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ICE

PROCEEDINGS OF THE SOCIETY'S SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY

Cambridge, 15-21 September 1974

The Proceedings will appear as Volume 15, Number 73 of the Journal of Glaciology, in the middle of 1975. Members of the Society are entitled to receive this volume free, in addition to the normal issues for 1975, which comprise Volume 14, Nos. 70, 71 and 72. (The order in which numbers are received will probably be: 70, 73, 71, 72.)

(See page 1 of this issue of ICE.)

ICE

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

1st ISSUE 1975 NUMBER 47

CONTENTS

DEATH OF H. C. HOINKES. We were greatly saddened to hear of the sudden death, at the age of 59, of Professor Hoinkes, Director of the Institut für Meteorologie und Geophysik of Innsbruck University, Austria. Friedl was well known to many members of the Society and had served as a Vice-President 1964-67. His major contribution to glaciology was in the field of glacial meteorology, but no less important was his training of many excellent students: his "Gang". An obituary will be published in the Journal of Glaciology.

1975 DUES. Please note that those members who have not paid their dues by the end of June will not receive numbers 71 and 72 of Volume 14 until they do. In addition, the "bonus" volume this year (Volume 15, number 73—Proceedings of the Symposium on Remote Sensing in Glaciology) will also be held until payment is received. To cover the extra costs involved in handling and mailing these issues separately from the bulk mailings at the time of publication, we shall have to charge £1.00 to every member who pays after the end of June. SO—PLEASE PAY NOW, and make everyone's life easier!

COVER PICTURE. Laser interferogram of a saddle type surface (region where interference fringes are hyperbolae-like) on a single ice crystal, which is situated between two points of higher elevation (regions with concentric type fringes). Contributed by Thomas M. Tobin and Kasuhiko Itagaki, Snow and Ice Branch, CRREL.

RECENT WORK

CANADA

Glacier Research

Defence Research Establishment, Ottawa

GLACIER AND ICE SHELF STUDIES (H. Serson)

No new work has been initiated in this field, but ablation and accumulation measurements on the Ward Hunt Ice Shelf and on the small ice caps north of St. Patrick Bay, north Ellesmere Island, have been continued. Air photography of the latter was obtained in August to measure areal extent. No large pieces have broken off the Ward Hunt Ice Shelf in the last year.

The ablation stake data have not yet been analysed, but it appears that some of the stakes on the Ice Shelf which were thought to be lost through ablation have actually been buried in ice through flooding and freezing of troughs. A regularly maintained survey line would be necessary to keep track of this sort of change in topography.

Glaciology Division, Department of the Environment *(O. H. Loken)*

PERENNIAL SNOW AND ICE SECTION (C. S. L. Ommanney)

Field work has been undertaken in the following areas:

(a) **Barnes Ice Cap, Baffin Island**
(G. Holdsworth)

The triangulation/trilateration network on the north-east side of the South Dome was resurveyed in April and May 1974. Reference markers were established along the central flow line of the surge area, south-west side of the South Dome, for surveying and for the radio-echo sounding carried out by S. J. Jones.

(b) **Mount Logan, Yukon Territory**
(G. Holdsworth)

The height of Mount Logan was resurveyed and established to be 19,250 ft above sea level as opposed to the previous figure of 19,850 ft. A reconnaissance was undertaken of a possible drill site in the plateau-north-west col area.

(c) **Tweedsmuir Glacier, British Columbia**
(G. Holdsworth)

The glacier was resurveyed in August and determined to be in the final stage of its surge. Terrestrial and aerial photogrammetry is being used to plot the progress of the surge. The glacier has not completely dammed the Alsek River as it was previously thought it might do.

(d) **Queen Elizabeth Islands, N.W.T.**
(K. C. Arnold)

For the fourth consecutive year an RC-10 aerial camera was used to obtain photography in the High Arctic; 80½ hours were flown in an aircraft under charter to the Polar Continental Shelf Project. Certain specific glaciological targets were photographed—the calving glacier at the head of d'Iberville Fiord, the Ward Hunt Ice Shelf, niche glaciers in the Stokes Range of Bathurst Island, an isolated small ice cap south of Mokka Fiord, two isolated ice caps south of Alert and near St. Patrick Bay.

(e) **I.H.D. mass balance studies, Western Canada**
(A. D. Stanley, O. Mokievsky-Zubok, G. J. Young, T. M. H. Beck)

The measurement of winter and summer balance was continued at 5 glaciers in the southern Cordillera (Place, Sentinel, Woolsey, Ram and Peyto) and the net balance only obtained for Berendon Glacier in British Columbia. Stream discharge and meteorological data were obtained using long-term recorders. Observers were stationed continuously at Peyto and Sentinel glaciers. At most glaciers the winter accumulation was greater than previously measured while the summer melt was near normal. Data collected from all glaciers during the I.H.D. will be reduced for publication this winter.

(f) **Testing of Digiray profiling densitometer**
(G. J. Young)

A single probe instrument for measuring the density of a snow pack using a gamma back-scatter principle is in the final stages of field testing. The digiray, manufactured by General Nucleonics of Pomona, California, is used in conjunction with the standard Mt. Rose snow sampler.

Progress on what are primarily office projects is as follows:

(g) **Glacier Inventory of Canada**
(C. S. L. Ommanney)

Glaciers in 68 of the approximately 89 hydrological basins designated on Ellesmere Island have been identified and indexed. Maps for those parts of the Island that have been completed are in the final stages of preparation. Data files on alpinist activity in glacierized areas are being developed to provide information on glaciers. The bibliography has been expanded and now includes almost 1400 items; they relate mainly to the Cordillera. Identification, mapping and measurement of glaciers for the inventory of the Canadian St. Elias Mountains should be completed by early 1975.

(h) **Long term fluctuations of arctic weather types** (S. Fogarasi)

Long term variations of the mean temperatures at the 500, 700 and 850 mb levels for certain prevailing arctic weather types are being investigated through Fourier analysis. Relationships are being sought between long term variations in the mean temperatures of the lower atmospheric layers and the surface temperatures. If a meaningful relationship can be established this will then be related to the behaviour of some arctic glaciers and the extent of floating ice.

(i) **Data reduction system for glacier mass balance** (G. J. Young)

Work continues on an automated system for the compilation and analysis of glacier mass balance data. A general purpose contouring package is now being used for plotting data from the 5 representative I.H.D. glaciers in Western Canada.

Polar Continental Shelf Project, Department of Energy, Mines and Resources *(G. D. Hobson)*

Queen Elizabeth Islands (R. M. Koerner and W. S. B. Paterson)

A party consisting of R. M. Koerner and three assistants was landed at the top of the Devon Island ice cap on 24 April. The mass balance of the north-west side of the ice cap for the period August 1972 to August 1973 was found to be −95 mm water equivalent.

Approximately 1000 miles of skidoo-mounted traverses were then made over the Axel Heiberg ice cap and over all the major Ellesmere Island ice caps with the exception of those to the north and north-west of Tanquary Fiord. Snow and ice samples were collected for every 100 m change of elevation for O^{18}, electrolytic conductivity, water equivalent and density determinations; firn line elevations were also measured. At the top of each ice cap a 13 m core was taken to uncover the 1962 summer-melt layer and the 1963-64 bomb-test horizon. The cores were measured and weighed for density and water equivalent to determine the accumulation rate over the past 10-12 years. Some cores were taken for Tritium and gross-β activity measurements. At two of the core sites a continuous sequence of annual layers was traced between the surface and the 1962 summer surface. At the remaining 5 sites the sequence was broken either by the absence of summer melt or by excessive melt destroying the original structural sequence. At each site precleaned plastic tubes were used to collect samples for snow chemistry and particulate analysis. Also, bulk surface snow samples were collected at five sites for pollen studies. All the samples were shipped frozen to Resolute. The traverse ended on Meighen Island on 10 June.

A party, consisting of C. S. M. Doake (British Antarctic Survey), M. Gorman (Scott Polar Research Institute) and W. S. B. Paterson, made a second set of radio-echo measurements on the Devon Island ice cap to determine the ice velocity at a point about 3 km down slope from the borehole sites. The first set of measurements was made in 1973. The velocity (2.6 m/yr) agreed, within the precision of the measurements, with the value obtained by integrating the measured longitudinal strain rates from the ice divide. Some temperature and diameter measurements were made in the 1972 borehole.

University of British Columbia, Department of Geophysics and Astronomy *(G. K. C. Clarke)* and Department of Geological Sciences *(W. H. Mathews)*

(a) **Isotope studies** (T. K. Ahern and R. D. Russell)

Isotopic techniques have often been applied to ice and snow samples to determine accumulation rates. In order to make such measurements, two assumptions must be made. First, the precipitation in a given location must display periodic annual variations in its isotopic composition. Second, the isotopic composition of the snow must remain unaltered after it falls.

A study by T. K. Ahern was conducted on Mount Seymour, B.C. during the winter of 1973/74. The interaction of the solid and liquid phases in the snow was the principle feature investigated. Several conclusions were reached using an artificial tracer that was isotopically very different from the snow. The correlation between density changes and isotopic changes gave insight into the method of water movement through snow; future studies of isotopic changes with time are expected to give an indication of both flow velocity and the ratio of liquid to solid water at any given layer.

The most important conclusion reached was that the isotopic composition of any given layer in a sub-zero snow pack can change dramatically if liquid water from either a rainstorm or surface melt passes through it. It was found that the isotopic profiles obtained were indeed manifestations of water percolation and were not correlated with isotopic variations in the individual snow-storms. The isotopic profiles obtained could be explained in terms of density variations and snow stratigraphy.

The conclusion to be reached is that the assumption of non-varying isotopic composition of snowpacks does not apply to regions where water is free to flow in the snow. However, it is probably valid in the polar regions.

(b) **Radio-echo sounding** (B. B. Narod and G. K. C. Clarke)

B. B. Narod and G. K. C. Clarke in cooperation with Dr R. H. Goodman of Innovative Ventures

Limited (Calgary) are constructing a back-portable radio-echo sounder which should be ready for field testing in 1975. The transmitter will operate at 840 MHz with 3 Kw peak pulse power; the wavelength in ice is approximately 20 cm, of the same order as the transition wavelength for glacier sliding, so that remote sensing of the scattering properties of the glacier bed may give useful information for sliding theory calculations. Collinear two-element dipole arrays feeding 60° corner reflectors will be used as transmitting and receiving antennae for polarization studies, but a single transmit/receive corner reflecting antenna will be used for conventional depth soundings.

(c) **Surging glacier studies** (G. K. C. Clarke and G. T. Jarvis)

In the 1973 summer field season G. K. C. Clarke and G. T. Jarvis thermally drilled and instrumented seven holes at three sites on Steele Glacier with the aim of determining its thermal regime and testing surge theories. The shortness of the 1973 field season prevented equilibrium temperatures from being measured that summer and it was not until September 1974 that these temperatures were measured by Clarke. Results were surprising and their significance is still being pondered. One hole clearly shows a reversed temperature gradient similar to that found in the single 1972 Steele Glacier hole; this is interpreted as due to water penetration during the surge. The holes at the two other 1973 sites give remarkably warm ice temperatures at depth. This may indicate that much of the Steele Glacier ice is relatively warm and that the recent surge was not due to the thermal instability mechanism suggested by thermal measurements in the Rusty and Trapridge Glaciers. On the other hand, the relatively warm ice may simply reflect the extreme disturbance of Steele Glacier's thermal regime caused by its last surge. Deeper ice temperature measurements and some knowledge of ice thickness will be required to resolve this question.

