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SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY

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Details of accommodation and preparation of summaries and final papers are printed in the First Circular, on pages 33-36 of this issue of ICE.

ICE

NEWS BULLETIN OF THE

INTERNATIONAL GLACIOLOGICAL SOCIETY

1st ISSUE 1973 NUMBER 41

CONTENTS

DEATH OF GERALD SELIGMAN. Gerald Seligman, Founder of the Society, died on 21 February 1973 after a long illness. An obituary appears in the Journal of Glaciology, Volume 12, Number 65, 1973. On page 17 of this issue of ICE we publish extracts from some of the letters of sympathy and appreciation that were received in the Society's office.

AWARDS. The Council of the Society is pleased to announce the award of a Seligman Crystal to Dr Stanley Evans for his pioneering work in radio echo sounding of ice, and of Honorary Memberships to Dr Robert P. Sharp, Dr Sigurdur Thorarinsson and Dr Zyungo Yosida. Details on page 17 of this issue of ICE.

COVER PICTURE. Old print of the Mer de Glace, France. Contributed by Robert Vivian.

RECENT WORK

CANADA

Glacier Research

The Sub-Committee on Glaciers held a meeting on 23 February 1972. The proposed "Symposium on the thermal regime of glaciers and ice sheets" is now scheduled for 8-10 April 1975 at Simon Fraser University, Burnaby, British Columbia.

University of British Columbia, Departments of Geophysics and Geology, *(G. K. C. Clarke, W. H. Mathews)*

Surging glaciers and other studies

G. T. Jarvis and G. K. C. Clarke began geophysical studies on Trapridge and Steele Glaciers, two surge-type glaciers in the Icefield Ranges of Yukon Territory. Measurements in seven thermally-drilled holes indicate that Trapridge is a cold glacier with a temperate to near-temperate bed. Measurements on Steele Glacier, in a single hole believed to stop far short of the glacier bed, show that at least the upper 100m are cold.

Radio echo soundings were taken on Trapridge and Rusty Glaciers by R. Goodman (Department of the Environment) and Clarke using Goodman's 620 MHz high-resolution set. Excellent results were obtained and ice thickness maps for both glaciers have been calculated. This sounder yields unambiguous reflections in ice as thin as 40m.

Thermal drilling at two sites on Helm Glacier, B.C., was undertaken by B. Narod and Clarke. Equilibrium temperatures have not yet been recorded. W. H. Mathews studied ground temperatures in the nearby Cinder Cone and found permanently frozen ground with temperatures about —0.2°C where the cinder has been exposed in the past few years by the glacier's retreat.

Mathews also worked with A. D. Stanley and T. Beck (Department of the Environment) on accumulation, ablation, and long-term changes of thickness of Berendon Glacier in the northern Coast Mountains of B.C.

A mathematical model of thermally-regulated water-film instabilities in sub-polar glaciers has been developed by J. W. Hoffman and Clarke to account for surges in cold glaciers. The parameters which determine the length of the surge cycle and the intensity of the surge are glacier slope, surface temperature, geothermal flux, accumulation rate and bed smoothness. Surge models for Tikke, Variegated, Walsh and Trapridge Glaciers have been calculated and give realistic results. Clarke has computed numerical solutions for rectilinear glacier flow in rectangular channels using a method which appears to be more flexible than that developed by Nye in 1965. Weertman's sliding equation is used to provide the velocity boundary condition at the channel boundary. Non-isothermal flows have also been computed and the effects of viscous self-heating on the temperature distribution calculated. A generalization of the method to arbitrary channel cross-sections is being attempted.

The 16 mm colour film GLACIER! by Clarke, Classen and Crossley is now completed and being sold to film libraries and educational institutions. Complete with animations and sound track the 22-minute film presents an informal look at glaciological research on Rusty Glacier. Since its completion GLACIER! has been shown at a number of scientific meetings and a somewhat revised version was televised on the CBC network in autumn 1972.

University of Calgary, Department of Physics, *(H. R. Krouse, K. West, H. M. Brown, R. Hislop)*

Oxygen isotope analyses

Facilities have been established for H_2O^{18}/H_2O^{16} abundance analyses. An H/D analyzer has been purchased and a line is under construction to permit direct injection of water for hydrogen isotope analyses. Instrumental development has emphasized reduced operational costs and increased rate of analyses.

Over the past year, H_2O^{18}/H_2O^{16} analyses were carried out on some of the ice cores collected from Devon Island during 1971. Analyses of the Meighen Island ice core continued. Both of these projects were in co-operation with the Polar Continental Shelf Project of the DEMR.

H_2O^{18}/H_2O^{16} analyses have been carried out on ice samples of different ages collected from the Arctic by R. Mackay, University of British Columbia. Other work has been undertaken on the Peyto Glacier, Ellesmere Island, and St. Elias Mountains.

University of Colorado, Institute of Arctic and Alpine Research, *(J. T. Andrews, J. J. Jacobs)*

"Boas" Glacier

The mean snow depth on "Boas" Glacier in early June was .948m ± 0.06m. Average snow density was .326 g/cm^3 giving a specific winter balance of .31m H_2O. The glacier could not be visited in August due to extremely bad ice conditions; however, on the basis of previous years' weather, we predict that the net specific balance will be positive and greater than 0.3m H_2O. The strain diamond was remeasured; the principal strain axis is directed down-glacier and shows a compressive strain of 10^{-6} yr $^{-1}$ (based on two years of measurements). From the mass balance data, a discriminant equation has been developed based on September to May accumulation at Broughton Island, and accumulated summer degree days (June, July, August). Investigations of other mass balance data suggest that the Broughton Island data are a sensitive predictor of mass balances as far north as Devon Island. This finding agrees with a paper submitted by Bradley that indicates a broad similarity of climatic events throughout major sections of the Arctic.

Glaciation limits

Glaciation limits are being mapped for the high Canadian Arctic under contract with the Glaciology Division, Department of the Environment, by Andrews, Bradley and Miller. The glaciation limit is being compared and correlated with the freezing level in the atmosphere, using radiosonde data. Other climatological studies on the interpretation of glaciation limit are being carried on.

Quaternary geology

G. H. Miller investigated Neoglacial, Wisconsin and pre-Wisconsin local ice advances in the area between Cape Dyer and Padloping Island. Dr. G. Boulton, University of East Anglia, England, visited the area and collected a peat monolith in front of the Maktak Glacier, and Dr. M. Church, University of British Columbia, carried out investigations on the Maktak sandur.

University of Minnesota, Department of Geology and Geophysics *(R. Le B. Hooke)*

Barnes Ice Cap

(Work supported partly by Glaciology Division, Department of the Environment, Canada.)

Pole lines perpendicular to the ice-cap margin were resurveyed, as were four short boreholes and 68 strain nets in the wall of a 125m ice tunnel. Within a kilometer of the margin, vertical velocities have doubled over the past two years, despite a 3 to 6% decrease in the horizontal velocities. However, net ablation still exceeds the increased emergence velocity by 25 to 50cm/yr, so the ice cap margin is thinning.

A vertical shaft of 8 m depth was excavated to the bed of the glacier near the margin. Further evidence was found for the existence of a wedge of moderately deformed superimposed ice beneath ice-cored moraines which occur about 100 m up-glacier from the margin. Flow processes in dirty ice were studied in a short tunnel.

Defence Research Board, *(G. Hattersley-Smith)*

Investigations related to climatic change

A survey was made of the larger of two small ice caps situated 25 miles southwest of Lincoln Bay. These ice caps reach a maximum elevation of only 800 m and hence may be expected to be particularly sensitive to small climatic changes. Air photographs reveal that in 1959 their entire surface had been subject to a long period of ablation. The present survey on the larger ice cap shows a build-up of up to 50 cm of ice over its entire area in the past 13 years and a significant extension in its boundaries. The maximum thickness of the ice cap does not exceed 15-20 m. The changes in thickness and extent of the ice cap are seen as a direct result of generally cooler summers in the last decade in this area adjacent to Robeson Channel.

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

During the last twelve months, there has been extensive regrouping of our glaciological programmes in response to a reorganization within the water sector and the need for increased knowledge of Arctic areas.

ARTIC HYDROLOGY SECTION (D. K. MacKay)

Field work has continued and scientific recommendations for the Mackenzie Valley Oil Pipeline Route study have been made.

There are now two main aspects:

1) River crossings: involving freeze-up and break-up, ice jams, aufeis, dendrochronology, hydrologic effects of storms, delta flow.
2) Drainage basins: basin morphometry, hydrologic and geomorphic characteristics of sub-basins, groundwater flow, hydroclimatic elements, physical limnology of lakes.

