used in the Finnish text with brief explanation or translation. (AB83982) AB83982

1202. **Vasari, Y.** 1963. Studies on the Vegetational History of the Kuusamo District, Northeast Finland, during the Late-Quaternary Period, 2; Radio-Carbon Datings. *Suomalainen elain- ja kasvitieteellinen seura Vanamo. Tiedonannot: Archivum, v. 18, no. 2, pp. 121-127.*

Reports radiocarbon determinations of samples from areas earlier dated by pollen analysis. In most cases the results of the two methods do not agree. (AB92658) AB92658

1203. **Vasari, Y.** 1965. Studies on the Vegetational History of the Kuusamo District (North East Finland) during the Late-Quaternary Period. III. Maanselansuo, a Late-Glacial Site in Kuusamo. *Annales Botanici Fennici 2(3):219-235.*

The history of the bog is one of progressive impoverishment. Carbon 14 dating places the lowest horizon of site A at late Preboreal rather than the Late-glacial implied by the pollen profile. Necessary revaluations of time scales may be explained by differences in historic prevailing conditions at different sites; and comparisons are made with other work in the Kuusamo district and correlations made with vegetational history in southern Finland. The Late- and Post-glacial periods for Maanselansuo are described in detail. (P.J. Jarvis)(JTA) GA 66B/414

1204. **Vasari, Y.** 1972. The History of the Vegetation of Iceland during the Holocene. *Climatic Changes in Arctic Areas during the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, 4-10 October, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 239-252), 511 pp.*

Climatologically, Iceland is in such a key position that a reliable dating of the various climatically conditioned vegetation periods would be of paramount importance. Supposing, however, that the concept of the history of vegetation in Iceland that has been presented above is correct, the following conclusions can be made: a) the climate of Late-glacial time in Iceland must have been especially rigorous as no signs of plant life during the Late-glacial proper have so far been found, b) the period in which vegetation became denser and when the deposition of organic material in the lakes commenced, did not begin before the (late) Boreal period, c) the spread of birches over the country, covered until then by treeless vegetation, took place quite rapidly during the early part of the Atlantic and led, at the beginning of the late Atlantic (AT 2), to the first Birch period, d) during the early part of the Sub-boreal the climate is likely to have become more humid which led to an increase of grass and herb vegetation at the expense of birches, e) towards the end of the Sub-boreal the birch forests experienced a further expansion before a new decline during the Sub-atlantic, and f) since the beginning of human settlement, the history of the vegetation in Iceland has been very closely connected with man's activities. (Auth)(JTA)

1205. **Vasari, Y.** 1974. The Vegetation of Northern Finland - Past and Present. *Inter-Nord 13-14:99-118.*

The regional pattern also forms a basis for the treatment of the vegetational history: the present vegetation zones have had a different history, each one of them. The question of the Late-glacial vegetation in Northern Finland is particularly interesting and still somewhat disputed. During the period of the climatic improvement – from the end of the Late-glacial until the Atlantic period (10,000 - 6,400 B.P.) the different vegetation formations: treeless periglacial vegetation, birch forests and pine forests followed each other metachronously being generally later and of shorter duration the further north one goes. The Atlantic period (6,400 - 4,800 B.P.) has been a time of equilibrium in forest and mire vegetation alike. The beginning of the Subboreal (about 4,800 B.P.) meant a marked deterioration of the climate which became cooler and more humid. This process has continued up to the present time and led to the present state of the vegetation of Northern Finland. (Auth)(JTA)

1206. **Vincent, J.-S.** 1973. A Palynological Study for the Little Clay Belt, Northwestern Quebec. *Naturaliste Canadien 100:59-69.*

Little information is available on the postglacial geochronology, vegetation and paleoclimates of the Clay Belt of northwestern Quebec and northeastern Ontario. Based on the analysis of a sediment core recovered from Lake Louis, Laverlochere Township, Temiscamingue County, Quebec, a pollen stratigraphy for the Little Clay Belt is presented. Six stratigraphic pollen zones determined for the Lake Louis site are correlated with other pollen zones of central Quebec and the St. Lawrence Lowlands. After the initial warm period that followed deglaciation and the partial drainage of Lake Barlow-Ojibway, a colder, moist period existed. This was followed by the two distinct periods of the hypsithermal interval in which the later period is warmer and drier. The hypsithermal was followed by a warm but moist climate, and then later on by the present cooler, moist climate. The first vegetation colonized the Lake Louis site 9,090 + or - 240 B.P. years ago (GSC-1432). A radiocarbon age determination at the boundary between the two periods of the hypsithermal gave a date of 7,280 + or - 250 B.P. (GSC-1481). This dates the shift in vegetation from jack-pine to white and red pine, which indicates the continuing warming trend of the climate during that period. Another Carbon 14 age determination at the end of the hypsithermal gave a date of 4,260 + or - 240 B.P. (GSC-1491). At this time, the warm climate had already started to deteriorate in the area. The "Cochrane Surge" probably occurred at the end of the colder, moist period that followed the initial warm period. (Auth)

1207. **Waddington, J.C.B., and H.E. Wright, Jr.** 1974. Late Quaternary Vegetation Changes on the East Side of Yellowstone Park, Wyoming. *Quaternary Research 4(2):175-184.*

A bog 4 km east of Yellowstone Lake has a pollen record starting with an ARTEMISIA spruce assemblage, implying alpine vegetation. A layer of volcanic ash, dated as 14,360 + or - 400 B.P. (probably Glacier Peak or Mt. St. Helens J), occurs within the zone, which terminates at 11,630 + or - 180 B.P. The rest of the pollen sequence is dominated by lodgepole pine, with reappearance of spruce pollen in modest quantitites about 4500 B.P., according to dating provided by a layer of Mt. Mazama ash (6600 B.P.). The present vegetation of the area is marked by forests of lodgepole pine with some stands of spruce and fir. The pollen sequence suggests that the upper treeline before 11,600 y.a. was perhaps 500 m lower than today. The climate then became warmer and/or drier than today (Altithermal interval). About 4500 y.a., a slight climatic reversal took place, roughly contemporaneous with the regrowth of glaciers in the western mountains (neoglaciation). (Auth) GA 75A/0157

1208. **Walker, D.A.** 1981. Late Holocene Pollen and Present-Day Vegetation, Prudhoe Bay and Atigun River, Alaskan North Slope. *Arctic and Alpine Research 13(2):153-172.*

Four peat profiles of late Holocene age and a single stratum of peat of middle Holocene age were radiocarbon dated, and their pollen spectra analyzed. The samples were from four sites close to

Prudhoe Bay on the arctic coast of Alaska and from one site at the edge of the Brooks Range, Alaska, near Galbraith Lake. Nearly all levels in the pollen profiles showed significant amounts of PICEA and PINUS tree pollen. At sites near the coast the quantities of ALNUS and BETULA pollen were also high despite the fact that the floristic limits of these genera occur 120 and 70 km to the south. The pollen profiles were frequently dominated by Cyperaceae pollen. Because the prevailing winds in May and June across the Prudhoe Bay region are from the east and east-north-east, the high percentages of PICEA and PINUS in the diagrams may represent pollen transport from the forest-tundra ecotone and boreal forest of northwestern Canada. Many important taxa in the present vegetation were not represented in the pollen profiles, and difficulties of making inferences regarding past vegetation and climate are emphasized. (Auth)

1209. **Walker, M.J.C.** 1975. A Pollen Diagram from the Pass of Drumochter, Central Grampian Highlands, Scotland. *Transactions Botanical Society of Edinburgh 42(3):335-343.*

Three pollen assemblage zones were identified in the Pass of Drumochter profile which spans the mid- and late-Postglacial periods. The earliest record is of birch and hazel woodland, which was succeeded by the establishment of pine forest, possibly c. 7000 B.P. Declining arboreal pollen percentages and increased values for open habitat taxa in the upper reaches of the profile reflect the impact of Neolithic man in the area, with the destruction of the forests, and the spread of dwarf shrub heath and heather moor across formerly wooded hillsides. (from Author) Ecol Abs 76L/3730

1210. **Wardle, P., and A.D. Campbell.** 1976. Seasonal Cycle of Tolerance to Low Temperatures in Three Native Woody Plants, in Relation to their Ecology and Post-Glacial History. *New Zealand Ecological Society, Proceedings 23:85-91.*

The post-glacial pollen sequence for inland regions of the eastern South Island, New Zealand, is from grass to COPROSMA to DACRYDIUM to PHYLLOCLADUS to PODOCARPUS and DACRYCARPUS to NOTHOFAGUS. If this is interpreted simply as a response to climatic warming, the position of DACRYDIUM is anomalous. Nor can its position be explained in terms of pedogenesis. DACRYDIUM BIDWILLII is mostly found on the valley terraces subject to severe frost. This suggests: 1) that it is more tolerant of winter cold than either PHYLLOCLADUS ALPINUS or NOTHOFAGUS SOLANDRI CLIFFORTIOIDES, and 2) that early post-glacial times, as well as being generally cooler than now, may also have been characterised by severe temperature inversions. (Auth)(JTA) Ecol Abs 78L/3129

1211. **Welten, M.** 1982. Pollen Analytical Research on the Vegetation History of Swiss National Parks. Pollenanalytische Untersuchungen zur Vegetationsgeschichte des Schweizerischen Nationalparks. German, English Summary. *Ergebnisse der wissenschaftlichen Untersuchungen im Schweizerischen Nationalpark, Resultats des recherches scientifiques au Parc National suisse, Band XVI, 80, 43 pp.*