S. G. Collins of the Arctic Institute of North America in co-operation with Clarke led a survey expedition to Steele, Trapridge and Rusty Glaciers, all surge-type glaciers in different stages of the surge cycle. In addition to rejuvenating and re-surveying the existing ice motion networks on Rusty and Trapridge Glaciers, a network of 19 survey targets was established on Steele Glacier. The Steele array will allow ice motion studies as well as provide a framework for future drilling and geophysical surveys. In addition to the glacier surveys the present margins and depth of Hazard Lake, an ice-dammed lake created by the 1965-66 Steele surge, were mapped. The maximum water depth recorded was 39 m; the present water level is controlled by a temporarily stable drainage channel formed at the margin of Steele Glacier, but future catastrophic drainage cannot be ruled out.

(d) **Instrumentation** (B. B. Narod)

B. B. Narod is investigating the problem of designing optimal resistance measuring bridges suitable for thermistor measurements. A bridge with 80 dB resolution is now under construction.

(e) **Berendon Glacier studies** (W. H. Mathews)

W. H. Mathews worked again with members of the Glaciology Division, Canada Department of Environment, on the annual monitoring of Berendon Glacier. A new development was the installation of 10 foot diameter loops of cable, tuned to resonate in frequency with an electromagnetic (Geonics EM 15) detector, to mark accumulation stations on the neve. Preliminary tests indicated clear responses by the detector held 2 m above the loops.

University of Colorado, Institute of Arctic and Alpine Research

(a) **Mass balance of "Boas Glacier", Northern Cumberland Peninsula, Baffin Island** (R. Weaver)

The estimated net specific balance for the 1973-74 balance year was at least −0.5 m water equivalent. Accurate measurements were not possible because most of the ablation poles melted out during the 1974 summer. The glacier was not visited in spring 1974 to measure the winter budget; by extrapolating precipitation data from Broughton Island, about 60 km to the south-east, we estimate that 0.2 m w.e. were accumulated. This suggests that precipitation for the 1973-74 accumulation season was below normal. Summer ablation was heavy; the estimate is 0.74 m w.e. with the actual figure probably larger. The ablation season mean temperature (June, July, August) was the highest in the sixteen-year record for the Broughton Island climatiological station.

The "Boas" glacier exhibited a two-year alternation of strong mass gains and losses during the first four years of the period 1969-74. The estimated net mass balance for the five-year period is −0.16 m w.e. despite an accumulated net mass gain of 0.38 m w.e. for the first four years.

(b) **Three-dimensional ice flow model**
(M. Mahaffy, J. C. Harrison and J. T. Andrews)

A three-dimensional ice flow model has been developed and has been used on two specific problems. As part of her Master's thesis, Mahaffy developed an ice sheet flow model and tested the model against the Barnes Ice Cap. Many of the specific attributes of this ice sheet were faithfully duplicated in the model. Copies of the programme can be obtained by writing to Molly Mahaffy, c/o Natural History Building, University of Illinois, Urbana.

In addition to the Barnes Ice Cap analyses, we are also using the model to try and evaluate the speed at which a large ice sheet can build up. To date we have run the model for a period of 4,500 years with an order of magnitude increase in net accumulation across Baffin Island, Keewatin and northern Labrador. The resulting ice sheet had a volume of ca. 3×10^{14} m^3 water equivalent.

(c) **Computations of heat and water balances of snow and ice from climatic data**
(L. D. Williams and G. H. Miller)

Several computer programmes have been written to estimate summer mass balances on glaciers or depletion of seasonal snow cover using commonly observed meteorological data with energy budget methods. One version produces maps of water equivalent over a gridded topography, with winter balance specified by least-squares fit to elevation and surface curvature, and using daily weather observations at two elevations. For a larger area containing several weather stations, trend surfaces are fitted to weather data and winter balance and equilibrium lines are estimated from summer balance at high and low elevations in each grid square. For paleoclimatic reconstructions, total energy budgets over monthly (or shorter) intervals are estimated from means and frequencies of weather data, using iterations to include feedback effects. The last version has been used (1) to calculate the response of equilibrium line and its variation with aspect to various changes of climate in eastern Baffin Island, comparing the results with cirque distribution, and (2) to find a combination of summer temperatures and winter balance which would account for south-eastern Baffin Island glaciers with two distinctive area-altitude profiles having remarkably different amounts of late Wisconsin advance. All versions of the model have been extensively tested against summer balance observations on Baffin Island glaciers.

(d) **Mapping the former extent of Little Ice Age snowfields** (J. T. Andrews, P. T. Davis and C. Wright)

ERTS-1 imagery and conventional 1:60,000 black and white air photographs are being used to map, at a scale of 1:500,000, the former extent of thin snowfields that mantled large tracts of the eastern Canadian Arctic during the Little Ice Age. These areas are readily identified because of their light grey tones which represent the effect of lichen-kill. Radiocarbon dates of dead moss within the lichen-trim lines indicate that the period of snow accumulation commenced 300-500 years ago whereas lichen studies within the margin of the former snowfields indicate recession started about 80 years ago. In areas north of the Barnes Ice Cap snowfields accumulated down to 600 m a.s.l.

(e) **Neoglacial chronology** (G. H. Miller and J. T. Andrews)

A history of glacier fluctuations over the last 4,000 years or so has been developed based on mapping lichen sizes on moraines fronting 45 glaciers in northern Cumberland Peninsula. The earliest Neoglacial moraines date a glacier recession that started about 3,200 years ago and the latest recession dates from about 80 years ago. In the majority of cases, the latest glacier expansion has been the most extensive.

This work is now being complemented by detailed stratigraphic studies on thick loess-like sections which record many fine details of climatically related processes, notably periods of soil and peat formation within the sections.

(f) **Palynology and climatic reconstructions**
(H. Nichols, J. T. Andrews, P. W. Webber and A. Millington)

Peat cores covering parts of the last 2,500 years are being examined for pollen content and macrofossils. Currently, six profiles have been completed and radio-carbon dates obtained on critical levels. The sedimentation rates vary between 0.3 cm/yr to 0.0075 cm/yr. One section of 1.37 cm covers only the last 650 years and is being used to interpret the Little Ice Age climate of Pangnirtung Pass and Cumberland Peninsula.

(g) **Climatic models using the NCAR GCM**
(J. Williams and R. G. Barry)

The NCAR Global Circulation Model (GCM) has been used to examine the January and July climate during the last glacial maximum 18,000 years ago. In addition, new runs have now been completed to examine the effect of a July snow cover on the general circulation.

(h) **Inception of the Laurentide Ice Sheet**
(J. T. Andrews, R. G. Barry, R. Brumber, L. D. Williams, J. D. Ives, P. T. Davis, C. Wright, M. Mahaffy, A. Millington)

Many of the above problems are related to the overall problem of the mode of inception of the Laurentide Ice Sheet. The extensive snowfield cover of the Little Ice Age is being used as an analog for conditions that led to the development of the Laurentide Ice Sheet possibly 115,000 years ago. In addition to the work noted above, Barry and Brumber are studying the synoptic influence of late snow covers.

McGill University

STUDIES ON AXEL HEIBERG ISLAND, N.W.T. (F. Müller)

Axel Heiberg Island was visited twice during the summer of 1974 by field parties, in the periods 7 - 22 May and 24 July - 28 August. Logistic support was once again provided by the Polar Continental Shelf Project of the Department of Energy, Mines and Resources.

(a) **Mass balance of White Glacier and Baby Glacier** (F. Müller)
Winter 1973-74 accumulation on White Glacier was measured during May and the final mass balance for White and Baby Glaciers was measured during August. Maintenance of the White Glacier stake network was carried out during August. Stakes and snout positions of Thompson and White Glaciers were resurveyed.

(b) **Automatic weather stations** (K. Schroff)
During the spring visit it was found that none of the automatic weather stations had worked continuously over the winter and they were all reset for operation over the summer. In August it was found that the Ott Station at Base Camp and at Lower Ice Station had not worked during the summer. The decision was made to pull the machines out for extensive repair and modification in the south. They have been in field operation for 5 and 7 years respectively with relatively little attention since the spring of 1972.

(c) **Thermal regime of White Glacier**
(F. Müller and H. Blatter)
A new glacier drilling programme was initiated using an Open System Hot Water drill for the first time on a sub-polar glacier. The power for the heater was provided by propane (provided by PCSP, Resolute Bay). The equipment and propane fuel tanks were landed on White Glacier during May by Twin Otter before the onset of melt conditions. In late July the field party returned to the glacier to perform the drilling. The large amounts of water required were taken from melt streams. Three bore holes were drilled in the ablation area of the glacier, 180 meters, 280 meters and 220 meters deep. At first drilling rate was 25 m/h, but as the team gained experience with the operation of the system a drilling rate of 40 m/h was achieved with a propane fuel consumption of roughly 5 kg/h. Thermistor strings were frozen into holes and temperature was measured until equilibrium was achieved. The temperature at the bottom of the deepest hole (at 270 m) was −3.5°C which extrapolated to the inferred bottom of the glacier at that point (300 m) gave a temperature of −1°C.

It is intended to drill 5 or 6 more holes in the 1975 summer season using the same system and to attempt to drill to 400 meters in the accumulation area. The results of measurement of temperature in the various profiles will be used as input data to a two-dimensional thermodynamic model of the thermal regime of a sub-polar glacier.

(d) **Heat balance and meso-climate**
(A. Ohmura)
No field work was carried out for this programme during 1974. However, analysis of the data collected 1969-72 is proceeding. Computations of daily heat balance at Base Camp using Bowen's Ratio have been completed up to the end of summer, 1972 and data reduction for 1972 has been completed. Useful empirical formulations for radiation balance components have been developed in terms of synoptic meteorological parameters (temperature, relative humidity, sunshine duration and cloud amount).

(e) **Data reports 1959-74**
Data reports are in preparation for all the data collected in the period 1959-74 by the Axel Heiberg Expedition. The planned reports comprise: survey data, meteorological and climatological data, ablation and mass balance data, and an assessment of the operation of the automatic weather stations.

McGill University and Swiss Federal Institute of Technology

(a) **North Water Glacier—Climatology Project** (F. Müller)
During the winter of 1973-74 all three North Water project stations (Coburg Island, Cape Herschel and Carey Islands) were occupied by wintering parties totalling eight men and four women. Routine programmes of surface weather observation, radiation measurements, shore ice observations, sea ice thickness observations and the collection of air moisture and precipitation samples for isotopic analysis were carried out at all three stations. Once-daily radiosonde ascents were made at Coburg Island and Carey Islands, and the personnel at all three stations maintained automatic weather stations remote from the manned camp.