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

Field work was carried out in the following areas:

1) **Leffert Glacier,** S.E. Ellesmere Island, (G. Holdsworth). Extensive ground surveys of horizontal and vertical movement were made in order to determine flow regime and marginal deformation and to investigate the processes of calving from a floating ice tongue.
2) **Selected small highland ice masses in Arctic areas** (K. Arnold). A Wild RC10 camera was used to obtain aerial photographs of thin ice masses in order to measure volumetric changes and study regional patterns of glacierization.
3) **Decade Glacier, Baffin Island** (A. D. Stanley). The winter balance was measured in late June, but no observations were obtained during the summer.
4) **I.H.D. mass balance studies, Western Canada** (A. D. Stanley, O. Mokievsky-Zubok, T. M. H. Beck). Measurement of winter and summer balance were continued at six glaciers in the Cordillera, (Berendon, Place, Sentinel, Woolsey, Peyto and Ram Glaciers.) Stream discharge and meteorological data were also obtained using long term recorders. Observers were stationed

continuously at Sentinel and Peyto Glaciers. At most glaciers the winter accumulation was greater than average and the summer melt was near normal.

Ottawa based programmes included:

5) **Glacier Inventory** (C. S. L. Ommanney). Work on the Glacier Inventory of Canada has continued. Glaciers in south, central and western Ellesmere Island have been indexed and a start made on data compilation for the Nelson River Basin, Alberta, using a D-mac pencil follower, interfaced with a PDP8/I computer. Assessment of tidewater at a glacier for iceberg production has been carried out in conjunction with the Ellesmere Island inventory.
Key word listings have been prepared for some 300 articles containing references to Canadian glaciers as part of a computer-based information retrieval system. In this connection, the list of named glaciological features in Canada has been updated.
Summaries of glacier surveys by the Water Survey of Canada are being continued.

ALPINE AND SNOW HYDROLOGY (L. Derikx)

1) **Heat balance measurements at Peyto Glacier** in 1971 formed the basis of detailed study of latent and sensible heat transfer during different weather conditions.
2) **Mass and energy transfer in a shallow snow pack, Mer Bleue, Ottawa** (L. Derikx). Data collected at the Snow Hydrology Field Laboratory at Ottawa during two winters are being analysed The heat balance of the winter snow pack showed some unexpected results.
3) **d'Iberville Fiord, Ellesmere Island** (L. Derikx). This is a new project to estimate the average daily freshwater run-off into d'Iberville Fiord, Ellesmere Island for the Frozen Sea Research Group, as input for a model to simulate the hydrology of an arctic fiord.
4) **Glacier meltwater contribution to streamflow in the North Saskatchewan headwaters** (H. S. Loijens). Field work concentrated on the measurement of summer streamflow from seven highly-glacierized sub-basins in the North Saskatchewan headwaters. The data will be used to verify the recent application of a glacier run-off simulation model (Derikx and Loijens) to all glacierized areas in the Mistaya River Basin and to study the flow transformation characteristics of the Mistaya River from the head of the basin (Peyto Glacier) to the outlet gauging station.

ICE SCIENCE SECTION (S. J. Jones)

X-Ray topography of dislocation (S. J. Jones and N. K. Gilra). Equipment is being designed to stress samples while on the X-ray apparatus.

REMOTE SENSING (J. Kruus). Members of the Division are involved in aerial projects to extract hydrological information from images received from Earth Resource Technology Satellites. These include snow line studies and models to obtain spatial distribution of data.

RADIO ECHO SOUNDING (R. H. Goodman). A greatly improved radio echo sounding apparatus was constructed and mounted on a Flextrack vehicle. During the summers of 1971 and 1972, tests have been carried out on Athabasca Glacier. Part of the equipment was used on Rusty and Trapridge Glaciers.

Icefield Ranges Research Project, American Geographical Society and Arctic Institute of North America *(R. H. Ragle and S. G. Collins)*

Glaciers in St. Elias Mountains

Positions of marker poles previously set in Trapridge Glacier were resurveyed and additional markers installed. Twenty-eight markers were located in three dimensions with an estimated accuracy of ± 0.3 m. Radio echo sounding and thermal drilling were also carried out (see above).

Conclusions from studies of aerial photographs in the 1972 "Pilot study for an inventory of glaciers in the St. Elias Mts." were checked by direct examination of specific areas from the air. Only trivial differences were found between conclusions drawn from direct observation and those made after stereoscopic examination of good aerial photographs. The inventory of 116 glaciers in the Steele Creek Basin, part of this pilot study, was completed.

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

Devon Island Ice Cap (W. S. B. Paterson, R. M. Koerner). A borehole, 299 m deep, was drilled to bedrock about 300 m down-slope from the hole drilled in 1971. A complete core was recovered in good condition. Preliminary results of oxygen-isotope analyses, carried out at the Geophysical Isotope Laboratory in Copenhagen (W. Dansgaard), indicate that the core spans the Wisconsin Glaciation and the Sangamon Interglacial with traces of an earlier glaciation at the bottom. Macroscopic dirt inclusions, but no dirt layers, were observed in the lowest 3 m of core. Bubble stretching and closely-spaced horizontal fractures were observed below 175 m, except in the lowest 4 m where the ice was unfractured. Electrolytic conductivity of the melt water from the drill varied between 1.5 and 3 μS/cm, with higher values in most of the lower third of the core. Temperatures in the borehole were -23.0°C at 12 m and -18.5°C at the bottom. The gradient near the bottom would correspond to a geothermal heat flux of 1.5 μcal cm^{-2} sec^{-1} which is close to the world-wide average. Inclination and diameter were measured in both boreholes.

Samples were collected from a 5 m pit and hand-augered cores near the drill site and also from the current annual layer on a traverse across the ice cap from north-west to east. These samples will be analysed for β-activity, deuterium and tritium by Atomic Energy of Canada Ltd., as well as for oxygen isotopes. The 1970-71 mass balance of the north-west part of the ice cap was –69 kg m^{-2}, the 1960-71 average is –72 kg m^{-2}. However, comparison of measured strain rates with present accumulation rate suggests that the ice cap may be thickening slightly in the vicinity of the drill site.

Axel Heiberg Island, N.W.T., McGill University *(F. Müller)*

With six field personnel at the beginning of the season a party of three remained throughout to carry out routine field work for the 14th consecutive summer. Logistic support was again provided by the Polar Continental Shelf Project of the Department of Energy, Mines and Resources, Ottawa, between 8 May and 27 August.

Mass balance of the White and Baby Glaciers. A total network of some 120 stakes for the two glaciers was maintained. Accumulation measurements were made three times for the White Glacier and six times for the Baby Glacier and ablation readings were made every two weeks. The amount of winter accumulation (71/72) was slightly higher than usual and the equilibrium line was found to be much lower than in an average year. The higher Baby Glacier showed almost no ablation whereas the lower White Glacier showed a near usual loss.

Automatic weather stations (K. Schroff). With heating and power supply for the weather stations still causing problems for winter operations, the short time available to the expedition electrical engineers, also involved in the North Water project, was spent in modification and repair of the six automatic weather stations installed in earlier years. Winter data for wind speed and direction, temperature and relative humidity were recovered for the first time from the accumulation area of the White Glacier. All other stations, at the equilibrium line and tongue of the White Glacier and at base camp, were maintained in continuous operation.

Heat budget and meso-climate (A. Ohmura). An important addition to the project was an improved radiation programme using a pyrheliometer and Davos PD-4 pyranometer/pyrradiometer for separate measurement of the four main radiation components from which the net-radiation can be computed. This overcomes the disadvantage of the net-radiometer, used in previous years, whose calibration-coefficient drifted significantly over surfaces of high albedo. Pyrheliometry was carried out whenever cloud-free sky conditions prevailed. The resulting measurements of direct beam solar radiation will serve to determine the contribution of this radiation component to the global radiation at low sun angles, to provide calibration of the other radiometers in the field and finally to determine the turbidity coefficient of the high arctic atmosphere. From the global radiation and reflected radiation the change of albedo of snow with variable solar elevation, which is still a controversial question, was computed. It was found that the albedo increased with increasing solar elevation. Angström's turbidity coefficient was calculated and found to be small with an average value of 0.016. The calibration-coefficients of the PD-4 remained constant throughout the season with slight dependence on the solar elevation. Turbulent heat fluxes were measured by three independent methods; by lysimeter, Bowen's Ratio and by the aerodynamic wind profile approximation. The thermographs were maintained in the expedition area as in other years and distinct patterns of temperature distribution were found.

Glacier movement (A. Iken). Analysis of results from previous years has been completed, and a data report containing all glaciological surveying measurements collected between 1959 and 1972 will be published.

North Water Glacier Climatology Project, Arctic Institute of North America and Swiss Federal Institute of Technology, **(F. Müller).** Two camps out of the three that were planned in the North Water area in northern Baffin Bay were established for the first time this summer, involving up to twelve field personnel. After a reconnaissance of the area in early June a party of four landed on Coburg Island, N.W.T. on 16 June to establish the Coburg Island base station. Logistic support was provided by the Polar Continental Shelf Project, Department of Energy, Mines and Resources, Ottawa. The establishment of the second base station, on Nordwest Ø. in the Danish Carey Islands, after serious difficulties was effected with the help of the United States Air Force, operating from Thule, in early October. The winter programmes of data gathering for both stations are similar, with meteorological data collection by manual synoptic observations and by the use of OTT eight-channel automatic weather stations. A feature of the programme is the emphasis on mesoscale data collection with unattended automatic weather stations on mountain tops near both base stations and a third unattended station on Clarence Head, Ellesmere Island, N.W.T. Regular sea ice observations will be made from both stations throughout the winter together with the daily sampling of isotope content of atmospheric water (using a system designed at the University of Bern) and isotope sampling of settled snow after major precipitation events. Both base stations are manned by three-man parties during the winter-period.