When in 1955 we began research work on the vegetational history of the Swiss National Reserve in Lower Engadin (Canton Graubunden) little information from the southern parts of the Central Alps was available. Since then a lot of investigations and radiocarbon datings have procured a frame for evaluation and comparison of our 12 local borings and pollendiagrams around the Swiss National Park. Our profiles are situated between 1546 and 2617 m above sea level and yield information from the Bolling-Allerod-Interstadial up to historical times. They are dated with 38 radiocarbon-dates measured by Prof. Oeschgers Laboratory at the University of Bern. Results reveal the vegetational development of a region in proximity of glacial relics on the one hand (PINUS SILVESTRIS, PINUS MUGO, LARIX, PINUS CEMBRA, PICEA, ABIES, BETULA, JUNIPERUS, HIPPOPHAE) and under the strong influence of a dry and continental inneralpine climate on the other hand. Lower Engadin seems to preserve a vegetational landscape of Early Glacial character, little altered by the invading of Eastern Alpine spruce. (Auth)

1212. **White, J.M., and R.W. Mathewes.** 1982. Holocene Vegetation and Climatic Change in the Peace River District, Canada. *Canadian Journal of Earth Sciences 19(3):555-570.*

A sediment core from a pond on the Alberta Plateau in the Peace River district of British Columbia was studied using pollen analysis and radiocarbon dating. Percentage and influx diagrams were produced, and radiocarbon dates were corrected to calender years to calculate the sedimentation rate. The 231 cm core terminated in clay, and a basal date of 7250 + or - 120 years B.P. was obtained, several thousand years after the recession of Glacial Lake Peace. The formation of the pond is interpreted as resulting from a climatic change, probably a transition from the peak of the Hypsithermal. Zone 1, from 7250 to 5500 years B.P., is interpreted as representing a seasonal slough, with upland vegetation percentages consistent with a boreal forest. At about 5500 years B.P. a permanent pond with surrounding sedge wetlands was formed. Vegetation has been essentially modern during the last 3100 years. Measurements of spruce grains suggest the presence of black and white spruce throughout the pollen record. The formation of permanent ponds and wetlands on the Alberta Plateau at about 5500 years B.P. is thought to have been the most important vegetation change of the last 7000 years, which may have affected faunal and human populations. (Auth)

1213. **Wright, H.E., Jr.** 1972. Interglacial and Postglacial Climates: the Pollen Record. *Quaternary Research 2(3):274-282.*

Pollen studies of four European interglacial intervals indicate a strong similarity in vegetational sequence: a pretemperate phase (I) marks the late-glacial, early temperate (II) and late temperate (III) phases mark the interglacial proper, and a post temperate phase (IV) represents the beginning of the next cold period. A broadly similar record is now known for the last interglacial (Sangamon) of central and southeastern United States. The Holocene sequence in both Europe and America are completely typical of the last interglacial sequence, although much more is known of the geographic variations. Estimates for the duration of the interglacials range from 10,000 to more than 30,000 yr, according to counts of annually laminated sediments (organic varves). The Holocene has already run a course of at least 10,000 yr. If it is like earlier interglacials, it will end soon, giving way to gradually developing cold conditions, which may not lead to glacial maxima for tens of thousands of years. (Auth) GA 73A/1381

1214. **Wright, H.E., Jr., A.M. Bent, B.S. Hansen, and L.J. Maher, Jr.** 1973. Present and Past Vegetation of the Chuska Mountains, Northwestern New Mexico. *Geological Society of America Bulletin 84:1155-1179.*

The vegetation history is worked out by pollen analysis of sediments of four lakes from the mountain crest. An 11 m core from Dead Man Lake gives the longest record, representing perhaps the last 50,000 yrs. Pollen zone 1, of Holocene age, is only a few decimeters thick. It is dominated by pine pollen, derived from the vegetation similar to today's for the area. (Auth)(JTA)

1215. **Young, S.B., and E.K. Schofield.** 1973. Palynological Evidence for the Late Glacial Occurrence of PRINGLEA and LYALLIA on Kerguelen Island. *Rhodora 75(802):239-247.*

LYALLIA KERGUELENSIS Hook, F. and PRINGLEA ANTISCORBUTICA R. Br. ex Hook. F., belong to monotypic genera which have no close relatives. In the subarctic flora these two genera are unique with regard to their taxonomically isolated position, and they provide the main support for the contention that the Kerguelen region can properly be considered to be a distinct phytogeographic province. The taxonomy and ecology of the two species are described. Analysis of peat and soil cores from the south shores of the Gulf of Morbihan for pollen content showed PRINGLEA pollen present in the lowermost sample of both cores, dated at approx 11,000 to 12,500 B.P. LYALLIA pollen was not found in core 2 and occurred in only 3 samples from core 1. However, its presence shows that the species did grow on the island more than 10,000 yr ago. The evidence demonstrates with certainty that both PRINGLEA and LYALLIA were present on Kerguelen during late-glacial times. (AntB E-13148) AntB E-13148

1216. **Young, S.B., and E.K. Schofield.** 1973. Pollen Evidence for Late Quaternary Climate Changes on Kerguelen Islands. *Nature 245(5424):311-312.*

Pollen analysis of two cores collected at Kerguelen Is. gave evidence of the following climatic changes. A first warming trend began about 12,000 B.P., culminating in a major glacial retreat by 10,000 B.P. Thereafter, low temperatures prevailed for about 1,000 yr; most of the deglaciated areas supported a cold-tolerant vegetation consisting mainly of AZORELLA and grasses. ACAENA became important as a major warming trend began. By 8,000 B.P. several cold-tolerant species had colonised the core sites. This apparent expansion of a vegetation containing a mixture of "lowland" species suggests that the climate of Kerguelen at that time was considerably warmer than at present. BLECHNUM and UNCINIA presently grow most luxuriantly in moist habitats, while GALIUM is usually found in dry habitats. As GALIUM pollen reached a peak later than the other "lowland" species, possibly the latter part of the climatic optimum was drier. By 5,000 B.P., the cold-tolerant species (partially excepting GALIUM) had declined to low levels, indicating that the warm period on Kerguelen was over. (AntB E-12898) AntB E-12898

1217. **Zeist, W. van, and H.E. Wright, Jr.** 1963. Preliminary Pollen Studies at Lake Zeribar, Zagros Mountains, Southwestern Iran. *Science 140(3562):65-67.*

A late Pleistocene ARTEMISIA steppe, implying a cool, dry climate, changed about 13,000 years ago to an oak-pistachio savanna, as the climate became warmer. About 5,500 years ago the savanna thickened to an oak forest, presumably reflecting an increase in precipitation or decrease in temperature to modern levels. (Auth) GA 64/426

1218. **Zinderen Bakker, E.M. van** 1969. Quaternary Pollen Analytical Studies in the Southern Hemisphere with Special Reference to the Sub-Antarctic. *Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Volume 5. A.A. Balkema, Cape Town, (pp. 175-212), 240 pp.*

In order to assess the influence of the last Antarctic glaciation on the climatic history of the world, a number of pollen sequences known from the southern islands and the southern oceans and continents have been surveyed and compared. Glacial evidence has also been taken into account. The pollen zones of these sequences can be used as biostratigraphic rock units for the construction of a framework for the stratigraphy of the Quaternary and as a means of assessing former climatic evolution. A study of these paleoclimatic data in conjunction with radiocarbon dates reveals that, at least during the Upper Pleistocene and Holocene, temperature variations were synchronous and of a world wide nature. (AntB E-8829) AntB E-8829

1219. **Zinderen Bakker, E.M. van** 1972. Pollen Analysis of Peat Samples of Holocene Age from Ile de la Possession (Crozet Islands, Sub-Antarctic). *Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Volume 7, covering the years 1969-1971. E.M. van Zinderen Bakker (Ed.). A.A. Balkema, Cape Town, (pp. 31-34).*

The results are presented of pollen analysis of four peat samples collected from a site on Possession I. surrounded by DESCHAMPSIA ANTARCTICA (?), some BLECHNUM-PENNA-MARINA, other grasses and many mosses. The pollen spectra are representative of the vegetation of mires such as those described from Marion I. The spectra of the lower levels (-72 and -56 cm) indicate that wetter conditions prevailed in the mire during the deposition of the higher levels (-40 and -24 cm). The proximity of the sea and some biotic influence on the vegetation are indicated. Human influence is indicated by the low percentage of 0.4 of cribalate pollen of Caryophyllaceae. The top part of the profile was either less compressed or grew more quickly than the bottom part. The four samples give a very incomplete picture of the former vegetation but they indicate that no changes which can be assigned to climatic changes, took place in the Subantarctic region during the late Holocene. (AntB E-14880) AntB E-14880

1220. **Zinderen Bakker, E.M. van** 1973. Glaciation(s) of Marion Island (Sub-Antarctic). *Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Volume 8, Scientific Committee on Antarctic Research Conference on Quaternary Studies, Canberra, Aug. 9-12, 1972. E.M van Zinderen Bakker (Ed.). A.A. Balkema, Cape Town, (pp. 161-178), 198 pp.*

Geological and palynological evidence indicates that Marion Island was glaciated at least once during Late-Pleistocene times. Potassium/Argon dating of grey lava smoothed by glacial action gives an age of between about 100,000 and 15,000 years B.P. for the last glaciation. This glacial was therefore contemporaneous with those of the Northern Hemisphere and the tropical East African mountains. During the glacial maximum the vegetation on the island was very limited. From about 16,000 to about 14,500 B.P. upland flora of AZORELLA existed near the coast. In Late-Glacial times the AZORELLA vegetation was replaced by the lowland ACAENA vegetation which was followed by a grass-moss soligenous mire which existed right through the Holocene. (Auth) AntB I-16403