In April an extensive exchange of personnel took place with replacement of the wintering teams. The routine programme was continued throughout the summer until the final evacuation of the stations at the end of September. Evacuation was carried out by the icebreaker Louis S. St. Laurent during a one week operation. Automatic weather stations were left operating to collect further data over the 1974-75 winter.

In parallel with the routine observations the following special programmes were carried out during 1974.

(b) **Remote sensing** (F. Müller, H. Blatter and G. Kappenberger)
In the period April to June 1974 three overflights of the North Water were made with a Beechcraft carrying a PRT-5 radiometer mounted in parallel with a Super 8 movie camera. During these flights and also during a series of DC-4 North Star overflights of North Water at the end of April many oblique aerial photographs were taken. Analysis of the radiometer data and aerial photographs show that there is an association between surface temperature and different sea ice types. Analysis of ERTS-1 and NOAA-2 and NOAA-3 imagery of North Water will soon start, using the data collected by the project for ground truth.

(c) **"Laika" Glacier mass balance and movement** (F. Müller and G. Kappenberger)
The "Laika" Glacier (unofficial name), about one mile west of Coburg Island base camp, has been chosen for long term study. A stake network was set up in fall 1973 and a mass balance and movement study for 1973-74 was carried out. Maps of the glacier are in preparation from aerial photographs and a study of the thermal regime of the glacier is planned for the 1975 field season.

(d) **Accumulation patterns on surrounding ice masses** (F. Müller and B. Stauffer)
During April and May 1974 three ice cap sites on Ellesmere Island and two in Greenland were visited and snow samples were taken from pits and cores to a depth of 20 meters. Accumulation in past years was assessed by classical stratigraphic techniques and samples were taken for isotopic analysis. Samples from a further site on Ellesmere Island were made available by Dr. R. M. Koerner (PCSP).

(e) **Environmental isotopes** (F. Müller, B. Stauffer and G. Schriber)
In addition to the routinely collected air moisture and precipitation samples for isotopic analysis, samples from surrounding ice masses will be analysed. In September sea surface water samples were collected continuously during the icebreaker cruise and water samples were collected to a maximum depth of 610 meters by bottle casting from the ship at four oceanographic stations. Analysis of all samples for tritium and O_{18}/O_{16} will be made in the Department of Physics, University of Berne, (Prof. H. Oeschger), who will also carry out C_{14} analysis on eleven 50-litre sea water samples.

It is intended to mount a reduced North Water project operation next summer with partial reoccupation of the Coburg Island and Cape Herschel stations, servicing all automatic weather stations left operating during the winter 1974-75, repetition of the sea ice dynamics study and extension of the remote sensing programme.

Throughout the 1974 field operation logistic support was provided by the Polar Continental Shelf Project, Department of Energy, Mines and Resources, Ottawa, by the Canadian Armed Forces, Canadian Coast Guard and the USAF base at Thule, Greenland.

University of Minnesota, Department of Geology and Geophysics

(a) **Barnes Ice Cap, Baffin Island**
(R. Le B. Hooke)
During the 1974 field season a party of four spent nearly 8 weeks on the Ice Cap. In a continuation of our study of the near-surface temperature distribution, temperatures were measured to depths of 20 to 30 m in 5 boreholes located along a flow line from the divide to the margin. Measurements were made in early June, early July, and late July. Computer modeling of the temperature distribution is in progress. The objective of this study is to evaluate the effect of heat released to the ice by refreezing of percolating melt water. In addition, temperature profiles were obtained in two 100 m boreholes which reached the base of the glacier about 1 km from the margin. The boreholes are only 12 km apart, yet the temperature gradient in one is consistently two-thirds the gradient in the other at comparable depths. The difference in gradient is believed to reflect a difference in geothermal flux resulting from a difference in radioactive heat production in the bedrock beneath the respective holes.

Work was continued on the detailed examination of structures within the wedge of deformed superimposed ice at the margin of the ice cap. In particular, ice c-axis fabrics were determined at closely-spaced intervals across narrow zones of shear, in order to relate degree of preferred orientation to progressive finite deformation, estimates of which can be made using bubble plunge and elongation.

Laboratory and field studies of deformation processes in dirty ice and of the effect of grain size on creep rate are also in progress.

In 1975 we expect to drill one or two holes to the base of the ice cap for temperature, ice fabric, and deformation measurements. These will be the first of 5 or 6 holes to be drilled along a flowline extending from the divide to the margin.

University of Ottawa, Department of Geography and Regional Planning

(a) **Buried ice in glaciated areas**
(P. G. Johnson)
Research into the processes of formation of glacier-ice-cored land forms and deposits was continued in Grizzly Creek, South West Yukon Territory (61 N, 139° 15′W). Resultant processes of mass movement of material due to the presence of glacier ice (moraine glaciers) are being compared with mass movement resulting from the formation of ice in talus material originating from talus drainage (talus rock glaciers) or from inclusion of avalanche snow (avalanche rock glaciers). The nature of the ice determines the mechanisms of movement and controls the morphology of the land form.

In the valleys, the ablation of buried ice is controlled by the shallow valley wind systems and the microclimate existing within them. Use of standard meteorological data is of little use in predicting amounts of terrain disturbance. The local patterns of wind direction, wind run, rainfall and net radiation control the thermal exchange at the surface and hence major variations occur over short distances. Implications are that to plan to minimize terrain disturbance by man's activities one needs far more data than general measurements of climatic conditions.

Defence Research Establishment, Ottawa

(a) **Ice drift in Robeson Channel** (M. Dunbar)

The study of ice drift in Robeson Channel, north Ellesmere Island, started in 1971, was continued. Processing was completed of the drift data obtained in the 1972 field season, using a shore-based radar to track ice-floe stations equipped with transponders, wind recorders and, when possible, current meters, and analysis of the data was started. As expected, the situation is proving to be quite complex. A second field season July-August 1974 completed the data-gathering phase. This time use of a simpler current meter enabled all stations to obtain current data. Atmospheric circulation proved to be very different from 1972, resulting in a very different drift pattern. Persistent southerly winds impeded the southward drift that was observed in 1972, though net drift for the season was probably still south.

Monitoring of ice conditions throughout Nares Strait (of which Robeson Channel forms a part) was also continued, with a Canadian Forces flight equipped with SLAR in April and local reconnaissance by helicopter in the summer. Satellite (NOAA) pictures provided data throughout the year. Some interesting data on the blocking of Kennedy Channel by large floes were obtained.

(b) **Study of the ice/shore interface** (M. Dunbar)

A field study of ice action at the shoreline in Robeson Channel has been carried out, with observation at various times of year. This is an area where ice piles up to a considerable extent on the shores of bays and on the permanent ice foot which lines most of the coast. High linear forces have been measured, but pressure, in the engineering sense, has been found to be surprisingly low.

Glaciology Division, Department of the Environment *(O. H. Loken)*

ICE SCIENCE SECTION (S. J. Jones)

(a) **Dielectric properties of D_2O ice** (G. P. Johari)

The experimental work is completed and a report is being prepared. See ICE No. 44.

(b) **Fracture of ice at 77°K** (V. R. Parameswaran)

Single and polycrystalline ice has been tested in compression at 77°K. Brittle fracture was observed at stresses of the order of 500 bar. A report is in preparation.

(c) **Mechanical properties of ice under hydrostatic pressure** (V. R. Parameswaran)

The project is continuing. See ICE No. 44 for details.

(d) **Radio depth-sounding** (R. A. O'Neil and S. J. Jones)

This project is complete and a report is in preparation.

(e) **Oil and ice studies** (E. C. Chen)

The studies have been continued. The surface-tension spreading as well as the aging of crude oil on ice were investigated. A correlation was developed between the oil slick area and the elapsed time. The influence of freezing and thawing on the stability of oil/water emulsions was also studied. Mechanical effects caused by the formation of ice crystals were found to increase coalesence of droplets in the water emulsion.

FLOATING ICE SECTION (R. O. Ramseier)

(a) **SKYLAB experiment** (R. O. Ramseier)

The lake and sea ice programme was conducted during January and February over the Thousand Islands area of Lake Ontario, St. Lawrence River and the Gulf of St. Lawrence. Underflights with NASA and DND aircraft, supported by extensive ground truth programmes, also took place during this period. The main agencies involved were the U.S. Geological Survey, CRREL, NASA, Aerojet Electrosystems, Department of National Defence and the Department of the Environment. The SKYLAB astronauts' hand-held imagery has been analysed. The other data from the aircraft and the ground survey looks good but has not yet been analysed.

(b) **St. Lawrence River** (M. Vant, R. Weaver)

Work continued on the ice regime in the St. Lawrence River between Montreal and Lake Ontario. An x-band impulse radar developed in a cooperative programme between the Communications Research Centre and the Department of the Environment was successfully tested in the St. Lawrence River. Under ideal conditions the thickness measurements are accurate to ± 0.01 m with a measurable minimum thickness of 0.14 m and a maximum thickness of several meters.

PERENNIAL SNOW AND ICE SECTION (C. S. L. Ommanney)

(a) **Air photography, Mackenzie River** (K. C. Arnold)

An RC-10 aerial camera was used to obtain photography over the Mackenzie River; 70 hours were flown in an aircraft under charter to the Polar Continental Shelf Project. The pattern of break-up was recorded for the third consecutive year and this pattern compared with ERTS imagery. More emphasis is now being placed on a year-by-year study of specific sections of the river, to relate changes of current velocity (measured stereometrically in channels with floating ice debris) to channel scour and shifting.

AVALANCHE GROUP (R. I. Perla)

In July 1974 the Glaciology Division formally established a group in Calgary to carry out avalanche research. In cooperation with Parks Canada, a snow laboratory has been set up near Sunshine Ski area, Banff National Park, where the major research effort will be concentrated on evaluation of avalanche slope stability during next winter. Analysis of data collected previously from this area by Park officials has started. Another research project on impact pressures has been started in Rogers Pass in cooperation with Mr. P. Schaerer, National Research Council.

National Research Council, Division of Building Research *(L. W. Gold)*

(a) Ice mechanics

Results of an investigation into the strain rate and temperature dependence of Young's modulus for granular and columnar-grained ice have been partially analysed. For strain rates in the range 10^{-8} sec^{-1} to 10^{-3} sec^{-1} Young's modulus appears to be controlled by a relaxation process involving time raised to the 2/3 power. This time dependence can be important for calculations of ice pressure and the bearing capacity of ice covers. The analysis will be extended to include the effect of temperature. It is planned to conduct further laboratory investigations of the elastic moduli and their dependence on relaxation processes.

Additional biaxial compression (plane strain mode) tests have been made on columnar-grained and granular ice. Special measures were taken to eliminate frictional loads. A fundamental difference in strength was noted between the two ice types. The results are presently being analysed.

(b) Ice engineering

Field measurements of the vertical loads developed on small diameter piles by a floating ice cover have been completed. A new loading arrangement, with a load capacity of 5,000 kg and a capability of applying a constant rate of pull-out, is being assembled for laboratory and field use.

Further laboratory experience has been gained on the in-situ measurement of stresses in ice. Commercially-available, plate-type pressure cells for use in concrete have proven to be satisfactory. This work has indicated the problems and limitations in making such measurements in the field.