Snow and Ice other than Glaciers

University of Colorado, Institute of Arctic and Alpine Research *(R. G. Barry, J. J. Jacobs)*

Sea ice

Surface energy budgets of fast ice at Broughton Island (67.5°N, 64°W), N.W.T. were studied from late May to August, 1972. The programme included micrometeorological measurements on the fast ice and ice thickness surveys. Climatological observations were continued. The summer of 1972 was one of unusually severe ice conditions for this section of Davis Strait, and our results are being examined together with synoptic data in an attempt to understand this situation. Meteorological satellite data are being analyzed to obtain regional extrapolations of synoptic surface energy budgets.

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

Ice formation

Frazil ice formation is being studied in a cylindrical tank in a laboratory cold room. Air-water temperatures are measured at the interface and forms and types of ice formation are observed by varying the flow velocity in the tank. Many studies were made last winter on the discharge of ice on the St. Lawrence river and on the characteristics of the glaciological winter along its course.

Mechanical properties of ice

An extensive programme is being completed on brittle behaviour of fresh water ice. Flexural strength of river ice was measured last winter in the St. Lawrence river on small and large beams. The studies on ice thrust exerted by thermal expansion are completed.

Model ice techniques

A programme is under way on the ductile behaviour and properties of model ice for simulation purposes. Tests were carried on with model ice on cylindrical and conical structures and an ice jam in the Bécancour river was studied.

McGill University, Ice Research Project *(E. R. Pounder)*

Sea ice

Four people took part in the pilot project for AIDJEX in April 1972. They carried out micrometeorological profile measurements to determine the surface roughness of the ice, and the influence of advective transport of air. A number of conductivity, temperature, depth probes were carried out below the ice surface to a depth of several hundred metres. An experiment to measure the under-ice roughness using a two-component hot film current meter was unsuccessful when the hot films proved to be inadequately insulated against sea water under pressure.

Defence Research Board, *(G. Hattersley-Smith, H. V. Serson)*

Sea ice and ice shelf Surveys

Between 22 April and 1 June ice thickness measurements were made on a traverse from the head of Tanquary Fiord through Greely Fiord to the mouth of Nansen Sound, thence across Sverdrup Channel and Peary Channel into Prince Gustaf Adolf Sea. The two-man party, travelling with two "Alpine" Ski-doos and four sleds, covered 1230 miles.

The 1540 km² plug of multi-year ice occupying the mouth of Nansen Sound was found to have broken up. A 910 km² section was found frozen into one-year ice off the mouth of Otto Fiord, while the remainder of the ice plug occupied the north-eastern side of Nansen Sound between White Point and the Fjeldholmen Islands. The lines of ablation stakes established in 1970-71 were lost, but data from four integrating solar radiation meters were recovered. Samples of ice-rafted gravel were obtained off Krueger Island and a hole was drilled through a piece of ice shelf in Audhild Bay.

The ice cover on Rens Fiord was typical of the fiords of north-western Axel Heiberg Island. Smooth one-year "lake" ice at the head of the fiord overlay 3 m of fresh water which was dammed in by heavy multi-year ice at the mouth of the fiord. The multi-year ice in Sverdrup Channel appeared unchanged since 1970, except that the surface topography was more irregular; the ice thickness varied from 5.92 m at the northern end of the Channel to 4.44 m between Meighen Island and the Fay Islands. Peary Channel was covered by 9/10ths new ice and 1/10th multi-year ice lying along the north-east side of Ellef Ringes Island. Multi-year ice, 3.94m thick, covering Louise Fiord, had apparently formed in situ, as there was no evidence of pressure. Polar ice covered Prince Gustaf Adolf Sea where one-year ice between old floes had been subject to extreme pressure.

Between 1 June and 7 June the accumulation networks on the Ward Hunt ice rise and ice shelf were scaled, and twenty missing stakes were replaced. Although a few small pieces of ice shelf had calved off, the northern boundary remained the same as in 1963.

Investigations related to climatic change, (G. Hattersley-Smith)

Climatic change over recent decades and centuries has a direct bearing on the movement and distribution of sea ice. Knowledge of past changes can help to interpret present trends in sea ice behaviour.

In continuation of previous studies, field work during July and August in Disraeli Fiord provided further information on the unique ice regime in this fiord, which is covered by perennial freshwater ice. Driftwood was collected from various points on the fiord; it will be identified as to species and then radiocarbon dated. From these data, it is hoped to make deductions on changes in concentration of Arctic Ocean ice with time, and a more accurate assessment of the period when Disraeli Fiord became sealed off by the Ward Hunt Ice Shelf, the main source of existing ice islands.

Frozen Sea Research Group, Department of the Environment, *(E. L. Lewis)*

Sea ice

During March and April 1971 a field operation was conducted from the Greely Fiord base (80° 36′N, 79° 35′W). Oceanographic conditions were measured along the fiord and simultaneously at two locations in an attempt to understand water movement and the flushing action of tides. Observations of dye puffs injected immediately below the growing ice sheet showed that the current reversed at a depth of 1 m. These studies are related to an understanding of pollutant dispersion. In the same context, a study of run-off in Arctic regions has been completed in order to estimate the annual fresh water input to the fiord. We consider that we are now able to obtain temperature and salinity measurements at known limits of accuracy during the Arctic winter and spring with the Guidline C.T.D. system. This has incorporated a study of experimental work by the National Research Council on the electrical conductivity of seawater very close to freezing point.

Preliminary experiments were conducted on the freezing point of seawater samples collected immediately below the growing ice sheet in order to ascertain whether the potentially different ionic concentrations of salts in the water had a significant effect.

Starting in August 1971 a series of field operations was undertaken in Cambridge Bay, N.W.T. (105°W, 69°N), to study seasonal variations in surface water structure associated with the growth and decay of sea ice.

An oceanographic sled was mounted on a 10,000 lb raft anchored in Cambridge Bay in order to make measurements of temperature and salinity during late summer and fall.

Geological Survey of Canada, *(D. A. Hodgson, V. N. Rampton)*

Ground ice

Ground ice content was recorded in the course of mapping surficial materials and assessing terrain sensitivity on the Fosheim Peninsula, Ellesmere Island. Preliminary studies indicate a considerable volume of ice present as sills and veins in fine-grained deposits and even in poorly lithified bedrock. Ice wedge polygons are widespread in all but the coarsest materials.

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

Floating ice section (R. O. Ramseier)

Theoretical and experimental work has been completed on the behaviour of different types of fresh water ice in the ductile range and present projects include large scale field investigation on lake and river ice.

1) **Lake and river ice**

The programme includes detailed studies of growth and mechanical properties in order to predict the physical properties of floating ice by using standard meteorological and hydrodynamic information and remote sensing techniques. Other studies include direct examination of physical and mechanical properties of ice from selected sites in the St. Lawrence River, St. Claire River, Lake Erie and Lake St. Clair. This includes large "in situ" beam tests in the 1971-72 winter season.

2) **Sea ice ground truth**

As part of the AIDJEX programme, a study was initiated to obtain data on the vertical and horizontal variations of physical properties of first-year and second-year sea ice for correlation with remote sensing information.

Ice Science Section (S. J. Jones)

Oil pollution studies (E. C. Chen)

Present studies include: (a) determination of spreading coefficients of oils and ice surfaces, (b) investigation of the effects of oil/water emulsions, (c) ageing petroleum oils on ice surfaces, and (d) vapour-liquid equilibrium of hydrocarbon-oils/ice system. The project included participation in U.S. Coast Guard Oil Arctic Winter Oil Spill Test in January 1972.

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

Ice mechanics

A study was completed on the deformation of a specimen of columnar-grained ice under a constant compressive stress of 1 kg/cm^2. The load was applied continuously over a period of about 4 years and produced a total strain of about 2%. The temperature was changed during the test over the range 0 to −40°C.

The strain-rate dependence of Young's modulus of granular and columnar-grained ice has been studied with the assistance of A. Traetteberg, a visiting scientist from the Hydraulic Institute in Trondheim, Norway.

Preliminary work has been completed on the deformation behaviour of columnar-grained ice, subject to a constant rate of strain perpendicular to the long direction of the grains, essentially to complete restraint in the second principal strain direction and with no restraint in the third. The yield strength is increased by a factor of about 2 when the direction of no restraint is parallel to the long direction of the grains.

Ice engineering

The uplift force exerted on piles and foundation walls by an ice cover, subject to a change in water level, is being investigated.

Avalanches

A model for the prediction of the size of a 10-year and 30-year maximum avalanche was developed for the Rogers Pass area of British Columbia. This model is now to be tested in other areas. Observations have been carried out over several years on dynamic avalanche pressures using small pressure cells. Difficulties were experienced in measuring impact pressures during winter 1971-72 because unusual avalanche conditions damaged the equipment.