Pedologic

1221. **Aaby, B., and H. Tauber.** 1974. Rates of Peat Formation in Relation to Degree of Humification and Local Environment, as Shown by Studies of a Raised Bog in Denmark. *Boreas 4:1-17.*

In the raised bog Draved Mose, rates of peat formation and degrees of humification were determined in the two peat sections. Based on 59 calibrated Carbon 14 dates, accumulation rates during the last 6500 years of 0.16 to 0.80 mm/year were found. The peat layers were analysed for SPHAGNUM species, rhizopods, and pollen and spores. A clear relation between humification degrees and humidity at the time of formation was found, while the relation between measured growth rates and degrees of humification varied throughout the 2.5 m thick peat section. These variations are thought to be mostly a result of autocompaction. (Auth)

1222. **Birkeland, P.W.** 1978. Soil Development as an Indication of Relative Age of Quaternary Deposits, Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 10:733-747.*

The soils of the three areas studied, Pangnirtung Fiord, Moon Valley and southeast of Kingnait Fiord, all show a fairly consistent progression in development with age and proximity to the coast or deltaic composition. In the study area, the general ages of older deposits can be inferred from topographic position, boulder weathering and soil development. Lichenometry can be used for aging the youngest deposits. Based on the work of Andrews (1975) and Dyke (1977), the following ages are suggested for deposits of the study area: 1) Neoglacial deposits of front glaciers are probably less than 4,000 yr old; 2) late Wisconsin deposits are in close proximity to Neoglacial deposits, dated about 10,000 yr old; 3) middle Wisconsin tills contain records of major ice expansion in the fiords and valleys at about 50,000 B.P.; and 4) early Wisconsin moraines, well-preserved in the area, are evidence of the most extensive ice expansion and are called Duval, a morphostratigraphic term by Dyke (1977). (Ecol Can 2785)(JTA) Ecol Can 2785

1223. **Brown, J.** 1967. Tundra Soils Formed Over Ice Wedges, Northern Alaska. *Soil Science Society of America Proceedings 31(5):686-691.*

Cabon 14 dates of between 1775 + or - 120 yrs B.P. and 2450 + or - 120 yrs B.P. were obtained on buried peats overlying ice wedges near Barrow, Alaska. These peat samples substantiate the active frost churning processes associated with soils overlying ice wedges. (JTA)

1224. **Bryson, R.A., W.N. Irving, and J.A. Larsen.** 1965. Radiocarbon and Soil Evidence of Former Forest in the Southern Canadian Tundra. *Science 147(3653):46-48.*

Radiocarbon dating of charcoal on podzols along a transect reaching 280 kilometers north of the present tree line from Ennadai Lake indicated that former forests were burnt about 3500 years ago and again about 900 years ago. These forests probably were associated with periods of relatively mild climate. (Auth)

Seven Carbon 14 dates are reported on buried charcoal layers. (JTA)

1225. **Dort, W., Jr.** 1968. Paleoclimatic Implications of Soil Structures at the Wasden Site (Owl Cave). *Tebiwa, The Journal of the Idaho State University Museum 11(1):31-36.*

Ice-wedge casts are described from the cave site. Carbon 14 dates suggest that the formation of ice wedges occurred about 8000 BP. Another short interval of ice wedge formation is recorded in the deposits prior to 6600 BP, indicating a climate considerably colder than present. (JTA)

1226. **Dumanski, J., S. Pawluk, C.G. Vucetich, and J.D. Lindsay.** 1980. Pedogenesis and Tephrochronology of Loess Derived Soils, Hinton, Alberta. *Canadian Journal of Earth Sciences 17:52-59.*

The loess derived soils of the Hinton district provide a record of soil formation for the entire postglacial period. Loess originates from the shorelines of Brule Lake and from the sandbars and braided channels of the Athabasca River. The geochronology of the loess, as established through the study of paleosols and volcanic ash beds, indicates that loess deposition was continual but irregular. Soil formation occurred contemporaneously with loess deposition, and varying soil morphologies were attributed to differing local rates of loess accumulation. There was no evidence for marked climatic change during the Holocene in the study area, but increased loess supply after 4000 years B.P. may reflect gradual change. (Auth)

1227. **Dyke, A.S.** 1981. Late Holocene Solifluction Rates and Radiocarbon Soil Ages, Central Canadian Arctic. *Geological Survey of Canada Paper 81-1C, (pp. 17-22).*

Twelve radiocarbon dates on humus buried beneath four solifluction lobes indicate long-term average solifluction rates of 2.2, 3.3, greater than 3.5, and 1.3 mm/year. The lobes are composed of till, sand, bouldery gravel, and cobble gravel on slopes of 2 deg to 25 deg. Availability of moisture seems to be more important than slope angle or texture in determining solifluction rates. The rates of advance of two lobes have varied through time, though not synchronously. Radiocarbon ages of soils at time of burial range from 285 to 953 years and are important components of the radiocarbon ages of the paleosols. (Auth)

Carbon 14 dates range in age from 2210 to 570 B.P. (JTA)

1228. **Gudbergsson, G.** 1975. Soil Formation in Skagafjordur, North Iceland. Icelandic, English Summary. *Islenzkar Landbunadar Rannsoknir 7(1-2):20-45.*

Loessial soil formation during the Holocene in Skagfjordur is investigated. Twenty seven soil profiles have been measured and grain size and mineralogical analyses have been made. Tephrochronology, based on four light tephra layers from the volcano Hekla, provides a time scale for the history of the soil formation. Accumulation of soil has been relatively slow up to 4500 B.P., averaging about 0.05 mm/year. During the time between 4500--2900 B.P., the accumulation decreases to 0.04 mm/year. During the later Birch Period climatic conditions have been more favorable than at any other time during the Holocene. Rate of accumulation was then doubled during the period 2900 B.P. to the Settlement (874 A.D.) to become 0.07 mm/year. This is due to deteriorating climate during the earlier half of the later Bog Period. Since the beginning of the Settlement the accumulation rate increases greatly, probably due to influence of dense population and subsequent clearing of shrubland for farming and grazing. From 874 A.D. to 1104 A.D. the accumulation rate is 0.74 mm/year, and from 1104 A.D. to the present the rate has been 0.5 mm/year. It is noteworthy how close the relationship is between the soil formation and the changes in vegetation cover during prehistoric time as can be seen by the low sand/fines ratio. This relationship is greatly disturbed by human activity in historical time. (Auth)(JTA)

1229. **Jungerius, P.D.** 1976. Quaternary Landscape Development of the Rio Magdalena Basin between Neiva and Bogota (Colombia). *Palaeogeography, Palaeoclimatology, Palaeoecology 19:89-137.*

The Quaternary landscape development of part of the middle Magdalena basin is reconstructed from evidence provided by paleosols and slope deposits preserved on glacis surfaces. The paleosols were formed during stable periods with tropical conditions which we have correlated with the Interglacials. The slope deposits were mainly formed during unstable periods with alternating very dry and very wet conditions which we have correlated with the Glacials. If these correlations are correct, it appears that, with the progress of the Quaternary, the (seasonal) variability of the Glacial climates became less pronounced and that of the Interglacial/Postglacial climates more pronounced, leading to a gradually diminishing amplitude of the Quaternary climatic fluctuations. The glacis were formed during periods of pronounced landscape instability (Phase 1, possibly Early or Middle Pleistocene Glacials). Next came a period of landscape stability which left a ferric hydromorphic soil formed in a humid climate (Phase 2, possibly Middle Pleistocene Interglacial(s)). This was followed by an unstable period during which the surfaces of the glacis were somewhat enlarged and covered by coarse slope deposits (Phase 3, presumably penultimate Glacial). After this, part of the area was raised by tectonic movements, streams incised to the glacis surfaces, and stream terraces were formed (Phase 4). During a stable period, plinthic hydromorphic soils and red ferrallitic soils were formed which show the effect of dry seasons (Phase 5, presumably last Interglacial). They were covered with slope deposits formed from shallow mass movements and soil erosion (Phase 6, presumably last Glacial). The sedimentation of volcanic materials began in this period and continued into the first part of the Holocene (Phase 7). Also continuing into the Holocene were (soil) erosion and deposition of colluvium (Phase 8). During the Holocene, loss of clay due to alternating dry and wet conditions became a more important aspect of soil formation (Phase 9). (Auth)

1230. **Kelletat, D.** 1970. On the Problem of the Distribution, Age and Period of Formation of Old (Inactive) Periglacial Phenomena in the Scottish Highlands. Zum Problem der Verbreitung, des Alters und der Bildungsdauer alter (inaktiver) Periglazialerscheinungen im Schottischen Hochland. *Zeitschrift fur Geomorphology/Annals of Geomorphology/ Annales de Geomorphologie 14(4):510-519.*

Inactive but substantial and extensive solifluction forms - lobate, garlanded and terraced features in coarse detritus - are widespread in the Scottish Highlands between 500 and 1100 m above sea level. A change of about 500 m in the level of formation seems to be involved. Glaciers remained extensive in the Highlands down to 6000 B.C. The inactive solifluction features formed later than this, but prior to the climatic optimum about 3000 B.C. In some cirques, small glaciers reformed in the Subatlantic. (J.N. Jennings) GA 71A/1861