A model study of the edge loading of an ice cover was carried out in the laboratory. The results, obtained on columnar-grained ice, indicate that identation load is a function of indentor width, but not of ice thickness. This is in contrast to field observations which indicate that it is a function of the ratio of indentor width to ice thickness.

Considerable experience was gained over the past winter in monitoring the performance of a large ice platform from which an offshore exploration well was drilled in the high Arctic. Special instrumentation was developed for measuring vertical deflections of the ice cover. A need was demonstrated for an analytical technique for determining the safe bearing capacity of an ice cover for static loads. Such a study is in progress.

(c) Avalanches

Observations on avalanche impact pressures on a surface of 1 sq. in. were continued at Rogers Pass. Observations of avalanche speeds and outrun distances yielded friction coefficients different from those used in Switzerland for the calculation of dynamic effects of avalanches. It is planned to increase the number of small sensors for measuring dynamic pressures and to make comparative measurements with sensors having a loading surface of 10 sq. in.

Observations were continued on the mass of avalanches at Rogers Pass and the variation with elevation of snow on the ground at 16 sites in southern British Columbia. These observations must be continued for another two years to obtain information sufficient for the prediction of 30-year maximum avalanches and snow loads.

(d) Permafrost distribution

Regular ground temperature observations are being taken at Churchill, Manitoba; Rankin Inlet, and Hall Beach, N.W.T. and 12 microwave stations on mountain summits in British Columbia. The programmes at Yellowknife and Devon Island, N.W.T. have been terminated. These observations are being analysed to determine the temperature regimes of permafrost at these locations.

Thermocouple and thermistor cables were installed at three locations in south-central Keewatin District for studies of permafrost conditions at the boundary of the discontinuous and continuous permafrost zones, and on the proposed polar gas pipeline route. In the Cordillera, thermocouple and thermistor cables were installed at 8,300 feet on Plateau Mountain, 100 miles southwest of Calgary, to investigate alpine permafrost in cooperation with the Department of Geology, University of Calgary. A helicopter reconnaissance to investigate the relation between snow-free areas and alpine permafrost in southern British Columbia was carried out in cooperation with the Department of Geography, University of B.C. Several high altitude sites were selected for ground temperature measurements using automatic recorders.

(e) **Permafrost environmental studies**

Regular observations on microclimate, surface energy exchange and ground temperatures, and their analysis are continuing at Thompson, Manitoba. This programme will continue at the present level.

(f) **Ground thermal regime**

Development of a one-dimensional thermal model has been completed and two reports have been prepared. The programme has been used for a detailed parameter study of the effects of snow cover on ground thermal regimes.

The programme has also been used to study temperature regimes within an evolving seasonal snow cover and is being applied for frost penetration predictions at three skating rinks. A one-dimensional model for nonlinear surface heat transfer problems is being used to calculate temperatures in ice covers heated by solar radiation.

A redesigned thermal conductivity probe has been constructed and performance verified. Probes of this type are now being used for a laboratory study of thermal conductivities of CuS and ZnS ore concentrate samples for the Canadian Institute of Guided Ground Transport at Queen's University, Kingston, Ontario. These values are required to calculate the thermal pattern in ore-filled rail cars during shipment in the winter.

(g) **Deformation and strength of frozen and thawing soils**

Several methods of cutting, machining and preparing frozen soil samples for laboratory testing have been investigated. The efficiency of each procedure depended on the soil type; e.g. a hot wire would easily cut through a frozen clay specimen, but not through frozen sand.

Unconfined compression and long-term creep tests were started on artificially frozen samples of Ottawa sand, Niagara silt and naturally-frozen Leda clay. It is planned to initiate confined compression tests to better establish the stress-strain-time characteristics and mode of failure of frozen soils.

Assistance was provided for Professor B. Ladanyi, École Polytechnique, Montreal, Quebec, who conducted a programme of in-situ pressure meter and penetrometer tests in permafrost at Thompson, Manitoba, in July 1974.

Polar Continental Shelf Project, Department of Energy, Mines and Resources *(G. D. Hobson)*

Sea ice reconnaissance (D. Lindsay)

The systematic airborne sea ice reconnaissance surveys conducted from April through October 1974 marked the fourteenth consecutive year for this programme. Observations in 1974 were made in the channels of the Canadian Arctic Archipelago between Alert and Tuktoyaktuk eight times during the season. The majority of the surveys were concentrated in Parry Channel and the Queen Elizabeth Islands. Generally the favourable weather throughout the season permitted good coverage and approximately 425 hours of flying time were used to collect information. Break-up in 1974 came one to two weeks later than usual with the result that the amount of open water and the extent of break-up was smaller than normal. The ice cover in the northern channels remained unbroken at the end of the season. The patterns of break-up were normal. An ice island located 150 kms north of Herschel Island is believed to be one previously visited and marked by the Polar Continental Shelf Project in 1967 when it was near Ward Hunt Island.

University of British Columbia, Department of Geography *(J. R. Mackay)* and Geological Sciences *(W. H. Mathews)*

Snow creep

Mathews and Mackay have completed and submitted for publication a final report on "Snow Creep: its engineering problems and some techniques and results of its investigation".

University of Colorado, Institute of Arctic and Alpine Research

Sea ice (R. G. Barry, J. D. Jacobs, D. Goth, R. L. Weaver)

Surface energy budgets of fast ice were studied at a station one km south of Broughton Island (67°N, 64°W), N.W.T. from late May through local break-up in early July. The programme included micrometeorological observations, englacial temperature profiles, oceanographic temperature and salinity measurements and surficial transects of extent of puddling, ice thickness, etc. The 1974 season concluded a field measurement programme of three years duration. Climatological observations, in association with the cooperative observer programme of the Atmospheric Environment Service, Canada, were continued at Broughton Village and extended the period of record to three calendar years. Anticyclonic dominance of the synoptic weather patterns, and abnormally high temperatures during May and June led to the earliest local fast ice break-up (10-15 July) in at least five years. The ablation season (June, July, August) mean monthly temperature of 3.9°C was the highest in the sixteen years of record for the Broughton Island DEW line weather station, in striking contrast to the record low mean ablation season temperature of −1.2°C in 1972.

Comparisons of local fast ice for 1973 and 1974 at Broughton Island using ERTS-1 imagery have identified surface features, such as cracks or thaw holes, forming in identical geographic locations in both years. The 1974 inshore break-up pattern was strikingly similar to 1973, but the seaward extent of the fast ice was approximately seven km less in 1974 for the same relative time in the melt sequence.

Comparisons between late May 1973 and 1974 using NOAA-2 Very High Resolution Radiometer (VHRR) imagery show a reduced pack ice concentration in the Davis Strait and Baffin Bay area for 1974. A decrease in mean August pack ice concentration in excess of 5/10ths has been noted from analysis of Canadian Ice Forecast Maps for the period 1970 to 1974. Analyses of other months of the summer are in progress.

Université Laval, Ice Mechanics Laboratory *(B. Michel)*

(a) **Ice formation**

Studies are continuing on the mechanism of nucleation of frazil. A small nucleator is used to study nucleation in various cases and particularly to confirm or reject the theory of nucleation from ice-borne crystals.

(b) **Break-up of river ice**

Research is being completed on the stability of a solid ice cover under increasing river discharge at break-up. A model study is being undertaken on the equilibrium of unconsolidated ice covers in meandering rivers.

(c) **Mechanical properties of ice**

The programme on mechanical properties of fresh water ice under uniaxial loading is being completed. A new press has been built to study the indentation of ice plates.

McGill University and Swiss Federal Institute of Technology

Sea ice dynamics (H. Ito)

As part of the North Water Project under the direction of F. Müller, measurements of the deformation of the ice cover on a meso-scale were made to the north-east of Cape Herschel station for the second successive field season. A total of eleven survey points were laid on the ice and repeatedly surveyed by traverse until travelling conditions were too bad when they were surveyed by intersection from base lines on shore. Visual observations of the retreat of the fast ice boundary near Cape Herschel were made.

W. S. B. Paterson

ICELAND

In 1974 the glaciological studies carried out by the Iceland Glaciological Society were restricted to an expedition in the spring to Grímsvötn and the Kverkfjöll area in Vatnajökull and measurement of the longitudinal variations of glaciers.

The North Iceland Glacier Inventory is a glacier research programme organized by A. E. Escritt in co-operation with Icelandic glaciologists. The programme will be carried out by the Iceland Unit of the Young Explorers' Trust in Great Britain. It involves reconnaissance of the numerous glaciers in the area between Eyjafjördur and Skagafjördur in North Iceland, ground-mapping of selected glaciers on a scale 1:5000, and repeated measurements and mapping at regular intervals of some of the 106 glaciers (including some rock glaciers) now localized and indexed in the area. Four were visited in 1973 and in 1974 three groups did a preliminary study of nine glaciers.

On December 20 1974 a disastrous avalanche destroyed the industrial area of the small town Nordfjördur in East Iceland. The avalanche killed 12 persons and paralyzed the economic life of the town. This disaster has opened the eyes of the Icelandic authorities to the necessity for a systematic study of snow conditions and avalanche risks in Iceland. It is a fact, not generally realized, that during the 1100 years history of the Icelandic nation avalanches have directly taken a greater toll in human lives than volcanic eruptions and earthquakes. M. de Quervain has accepted an invitation from the Icelandic Civil Defence to visit Iceland and help in the organization of the avalanche research.

Sigurður Thorarinsson

SWEDEN

MASS BALANCE STUDIES ON STORGLACIÄREN 1973-74

Beginning of ablation season	20 May
End of ablation season	10 Sep
Total winter balance in $10^6 m^3$	4.07
Specific winter balance in m	1.31
Total summer balance in $10^6 m^3$	−5.11
Specific summer balance in m	−1.65
Total net balance in $10^6 m^3$	−1.04
Specific net balance in m	−0.33
Height of equilibrium line in m a.s.l.	1480
Length of ablation season in days	94

After a test drilling in May 1973 plans were made to drill to the bottom of Storglaciären in March 1974. Good cores with a diameter of 15 cm were obtained down to 51 m depth, where suddenly water was met with. Water rose in the hole to 23.4 m below the snow surface and further drilling was stopped. Since the meltwater flow from Storglaciären has ceased at this time of the year, the existence of a large water body in the accumulation area was not quite expected. Another three test holes in this area were drilled later in the summer and measurements of the water stage were carried out throughout the season. From March until 16 June the level rose 0.5 m, during the next 10 days 7 m, and then it stayed almost constant 1.5 m below the maximum June level during the rest of the summer. The four holes reacted simultaneously to the variations. At the end of the season the level sank 2 m in 8 days.

The recovered cores were taken to Stockholm for analysis. Annual stratification is studied by means of structure, density, ice layer distribution, particle content, O^{18}/O^{16} and total β-activity—the last in co-operation with the Geophysical Isotope Laboratory, Copenhagen.