Permafrost distribution

Ground temperatures in permafrost are being measured regularly at Yellowknife, N.W.T., the Tundra Biome site on Devon Island, N.W.T., and at 12 mountain summits in British Columbia. Similar instruments were installed at Rankin Inlet, N.W.T. and will be installed at Churchill, Manitoba, and at sites between Hudson Bay and the Mackenzie Valley. These observations help to define the boundaries of the discontinuous and continuous permafrost zones.

Permafrost environmental studies

Observations on ground temperature and heat flow, air temperature, net radiation, wind speed, and other factors are being made at Thompson, Manitoba, near the southern boundary of discontinuous permafrost. Four sites have been chosen; two with permafrost and two without. Surface factors such as type and thickness of cover, and drainage appear to be more important than local variations in climate in determining whether permafrost occurs.

Ground thermal studies

Computer programmes are being developed for ground temperature calculations and soil thermal properties measured. A one-dimensional programme has been prepared that can take into account phase change during freezing and thawing, temperature-dependent soil thermal properties and heat exchange at the ground surface.

A probe has been developed for laboratory and field measurements of the thermal conductivity of frozen ground.

Other studies

The "Summary of current research on snow and ice in Canada" (Technical Memorandum 106, June 1972, National Research Council, Ottawa, Canada, $1.00) lists many projects (particularly in the fields of sea, lake and river ice) in addition to those described above.

W. S. B. Paterson

ITALY

During 1973 many research projects were organized by the Comitato Glaciologico Italiano supported by C.N.R. and ENEL.

S. Belloni worked up the data about snow avalanches in Lombardy. 80% of these are periodical. February is the most common month for the incidence of avalanches and the most frequent volume is between 21,000 and 104,000 m^3. NNW is the least favourable slope exposure; NW and SE are the most favourable. The shortest vertical drop of an avalanche was 60 m and the greatest 2,000 m; the most frequent drop was between 400 and 600 m. The most frequent altitude seems independent from the exposure of the slope and lies between 2,000 and 800 m; two-thirds of the avalanches studied passed through this zone.

C. Lesca and E. Armando carried out photogrammetrical and geophysical surveys of the Lex Blanche (Mont Blanc Group). C. Lesca carried out, in the same group, other photogrammetrical surveys (1:5000 scale) of the Miage, the Brenva and the Brouillard glaciers. The variations in length, surface, volume of the terminal tongue of these glaciers have been determined. The method proposed by C. Lesca in 1971 was used to carry out volumetric variation measurements, with good results. For the Miage, the surface speed at more than 100 points was determined by an analytical photogrammetric method and the corresponding depths calculated by different formulae. These have been compared with the depths calculated from geoseismic surveys and soundings. C. Lesca has also perfected a photographic system for obtaining economically and rapidly detailed relief maps of very crevassed glaciers.

G. Palmentola and F. Boenzi have continued research into traces of glaciation in the Apennines.

G. Zanon has resumed his studies on the mass balance of the Careser glacier in Ortles-Cevedalo (Central Alps). The 1971-72 balance was positive, with about 2 m water equivalent. The 1971-72 summer was characterised by cool and inclement weather. The height of the 1971-72 balance line has been calculated as 3014 m compared with 3088 m for a net balance.

In addition, in spite of bad weather, 40 surveyors investigated 156 glaciers with the following results: 54% advancing, 20% retreating, 26% stationary.

The reports given the past years are partially wrong, and therefore not comparable.

C. Lesca

NORWAY

Spitsbergen

In 1972 mass balance studies were carried out on the two glaciers Brøggerbreen and Lovénbreen on the west coast of Spitsbergen near Ny-Ålesund. As in the six preceding years the mass balance in 1971-72 was negative. This is remarkable as in the same six years the winter precipitation at the nearest meteorological station at Kapp Linné was above normal and the summer temperature was below normal. This indicates that the station is not representative for the glacier climate in this region though it is only about 100 km away and is also situated on the west coast.

The 12 glaciers reported surging in 1970 and 71 are still advancing, but the two outlet glaciers from Hellefonna have now nearly stopped. The velocity of Hinlopenbreen is still 14 m a day at the front, but 2/5 of the advance is lost by calving which is about $2.0.10^9$ m^3/year.

In April 1972 three holes were drilled through the glacier Foxfonna near Longyearbyen and depth profiles made by means of radio echo soundings. The temperature at the bottom was below melting point all over the glacier. (In the deepest borehole: ÷ 3.4°C).

Jan Mayen

The glacier Sørbreen on the south side of Berenberg was visited in the summer 1972. Stakes for mass balance measurements were placed on the glacier and stereophotograms were taken for detailed map construction.

Norway

Mass balance studies were carried out on 10 glaciers: eight by the Norwegian Water Resources and Electricity Board (NVE) and two by Norsk Polarinstitutt. The results are seen in the table below, together with the measurements from Spitsbergen, expressed in meters.

	c	a	b
Spitsbergen			
Brøggerbreen	0.95	1.26	−0.31
Lovénbreen	0.98	1.20	−0.22
North Norway			
Engabreen	3.20	3.29	−0.09
Trollbergsdalsbreen	2.44	3.68	−1.24
South Norway			
Ålfotbreen	3.81	3.70	+0.11
Tunsbergdalsbreen	2.02	2.52	−0.50
Nigardsbreen	1.88	2.02	−0.14
Vesledalsbreen	1.92	2.27	−0.35
Hardangerjøkulen	1.78	1.86	−0.08
Storbreen	1.39	1.70	−0.31
Hellstugubreen	0.94	1.43	−0.49
W. Memurubre	1.19	1.47	−0.28
A. Memurubre	1.02	1.42	−0.40
Gråsubreen	0.66	1.30	−0.64

Blomsterskardbreen, an outlet glacier from Folgefonni in S.W. Norway, had a net balance of + 0.32 (winter and summer balance was not measured).

There is a pronounced trend from positive balance in the most maritime climate in the west to negative balance in the east and more continental areas. This is caused by winter precipitation above normal in the west and below normal in the east.

In connexion with a planned tunnel under Bondhusbreen, an outlet glacier from Folgefonni, NVE made some special investigations. Above the place where the planned tunnel is catching the sub-glacial river, a 100 m/year velocity was measured, and the depth of glacier was ca 150 m measured by 20 drill holes. The sediment transport in the glacial river was also measured. Total transport during the summer months was $1.4.10^{10}$ gr. of which 50% had a grain size larger than 1 mm.

The registration by NVE of the glaciers in North Norway is now completed. The number of glaciers was 913 with an area of 1127 km^2. The total number of glaciers in Norway is 1591 and the total area 2744 km^2. The total for Scandinavia is 1885 glaciers and 3058 km^2.

Olav Liestøl

POLAND

Standard observations and special snow investigations were continued in the Karkonosze Mountains, mainly in the region of Mt. Szrenica, by the Mountain Branch of the Meteorology and Climatology Observatory of Wrocław University, In these investigations the following parameters were taken into consideration: snow accumulation, ablation, melting and evaporation on the surface, melting on the bottom and sinking into the ground. The interdependence of these parameters was studied in various vegetation conditions.

Into consideration were also taken measurements of rime frost accumulation, which is very frequent and intensive and is destructive of forests in the Karkonosze Mountains but very important for water resources; and special measurements of snow cover ablation and turbulent evaporation during foehn winds, very frequent and strong due to frequent SW winds that reduce water supplies here and on the wide lowland forefield of Silesia and cause very great devastation of the mountain forests.

Special snow cover and rime frost investigations were carried out also in the Tatra Mountains. In both these mountain regions the very frequent avalanches during the winters 1971-72 and 1972-73 were also investigated.

Spitsbergen

In SW Spitsbergen the Polish Expedition carried out glaciological and periglacial research from the end of June to the end of September (98 days), continuing the investigations IGY-IGC 1957-1960, and 1970, 1971. The Expedition was organized mainly by the Geographical Department of Wrocław University; 8 members participated: 5 from Wrocław University, 1 from Wrocław Polytechnic School, 2 from N. Copernicus University in Torun.

The glaciological-meteorological investigations were concentrated on Werenskiold Glacier. 2 meteorological stations were active, the lower one at about 40 m, 1.5 km from the glacier snout and 0.5 km from the sea, and the upper station at about 400 m in the firn-line zone, near the old IGY-IGC Station, which is now buried beneath the glacier surface.

At the lower meteorological station the following elements were taken into consideration: sunshine duration, global radiation, air temperature, ground temperature, vapour pressure and humidity, potential evaporation, precipitation, wind velocity and direction, and visual observations on cloudiness, etc.

The ablation measurements on Werenskiold Glacier were carried out along the transverse polygons in the lower, middle and upper parts of the glacier, as well as along the longitudinal polygons, installed and used during the IGY-IGC 1957-60 investigations. In the lower part of Werenskiold Glacier glacier thickness is diminishing, but the upper firn part is either stagnating or slightly increasing.

In addition to these glaciological studies, periglacial investigations were carried out. Chemical analysis of 300 samples of glacial and precipitation water were made. The products of weathering of organic substances in soil samples were examined and compared with ones from the Karkonosze Mountains.