1231. **Mahaney, W.C.** 1970. Soil Genesis on Deposits of Neoglacial and Late Pleistocene Age in the Indian Peaks of the Colorado Front Range. *Ph.D. Thesis, University of Colorado, Boulder, CO, 246 pp.*

Neoglacial deposits in the Indian Peaks Region of the Colorado Front Range have been dated lichenometrically by recourse to a growth-rate curve developed for RHIZOCARPON GEOGRAPHICUM. Radiocarbon dates provide age control for the lichen chronology (Benedict, 1968). Older tills of late Pinedale age have been mapped in the lower valleys. (Auth)(JTA)

1232. **Mahaney, W.C.** 1975. Soils of Post-Audubon Age, Teton Glacier Area, Wyoming. *Arctic and Alpine Research 7(2):141-153.*

Glacial deposits of late Neoglacial age in the Teton Range are dated by use of relative age-dating criteria. Soils of post-Audubon (1,850 to 950 B.P.) and post-Gannett Peak (300 to 100 B.P.) age are recognized on moraine surfaces. Morphological, physical, and chemical characteristics of the post-Audubon soils are discussed and correlated with soils of the Colorado Front Range. Recent geomorphological and pedological investigations suggest that glacier fluctuations in the Teton Range during the late Neoglacial may be broadly synchronous with those defined elsewhere in the Rocky Mountains. (Auth)

1233. **Matthews, J.A.** 1980. Some Problems and Implications of Carbon 14 Dates from a Podzol Buried Beneath an End Moraine at Haugabreen, Southern Norway. *Geografiska Annaler 62A(3-4):185-208.*

Eight Carbon 14 dates have been obtained from a 5 cm thick A sub h horizon of a podzol soil buried in situ beneath the outermost end moraine of the Haugabreen gletschervorfeld, southern Norway. The dates ranged from 880 + or - 35 to 3140 + or - 55 Carbon 14 years B.P.: a strong increase in age with depth was indicated; various fractions of soil organic matter were found to differ significantly in age. Ten problems in the interpretation of these results were considered. Date of burial of the palaeopodzol was discussed using multiple working hypotheses, assuming different forms of age/depth relationship and the presence or absence of contamination. Burial during the "Little Ice Age" is most likely, although a conservative maximum estimate of time elapsed since burial is given as 1400 Carbon 14 years. The recognition of numerous and precisely dated pre- "Little Ice Age" Neoglacial glacier maxima on the basis of Carbon 14 dates from well-developed palaeosols is criticized. Apparent mean residence times within such soils are likely to increase steeply with depth and may be of the order of 1000 years within the top 2.5 cm. Some other pedological implications are outlined; it is inferred that at least 3000 years were required for formation of this soil horizon. (Auth)

1234. **Sorenson, C.J.** 1971. Paleosols and the Forest Border in Keewatin, N.W.T. *Quaternary Research 1(4):468-473.*

The morphology of paleosols and radiocarbon-dated charcoal from buried surface horizons of soils provide evidence to suggest that between periods of northward forest encroachment tundra climate has dominated areas at least 50 km south of the present forest/ tundra border in southwest Keewatin. The present forest/tundra border climate is nearly as severe as any climate that has prevailed in the area since deglaciation. (Auth) GA 72A/2366

1235. **Sorenson, C.J., and J.C. Knox.** 1973. Paleosols and Paleoclimates Related to Late Holocene Forest/Tundra Border Migrations: Mackenzie and Keewatin, N.W.T., Canada. *International Conference on the Prehistory and Paleoecology of the Western North American Arctic and Sub-Arctic, S. Raymond and P. Schledermann (Eds.), Calgary, Alberta, Canada, Nov. 1972. The University of Calgary Archaeological Association, (pp. 187-203).*

Paleopodzols and frost wedge polygons in and near the forest/ tundra ecotone indicate that Holocene fluctuation of the forest border has varied from 280 km (170 mi) north to a minimum of 50 km (30 mi) south of the modern forest border in southwest Keewatin. The 330 km (200 mi) wide range for Keewatin appears to decrease systematically northwestward across Mackenzie. Canonical transform functions derived from correlation properties between surface soils and modern climatic variables were applied to characteristics of buried soils to reconstruct paleo airmass frequencies and former locations of the forest/tundra boundary for climatic episodes of the Holocene. Key periods of significant forest/tundra border displacement seem to have occurred at least six times during the post glacial period in response to relatively conservative changes in the incidence of Arctic and Pacific derived airmasses. (Auth)

This paper includes a time-distance diagram showing the suggested variations in tree-line throughout middle and late Holocene time. (JTA)

1236. **Stuckenrath, R., G.H. Miller, and J.T. Andrews.** 1979. Problems of Radiocarbon Dating Holocene Organic-Bearing Sediments, Cumberland Peninsula, Baffin Island, N.W.T., Canada. *Arctic and Alpine Research 11:109-120.*

In 1973, several samples of buried organic-bearing sediments were collected from beneath and within the "layered sands" of Pangnirtung Pass and the Padle/Kingnait Pass, eastern Baffin Island, N.W.T. Radiocarbon dates on some samples yielded apparent ages in conflict with their stratigraphic position, and it was clear that contamination was present within these well-drained sediments. In 1974, three sites were revisited and larger (>3000 g) samples were collected. Organic content varied between 2.5 and 8.2% by weight. We report the results of 28 individual age determinations, stratified according to (1) different laboratory preparations, (2) different size fractions of the organic materials, and (3) different Sodium Hydroxide solubility fractions. Statistical analysis of these data indicated that in no instance could we reject a null hypothesis, and hence no statistically significant trends could be outlined. Differences in age within a sample varied between 720 and 1245 yr. We suggest that the most reliable fraction for dating these sediments is the >125 micrometer organic fraction which is insoluble in Sodium Hydroxide. However, the >125 micrometer Sodium Hydroxide insoluble fraction gave ages consistently younger than in the <125 micrometer Sodium Hydroxide insoluble fraction. These age differences might be associated with a soil residence time for the finer fraction. (Ecol Can 3589) Ecol Can 3589

1237. **Tarnocai, C., and S.C. Zoltai.** 1978. Soils of Northern Canadian Peatlands: Their Characteristics and Stability. *Forest Soils and Land Use, C.T. Youngberg (Ed.), Proceedings of the Fifth North American Forest Soils Conference, Colorado State University, Fort Collins, Colorado. (pp. 433-448).*

On the continental part of northern Canada, peat began forming 4,000 to 6,000 years ago and several thousand years after retreat of glacial ice. However, on the arctic islands, deposition of peat began 8,500 to 9,000 years ago, shortly after ice melt. The time differences are the result of a climate that was too dry and warm for peat formation on the continent whereas a cooler and more moist climate existed in the arctic islands and was more favourable for peat deposition. About 5,000 years ago, the climate of the arctic islands became cooler and peat development ceased since that time while the boreal and subarctic regions have become areas of optimum peat development. With further climatic deterioration, permafrost formed in the peat deposits which resulted in such perennially frozen peat landforms as palsas, peat plateaus and polygonal peat plateaus. Perennially frozen peatlands have a cyclic nature, which is independent of climate, resulting in developing, mature, overmature and collapse stages. The collapse or degrading stage is most striking in the arctic islands where most peatlands are very old and strongly eroding despite the cold conditions. Unfrozen peatlands do not possess this cyclic feature and continuous growth at varying rates is maintained until some external factor, such as altered hydrological regime or fire, changes the environment. (Ecol Can 4082)(JTA) Ecol Can 4082

1238. **Tedrow, J.C.F.** 1972. Soil Morphology as an Indicator of Climatic Changes in the Arctic Areas. *Climatic Changes in Arctic Areas During the Last Ten-Thousand Years, Y. Vasari, H. Hyvarinen and S. Hicks (Eds.), A Symposium held at Oulanka and Kevo, October 4-10, 1971. Acta Universitatis Ouluensis, Series A, Scientiae Rerum Naturalium No. 3, Geologica No. 1. University of Oulu, Oulu, Finland, (pp. 61-73), 511 pp.*

The possibilities of using pedologic information to reconstruct past climates of the arctic region are considered. The arctic region is divided into three soil zones: (1) Polar Desert, (2) Subpolar Desert and (3) Tundra, with zonal boundaries corresponding approximately to high arctic, mid-arctic and low arctic, respectively. Within each zone, four genetic varieties of soil are listed. The old landscapes of the far north of North America, including Greenland, have certain soil properties which suggest a past warmer climate. The time under consideration in these sectors, however, is Early Pleistocene or possibly Late Tertiary. Within the Tundra and Polar Desert soil Zones, buried organic matter was studied with respect to age and pollen composition. Ages of the buried organic matter ranged from 1,200 to 10,600 yr B.P. Pollen from the buried organic layers is similar to that of the present with some buried samples indicating possibly warmer conditions. The buried organic matter which is as much as 4 feet deep probably reached its present position during a warmer episode at which time there was deeper seasonal thaw in the soil which in turn would suggest warmer summer temperatures. Several cases of buried soil profiles are considered along with paleoclimate implications. In Alaska, one soil buried beneath Early Wisconsin (Wurm) drift and one buried beneath dune sand (3,840 yr B.P.) showed soil features similar to those soils presently in the area. One buried from northern Sweden indicated past climate that was warmer and more moist. (Auth)

1239. **Tedrow, J.C.F., and G.F. Walton.** 1964. Some Quaternary Events of Northern Alaska. *Arctic 17(4):268-271.*