Valter Schytt

UNITED KINGDOM

JOINT UNIVERSITIES EXPEDITION TO SOUTH-EAST ICELAND

During July and August of 1974 members of the School of Environmental Sciences, University of East Anglia, the Department of Civil Engineering, University College of Swansea, and the Science Institute, University of Iceland, Reykjavík, formed a joint expedition to Breidamerkurjökull, south-east Iceland. Two main research projects were carried out: (i) glacio-lacustrine sedimentation studies in the proglacial lakes, Jökulsarlon, Breidarlon and Fjallsarlon, and (ii) studies of fluted ground moraine, close to the margin of central Breidamerkurjökull.

The first of these projects involved the collection of bottom sediment samples from the lakes mentioned. Both core and grab samples were taken in order to obtain information on the nature of these lake sediments, their grain-size characteristics, the rates of sedimentation in the lakes and the varvity of the sediments. In addition vertical water temperature profiles were taken in all the lakes, together with measurements of water salinity. Water samples were collected at several locations in Jökulsarlon and Breidarlon enabling profiles of density and suspended sediment concentration to be constructed. Measurements were made of the turbidity of the surface waters of all three lakes, and both the pattern of water flow in the lakes and the fluctuations of lake levels were monitored.

The second project entailed measurements of the size, orientation and position of stones in fluted ground moraine to determine the pattern of flow in the sub-glacial material when the flutes were formed. Samples of flute material were collected from three areas for magnetic remanence studies. Measurements of some mechanical properties of flute material were made in the field. Further measurements of stream-lined boulders were made to provide data for a theoretical analysis of the shape of sub-glacial obstacles.

P. W. V. Harris, E. M. Morris

BREIDAMERKURJÖKULL

Working in close liaison with the Geological Institute of the University of Iceland, Reykjavík, two members of the School of Environmental Sciences at the University of East Anglia visited the Breidamerkursandur area of south-east Iceland during January and February of 1975. This work continued that which was begun by members of the Joint Universities Expedition, in July and August of 1974.

Research on the sedimentological and hydrological characteristics of several large proglacial lakes was the chief concern. Holes were dug through the frozen surfaces of these lakes, and measurements of lake water temperatures and quantities of suspended sediments were made. A particular study was made of the salinity variations in Jökulsarlon—the largest proglacial lake of the Breidamerkursandur—and with these and similar measurements made in the spring and summer of 1974, a picture of the structure of the lake water and its seasonal salinity variations has been built up.

Observations on the stream discharges and sediment loads of the rivers Fjallsa, Jökulsa and Stemma were also made. The stream-bed profile of the Jökulsa was determined; this river has deepened its bed by more than 2 m since 1969.

A further expedition to the Breidamerkursandur is planned for the summer of 1975.

P. W. V. Harris

CAMBRIDGE EAST GREENLAND EXPEDITION

During July and August 1974 a nine-member team visited the Roslin glacier in the Staunings Alps, East Greenland (Base camp Lat. 71° 51', Long. 24° 59') to continue work started by previous Cambridge expeditions to the area and to carry out new studies.

Three projects were completed. A geophysical wire strainmeter with a resolution of 1 in 10^7 was installed to measure horizontal strain changes on the glacier surface. The interesting records produced showed such a strainmeter could give useful new information about rates of change of strain in the glacier. Three thermal probes, which could measure tilt and temperature, were designed and built to descend to the glacier bottom. Unfortunately all three probes failed because of faulty heating elements. The majority of the stakes previously set up on the Roslin and Lang glaciers were resurveyed. At the snout of the Roslin glacier three new stake lines were set up and surveyed. Maps were made of the snout and the base camp area of the Roslin glacier.

D. J. Goodman

U.S.A.

A SYNOPTIC CLIMATE MODEL OF SNOW ACCUMULATION AND MELT FOR NEW ENGLAND

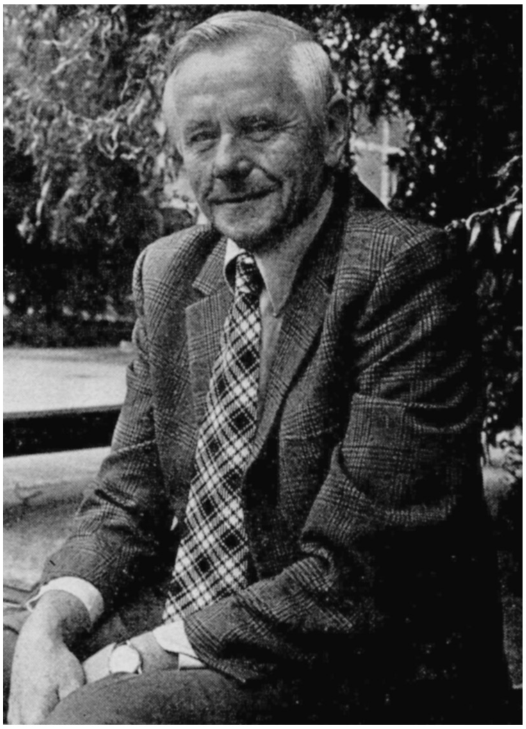
The National Weather Service weather network provides very little direct information on snowpack water content and melt in the northeast but their ordinary temperature and precipitation data can, through appropriate time-space modelling, be converted into reliable estimates of the snow climate and ten-day synoptic snowpack behaviour over an entire region.

Two geographic parameters, elevation and thermal latitude, account for much of the spatial variation of New England's temperature and precipitation climates during the winter and spring seasons. As the rain-snow distribution and snow-melt are highly responsive to temperature a modelling of elevation and latitude effects on temperature and precipitation leads to a time-space seasonal climate of snowpack (water equivalent) accumulation and melt.

When used on a ten-day synoptic basis the model explains 84 per cent of the seasonal snowpack variation. This compares with 54 per cent explained by climatological averages. When used to estimate snowpack behavior at points or over watersheds remote from predictor weather stations the model retains significant skill over distances up to about 90 miles and over all elevation ranges.

Application to snow and snowmelt resource problems are numerous, particularly in estimating flood and water supply potentials from snowpacks in ungauged areas.

Robert L. Hendrick and Roger J. DeAngelis
(New England Watershed Research Center,
Agricultural Research Service,
150 Kennedy Drive,
So. Burlington, Vermont 05401, U.S.A.)



MAXWELL GAGE

Maxwell Gage was born in Auckland, New Zealand, in 1913, the son of E. C. Gage, who worked for the New Zealand Post Office as an electrical engineer primarily concerned with telephones and early radio communications. His mother, too, was involved with communications, for she was the first woman telegraph operator in New Zealand, in 1895. He was educated in Auckland at the Grammar School and at the University College, from which he graduated with a B.Sc. and a Senior Scholarship in geology in 1934.

In 1935 he moved to Wellington, to take up a post as Demonstrator in the Geology Department of Victoria University College, the Wellington campus of the University of New Zealand. Here he obtained an M.Sc. with 1st class honours and the Haast Prize in 1937. Max's next post was with the New Zealand Geological Survey, where he concentrated mainly on economic geology and, in particular, on gold and coal, and conducted many regional surveys. He married Molly Rose Black in 1938, and they continued to live in the Wellington area until 1948, when Max was appointed Senior Lecturer in Geology at Canterbury University College, Christchurch. Their home has remained in Canterbury ever since and has been the happy scene of many dinner parties for visiting geologists and glaciologists.

It was soon after his move to Christchurch that Max's interest in glacial geology and the Pleistocene epoch was aroused, during geomorphological field classes in the mountains. He was inspired to join the Glaciological Society in 1950, a reflection of his changing interests. In 1952 he received a senior doctorate, D.Sc., from the University of New Zealand, and became increasingly involved in the activities of the Royal Society of New Zealand and its member bodies, as well as in those of the Geological Society of New Zealand.

A Fulbright-supported visit to the University of Illinois in 1952-53 was crucial in giving confidence that there was a multi-glacial record in New Zealand. He worked on comparisons with the North American mid-west and west, and associated himself with some simple glaciological work—though he says he has never considered himself a glaciologist. In 1958 he received the McKay Hammer Award of the New Zealand Geological Society, for a paper on glacial geology, and the following year was promoted to the position of Reader at the University of Canterbury. He spent the year 1959-60 abroad, when he went to the United Kingdom on a Fellowship from the Royal Society and the Nuffield Foundation, to work at the University of Birmingham.

Work in Christchurch expanded continually, with service on the various scientific committees concerned with advising the New Zealand Forestry Research and the Westland National Park, on the New Zealand National Committees for Geology and for Quaternary Research, on the Canterbury Museum Trust Board, and for the Geological Society of New Zealand, where he served as President. He was elected to a Fellowship of the Royal Society of New Zealand in 1961 and of the Geological Society of America in 1962.

Fortunately for his friends and colleagues in other parts of the world, Max undertook several lecturing and research appointments in the northern hemisphere. In 1964 he spent three months in the USA on the American Geological Institute's "Distinguished Visiting Scientist Program": this was a hectic time, for he visited and lectured at 22 Institutions. In 1969-70, he divided his time between England, where he was a Research Fellow in the Geology Department of the University of Birmingham, and the United States where he was a visiting professor at Syracuse University, New York. By now, Max was Professor and Head of the Geology Department at the University of Canterbury, receiving his promotion in 1966 upon the retirement of Robin Sutcliffe Allan.

One of the recent tasks undertaken by Max, and one for which his lively good humour eminently suited him, was the organization of the IXth INQUA Congress, held in Christchurch in 1973. He was Chairman of the Organizing Committee, which worked from 1970-1973 to make this big meeting of Quaternary specialists an outstanding success. In 1974, Max retired from the University of Canterbury, and took up an appointment as Research Associate in Geology, Canterbury Museum. He is now also doing work as a consultant for the New Zealand Forest Service and in engineering geology. Always a very active person, Max hopes that in his retirement he can continue his studies of the New Zealand Pleistocene glacial record and its overseas relationships: work that will be welcomed.

Recognition of his great contributions to glacial and Quaternary studies was made in 1974, when he was awarded the Hutton Medal by the Royal Society of New Zealand: an award that gave his colleagues and friends as much pleasure as it gave him.

INTERNATIONAL GLACIOLOGICAL SOCIETY

1976 SYMPOSIUM ON APPLIED GLACIOLOGY

Response to the First Circular has been very good. The Second Circular will be published in ICE No. 48 (2nd issue 1975), and will include instructions for the submission of summaries, and forms for registration and accommodation bookings.

Owing to the high cost of postage, **separate copies of the circular will not be sent** to all members of the Society: please use the forms on the appropriate pages of ICE 48 if you wish to book for the Symposium.

BRANCH NEWS

NORDIC BRANCH

The 1974 Annual Meeting of the Nordic Branch was held in the Jostedalsbreen-area, Western Norway, 25-30 August. 34 members from all nordic countries, 2 from UK and Canada and 18 "family members" (the youngest only 7 weeks old!) enjoyed a pleasant time in this beautiful and interesting area. For practical reasons we had three "bases", Nigard with excursions to Nigardsbreen and Tverrbreen, Hafslo with an excursion to Austerdalsbreen, and Mundal in Fjaerland with excursions to Supphellebreen, Bøyabreen and Flatbreen. In the evenings lectures were held in the accommodation places.