A. Kosiba

U.S.A.

Blue Glacier, Washington

The University of Washington summer field program on the Blue Glacier of Mount Olympus continued for the 15th consecutive year. As in each of the past seasons, summer climate was documented on a daily basis, and routine mass balance measurements were carried out at ten-day intervals. Due to the record snowfalls which occurred in the previous winter and spring, the Blue Glacier experienced a substantial positive mass balance for the 1972 accumulation year. Very little bare ice was exposed in the ablation zone even by the end of August. It was not until mid-September that the snow-line retreated an appreciable distance upglacier. For the first time in several years, a significant thickening was noted near the terminus of the glacier. This increase is attributed to a general trend of slightly positive mass balances during the past decade, which culminated in two exceptionally heavy accumulation years in 1971 and 1972. There also appears to be an increase in thickness developing in the valley tongue of the Black Glacier on the northwest flank of Mount Olympus. A similar but transient thickening, accompanied by a short advance, was noted in this glacier during 1957-59.

The principal scientific effort this past year was an investigation of the thermodynamic properties of temperate glacier ice. This was a joint project by investigators from the University of Washington (C. F. Raymond and E. R. LaChapelle) and the University of Alaska (W. Harrison). Special attention was directed toward the amount, distribution, and impurity content of liquid water within the ice, and its effects on temperature distribution within the glacier. It has been noted on this and other temperate glaciers that englacial temperatures are somewhat below the commonly assumed pressure melting point, presumably as a result of the characteristics of the included liquid water. Departures from the pressure melting point (typically a few hundredths of a degree) were measured this year from thermistors which were embedded in the glacier to a maximum depth of 190 m during the summer of 1971. A 15 cm thermal coring auger was used to collect continuous ice cores down to a depth of 60 m near the center of the lower Blue Glacier. Thin sections of the core were prepared and photographed under crossed polaroids to document the crystallographic structure. A section of each core was placed in a special vessel and melted under a vacuum to prevent introduction of atmospheric carbon dioxide. Conductivity measurements of the meltwater prepared in this fashion give a measure of the ionic impurity content of the ice. The extremely low conductivity values observed indicate that the meltwater collected from the ice samples is substantially purer than either natural rainwater or laboratory-grade distilled water, suggesting that a purging mechanism may be at work in glacier ice as a result of internal meltwater migration. Immediately after retrieval, an ice sample from each core was examined microscopically. Liquid water was found to exist in a three-dimensionally connected network of veins lying along 3-grain intersections, in agreement with the thermodynamic analysis of Nye and Frank. There was no discernible trend in the size of the veins with depth, or dependence on texture. An upper limit on the downward flux of liquid water has been estimated on the basis of the vein sizes. Currently, an effort is underway to infer the migration and subsequent modification of liquid water in the Blue Glacier from data on conductivity and total air content of the ice.

South Cascade Glacier, Washington

A research station is operated adjacent to the South Cascade Glacier on Sentinel Peak in the Cascade Mountains by the U.S. Geological Survey, Water Resources Division, Tacoma, Washington under the direction of Dr M. F. Meier. Field activities during 1972 were concentrated on experiments related to the movement and storage of water in snowpacks and glaciers. Ice and water balance measurements, together with supporting climatological and hydrological data, were also collected as part of the International Hydrological Decade Program. The greatest snowpack on record was measured on the South Cascade Glacier in May 1972. Snow accumulation at Index Station P-1 was 5.13 m water equivalent for the 1971/1972 season; by comparison, the average snowpack at this station during the previous 13 years was 3.2 m water equivalent. Due to the heavy snowfall, it was necessary to spend three weeks repairing the main gaging station building and the weir which measures discharge from the glacier.

Efforts to measure the temporary storage of water in the glacier continued (W. V. Tangborn, R. M. Krimmel, and others). Five ablation tubes were operated throughout the summer at the P-1 station which allowed an accurate calculation of meltwater input to the glacier. These devices, designed by S. C. Colbeck (CRREL) and G. Davidson, also performed as quite accurate snow ablation recorders. Output (primarily run-off) from the glacier was independently checked by J. D. Smith (Department of Oceanography, University of Washington) using fast response current meters. His results are in excellent agreement with the existing method used for measuring discharge at this site.

The near-surface water table was monitored with a water-stage recorder in an effort to obtain more information on the internal water systems within the glacier. Water levels were also checked in several drill holes in the accumulation zone during the ablation season. The dye tracer studies begun in 1970 were continued. Although the 1972 experiments were complicated by the abnormally heavy snowpack, dye placed on the snow near the beginning of the ablation season produced a very subdued concentration peak in the output flow, similar to that observed during the 1971 experiments.

Snow and ice hydrology of the North Cascades, Washington

A numerical model of mountain snow and ice hydrology, based on synoptic meteorological and hydrological observations, is under development at the Tacoma Office of the U.S. Geological Survey (W. V. Tangborn, L. A. Rasmussen). This model emphasizes physically realistic relationships between the various parameters and a minimum of statistical inference. Two problems remain: a workable heat-balance system based on a very limited data input and the percolation and storage of water within the snowpack in conjunction with the infiltration and storage processes in the underlying soil and ground. The Salix Creek watershed (adjacent to the South Cascade Glacier) is being used to test the various concepts used in the model which will ultimately be extended to 30 different drainage basins of various sizes and altitude ranges in the North Cascades, Washington.

Eliot Glacier, Oregon

The Eliot Glacier is a moderately small glacier (about 1.2 km in width and 4.1 km in length) located on the north side of Mount Hood, a volcanic peak in Northern Oregon. Although this glacier has been relatively inactive during the past 10 years, the terminus is known to have retreated from an elevation of about 2100 m in

1900 to its present position at 2350 m. Since 1925 members of the Mazamas, a mountaineering club from Portland, Oregon, have sporadically charted its movement and position. Recently, N. A. Dodge and others have begun more comprehensive studies, including net mass balance, surface velocity, and surface profiles in the ablation zone. Ablation and accumulation measurements were taken at 10 stakes on the lower glacier and at about 15 selected locations on the upper glacier. In agreement with observations on other Northwest glaciers, strongly positive net mass balances have been calculated for the Eliot Glacier during the past two years. There has been a total surplus of 2.2 meters water equivalent during this period. No significant movement of the terminus was noted.

Aerial photography of North American glaciers

Aerial surveys of glaciers in western North America are conducted annually by the U.S. Geological Survey office in Tacoma. During 1972, Austin Post, with the assistance of L. R. Mayo, obtained extensive photographic data over California, Washington, British Columbia, and Alaska.

In contrast to Washington and British Columbia, 1972 was a year of record low snowfall in California. Late summer aerial reconnaissance and photography provided nearly complete coverage of all perennial snow and ice masses in the Sierra Nevada, Trinity Alps, Mt. Lassen, and Mt. Shasta areas of California. Data obtained during these flights are now being compiled by W. H. Raub (Department of Geology, California State University) for a glacier atlas of Sierra Nevada ice masses.

Observations in the Cascade Range and Coast Mountains disclosed generally heavier than normal snow accumulation remaining in late August; however, in some coastal portions of the St. Elias Mountains and in the Kenai Mountains firn lines were higher than normal. Tidal glaciers generally followed previous trends; an exception was the Dawes Glacier which advanced slightly, the first time an advance has been reported for this large glacier.

The Hubbard Glacier (Yakutat Bay, Alaska), which nearly closed the channel separating the glacier from Osier Island in early 1972, had, by September, retreated 490 m to approximately its September 1971 position. There is considerable evidence that many tidal glaciers advance in the spring only to retreat again in late summer so these changes may be normal. The situation at the Hubbard Glacier is presently of unusual interest as a very slight glacier advance will close off 45 km long Russell Fiord turning it into a large lake. Due to cloudy weather, potential surging glaciers in the Alsek Ranges and western Alaska Range could not be surveyed in 1972. Unusual activity was noted in Mt. Wood Glacier in the Icefield Ranges, Yukon Territory; in Alaska, the Hayden Glacier (a tributary to the Malaspina) was surging strongly, as was the Yentna in the Alaska Range. The western margin of the Malaspina piedmont glacier was advancing, and severe crevassing was present in most of the lobe fed by the Agassiz Glacier. The Agassiz Glacier itself, normally very active, showed no evidence of unusual surface features. A similar situation was observed on the Bering piedmont glacier, where the portion fed by the Steller Glacier was unusually crevassed and evidently advancing in limited areas. An important effect of this latter movement may be to thicken the Berg Lake ice dam which could delay the predicted catastrophic breakout of this 28 km^2 body of water.

Glacier Bay, Alaska

In July 1972, personnel from the U.S. Geological Survey, Tacoma (A. Post, R. M. Krimmel, L. R. Mayo) and the U.S. National Park Service conducted a cooperative study in the Glacier Bay region. The work was aimed at determining relationships between fiord configuration and the advance or retreat of tidal glaciers. Depth soundings were obtained aboard the Park Service Ship, *Nunatak*, in portions of Muir and Wachusetts Inlets which were, until recently, covered by tidal glaciers. The altitudes of recently abandoned ice surfaces as well as present ice levels were determined utilizing aerial photographs taken at intervals during the past decade. Selected photographic stations of W. O. Field were reoccupied, both in these areas and in the western portion of the bay. Interstatial wood was collected near the retreating glaciers for subsequent carbon-14 analysis. Various glacial and interglacial geologic formations were also examined in areas where detailed studies had not previously been made. Site selection studies were made for a proposed net of Park Service rainfall and snow gages to be arranged in a SW-NE profile across the bay.