This note presents the results of Carbon 14 dating and a study of the plant remains associated with an organic layer at a depth of 40 feet in poorly stratified, waterlain sands in the Killik River area at 68 deg 42 min N in Alaska. The date is 5,650 + or - 230 years B.P. which corresponds to the Hypsithermal Interglacial, the plant remains include willow and alder. This date necessitates a reappraisal of the glacial chronology of the region as these deposits were previously considered to be of Itkillick (? Early Wisconsin) age. The presence of alder in the organic deposit indicates that at the time of deposition the Upper Killick River climate was as warm, if not warmer than at present. (D. Ingle Smith) GA 65/778

1240. **Worsley, P., and M.J. Alexander.** 1972. Glacier and Environmental Changes–Neoglacial Data from the Outermost Moraine Ridges at Engabreen, North Norway. *Geografiska Annaler 58A(1-2):55-69.*

A fossil brown podzolic (Typic Cryochrept) soil covers the two outermost moraine ridges at Engabreen. This soil is buried by a sediment which is considered to be of aeolian origin and is thought to have been derived from an adjacent sandur which had been reactivated by a later glacial advance. The subsequent advance built a major moraine ridge just proximal to the two older ridges. A comparison of the palaeosol with the modern soils on the three ridges reveals similar development. It is suggested that these soils each indicate some 250 years of soil formation so consequently the two outer ridges were created by a glacial advance prior to 1450 A.D. This latter event was the maximal Neoglacial advance. The historically recorded early eighteenth century advance which destroyed a farm terminated at the major moraine ridge and thus was not the largest advance. (Auth)

1241. **Zoltai, S.C., C. Tarnocai, and W.W. Pettapiece.** 1978. Age of Cryoturbated Organic Materials in Earth Hummocks from the Canadian Arctic. *Proceedings of the Third International Conference on Permafrost, July 10-13, 1978, Edmonton, Alberta, Canada. National Research Council of Canada, Ottawa, Vol. 1, (pp. 326-331), 947 pp.*

Earth hummocks were studied in the low arctic and subarctic climatic-vegetation regions in the Canadian Arctic. The occurrence of organic material several thousand years old within the active layer is illustrative of the slow rate of decomposition in arctic soils. Some of the dates determined reflect the age of the hummocks as well as the cryoturbated material. Cryoturbation became active throughout northern Canada about 4,500 years ago. It was initially a severe rate based on the number of sites in the 3,000 to 5,000 year range and although now a slower rate the process continues to the present. Analysis of hummocks examined on an east-west gradient indicates that the average age of 14 age determinations from the central Arctic is 2,537 years while the average age from 21 samples in the western Arctic is 2,796 years. Only small differences were noted on a north-south gradient with average ages in the Mid- and High Arctic dated at 2,814 years, in the Low Arctic 2,610 years and in the Subarctic 2,562 years. (Ecol Can 3158)(JTA) Ecol Can 3158

Stratigraphic

1242. **Aaby, B.** 1975. Cyclic Climate Variations Since 7500 Years Ago Based on Raised Bogs and Marine Transgression. Cykliske klimavariationer de sidste 7500 ar pavist ved undersogelser af hojmoser og marine transgressionsfaser. Danish. *Danmarks Geologiske Undersoegelse, Arbog 1974:91-104.*

Recent investigations in Holocene Danish raised bogs show cyclic climatic variations with a periodicity at about 260 years during the last 5500 years. The shore line displacement in Southern Scandinavia, which is mainly influenced by eustatic sea level variations, shows a periodicity of 520 years, and the cyclic climate variation can be traced back to 7500 B.P. This result, showing a periodicity in climatic variations for most of the Holocene may tentatively be used for predicting the natural long-term trend of the future climate. (Auth)

1243. **Aaby, B.** 1976. Cyclic Climatic Variations in Climate Over the Past 5,500 yr Reflected in Raised Bogs. *Nature 263(5575):281-284.*

Investigations of Danish raised bogs apparently indicate cyclic long term climatic variations with a periodicity of about 260 yr over the past 5,500 yr. The result could be used for modelling future climatic trends. (Auth)

The chronology is based on a large number of Carbon 14 dates. The Carbon 14 dates have been calibrated to the bristlecone pine chronology. (JTA)

1244. **Alekseev, V.A.** 1965. New Data on the Absolute Chronology of the Upper Pleistocene and Holocene of Siberia. Novye dannye po absoliutnoi khronologii verkhnego pleistotsena i golotsena Sibiri. Russian. *Akademiia Nauk SSSR, Doklady 160(5):1147-1150.*

Presents radiocarbon dating of Upper Pleistocene and Recent deposits collected in the lower Yenisey and Malaya Kheta basins. Determination of their absolute age helps in determination of the geologic age and in solution of some controversial problems. Spore-pollen analyses of some deposits are also given. (AB84992) AB84992

1245. **Alexander, M.J., and P. Worsley.** 1973. Stratigraphy of a Neoglacial End Moraine in Norway. *Boreas 2:117-142.*

Three exposures in an outer end moraine ridge at Austre Okstindbredal, north Norway, are described and interpreted. The presence of perennially frozen ground is attributed to the present or very recent climate of the area and suggests the occurrence of true sporadic permafrost. A freeze-in phase (described) is of late Neoglacial age but not necessarily associated with the widespread eighteenth century advance in Scandinavia. The soils in part date from the postglacial climatic optimum. (Auth)(JTA)

Two Carbon 14 dates of 1600 + or - 90 and 6280 + or - 110 years B.P. were obtained from buried organic layers. The significance of these two dates is difficult to define in terms of climatic events. (JTA)

1246. **Andrews, J.T.** 1982. Chronostratigraphic Divison of the Holocene, Arctic Canada. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 56-64), 110 pp.*

In Arctic Canada, there is evidence that there were significant fluctuations in marine, terrestrial, and cryosphere systems during the last 10,000 years. A series of such records are reviewed and the fluctuations represented on a single figure. In 1978, Andrews and Ives proposed a chronostratigraphic (geochronologic) subdivision of the Holocene of Baffin Island. Boundaries were selected at 10,000, 9000, 8000, and 5000 years B.P. The last 5000 years of record were not divided. Following an analysis of several records from Arctic Canada, it is proposed that the last 5000 years be subdivided with the boundary fixed at 2500 radiocarbon years B.P. Two names are proposed based on extensive research in the vicinity of Pangnirtung and Pangnirtung Pass, Baffin Island. (Auth)

1247. **Barnard, W.D., and D.A. McManus.** 1973. Planktonic Foraminiferan-Radiolarian Stratigraphy and the Pleistocene-Holocene Boundary in the Northeast Pacific. *Geological Society of America Bulletin 84:2097-2100.*

Biostratigraphic studies of 17 piston cores from the continental slope off the coast of Washington indicate that the change in the foraminiferan-radiolarian ratio at the glacial-postglacial boundary separates geologic-climate units and is time-transgressive in the northeast Pacific. This change from foraminiferan-rich to radiolarian-rich sediment begins at 13,000 yrs B.P. west of the continental slope in Cascadia Basin, between 11,500 and 9,500 yrs B.P. on the lower continental slope, and at 8,000 yrs B.P. on the upper continental slope. The ratio, therefore, cannot be used to define the Pleistocene-Holocene time-stratigraphic boundary and should be used cautiously as an isochronous biostratigraphic indicator, especially where large depth variations exist. (Auth)

1248. **Birkeland, P.W.** 1973. Use of Relative Age-Dating Methods in a Stratigraphic Study of Rock Glacier Deposits, Mt. Sopris, Colorado. *Arctic and Alpine Research 5(4):401-416.*

Loess deposits are identified, and it is suggested that they date from Altithermal times. Mapping and relative age dating of rock mantles suggest that the rock glacier debris mantles are associated with periods of Neoglaciation in the Colorado Front Range. Three periods of Neoglaciation are recognised on Mt. Sopris and correlated with Gannett Peak, Audubon, and "early Neoglacial" stades in the Colorado Front Range and the Wind River Mountains, Wyoming. (JTA)

1249. **Bjorck, S., and T. Persson.** 1981. Late Weichselian and Flandrian Biostratigraphy and Chronology from Hochstetter Forland, Northeast Greenland. *Meddelelser om Gronland, Geoscience 5:1-19.*

Two lakes on Hochstetter Forland have been analysed with repect to lithostratigraphy and pollen and algae stratigraphy. The sediments have been radiocarbon dated and these dates show that Hochstetter Forland was not covered by the Inland Ice during the late Weichselian. The early Flandrian stratigraphic sequences of the two lakes are interrupted by barren interzones, dated at 10,100-8100 B.P. and 10,000-9200 B.P., which are partly correlated to an ice-advance. No evidence for an earlier ice-advance during the Late Weichselian has been found. Apart from the abundance of pollen grains indicating pioneer vegetation, ARTEMISIA pollen grains are found in high quantities in the Late Weichselian, although it is today not found within the area. The Flandrian pollen stratigraphy indicates a development similar to that which has been found in the Scoresby Sund area. However, CASSIOPE TETRAGONA and SALIX ARCTICA immigrate much earlier than further south. The Flandrian climatic optimum in the Hochstetter Forland area seems to have been reached between 6000 and 5000 B.P. (Auth)(JTA)

Eleven Carbon 14 dates are used to interpret the ages of the two cores. One core is truncated at about 5000 B.P. The accuracy of the dates is discussed. Figure 7 relates the pollen assemblage ozones from the two lake cores to radiocarbon chronology and Funder's (1978) vegetation types at Scoresby Sund. (JTA)