Slightly more than 200 years ago the farmers around Jostedalsbreen had more important problems to consider than the political and military tricks in the European courts and general staffs: advancing glaciers swallowed pastures and cottages in the higher parts of the valleys! The farmers insisted on tax relief because of the sinking real estate value of their homesteads. When you see the landscape today you can easily understand the farmers in the 18th century. There is a striking difference between the terrain not covered by ice during the last major glacier advance and the "boulder-and-moraine-terrain" between the outer moraine ridges and the present-day fronts of Nigardsbreen and Tverrbreen. The advance of Nigardsbreen stopped in 1748. Lichenometrical methods give good opportunities for following the retreat of the shrinking glacier. Near the front of Nigardsbreen there is a quite large bedrock area with beautifully sculptured, plastically scoured detail forms, which were keenly discussed and photographed by the excursion members.

One day, unfortunately a rainy one, we spent on and in the vicinity of Austerdalsbreen. The well marked ogives were studied, and some of the members questioned the classical interpretation. During the walk to the ice, deep glacier creeks instructed some of us in a very drastic way that sometimes you have to use rubber boots with long legs . . . . .

On one sunny day, when the moist ground was sweating, the melt water trickled in the glacier creeks, the snow sparkled and the wind slept somewhere, a small group climbed up to a 1 600 m high mountain peak, and had a wonderful view out over Fjaerlandsfjorden and Flatbreen (this is not true: when we arrived at the peak, low lying clouds swept in and spoiled the view. But we told the other members about wonderful sights . . .). Flatbreen ends in a calving front 700 m a.s.l. From here ice blocks fall 400 m vertically to Supphellebreen. Without this yearly contribution of 2 million m^3 of ice Supphellebreen would disappear in 4-5 years. Flatbreen calves also in a ice-dammed lake, which usually empties every August.

In the excursion areas glaciers and the cultural landscape are very close to each other. It was quite natural that one day Mr Orheim, Olav Orheim's father, gave a lecture on the history and the daily life in Fjaerland. While we were listening to his vivid description, sitting in the green grass on an old marine terrace, Bøyabreen sparkled behind us in the afternoon sun and cows grazed between boulders and moraine ridges formed by the glacier 250-300 years ago. In front of us was an old chalet, a "saeter", with cottages with peat-covered roofs. At the foot of the marine terrace one could see the modern village with painted houses, cars in the courtyards and tractors in the fields. When some of us climbed to the mountain peak the "junior league" and some other members visited another old "saeter". After the splendid dinner (with many speeches . . . .) on the last evening in Fjaerland we learned old Norwegian folk-dances. There was room both for science and arts in the programme . . . .

The evenings and the last meeting day were reserved for lectures:

J. L. Sollid
About plastically scoured detail forms in bedrock.

O. Liestøl
Austerdalsbreen.

A. Tvede
Observations in a tunnel constructed for power purposes beneath Bondhusbreen, Folgefonni.

H. Björnsson
Jökulhlaups from Vatnajökull.

G. Østrem
Run-off forecast in glacier rivers.

J. Nilsson
The inner drainage in glaciers as a mathematical-statistical model.

V. Schytt
A project to exploit iron ore beneath the ice sheet in SW Greenland.

S. Messel
Measurements of the energy balance on some glaciers in Norway.

O. Orheim
Mass balance measurements on Jan Mayen.

G. Østrem
Calculations of the size of the sedimentation chambers in power station tunnels beneath glaciers.

J. Mangerud
How do the glaciers advance and retreat in deep fiords?

W. Karlén
Dating of the Holocene climate change.

Ch. Hjort
Air reconnaissance for Quaternary geological purposes in Hochstetters Foreland-Shannon Øn, East Greenland.

Å. Hillefors
Glacial striae on the Swedish west coast indicating glacial ice in Skagerack-Kattegatt in Late Glacial Time.

M. Seppälä
Asymmetric form of glacial valleys controlled by bedrock structure.

P. Worsley
Aspects of the neoglacial history of Engabreen, Svartisen.

E. Kanavin
Engineering glaciology.

E. Olausson
Connections between earth magnetism and the glacial epochs.

W. Dansgaard
GISP 1974.

H. Björnsson
An ice core from Vatnajökull.

H. Clausen
Accumulation on the Ross Ice Shelf.

O. Orheim
Measurements of the mass balance of the ice shelves in Antarctica.

G. Østrem
Possibilities of obtaining the temporary snow line from ERTS-pictures.

The Annual General Meeting of the Branch was held on 30 August in Mundal Hotel, and the following officers were elected for 1974-76: President—Matti Seppälä, Vice-President—Erkki Palosuo, Secretary—Henrik Österholm, "Observer"—Helgi Björnsson.

The next meeting will be in Southern Finland, probably at Tvärminne zoological station, in March 1976. The central topic will be sea and lake ice and engineering glaciology. Welcome to Finland!

Henrik Österholm

NORTH EAST NORTH AMERICAN BRANCH

The NENA Branch of the International Glaciological Society meets every other year alternating between Canada and the U.S. The 1975 meeting was held at CRREL in Hanover, NH, 14-15 February. Many of the participants arrived early on Friday in order to tour the CRREL facility.

The technical presentations began on Friday evening with sea ice dominating the agenda:

Gerald Irwin
Ice pressure at shore of Lincoln Bay, NWT.

Jim Cragin
Chemistry of South Central Greenland.

Phil Langleben
Measurement of water stress on sea ice.

Ray Lowry
Laser profiling of sea ice.

Terry Tucker
Processing and analysis of laser profile data.

Malcolm Vant
Remote sensing of fresh and sea ice thickness.

Willy Weeks
The Arctic SLAR: an aid in determining lake depth on the Northslope.

Hans Weber
Ice floes in collision.

George Ashton
Bubblers for ice suppression.

Roger Terpening
The ERIM/CRREL shear wave generator.

Ian Worley
Potential nickel mining beneath the Brady Glacier, Glacier-Bay National Monument, Alaska.

After a late conclusion we regrouped at a local refreshment center, then continued Saturday morning with a glacier oriented program:

Father Dick Cameron
Theological considerations of ice movement.

Terry Hughes
WISP, Ice Cap Bulletin III.

Bill Hibler
Prediction of ice core climatic time series.

Steve Mock
Recent Greenland strain and flow measurements.

Carolyn Merry
Ice and snow accumulations in New England; shore-fast ice off the northwest coast of Alaska.

K. C. Arnold
Binary coded ablation and accumulation stakes.

Sam Colbeck
Water flow through veins in temperate ice.

Austin Kovacs
Use of impulse radar to detect crevasses and brine layers in the McMurdo Ice Shelf.

Ben Drake
SLAR with radar reflectors for measuring glacier flow rates.

Mike Bilello
Penetration of warm air to the Arctic.

The technical discussions concluded at noon on Saturday so that the participants in the 2nd Can-Am Ski Race could prepare. Austin Kovacs led the U.S. team (with the help of the race officials who just happen to be all Americans) to a narrow victory in the giant shalom over the Canadians, led by Ken (?) Gold. A protest was lodged with the officials to disqualify non-member Gold but this matter was settled when the officials learned that Kovacs had crashed the gate. Everybody went away happy, however, when Bill Hibler assured the officials that his statistical analysis of the race data (to be performed the next week) would show that the Americans had clearly won.

The traditional banquet provided a suitable finish for the two-day meeting—a social hour, gourmet dinner, presentation of the ski race results, speech on the state of the society by El Lieder Willy Weeks, and announcement of Phil Langleben's offer to host the next meeting. Many thanks were given to Tony Gow who, by failing to attend the previous meeting, had been landed the job of hosting the 1975 meeting.

The new officers of the NENA Branch are:
President: A. J. Gow
Vice-President: Phil Langleben
Treasurer: A. Kovacs

S. Colbeck

For the inspiration (and amusement) of members we append here the address given by Father Richard Cameron at the NENA Branch meeting.

Brethren—

We are gathered here this morning to reaffirm our faith in the ice movement, to pray for a cooling climate and increased snowfall.

Let me remind you that it was Hugi, in one of the years of our Lord, that first recognized the ice movement. Since then, our movement has advanced slowly but steadily in most parts of the world with a retreat here and there. Now we have the relatively new phenomenon within our movement—the surge. We must be cautious about surges, as they can be ill-conceived and of short duration and may not contribute substantially to our faith.

As Admiral Thomas of the U.S. Coast Guard once said, "Ice is where you find it." So be it. Let it be. In the north—in the south—high up—in the icebox, but certainly not down deep in hell—for ice is heavenly. In spite of the early missionaries to the arctic telling the eskimos that heaven was hot and hell was cold and ice, we know that is not true. Fire and ice are like evil and goodness—that everlasting fight for supremacy. In our own movement, we know of the battles in Iceland, Jan Mayen, Deception Island, Mount Erebus, and Mount Wrangell and the various crusades our members have led to these areas.

Robert Frost has written of "Fire and Ice":

Some say the world will end in fire
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To say that for destruction ice
Is also great
And would suffice.

It is obvious that Frost did not understand that ice sheets are clean and are the purest of all environments.

But to conclude my sermon, I must plead that the movement remain united. That those various sects that have developed over the years, the pit diggers, the bottom melters, the sea icers, the modellers, the radio-sounders, the isotopers, keep in mind that our mutual goal is the preservation of our faith. We must work and plan together for the glory of the ice movement and we must pledge to fight those who would have us believe that ice sheets might disintegrate, and we must debate vigorously with those who wish to drill completely through the ice sheets and allow the escape of the entrapped gases and vital fluids that hold up these ice sheets.

It is written both in the Old Estimate and the New Estimate that the faithful must endeavor to propagate the order. Go forth then from this ice temple with lectures and the written word to convert both young men and women to the way of ice.

Glory be to ice.

A-Women

JOURNAL OF GLACIOLOGY

The following papers have been accepted for publication in forthcoming issues of the Journal of Glaciology:

Chester B. Beaty
Sublimation or melting: observations from the White Mountains, California and Nevada.

J. G. Paren & G. de Q. Robin
Internal reflections in polar ice sheets.

G. Holdsworth
Instruments & Methods: Measurement of small strain-rates over short time periods.

R. A. Souchez & R. D. Lorrain
Chemical sorting effect at the base of an Alpine glacier.

Gary T. Jarvis & Garry K. C. Clarke
The thermal regime of Trapridge Glacier and its relevance to glacier surging.

G. P. Johari & P. A. Charette
The permittivity and attenuation in polycrystalline and single crystal ice Ih at 35 and 60 MHz.

J. R. Weber & M. Erdelyi
Ice and ocean tilt measurements in the Beaufort Sea.

R. S. Bradley
Equilibrium-line altitudes, mass balance and July freezing-level heights in the Canadian high Arctic.

D. v.d.S. Roos
Rapid production of single crystals of ice.

C. F. Raymond & W. D. Harrison
Some observations on the behavior of the liquid and gas phases in temperate glacier ice.

B. D. Chadbourne, R. M. Cole, S. Toothill & M. E. R. Walford
The movement of melting ice over rough surfaces.

V. R. Parameswaram & S. J. Jones
Brittle fracture of ice at 77 K.

H. Behrens, H. Bergmann, H. Moser, W. Ambach, O. Jochum
On the water channels of the internal drainage system of the Hintereisferner, Oetztal Alps, Austria.