Variegated Glacier, Alaska

A comprehensive program to define cyclic changes in the state of a surge-type glacier is underway. This study is being conducted by C. F. Raymond (University of Washington) and W. D. Harrison (University of Alaska), in cooperation with the U.S. Geological Survey and the California Institute of Technology. The Variegated Glacier, located at the head of Yakutat Bay, Alaska, was chosen for the study as it appears to satisfy several basic criteria: (i) a well-documented surge history, (ii) a short surge period, (iii) accessibility, (iv) small size, and (v) warm temperatures. Records indicate that this glacier has surged once every twenty years since 1905. Preliminary temperature measurements in the upper portions of the glacier indicate that it is probably temperate. The first full field season will begin in spring 1973 and will include measurements of ice thickness, internal temperatures, surface velocity, strain rates, and mass balance distribution.

Black Rapids, Gulkana, and Wolverine Glaciers, Alaska

A reconnaissance study of the Black Rapids Glacier by the U.S. Geological Survey was continued during the summer of 1972, in anticipation of a surge occurring sometime in the 1980's. Velocity markers and mass balance stakes placed the previous summer were visited and some preliminary data obtained. Additional stakes and markers were placed and a surveying net established. Thermistor probes were inserted at three locations on the glacier to a depth of about 10 m. These probes will be visited in the spring of 1973 after they have had time to reach thermal equilibrium.

Mass and water balance studies on the Gulkana and Wolverine Glaciers are part of a contribution by the U.S. Geological Survey to the International Hydrological Decade which includes similar studies on the Maclure and South Cascade Glaciers. The field program on these glaciers was continued during 1972 with few changes from previous seasons.

Muldrow Glacier, Alaska

During the past three summers, flow measurements have been taken by R. C. Priebe on the Muldrow Glacier system. These measurements were made to determine the changes which have taken place in the glacier since the surge in 1956-57, and to provide a basis for future studies of the glacier. In 1972, movement and ablation measurements were repeated in the vicinity of McGonagall Pass and as far down glacier as the junction of the Brooks and Muldrow glaciers.

Near McGonagall Pass, the Muldrow Glacier is joined by the Traleika Glacier. At this junction, both glaciers are almost stagnant. The surface level of the glacier, in this area, is still decreasing due to ablation. The ablation rate is about 3.5 cm/day at 1700 m. About 2 km up glacier from McGonagall Pass, the movement rate increases to about 10 m/yr on the Muldrow Glacier, and the thickness of the ice is increasing.

The Brooks Glacier joins the Muldrow 6.5 km down glacier from the Muldrow-Traleika junction. The Brooks Glacier moves at a rate of 50 m/yr near this junction. The ablation rate is about 5.2 cm/day at the 1650 m level of the Brooks Glacier, and 4.5 cm/day on the Muldrow near the Brooks junction.

Several early photographs of the Muldrow Glacier were tied into a system of survey points along the edge of the Muldrow Glacier. These early photographs should help to infer movement rates on the glacier prior to the 1956-57 surge.

Yentna Glacier, Alaska

The Yentna Glacier was observed to be surging in 1972. The surge was first observed by Chalon Harris, a bush pilot, who took a series of photographs of the glacier to determine the rate of movement during the surge. There are several well-defined waves which are travelling down this glacier during the surge.

McCall Glacier, Alaska

Glacio-meteorological studies of the McCall Glacier have been carried out for the past four years by personnel from the University of Alaska (C. S. Benson, G. D. Wendler, H. Pulpan, G. E. Shaw, G. E. Weller, C. B. Fahl, and D. C. Trabant). The glacier is located in the eastern part of the Romanzoff Mountains of the Brooks Range, Alaska and is the only arctic glacier being studied in the United States at the moment.

Glacier mass balances have been computed both directly from measurements of snow and ice ablation, and indirectly from streamflow measurements about 2 km below the terminus of the glacier. Results indicate a strongly negative net mass balance (e.g. −253 mm water equivalent in the 1970-71 hydrological year) during each of the past three years. This is in agreement with the general trend noted in other glaciers in arctic Alaska during the last 50 years. Position and ice motion surveys were carried out on the ablation-accumulation stake network, indicating a maximum surface velocity of about 3.5 cm day^{-1} in the vicinity of the firn line. Detailed motion and profile surveys were also made at selected cross sections on the glacier. Routine micrometeorological and climatological data were gathered as in previous years. A new humidity system was installed in late 1971 to obtain more detailed information on the latent heat flux over the glacier surface. Continuous winter climatological data were obtained from the glacier for the first time during 1971-72.

A gravity survey was conducted to determine ice thickness. Seven profiles were taken across the glacier, and reduction of the data is underway. During the summer of 1971, a photogrammetric survey was carried out by Dr Dorrer of the University of New Brunswick. The resulting map will be compared with the IGY map to obtain the mass change for the period from 1958 to 1971. An extensive zone of overflow ice (aufeis) occurs below the terminus of the McCall Glacier. Much of the winter run-off is trapped in this ice mass. A detailed survey was made of the aufeis field to aid in the determination of its annual mass balance. This field is 2 km long, has an average width of 50 m, a maximum thickness of about 12 m, and is a perennial feature.

Studies of the snow stratigraphy on the glacier and temperature structure in the snow revealed that there is considerable percolation of melt water through the annual snow pack which destroys much of the stratigraphic detail and leads to the formation of large ice lenses. This percolation also transports heat downward into the snow and firn and results in significantly higher subsurface temperatures at the upper levels of the glacier than in the lower portion. Attempts to identify annual snow layers continued with the digging of deep pits, up to 7 m in depth, and coring down to 17 m.

In June 1971, work began on a cooperative program to study the transformation of snow into glacier ice in the Arctic and Pacific region. Research is carried out jointly by investigators from the Institute of Low Temperature Science of Hokkaido University, Sapporo, Japan and from the Geophysical Institute of the University of Alaska. Principal investigators for the project are C. S. Benson and D. Kuroiwa. Although some work is being done on the Mendenhall Glacier in southeastern Alaska and in the seasonal snow cover of interior Alaska, the main part of the study is taking place on the McCall Glacier. Activities on the McCall Glacier include petrofabric-structure studies across a thrust fault near the terminus, establishment of several strain grids, and a pit study in the lower cirque. These will be combined with the pit studies carried out by the Geophysical Institute staff during the past four years.

Light transmission in arctic sea ice

Two programs to observe light transmission through natural sea ice were carried out during the 1972 field season. In May, R. C. Smith (Scripps Institution of Oceanography, University of California) made measurements of total short-wave radiation beneath a continuous sea ice cover using an "arctic irradiance meter". The observations took place beneath 5 m thick ice (covered with 30-45 cm of snow) on Colby Bay, adjacent to ice island T-3 in the Central Arctic. Light levels encountered were roughly 5 orders of magnitude smaller than ambient values at the surface.

A second study was conducted during June 1972 in first year ice near Point Barrow, Alaska by investigators (R. R. Roulet, R. M. Sprenger, and H. Lahore) from the Department of Atmospheric Sciences, University of Washington. Ice thickness varied between 130 and 200 cm. Whereas the first program described above was designed primarily to determine characteristics of light transmission in the ocean, the objective of the latter program was to measure absorption and scattering in sea ice as a function of wavelength under a variety of surface conditions. For this purpose, the experiment was timed to coincide with the beginning of the melt season when dramatic changes in the character of the surface begin to occur. The basic instruments utilized were two highly directional, narrow band spectrophotometers developed by R. R. Roulet. One was placed in the ocean beneath the ice, while the second was used at the surface to monitor backscattered radiation in the upper 50 cm of the ice. Supplemental measurements of total downward short-wave radiation were taken at the surface by a Kipp radiometer and beneath the ice with a small calibrated photodiode. The data obtained allow the calculation of wavelength dependent extinction coefficients in the ice, surface albedos, absolute light intensity beneath the ice pack as a function of thickness and surface conditions, and spectral distribution of light in the underlying ocean.

Sea ice observation by satellite

Satellites offer the potential to monitor routinely large-scale changes in the coverage and characteristics of sea ice. In an attempt to define what ice features can be distinguished with existing satellite imagery, G. D. Wendler (University of Alaska) selected a study area in the Arctic Ocean north of Barter Island. Size of the study site was approximately 12,000 km^2. Data collected by the ESSA-9 satellite provided a resolution of 10 km^2 and 15 levels of brightness for each point in the test area. By constructing five-day minimum brightness composites, it was possible to suppress much of the transient cloudiness. Analysis of a summer series of these five-day composites indicated that five surface types could be identified via satellite: (i) open water, (ii) open pack, (iii) compact pack, (iv) compact pack covered with snow, and (v) very close pack with fresh snow. The ice conditions as indicated by the satellite pictures were in good agreement with simultaneous observations taken from aircraft overflights.