Stratigraphic

1250. **Blake, W., Jr., I.U. Olsson, and A. Srodon.** 1965. A Radiocarbon-Dated Peat Deposit Near Hornsund, Vestspitsbergen, and its Bearing on the Problem of Land Uplift. *Norsk Polarinstitutt Arbok 1963:173-180.*

A radiocarbon age determination shows that the basal peat in a bog 12 m above sea-level near Hornsund is 1390 + or - 70 years old. The peat, at 55-60 cm depth, apparently did not start to accumulate until after the site had emerged from the sea. (Auth)(JTA)

The basal date was from brown peat. Two additional dates, on a light-brown peat that overlies the brown peat, give dates of 620 + or - 80 and 260 + or - 110 years B.P. These dates suggest that peat growth ceased between about 1400 to 500 years ago and may reflect a period of severe climate. A pollen profile from his site was presented by Srodon (1960). (JTA)

1251. **Boiarskaia, T.D., and N.G. Zaikina.** 1967. Vegetation, Lacustrine and Climatic Changes in the Polar Ural in the Holocene According to the Data of Spore-Pollen and Diatom Analyses of Lake Khodata-Yugan-Lor Sediments. Izmeneniia Rastitel'nosti, Ozernosti i Klimata Poliarnogo Urala v Golotsene, po Dannym Sporovo-pyl'tsevogo i Diatomovogo Analizov Otlazhenii Ozera Khodata-IUgan-Lor. Russian. *Moskva. Univ. Vestnik 22 ser. 5: geog. no. 1:92-94.*

This paper reports study of a 1.50 m core of bottom sediments, in which two units are recognized on the basis of spore-pollen diagrams. They are described. Diatom analysis is also reported. These two parts of the Holocene deposits represent different physiographic conditions. (AB94117) AB94117

1252. **Bortenschlager, S.** 1982. Chronostratigraphic Subdivisions of the Holocene in the Alps. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 75-79), 110 pp.*

It seems likely that the Pleistocene-Holocene boundary appears around 10,000 B.P. This is in agreement with the observations in northern Europe. The Preboreal and Boreal of the Alps also correlate with northern Europe. The Atlantic and later chronozones do not seem to correlate very well in the two areas. (Auth)(JTA)

1253. **Costin, A.B.** 1972. Carbon 14 Dates from the Snowy Mountains Area, Southeastern Australia, and Their Interpretation. *Quaternary Research 2:579-590.*

Carbon 14 dates for fossil wood, peats, and organic soils from periglacial and glacial sites between 1100 and 2100 m in the Snowy Mountains area, southeastern Australia, are interpreted in relation to the site characteristics and the present climate. The dates indicate a widespread cold period commencing about 34,000-31,000 years ago, the effects of which apparently continued until about 15,000 and locally until about 9000 years ago; a subsequent warmer period; and a colder phase about 3000-15000 years ago. Mean annual temperatures during the first cold period are estimated to have been at least 8-10 deg C lower than at present, and at least 3 deg C lower during the cold phase of 3000-1500 years ago. (Auth)

1254. **Dodson, J.R.** 1974. Vegetational History and Water Fluctuations at Lake Leake, South-Eastern South Australia. I. 10,000 B.P. to Present. *Australian Journal of Botany 22(4):719-741.*

The stratigraphy and pollen analysis of the top 4 m of sediment in Lake Leake were used to describe the vegetation history and past changes in the water level in the lake basin. It is suggested that in south-eastern South Australia, immediately prior to 10,000 B.P., conditions were drier than at present and that after this time conditions became wetter, the wettest period of the last 10,000 years occurring 6900-5000 B.P. After this time conditions became drier, marginally wetter again 2000-1300 B.P., then relatively dry until the present day. Keys to aid identification of pollen of the Casuarinaceae, MYRIOPHYLLUM and the Myrtaceae for species growing in the lower south-east of South Australia are given. (Author) Ecol Abs 76L/0582

1255. **Funder, S.** 1978. Holocene Stratigraphy and Vegetation History in the Scoresby Sund Area, East Greenland. *Gronlands Geologiske Undersogelse Bulletin 129, (pp. 1-76).*

The Holocene stratigraphy in Scoresby Sund is based on climatic changes as reflected by fluctuations in fjord and valley glaciers, immigration and extinction of marine molluscs, and the vegetation history recorded in pollen diagrams from five lakes. The histories are dated by Carbon 14, and indirectly by emergence curves showing the patterns of isostatic uplift. From c. 10100-10400 to 9400 yr B.P. the major fjord glaciers showed oscillatory retreat with abundant moraine formation, the period of the Milne Land Moraines. The vegetation in the ice free areas was a sparse type of fell field vegetation but with thermophilous elements indicating temperatures similar to the present. From 9400 yr B.P. the fjord glaciers retreated rapidly in the narrow fjords, the few moraines formed are referred to the Rodefjord stages and indicate topographically conditioned stillstands. At 8000 yr B.P. the low arctic BETULA NANA immigrated into the area, and in the period until 5000 yr B.P. dense dwarf shrub heath grew in areas where it is now absent. In the fjords the subarctic MYTILUS EDULIS and PECTEN ISLANDICA lived, suggesting a climate warmer than the present. From c. 5000 yr B.P. the dense dwarf shrub heath began to disappear in the coastal areas, and a "poor" heath dominated by the high arctic SALIX ARCTICA and CASSIOPE TETRAGONA expanded. These two species, which are now extremely common, apparently did not grow in the area until c. 6000 yr B.P. In lakes in the coastal area minerogenic sedimentation (took place) at c. 2800 yr B.P., reflecting the general climatic deterioration. (Auth)

1256. **Heusser, C.J., and L.E. Heusser.** 1980. Sequence of Pumiceous Tephra Layers and the Late Quaternary Environmental Record Near Mount St. Helens. *Science 210(4473):1007-1009.*

Tephra in lake beds within 40 kilometers of Mount St. Helens was deposited an average of once every 2,700 years over the past 35, 000 years, for a total of 13 layers. Times of deposition span the period of the Fraser Glaciation and intervals before and after it, and include the series of climates prevailing when vegetation west of the Cascade Range shifted between a park-tundra type and the modern western hemlock forest. (Auth)

1257. **Hjort, C.** 1973. The Vega Transgression: A Hypsithermal Event in Central East Greenland. *Bulletin Geological Society of Denmark 22:25-38.*

A stratigraphical sequence, studied in a cliff on the island Gaseo, Vega Sund, Central East Greenland, has been interpreted as being the product of a regression of sea-level, followed by a transgression–and a renewed regression, leading down to (or perhaps even below) the present sea-level. The first regressional maxima has been found to postdate 3970 B.C. and the transgression has been dated to around 3690 B.C. This agrees well with Late Atlantic eustatic movements, recorded elsewhere. (Auth)(JTA)

Stratigraphic

1258. **Hyvarinen, H.** 1969. Trullvatnet: A Flandrian Stratigraphical Site near Murchisonfjorden Nordaustlandet, Spitsbergen. *Geografiska Annaler 51A(1-2):42-45.*

A sediment core from Trullvatnet, a lake at 1 m a.s.l. m in the inner Murchisonfjorden area, northwestern Spitsbergen was examined. The sediments in the 3 m-long core cover a period of about 7000 Carbon 14 years and show a sequence of two marine-lacustrine contacts in the lower region. The renewed connexion with the sea of the basin between 5500 + or - 140 and 4745 + or - 120 Carbon 14 years ago, followed by a final isolation, suggests an interruption in the general negative trend of shoreline displacements. (Auth)

1259. **Hyvarinen, H.** 1973. The Deglaciation History of Eastern Fennoscandia--Recent Data from Finland. *Boreas 2:85-102.*

Recent stratigraphical, morphological, and radiocarbon data indicate that most of eastern Finland north of North Karelia was deglaciated in early Flandrian times between about 9500 and 9000 BP. (Auth)(JTA)

1260. **Lichti-Federovich, S.** 1970. The Pollen Stratigraphy of a Dated Section of Late Pleistocene Lake Sediment from Central Alberta. *Canadian Journal of Earth Sciences 7:938-945.*

A 5.5 m section of limnic sediment from Lofty Lake in the Mixedwood Section of the Boreal Forest in central Alberta has yielded the first complete Late Pleistocene pollen stratigraphy for the province. The basal organic sediment was radiocarbon dated at 11,400 + or - 190 yr (GSC 1049) and a layer of Mount Mazama type ash was recognized at the 398 cm level. This represents the furthest extension into Canada of Mazama ash records. Five pollen asssemblage zones have been identified--at the base, a POPULUS-SALIX-SHEPHERDIA-ARTEMISIA assemblage, which is unique in the Late Pleistocene of North America, and is interpreted as a pioneer forest and shrub community which occupied the area immediately following deglaciation. This is succeeded by a spruce dominated assemblage which conforms in general to many early Late Pleistocene Picea assemblages from western Canada and adjacent United States, interpreted as a pioneering version of the boreal forest. There follows a tree birch-dominated assemblage with poplar and hazel, suggesting a slight amelioration of climate, and this trend appears to have continued to about 6000 B.P. when a birch-alder-herb assemblage reaches its maximum; this is followed by a spruce-birch-alder assemblage, which continued to the present and is interpreted as an expression of a deterioration in climate about 3500 B.P. The apparent absence at the site of grassland, although the birch-alder-herb assemblage suggests that the grassland might have advanced closer to the site than at present 240 km (150 miles), supports the hypothesis that there was never a Late Pleistocene connection between the Peace River and the main southern grasslands. (Auth)