Chalmers M. Clapperton
On the debris content of surging glaciers in Svalbard and Iceland.

J. Klinger
Low-temperature heat conduction in pure monocrystalline ice.

M. Leonard Bryan & R. W. Larson
The study of fresh-water lake ice using multiplexed imaging radar.

William I. Linlor & George R. Jiracek
Electromagnetic reflection from multilayered snow models.

P. R. Kry
Quantitative stereological analysis of grain bonds in snow.
The relationship between the visco-elastic and structural properties of fine-grained snow.

Short Notes

David R. Gaylord
Sediments exposed on the surface of the Ross Ice Shelf, Antarctica.

J. R. Mackay & W. H. Mathews
Orientation of soil stripes caused by needle ice.

J. W. Glen and J. G. Paren
The electrical properties of snow and ice.

W. J. Fitzgerald and J. G. Paren
The dielectric properties of Antarctic ice.

G. de Q. Robin
Radio-echo sounding: glaciological interpretations and applications.

M. V. Berry
Theory of radio echoes from glacier beds.

G. K. A. Oswald
Investigation of sub-ice bedrock characteristics by radio-echo sounding.

C. S. M. Doake
Glacier sliding measured by a radio-echo technique.

Preben Gudmandsen
Layer echoes in polar ice sheets.

V. I. Morgan and W. F. Budd
Radio-echo sounding of the Lambert Glacier basin.

Charles R. Bentley
Advances in geophysical exploration of ice sheets and glaciers.

David J. Drewry
Comparison of electromagnetic and seismic-gravity ice thickness measurements.

G. de Q. Robin
Velocity of radio waves in ice by means of a bore-hole interferometric technique.

J. Tatibouet, R. Vassoille and J. Perez
Ultrasonic properties of plastically deformed ice.

D. F. Page and R. O. Ramseier
Application of radar techniques to ice and snow studies.

Moira Dunbar
Interpretation of SLAR imagery of sea ice in Nares Strait and the Arctic Ocean.

Tadashi Tabata
Sea-ice reconnaissance by radar.

S. G. Tooma, R. A. Mennella, J. P. Hollinger and R. D. Ketchum
Comparison of sea-ice type identification between airborne dual-frequency passive microwave radiometry and standard laser/infrared techniques.

F. Müller, H. Blatter and G. Kappenberger
Temperature measurement of ice and water surfaces in the North Water area using an airborne radiation thermometer.

Mark F. Meier
Application of remote-sensing techniques to the study of seasonal snow cover.

Sam I. Outcalt
The analysis of the near-surface energy transfer environment from thermal infrared imagery.

A. O. Poulin
Significance of surface temperature in the thermal infrared sensing of sea and lake ice.

Åke Blomquist
Seasonal effects on ground-wave propagation in cold regions.

W. J. Campbell, W. F. Weeks, R. O. Ramseier and P. Gloersen
Geophysical studies of floating ice by remote sensing.

W. D. Hibler III
Characterization of cold-regions terrain using airborne laser profilometry.

Elizabeth Williams, Charles Swithinbank and G. de Q. Robin
A submarine sonar study of Arctic pack ice.

J. W. Lane
Optical properties of salt ice.

P. Gloersen and V. V. Salomonsen
Satellites—new global observing techniques for ice and snow.

R. M. Krimmel and M. F. Meier
Glacier applications of ERTS images.

Gunnar Østrem
ERTS data in glaciology—an effort to monitor glacier mass balance from satellite imagery.

W. F. Budd
Antarctic sea-ice variations from satellite sensing in relation to climate.

J. F. Nye
The use of ERTS photographs to measure the movement and deformation of sea ice.

THE LIBRARY

BOOKS RECEIVED:

AIDJEX Bulletin, No. 25, 1974.

AIDJEX Bulletin, No. 26, 1974.

Aitken, G. W. Reduction of frost heave by surcharge stress. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 184, 1974, iv, 25p.

Anderson, D. M. *and others*. The water-ice phase composition of clay/water systems. By D. M. Anderson, A. R. Rice and A. Banin. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 322, 1974, iii, 10p.

Calkins, D. J. A research hydraulic flume for modeling drifting snow. Design, construction and calibration. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 251, 1974, iii, 16p.

Dolov, M. A., *ed.* Sneg i snezhnyye laviny [Snow and snow avalanches]. *Vysokogornyy Geofizicheskiy Institut. Trudy*, Vyp. 18, 1972, 152p.

Dranevich, Ye. P. *Gololed i izmoroz'. Usloviya obrazovaniya, prognoz i gololednoye rayonirovaniye severo-zapada yevropeyskoy territorii SSSR* [*Glaze and hoarfrost. Conditions of formation, forecasting, and their distribution in north-west Eusropean USSR*]. Leningrad, Gidrometeorologicheskogo Izdatel'stvo, 1971. 228p.

Escritt, E. A. *North Iceland glacier inventory. Manual for the use of field survey parties.* [Castleton, Derbyshire. Peak District National Park Study Centre], Young Explorers' Trust, [1974]. [v], 60p, illus., folding map. £1.00. [Prepared for the use of groups in the Trollaskagi district, north-west of Akureyri.]

Ives, J. D. *and* Barry, R. G., *eds. Arctic and alpine environments.* London, Methuen, 1974. xviii, 999p, illus., plates. £35.
[Sections deal with present and past environments, present biota, development of biota, abiotic processes, man in cold environments, and man's impact on the environment. To be reviewed.]

Kamalov, B. A. Sovremennoye oledeneniye i stok s lednikov v basseyne Syrdar'i [Present-day glaciation and discharge from glaciers in the Syrdar'ya basin]. *Sredneaziatskiy Regional'nyy Nauchno-Issledovatel'skiy Gidrometeorologicheskiy Institut. Trudy*, Vyp. 12 (93), 1974, 80p.

Kaplar, C. W. Freezing tests for evaluating relative frost susceptibility of various soils. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 250, 1974, iv, 37p.

Moskalev, Yu. D. *and others. Ukazaniya snegolavinnykh nagruzok pri proyektirovanii sooruzhneiy* [*Instructions for calculating snow avalanche loads when planning buildings*]. *By Yu. D. Moskalev, A. V. Runich, V. S. Chitadze and A. M. El'mesov.* Moscow, Moskovskoye Otdeleniye Gidrometoizdata, 1973. 20p, separate maps.

Orvig, S., *ed. Klimat polyarnykh rayonov* [*Climates of the polar regions*]. Leningrad, Gidrometeoizdat, 1973. 443p.
[Russian translation of book published by Elsevier, 1970.]

Quaestiones Geographicae (Poznan), [No.] 1, 1974.

Santeford, H. S. *and* Smith, J. L., *comps. Advanced concepts and techniques in the study of snow and ice resources: an interdisciplinary symposium organized by the Work Group on Snow and Ice, the Work Group on Remote Sensing, and the Work Group on Nuclear Techniques of the U.S. National Committee for the International Hydrological Decade . . . . Monterey, California, December 2-6, 1973* . . . . Washington, D.C., National Academy of Sciences, 1974, x, 789p.

Sayles, F. H. Triaxial constant strain rate tests and triaxial creep tests on frozen Ottawa sand. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 253, 1974, iii, 29p.

Sayles, F. H. *and* Haines, D. Creep of frozen silt and clay. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 252, 1974, iv, 51p.

Schultz, G. *Ice age lost.* Garden City, New York, Anchor Press/Doubleday, 1974. xvii, 342p. [To be reviewed.]

Shul'ts, V. L. *and* Suslov, V. F., *eds.* Glyatsiologiya Sredney Azii. Ledniki [Glaciology of Central Asia. Glaciers]. *Sredneaziatskiy Regional'nyy Nauchno-Issledovatel'skiy Gidrometeorologicheskiy Institut. Trudy*, Vyp. 14 (95), 1974, 158p.

Smiley, T. L. *and* Zumberge, J. H., *eds. Polar deserts and modern man.* Tucson, Arizona, University of Arizona Press, [1974]. vii, 173p.

RECENT MEETINGS (of other organizations)

SYMPOSIUM ON THE THERMAL REGIME OF GLACIERS AND ICE SHEETS

(Burnaby, B.C., Canada, 8-11 April 1975)

A Symposium on the Thermal regime of glaciers and ice sheets was held at Simon Fraser University, Burnaby, British Columbia, Canada from 8-11 April 1975. Of the papers listed in ICE No. 45, p. 18, the following authors were not present and their papers were not read:

C. R. Bentley
S. S. Grigorian
P. A. Shumsky
M. S. Krass
H. Röthlisberger

The following additional papers and news of recent work were given:

H. J. Zwally, P. Gloersen & T. C. Chang
Satellite measurement of near surface ice sheet temperatures.

G. Dewart
Basal conditions of the west Antarctic Ice Sheet by seismic exploration techniques.

K. Philberth
On the temperature response in ice sheets to radioactive waste deposits.

M. M. Miller
Thermo-physical characteristics of glaciers: Toward a rational classification.

M. W. Mahaffy
The speed of glacierization of Canada during the Wisconsin Ice Age: The results of a three-dimensional ice sheet model.

W. D. Harrison & C. Raymond
Salt content and its distribution in a temperate glacier.

S. M. Hodge
Direct measurement of basal water pressures: A pilot study.

R. Bindshadler, W. Harrison, C. Raymond & C. Gantet
Thermal regime of a surge-type glacier.

W. Budd
Film of computer surge model results.

K. Philberth
Future regard to the atomic waste disposal problem.

M. M. Miller
Self regulation of natural systems.

M. F. Meier
Glaciological phenomena associated with the current activity of Mt. Baker.

L. Lliboutry
Some thoughts on bed roughness.

L. Lliboutry, M. Briat, M. Creseveur, M. Pourchet
15m deep temperatures in glaciers of Mont Blanc (French Alps).

The proceedings will be published as a separate volume of the Journal of Glaciology in 1976: Vol. 16, No. 74. Members will receive this free.

GLACIOLOGICAL DIARY

1975

26-28 June
National Symposium on precipitation analysis for hydrologic modeling, University of California, Davis. Sponsored by AGU Section of Hydrology. (AGU, 1707 L St., N.W., Washington, DC 20036, USA.)

30 June-2 July
National Symposium on water resources problems in metropolitan areas, New Brunswick, NJ. Sponsored by American Water Resources Association and Rutgers University. (William Whipple, Jr., Director, Water Resources Institute, Rutgers University, New Brunswick, NJ 08903, USA.)

11-15 August
Third International Conference on Port and Ocean Engineering under Arctic conditions, Fairbanks, Alaska, USA. (POAC 75, Institute of Marine Science, University of Alaska, Fairbanks, Alaska 99701, USA.)

18-20 August
Symposium on the geochemistry of natural waters, Burlington, Ontario, Canada. Sponsors: Working Group on Geochemistry and Cosmochemistry, the International Association of Hydrological Sciences and Canada Centre for Inland Waters. (Mary E. Thompson, Chairman, Canada Centre for Inland Waters, Burlington, Ontario, Canada.)