Complementary work on seasonal macroscale changes in the Beaufort Sea ice pack has been carried out by R. J. DeRycke (NOAA) using imagery from the ESSA-9 and NOAA-1 satellites. Data were obtained for the years 1969, 1970, and 1971, and examined for prominent features in the ice cover. Such features included length and orientation of leads, location of the edge of the ice pack, distribution and movement of ice floes, seasonal differences in the location of fast ice, and the concentration of ice. The pictures indicate that ice in the Beaufort Sea undergoes three distinct regimes during the daylight period. In the spring the only macroscale features readily identified were long, relatively straight leads or polynyas, measuring up to 800 km in length and 35 km in width. They generally occurred below 80°N and were usually orientated north-south or northwest-southeast. In early June the polynyas gradually disappear and the pack is characterized by large floes with dimensions between 8 and 80 km. As the melt season progresses, the large floes break up into floes of decreasing size, so that by the end of the summer the maximum floe dimension is only about 12 km. High-resolution observations made in 1972 with the ERTS and NOAA-2 satellites generally confirm the above description.

1972 AIDJEX Pilot Study

During March and April 1972, the Arctic Ice Dynamics Joint Experiment (AIDJEX) conducted one of the largest and most complex scientific projects ever undertaken on drifting sea ice. Investigators from 14 organizations in the United States, Canada, and Japan participated in some 23 separate research programs, ranging from ice mechanics and morphology to turbulence in the atmospheric and oceanic boundary layers. Altogether over 3600 man days were spent on the ice. The objectives and planned activities of the 1972 AIDJEX Pilot Study have been described previously (Ice, 37, 5-6), and no substantial changes were made during the execution of the experiment. A complete narrative of the experiment, together with some preliminary results, has been published in the AIDJEX Bulletin, 14. More substantial results from the field program were presented during a special three-day session at the annual meeting of the American Geophysical Union in San Francisco. Abstracts for the 55 papers presented appear in AIDJEX Bulletin, 18. Bulletins and further information regarding the AIDJEX Program may be obtained from the AIDJEX Coordinating Office, Division of Marine Resources, University of Washington, Seattle, Washington 98195, USA.

G. Maykut

Antarctica

SOUTH SHETLAND ISLANDS

Mass balance stake networks were measured and expanded on glaciers of both Deception and Livingston Islands. To augment the history of glacial economy in the Livingston Island area, aerially distributed ash and scoria from Deception Island volcanic eruptions were collected from Livingston Island glaciers and beaches. The samples are presently being analyzed in order to correlate key glacier ash deposits on Livingston Island with the well established chronologic and climatic records previously obtained at Deception Island.

The 1973-74 field season will be devoted toward expanding glaciological investigations to include James Ross Island (northeastern tip of Antarctic Peninsula), for the primary objective of establishing present paleo-climatic implications of that part of the Peninsula. Data of this nature will significantly aid in the reconstruction of the paleo-climatic record of the entire Antarctic Peninsula.

J. E. Curl

MICROPARTICLES IN DEEP CORE FROM BYRD STATION, ANTARCTICA

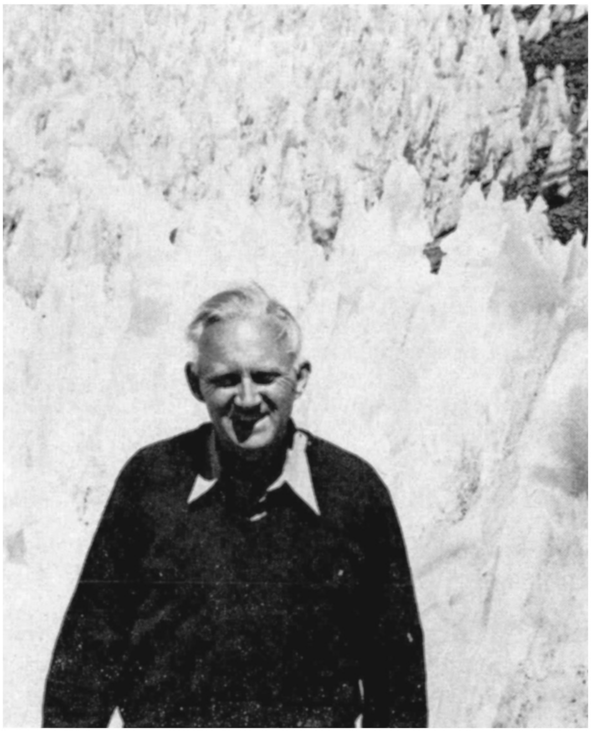
The concentrations of microparticles in sections of the 2164-meter-long ice core from Byrd Station, Antarctica, have been measured. The results of this study will soon be published, and in 1973-74 ice samples will be collected along the flowline from Byrd Station to the ice divide. The concentration of microparticles will be measured in these near-surface ice samples. From the variations in concentration and size distribution in samples from the various points, the effect of variations in snow accumulation rates and mean annual air temperature will be determined. This information will be essential in interpreting the microparticle data already obtained in samples from the deep ice core from Byrd Station.

L. G. Thompson

BYRD STATION STRAIN NETWORK, MARIE BYRD LAND, ANTARCTICA

Analysis is continuing on the data collected along the Byrd Station Strain Network. This traverse follows the flow line 160 km to Byrd Station. The balance results will soon be published, and in 1973-74 the final set of measurements in the detailed study area will be taken.

I. M. Whillans



GUNNAR ØSTREM

Gunnar Østrem's progress towards the state of being a glaciologist could be described as steady. Born in Oslo in March 1922, his education in that city revealed a preference for physical geography, allied to physics and chemistry, and developed into the choice of glaciology as the subject for his M.A. degree at the University of Oslo in 1954. Between 1947 and 1950, he taught in high schools in Oslo, and went on several expeditions to Norwegian glaciers and, in the summer of 1949, to Jan Mayen. Here he made tidal observations and did some survey work for Norsk Polarinstitutt. In 1950, he moved to Sweden, teaching in high schools in Köping and Transås for the next eight years. He married Britta Byström, who was Finnish, in 1952, and their first child, a son, was born in 1954.

Gunnar's connexions with Sweden became even closer in 1958, when he became Assistant Professor in Physical Geography at the University of Stockholm for the next four years. During this period he took his lower doctoral degree in geography at the University. Field investigations in Scandinavia continued, but in the summer of 1962 northern Canada enticed him across the Atlantic, and he did some research on Baffin Island, into ice-cored moraines, a subject that had always been of prime interest to him. He returned in 1963 and 1965 to undertake glaciological and hydrological investigations.

The hydrology of glaciers, with particular emphasis on mass balance studies and sediment transport, gradually occupied more of his interests and time. In 1962, he was appointed Head of the Glaciology Section at the Norwegian Water Resources and Electricity Board in Oslo, a position he has held up to the present time, with a few periods of leave to make other special studies.

During this period, he continued to be responsible for some courses in glaciology in the University of Stockholm, and commuted weekly between the two capital cities. In 1965, he presented his Dissertation in Geography at the University of Stockholm. This year also took him to Canada, where he took up an 18-month appointment as Section Head at the Glaciology Section of what was in those days named the Department of Mines and Technical Surveys in Ottawa. While he was in Canada, he was able to study the mass balance of glaciers in western Canada and help in the production of glacier maps. The problems of the height of the glaciation limit intrigued him during these studies, as well as the delineation of seasonal snowfall areas.

Upon his return to Europe in the summer of 1966, he was appointed Associate Professor at the University of Stockholm, a post he held until 1973, and resumed his double responsibilities in Oslo and Stockholm. His expertise was in demand by Unesco in 1969, when he went to Turkey to investigate the needs and possibilities of applied snow and ice studies, and in 1971, when he helped to conduct an International Course in snow and ice hydrology in Chile. The first half of 1972 was spent in the Geography Department of Carleton University, Ottawa, and he gave valuable help in the organization of field courses in snow and ice hydrology.

Always an enthusiast, on family outings with his wife, son and three daughters, and with his glaciological friends, Gunnar is stimulating company at any gathering. After the Society's 1969 Symposium on the Hydrology of glaciers, he organized a tour of Norwegian glaciers for some of the participants. It was a typical Østrem exercise: immaculately organized, with a multitude of kindnesses and thoughtful arrangements to suit varying weather conditions and transport problems. Inevitably, too, it showed his love, not only for mountains and glaciers, but for that highly appropriate food, ice cream. For all glaciologists know that that is what Gunnar thrives on and that they must ensure an adequate, which means an above-average, supply for him when he pays them a visit.

INTERNATIONAL GLACIOLOGICAL SOCIETY

DEATH OF GERALD SELIGMAN

The death of Gerald Seligman on 21 February 1973 marked the end of an era for the Society, for it was founded in 1936 by Mr Seligman and other enthusiasts. He was one month short of 87 years of age when he died and had devoted the major part of his life to the study of snow and ice. Obituaries appeared in "The Times" and are in press for various scientific journals, including the Journal of Glaciology.