1261. **Mangerud, J.** 1982. The Chronostratigraphical Subdivision of the Holocene in Norden; a Review. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 65-70), 110 pp.*

The Holocene geology of Norden is complex, and it has been intensively studied. This has led to a large number of different stratigraphic classification schemes. However, for chronostratigraphic subdivision and correlation, the Blytt-Sernander (Boreal, Atlantic, etc.) system has dominated completely. It was established as a combined litho-, climato-, and chronostratigraphic classification in 1894. With the development of modern pollen analysis, and the palynologists' interest in lake sediments, the names of the Blytt-Sernander units gradually became synonyms for Jessen's and other worker's pollen zones. In 1974 a joint Nordic group of Quaternary geologists proposed to restrict the Blytt-Sernander terminology to a chronostratigraphic/ geochronographic subdivision, with the boundaries defined in conventional radiocarbon years. With some few exceptions, this redefinition has been generally accepted. The basic philosophy and validity of it has been discussed. (Auth)(JTA)

1262. **Mangerud, J., H.J.B. Birks, and K.-D. Jager.** 1982. Chronostratigraphical Subdivisions of the Holocene: A Review. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 1-6), 110 pp.*

The INQUA Holocene Commission's Working Group on the chronostratigraphical subdivision of the Holocene was appointed in 1977 with the main aim of reviewing the prinicples and practice of such classifications in the Holocene. Of the two alternative major approaches, namely (1) the use of radiocarbon years without any formal subdivisions, and (2) the definition of chronostratigraphical units in terms of radiocarbon years, no formal recommendations are made, as both can be useful for particular purposes in Quaternary research. (Auth)(JTA)

1263. **Miller, G.H., J.T. Andrews, and S.K. Short.** 1977. The Last Interglacial-Glacial Cycle, Clyde Foreland, Baffin Island, N.W.T.: Stratigraphy, Biostratigraphy, and Chronology. *Canadian Journal of Earth Sciences 14:2824-2857.*

A study of the stratigraphic sequence (Carbon 14 and amino acid age control), marine bivalve faunal changes, and palynology of buried soils and organic-rich sediment collected from the Clyde Foreland Formation in the extensive cliff sections of the Clyde foreland, eastern Baffin Island, N.W.T., suggests that the last interglacial - Foxe (last glaciation) glacial - present interglacial sequence, included the Eglinton Member (10,000 years B.P. to present). A major unconformity exists between the Kogalu and Eglinton Members. Ravenscraig marine sediments were deposited during an early Holocene marine transgresion-regression cycle; the oldest dates on these sediments are ca. 10,000 years B.P. Locally a vegetation mat occurs at the base or within the Ravenscraig unit. Pollen from these beds is sparse, but indicates a terrestrial vegetation assemblage as diverse as that of today. There is no evidence that Laurentide Ice reached the foreland during the last 30,000 years. Eolian sands that overlie a soil developed on the marine sediments record a late Holocene climatic deterioration. Pollen in organic-rich sediments at the base of, and within, the eolian sands record a vegetation shift in response to climatic change. (Auth)(JTA) Ecol Can 2980

1264. **Miller, G.H., H.-P. Sejrup, J. Mangerud, and B.G. Andersen.** 1983. Amino Acid Ratios in Quaternary Molluscs and Foraminifera from Western Norway: Correlation, Geochronology and Paleotemperature Estimates. *Boreas 12:107-124.*

Accepting published age estimates for the Eemian interglacial beds, the average Weichselian temperature in western Norway is calculated to have been ca. 4 deg C below the average Holocene temperature, whereas the last interglacial was 1 to 2 deg C warmer than the Holocene. (Auth)(JTA)

Stratigraphic

1265. **Moar, N.T.** 1982. Chronostratigraphy and the New Zealand Post-Glacial. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 10-16), 110 pp.*

Problems associated with developing a chronostratigraphy for the New Zealand post-glacial are discussed and data from various disciplines are reviewed. It is accepted that the New Zealand post-glacial is best correlated with the Aranuian Stage of the Hawera Series of sediments. The lower boundary of the Aranuian is generally drawn at 14,000 yrs B.P. and any discussion of post-glacial stratigraphy must take this into account. Although the main basis of correlation in the post-glacial is likely to be by radiocarbon assay the data presented suggest that sub-division based on climatic change is possible. A major break at 1000 yrs B.P. records the effects of fire following Polynesian settlement in New Zealand. (Auth)

1266. **Morner, N.-A., and B. Wallin.** 1977. A 10,000-Year Temperature Record from Gotland, Sweden. *Palaeogeography, Palaeoclimatology, Palaeoecology 21(2):113-138.*

The sediment of Lake Tingstade Trask, a shallow CHARA-dominated lake on the Island of Gotland in the middle of the Baltic, was analyzed as to its Oxygen 18 and Carbon 13 content. The lake carbonate (Chara lime) was precipitated due to the assimilation of CO2 by CHARA during the summer months. The isotope curves give a very detailed record of the temperature fluctuations from 10, 700 to 1000 B.P. The depth scale was converted to absolute age via numerous identified levels. The Oxygen 18 curve was converted to temperature (mean summer temperature of the lake) via the relationship between measured lake temperature and corresponding isotope composition of the water. The corresponding mean air temperature was calculated. The temperature record shows: (1) a low temperature during the Younger Dryas Stadial; (2) a very rapid rise at the Pleistocene/Holocene boundary; (3) a rapid rise through the early Holocene with present-day values reached at about 9,300 B.P.; (4) a Holocene optimum of 1.5-2.0 deg C higher temperature than today, ending with a 2 deg C temperature fall at the Subboreal/Subatlantic transition at about 2500 B.P.; and (5) fluctuating Holocene temperature with warm and cold peaks at the same chronological levels as known eustatic and global climatic fluctuations. (Auth)

1267. **Morner, N.-A. (Ed.)** 1976. The Pleistocene/Holocene Boundary: a Proposed Boundary-Stratotype in Gothenburg, Sweden. *Boreas 5(4):193-275.*

The boundary between the last two geological epochs, the Pleistocene and the Holocene, is placed at 'the date 10,000 B.P., measured in radiocarbon years'. In the European chronostratigraphy, this corresponds to the Younger Dryas/Preboreal boundary, the pollen zone III/IV boundary and the Late Glacial/Postglacial boundary. The stratal sequence in the Botanical Garden of Gothenburg is proposed as a suitable boundary-stratotype of the Pleistocene/Holocene that fulfils the stratigraphical rules of marine environment and accessibility. A core, labelled B 873, has been analyzed for multiple parameters by various authors. The suggested Pleistocene/Holocene boundary in Core B 873 is indicated by a lithologic boundary, a palynological change tentatively correlated with the pollen zone III/IV boundary, and a distinct paleomagnetic intensity maximum, the Galon Magnetic Intensity Maximum, identified in numerous other cores at the Younger Dryas/Preboreal boundary and Gothenburg is proposed as a suitable boundary-stratotype of the Pleistocene/Holocene that fulfils the stratigraphical rules of marine environment and accessibility. A core, labelled B 873, has been analyzed for multiple parameters by various authors. The suggested Pleistocene/Holocene boundary in Core B 873 is indicated by a lithologic boundary, a palynological change tentatively correlated with the pollen zone III/IV boundary, and a distinct paleomagnetic intensity maximum, the Galon Magnetic Intensity Maximum, identified in numerous other cores at the Younger Dryas/Preboreal boundary and at the drainage of the Baltic Ice Lake in varved clay sequences (with the peak dated at the drainage + or - 4 varves). This boundary is closely radiocarbon dated at 10, 000 B.P. (10,000-9950 B.P.) in terrestrial lacustrine sequences within the proposed type area in Gothenburg and in Southern Sweden, the established type region for the Pleistocene/Holocene boundary. The corresponding varve date is 9965 varves B.P. (De Geer's varve -1073). The various parameters directly and indirectly connected with the study of Core B 873 make global correlations possible. Because every region has its own local characteristics, however, it will be necessary to establish regional type sections, hypostratotypes. (Auth)

1268. **Mottershead, D.N., and R.L. Collin.** 1976. A Study of Flandrian Glacier Fluctuations in Tunsbergdalen, Southern Norway. *Norsk Geologisk Tidsskrift 56:413-436.*

Variations in the extent of Tunsbergdalsbreen over the last 9200 years are considered, drawing on evidence from a variety of sources. Stratigraphy, radiocarbon dates, lichenometry and a variety of historical data are reviewed. It is shown that the glacier receded rapidly between 9200 and 8100 B.P., shrinking to a size smaller than the present between the latter date and 3800 B.P. A subsequent readvance culminated in the mid-eighteenth century, since which time there has been a generally increasing rate of recession. (Auth)

1269. **Neustadt, M.I.** 1982. On Problems of Terminology and Subdivisions of the Holocene, Especially in USSR. *Chronostratigraphic Subdivision of the Holocene, Striae 16, J. Mangerud, H.J.B. Birks and K.-D. Jager (Eds.). Societas Upsaliensis Pro Geologia Quaternaria, Uppsala, (pp. 91-94), 110 pp.*

Initially a historical review of the development of the concept the Holocene is given. In the USSR the early publications adopted the Blytt-Sernander System, but later other systems developed subdividing the Holocene into three or four parts. Some authors have used Nilsson's system for southern Sweden in a USSR version. There are also other systems for the subdivision in the USSR. It is argued that the Pleistocene-Holocene boundary ought to be changed to an earlier position, c. 12,000 y B.P. An adopted Blytt-Sernander chronostratigraphic system is suggested for the subdivision of the Holocene, together with a calibration by the means of absolute dating. A committee for the further work is recommended. (Auth)