18-21 August
International Association of Hydraulic Research Committee of Ice Problems and US Army Cold Regions Research and Engineering Laboratory—Symposium to include ice management and engineering as related to extended season navigation of inland waterways, ice jam control, and effects of sea ice on marine structures. (G. Frankenstein, CRREL, Hanover, N.H. 03755, USA.)

18-23 August
Symposium on Long-term climatic fluctuations, Norwich, England. WMO/IAMAP Sponsored. (Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, England.)

25 August-6 September
XVI General Assembly for the International Union of Geodesy and Geophysics, Grenoble, France. (C.N.F.G.G., 136bis, rue de Grenelle, 75700 Paris, France.) Symposium on isotopes and impurities in snow and ice, International Commission of Snow and Ice, Grenoble, France, during 1975 General Assembly of I.U.G.G. (Dr Fritz Müller, Secretary ICSI, Geog. Inst. der ETH, Sonneggstrasse 5, Zürich 8006, Switzerland.)

27 August
Symposium on snow and ice crystals, International Commissions on Cloud Physics (IAMAP) and on Snow and Ice (IAHS), Grenoble, France, during 1975. General Assembly of IUGG. (Dr R. List, Dept. of Physics, McLennan Physical Labs., University of Toronto, Toronto 5, Ontario, Canada.)

5 September
Symposium on weather modification, International Associations of Hydrological Sciences (IAHS) and Meteorology and Atmospheric Physics (IAMAP), Grenoble, France, during 1975 General Assembly of IUGG. (Dr H. K. Weickmann, International Commission on Cloud Physics, NOAA-ERL, PSRB No. 3, Boulder, CO 80303, USA.)

8-13 September
Symposium and Workshops on the application of mathematical models in hydrology and water resources systems, Bratislava, Czechoslovakia. Convened by International Association of Hydrological Sciences with support of Unesco and World Meteorological Organization. (Symposium Organizing Committee, Hydrometeorological Institute, Jeseniova 43, 88532 Bratislava, Czechoslovakia.)

6-10 October
Symposium on Remote sensing of environment, Ann Arbor, Michigan, USA. (University of Michigan, Extension Service, Conference Dept., Ann Arbor, Michigan 48104, USA.)

24-26 October
Conference on glacial and periglacial processes and landforms, Glasgow, U.K. British Geomorphological Research Group. (Dr R. B. Price, Dept. of Geography, University of Glasgow, Glasgow G12 8QQ, U.K.)

2-9 November
Symposium on global scale palaeolimnology and palaeoclimate, Kyoto, Japan. (Bureau, Otsu Hydrobiological Station, Kyoto University, Otsu 520-01, Japan.)

1-8 December
Symposium on hydrological characteristics of river basins, Tokyo Prince Hotel, Tokyo, Japan. Sponsored by International Association of Hydrological Sciences, organized by Science Council of Japan. (Arnold I. Johnson, USNC/IAHS, U.S. Geological Survey National Center, MS-417, Reston, VA 22092.)

12-17 December
The Second World Congress on Water Resources, New Delhi, India. (C. V. J. Varma, Secretary Indian National Committee for International Water Resources Association, Central Board of Irrigation and Power, Kasturba Gandhi Marg, New Delhi-110001, India.)

14-19 December
Conference on foundations on Quaternary deposits, Norwich, England. Engineering Group of Geological Society of London. (A. B. Hawkins, Dept. of Geology, University of Bristol, Bristol BS8 1TL, England.)

1976

August
23rd International Geographical Congress, Moscow, USSR, (V. Annenkov, Institute of Geography, Academy of Sciences USSR, Staromonetny 29, Moscow 109017, USSR.)

15-25 August
25th International Geological Congress, Sydney, Australia. (Secretary-General, 25th International Geological Congress, P.O. Box 1892 Canberra City, ACT 2601, Australia.)

17-20 August
International Cloud Physics Conference, Colorado Springs, USA. Sponsored by International Association of Meteorology and Atmospheric Physics and International Commission on Cloud Physics: co-sponsored by American Meteorological Society. (H. K. Weickmann, NOAA/APCL, Boulder, CO 80302, USA.)

23-27 August
International Weather Modification Conference, Colorado Springs, CO. Sponsored by International Association of Meteorology and Atmospheric Physics/International Commission on Cloud Physics and Weather Modification Panel of World Meteorological Organization; co-sponsored by American Meteorological Society and Academy of Science of Australia. (H. K. Weickmann, NOAA/APCL, Boulder, CO 80302, USA.)

Autumn
International workshop on dynamics of glacier fluctuations and surges, sponsored by ICSI, organized and held in USSR.

12-18 September
Symposium on Problems of Applied Glaciology, Cambridge, England. International Glaciological Society. (Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.) (See ICE 45 p. 15 for First Circular.)

1978

10-13 July
Third International Conference on Permafrost, Edmonton, Alberta, Canada. National Research Council of Canada. (M. K. Ward, c/o National Research Council of Canada, Ottawa, Ontario K1A OR6, Canada.)

August & September
Symposium on Dynamics of large ice masses. (Venue to be announced.) International Glaciological Society. (Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

NEWS

DIPLOMA IN POLAR STUDIES

The Scott Polar Research Institute of Cambridge University will start a 1-year postgraduate course in October 1975 leading to a diploma in polar studies.

The course will provide a broad background of polar knowledge and allow each candidate to investigate a topic of his choice in depth. This course will be especially appropriate for persons in government, in industry, and in academic life working in the polar areas. This type of course is not offered anywhere else. The course will run from October to June each year, with lectures and seminars covering natural environment, peoples, history, resources and problems of development, government, and social relations. Examinations for this part of the course will be six essays or exercises on set topics. Access will be given to the institute's library and a large collection of manuscripts. Each candidate will also write a thesis (10,000 to 20,000 words) on a particular subject chosen in consultation with his supervisor at the beginning of the course. There will be an oral examination on the thesis and on the essays or exercises.

Academic staff at the institute will be involved in the teaching of the course, and in addition, a number of visiting lecturers from other departments of the university, from the British Antarctic Survey, and elsewhere will make contributions.

After taking the diploma course, a candidate may seek permission to proceed to a Ph.D. course. He may be permitted to count the year of the diploma course towards the Ph.D. time requirements, but if he does this, he may not receive the diploma. Applicants should have a degree, although other evidence of fitness to study for the diploma may be accepted in special circumstances. Applications should be made to the Board of Graduate Studies, Mill Lane, Cambridge, England CB2 1RZ, which will send further information and application forms (including procedures in applying for college membership, obligatory for all candidates), and will inform successful candidates of their acceptance.

NEW MEMBERS

Akitaya, E., The Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan.
Ballantyne, Colin K., Department of Geography, McMaster University, Hamilton, Ontario, Canada.
Baroni, Dr Giovanni, Corso Martinnetti 83A/11, 16149 Genova Sanpierdarena, Italy.
Bradley, Raymond S., Department of Geology & Geography, University of Massachusetts, Amherst, MA 01002, USA.
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Day, T. E., 10 Fawn Road, Plaistow, London E13 9BL, England.
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England, Dr A. W., Branch of Regional Geophysics, U.S. Geological Survey, Federal Center, Denver, CO 80401, USA.
Feldman, Uri, Geography Department, McMaster University, Hamilton, Ontario L8S 4K1, Canada.
Gjessing, Yngvar T., Institute of Geophysics, Division of Meteorology, Universitetet i Bergen, Bergen, Norway.
Gloersen, Dr Per, 191 Topeg Drive, Severna Park, MD 21146, USA.
Gould, John E., Sir Roger Manwood's School, Sandwich, Kent CT13 9LB, England.
Holden, William G., Geography Department, University of Glasgow, Glasgow G12 8QQ, Scotland.
Ikegami, K., Water Research Institute, Nagoya University, Chikusa-ku, Nagoya, 464 Japan.
Izumi, K., The Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan.
Kobayashi, Shun-Ichi, The Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan.
Kodama, H., Water Research Institute, Nagoya University, Chikusa-ku, Nagoya, 464 Japan.
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Olivero, Marina, Via delle Rosine 8, Torino, Italy.
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Pennel, Jacques, FENCO, Suite 210, 9731-51st Avenue, Edmonton, Alberta T6E 4W8, Canada.
Pollini, Alfredo, Via Filippino degli Organi 9, 20125 Milano, Italy.
Reid, Bruce K., 51 Shrewsbury Road, Birkenhead, Cheshire L43 2JB, England.
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Sparrow, Dr G. W. A., Department of Geography, UBLS, Kwa Luseni, Swaziland, Africa.
Tabuchi, Hiroshi, 646-28 Mizuno, Sayama-shi, Saitama-ken, Japan.
Tettamanti, Lelio, Via Corso Cantu 3, Lambrugo, Italy.
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Traetteberg, Anton, River and Harbour Laboratory, Klaebuvegen 153, 7000 Trondheim, Norway.
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Young, Louis, P.O. Box 5329, Seattle, WA 98105, USA.
Yutaka, A., Faculty of Education, Yamaguchi University, 1677-1 Ooaza Yoshida, Yamaguchi-city, Japan.

Ice Ages: Ancient and Modern

Edited by **A. E. Wright** and **F. Moseley**

Geological Journal Special Issue No. 6

This is the first symposium volume to give a review comparing the features of the Pleistocene Glaciation and of present day glacial deposits with those of earlier and more controversial glacial rocks. The volume covers an interdisciplinary field where palaeoclimatology, palaeoecology, sedimentary petrology, tectonics and many other features have to be considered.

Published: **April 1975** *Price:* **£12·00 ($U.S. 33·00) postage included.**

Geological Journal Special Issues:

No. 2 Mechanism of Igneous Intrusion — Eds *Newall and Rast*
1970 £7·00/$U.S. 19·60

No. 3 Trace Fossils — Eds *Crimes and Harper*
1970 £8·00/$U.S. 22·20

No. 4 Faunal Provinces in Space and Time — Eds *Middlemiss, Rawson and Newall*
1971 £7·00/$U.S. 19·60

No. 5 The Boreal Lower Cretaceous — Eds *Casey and Rawson*
1973 £9·75/$U.S. 27·00

Cash with orders to **SEEL HOUSE PRESS, LIVERPOOL L1 4AY**

INTERNATIONAL GLACIOLOGICAL SOCIETY

Cambridge CB2 1ER, England

DETAILS OF MEMBERSHIP

Membership is open to all individuals who have scientific, practical or general interest in any aspect of snow and ice study. Payment covers purchase of the Journal of Glaciology and Ice. Forms for enrolment can be obtained from the Secretary. No proposer or seconder is required. Annual payments 1975:

Private members	Sterling:	£5.00
Junior members	Sterling:	£2.00
	(under 25)	
Institutions, libraries	Sterling:	£10.00 per volume (1975=2 volumes)

Note—Payments from countries other than Britain should be calculated at the exchange rate in force at the time of payment. If you pay by bank draft, rather than by personal cheque, please ensure that sufficient money is included to cover the bank charges of £0.50p per cheque. Thank you.

ICE

Editor: Hilda Richardson

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