1270. **Olausson, E. (Ed.)** 1982. The Pleistocene/Holocene Boundary in South-Western Sweden. *Sveriges Geologiska Undersokning, Serie C NR 794, Avhandlingar Och Uppsatser, Arsbok 76 NR 7, Uppsala, 288 pp.*

The boundary between the Pleistocene/Holocene epochs was placed at 10,000 Carbon 14 years B.P. (Libby half-time) by the Holocene Commission. This corresponds to the Younger Dryas/Preboreal boundary in the European geochronology. In search of a stratotype locality three cores from the province of Bohuslan, south-western Sweden, were scrutinized concerning different geophysical, geochemical and biostratigraphical parameters. The marine sequences of the cores from Moltemyr and Solberga reveal a distinct boundary and a transition zone respectively which meet the requirements laid down by the Holocene Commission. The cores are connected with the general chronology by inter alia the meltwater spike and the subsequent indications of the deglaciation of central and northern Fennoscandia and climatic improvement clearly registerd by fauna and flora. The suggested age of the lithological boundary is c. 10,200-10,300 years B.P. Either Moltemyr or Solberga can be chosen as a boundary stratotype and the other locality as a hypostratotype of the Pleistocene/Holocene transition. As regards the deep-sea deposits the recorded and pronounced Preboreal meltwater spike may be regarded as a synchronous global sign of the Pleistocene/Holocene boundary. (Auth)

This volume contains 24 chapters dealing with the specific properties of the cores; the regional glacial and paleoclimate setting; problems of radiocarbon dating; a short statement on the location of the Pleistocene/Holocene boundary in deep-sea sediments; and a discussion of local and global problems with the stratotype. Chapter 20 is a summary of the results from the Swedish sites. (JTA)

1271. **Orheim, O.** 1972. A 200-Year Record of Glacier Mass Balance at Deception Island, Southwest Atlantic Ocean, and Its Bearing on Models of Global Climatic Change. *Ohio State University, Institute of Polar Studies, Report No. 42, 118 pp.*

Subglacial volcanic eruptions on Deception Island (63 deg S, 60 min W) in 1969 and 1970 revealed ice stratigraphy in fissures and craters. Annual net mass-balance variations from about 1780 A.D. to the present were determined from this stratigraphy. Annual layers were exceptionally well marked by dirt layers, formed each summer when large amounts of dust are blown onto the glaciers from surrounding areas of loose volcanic material. Meteorological data are available from Deception Island from 1944 to 1967; summer degree days for these years are significantly negatively correlated with stratigraphically determined net mass balances (r=-0.55, P:0.01). Mean mass balances for 5-year intervals, and 5-year running means of balances for Deception Island are significantly negatively correlated with observed mass-balance variations from 1946 in the northern hemisphere, and balances in both hemispheres show a marked cyclicity of about 10 years. The same antiphase relationship, with a cycle of 11 years, and a weaker cycle of about 20 years, is found when the entire Deception record is compared with the precise record back to 1816 from Storbreen, Norway. Models proposed to explain climatic changes must account for global warming from late last century to about 1940, and an antiphase cyclic relationship, characterised by dominant periods of about 11 and about 20 years, in the climatic elements that affect glacier mass balances in middle to high latitudes in the two hemispheres. (From Author) GA 73A/1816

1272. **Pewe, T.L., A. Journaux, and R. Stuckenrath.** 1977. Radiocarbon Dates and Late Quaternary Stratigraphy from Mamontova Gora Unglaciated Central Yakutia, Siberia, U.S.S.R. *Quaternary Research 8(1):51-63.*

On the basis of biostratigraphy, 10 radiocarbon dates, and their relation to the nearby glacial record, it is felt that the upper unit at Mamontova Gora is Holocene and the middle unit is Wisconsinan. The youngest date available from the middle unit at this particular location is 26,000 years. Dates greater than 56,000 years were obtained in the lower part of the middle unit. The lower unit is definitely beyond the range of radiocarbon dating and probably is older than the last interglacial. The sediment, fauna, ice wedges, stratigraphy, and age of perennially frozen silt deposits in central Alaska are remarkably similar to those of the deposits exposed in central Yakutia. Both areas consist of unglaciated rolling lowlands and river terraces surrounded by high mountains that were extensively glaciated in Pleistocene time. The glaciers extended from the high mountains to the edges of the ranges. In both regions, extensively braided, silt-charged rivers drained the mountains and flowed through the lowlands on their way to the sea. It follows that there should be a similar late-Quaternary history. (Auth)(JTA)

1273. **Pheasant, D.R., and J.T. Andrews.** 1973. Wisconsin Glacial Chronology and Relative Sea-Level Movements, Narpaing Fiord, Broughton Island Area, Eastern Baffin Island, N.W.T. *Canadian Journal of Earth Sciences 10(11):1621-1641.*

Three distinct glacier advances and four major periods of adjustment of relative land and sea levels are recognized in the Wisconsin age stratigraphic and geomorphologic record of the Northern Cumberland Peninsula. The coast, which is presently undergoing submergence, is close to an isostatic equilibrium position following rapid land emergence during post-Cockburn time (ca. 8000-10000 B.P.). Laurentide ice advances during two earlier stades–the Alikdjuak ca. 115,000 B.P. and Napiat >40,000 B.P.–were more extensive than the Cockburn glacier advances and a positive relationship between ice load and amount of crustal deflection at the ice margin is demonstrated. Computations based on synchronous raised marine features and known extent of the ice load indicate a crustal flexural parameter (alpha) of >80 km and perhaps >135 km for this area. The date of the Alikdjuak stade suggests the time transgressive nature of the early-Wisconsin maximum position of the continental ice sheet margin and supports the hypothesis that continental glaciation may well have originated in the climatically sensitive uplands of the eastern Canadian arctic/sub-arctic. (Auth) BafBib 463

1274. **Saarnisto, M.** 1981. Holocene Emergence History and Stratigraphy in the Area North of the Gulf of Bothnia. *Annales Academiae Scientiarum Fennicae A, III, Geologica-Geographica, 130, 42 pp.*

Morphological, lithostratigraphical and biostragraphical data, together with radiocarbon dates, are presented relevant to the Holocene emergence history. A map is constructed for the land/water distribution during the formation of the highest shoreline following the deglaciation, approximately 9000 B.P., representing the Ancylus Lake phase. About half of the total emergence, i.e., 100 m, occurred within approximately 1000 yr prior to 8000 B.P., whereupon a marked retardation took place. Most of the shoreline displacement can be explained by isostatic land uplift. Emergence and uplift values are estimated for various time intervals. The dominant feature of the forest history is stability, major changes having taken place only within the initial birch zone, which lasted less than 1000 yr after deglaciation. (From Author) GA 82A/0739

1275. **Silo, N.A., V.G. Bespalyi, T.D. Davidovic, N.N. Dikov, and A.V. Lozkin.** 1974. Review of Radiocarbon Dating of the Upper Pleistocene and Holocene Deposits of the North-East Asia. Obzor Radiouglerodnyh Datirovok Verhnepleistrochenovyh i Golochenovyh Otlozenii Severo-Vostoka Azii. *TT-73-58004, 15 pp; Geologiya i Geofizika (1971)10:13-14.*

The widespread use of radio-carbon techniques for the absolute geo-chronology of the upper Pleistocene and Holocene deposits of North-East Asia, opens the possibility for a more precise and reliable comparison of the main periods of the geological history in this region, and of the events that occurred during those periods, in many places of Siberia, Europe and America. The complex use of radiocarbon techniques, accompanied by the traditional stratigraphic methods, enables correcting the existing stratigraphic columns of the North-East and Kamcatki. It elucidates also many of the unresolved paleogeographic and paleoclimatologic problems of the last glacial era, and gives a more exact age for the archeologic relics and monuments. (NTIS 379000 TT-73-58004) NTIS 379000 TT-73-58004

1276. **Sonstegaard, E., and J. Mangerud.** 1977. Stratigraphy and Dating of Holocene Gully Sediments in Os, Western Norway. *Norsk Geologisk Tidsskrift 57:313-346.*

At Os, near Bergen, western Norway, there occur several gullies in glaciomarine silt. The gullies, up to 450 m long and 7 m deep, lead into the lake Banktjorn, where the eroded sediments were deposited. The analyses of several cores from the lake sediments allowed the gully sediments to be identified and dated as having been formed in the period from 8,800 to 7,700 years B.P. Denudation rates for this period have been estimated at 1.45 mm/year in the silt covered area. The dating was based on pollen diagrams and Carbon 14 dates. The Holocene history of the vegetation, redeposition of pollen, and lateral variation of the pollen content in lacustrine sediments are also discussed. (Auth)

1277. **Wilson, A.T., C.H. Hendy, and C.P. Reynolds.** 1979. Short-Term Climate Change and New Zealand Temperatures during the Last Millennium. *Nature 279:315-317.*

These very preliminary results results mainly investigate the potential of stalagmites to study short-term temperature variations. Clearly, many stalagmites should be taken from different caves in different parts of New Zealand. However, the temperature curve for New Zealand is apparently broadly similar to England and such climatic fluctuations as the Mediaeval Warm Period and Little Ice Age are not just a local European phenomenon. It seems from the temperature curve that the cooling in New Zealand has been delayed and is generally more rapid than in central England. This may be caused by dating errors. (Auth)(JTA)

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