The following messages are some of those received by the Society. They reflect the high esteem in which Gerald Seligman was held all over the world. Many other messages of sympathy were sent direct to Mrs. Seligman, including ones from the President and from the Branches of the Society.

From Australian members: "We are all conscious of (and in debt to) him for creating this vehicle for the international glaciological community, and especially so since Australian glaciology grew from a similar interest in snow structure and ski fields."

From Japan: "Condolences and deepest sympathy from members and from the Institute of Low Temperature Science" (Hokkaido University) and from the Japanese Society of Snow and Ice.

From the Swiss Glacier Commission (President, R. Haefeli): "On the occasion of its meeting on 13 March the members of the Commission remembered their great colleague and express their deepest sympathy. With his famous book "Snow structure and ski fields", Gerald Seligman introduced a wide circle of scientists and amateurs to the secrets of the snow cover and has encouraged many further studies. The Commission is particularly touched by the fact that he was deeply attached to Swiss mountains and glaciers and found there excitement and scientific inspiration."

From the Swiss Commission on Snow and Avalanches, and the Institute for Snow and Avalanche Research, Weissfluhjoch: "He was a great pioneer in snow research and his achievement is preserved in his unique book and in the living body of the Society."

AWARDS

SELIGMAN CRYSTAL

Seligman Crystals are awarded "from time to time to one who has contributed in a unique way so that the subject is now significantly enriched as a result of that contribution." At its meeting on 30 April 1973, the Council agreed that a Crystal be awarded to Dr S. Evans for his pioneering work in developing the technique of radio echo sounding for measuring the thickness of glaciers. The Crystal will be presented at the next Annual General Meeting of the Society, in September 1974 in Cambridge, England.

HONORARY MEMBERSHIP

Under the Constitution of the Society, "Honorary Members shall be elected by the Council in recognition of eminent contributions to the objects of the Society, and shall not exceed ten in number." At its meeting on 30 April 1973, the Council elected the following Honorary Members, who have certainly made such contributions:

Robert P. Sharp, California Institute of Technology—for his own outstanding work and for his training and encouragement of many students who have become eminent glaciologists in their own right.

Sigurdur Thorarinsson, Iceland—for his own notable contributions and for the many ways in which he has stimulated interest in glaciological research in Iceland, (not forgetting the patience he has exercised when dealing with innumerable student expeditions).

Zyungo Yoshida, Institute of Low Temperature Science, Hokkaido University—for his eminent contributions to the study of basic physical properties of snow, and for his encouragement in ILTS of research into the scientific and technical problems of snow and ice.

The Honorary Members are now ten in number: H. W:son Ahlmann, W. O. Field, R. Haefeli, R. F. Legget, Sir Raymond Priestley, M. de Quervain, R. P. Sharp, S. Thorarinsson, Sir Charles Wright and Z. Yoshida. — An outstanding list of scientists and one of which the Society can be proud.

FUTURE MEETINGS

1974 SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY

The First Circular for this Symposium has already been mailed to members of the Society. It is reproduced at the end of this issue of ICE for the benefit of those who may have misplaced their copy and for other interested people who are not members of the Society.

1976 SYMPOSIUM ON THE PROBLEMS OF APPLIED GLACIOLOGY

The Symposium, to be held in Cambridge, England, in September 1976, will be concerned with **the application of fundamental properties of snow and ice to the solution of engineering problems.** Further details will be published in due course.

BRANCH NEWS

WESTERN ALPINE BRANCH

The Council of the Society has approved the change of name from "French Branch" to "Western Alpine Branch". The new name reflects more accurately the membership of the Branch, which includes glaciologists from France, Italy and Western Switzerland.

NORTHEASTERN NORTH AMERICAN BRANCH

The fifth meeting of the Northeastern North American Branch of the International Glaciological Society was held 2-4 March 1973, at Le Château Montebello, located on the north side of the Ottawa River, about 40 miles east of Ottawa, Ontario. Le Château, constructed of cedar logs from Western Canada on the picturesque grounds of the old Papineau seignory, provided a relaxed atmosphere for the technical and social sessions.

The purpose of the meetings of the Branch is to provide the members of the Society in eastern Canada and United States with an opportunity to describe and discuss informally their current glaciological interests and activities. Over 40 members came to Montebello from as far as Boston, New York City and Ann Arbor, Michigan.

The contributions were presented in three technical sessions. On Friday evening, Stan Peterson described some of the results of his recent work on the Devon Island Ice Cap; attempts to determine the annual layering in two cores from the ice cap using electrolytic conductivity, particulate distribution, oxygen isotopes and fabric analysis, were described by Fritz Koerner; Harold Serson reported on recent observations of the Nansen Sound ice plug; Sam Colbeck presented results of a study of water flow through snow.

In the second session on Saturday morning, Michel Metge described a simple method of measuring the thickness of ice; Gordon Cox spoke on measurements he is making of the partition coefficient during freezing of Na Cl solutions; Bill Hibler reported results of mesoscale sea ice strain rate observations made with a laser apparatus; Willy Weeks presented the results of a study he undertook with Bill

Campbell on the feasibility of using icebergs from the Antarctic as sources of fresh water; recent developments in the McGill University observations of ice drift in the Gulf of St. Lawrence were described by Elton Pounder; Bob Frederking reported on a study he has underway on uplift forces on piles exerted by ice covers when subject to a rise in water level; Rev. Thomas Hanley described observations of helical bubble traces in ice; Norio Higuchi, an engineer with the Hokkaido Electric Power Company, who is spending six months with the Ontario Hydro Corporation, gave an interesting report on the characteristics of the growth of damaging snow deposits on electrical power lines in Japan; results of attempts to determine the water equivalent of snow packs from aircraft, by measuring the attenuation of natural gamma radiation from the ground, were presented by Harry Loijens; John Hollin described his interest in dating old beaches in tectonically stable areas in order to obtain evidence concerning the possible surging of the Antarctic Ice Cap.

On Sunday morning, Anton Traetteberg, an engineer with the Hydraulic Institute in Trondheim, Norway, who is spending about a year in Canada in order to become familiar with techniques for studying ice, described measurements he has made on the strain rate dependence of Young's modulus for fresh water ice; A. Karpov presented his ideas on the origin of the ice ages; Peter Johnson gave a description of shear features observed at the termini of two temperate glaciers in the Yukon; Gerry Holdsworth presented results of measurements of the flow of the Barnes Ice Cap, and discussed implications with respect to the flow law; Gordon Young shared with the participants some thoughts on glacier stake networks; the use of computers for modelling the heat exchange at the surface and the ground thermal regime was described by Sam Outcalt; Hans Weber presented results of observations of wind induced tilt of the ice cover in the Beaufort Sea; ice shelf and ice problems in Disraeli Fiord, Northern Ellesmere Island, were described by Geoffrey Hattersley-Smith. The technical sessions concluded with the showing by Fritz Koerner of the BBC film of the British Trans-Polar Expedition.

One of the highlights of the meeting was a cross-country ski race. The participants became well dispersed over the course, but all managed finally to make their way to the finishing line. It was clear from later discussions in the bar that the very wet snow conditions for that time of the year had made it extremely difficult to choose the correct wax for the skis. The winner, Bill Hibler of CRREL, was in great shape for the event and had no difficulty staying in the lead. The trophy, an antique (well used) wooden spoon, was presented with suitable ceremony, at the banquet.

It was a pleasure to have at the meeting Dr R. F. Legget, an Honorory Member of the Society and a strong supporter of glaciological research in Canada. Dr Legget spoke to the banquet about his contacts with the Society, Dr Seligman and Swiss snow research in the 1940's, and the great influence these contacts had on his own efforts to encourage Canadian snow and ice research.

The meeting was saddened to hear of the passing of Dr Gerald Seligman on 21 February. Several in attendance had had the pleasure of knowing Dr Seligman personally and of visiting him at his home. The existence of the Branch and the opportunity to meet in the pleasant surroundings of Le Château Montebello and enjoy the pleasures and benefits of discussion and fellowship with friends, was evidence of Dr Seligman's great contributions to glaciology.

Finally, a word of thanks and appreciation must go to Bob Frederking and Stephen Jones for sorting out the programme and looking after details such as projectors, screens, etc., and to Fritz Koerner for organizing the cross-country skiing activity. Tony Gow, of CRREL, was elected as the next Vice President of the Branch, and organizer of the next meeting.

Lorne Gold, President,
Northeastern North American Branch

Northeastern North American Branch 1973 meeting


A technical session in progress


Assembling for the cross-country skiing event


They're off! — and running!

JOURNAL OF GLACIOLOGY

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

G. Wendler & N. Ishikawa:
Experimental study of the amount of ice melt using three different methods.

C. H. Harrison:
Radio echo sounding of horizontal layers in ice.

H. Weertman:
Position of ice divides and ice centres on ice sheets.

J. J. Clague & W. H. Mathews:
The magnitude of jökullhlaups.

H. B. Clausen:
Dating polar ice by ^{32}Si.

C. Schubert:
Striated ground in the Venezuelan Andes.

D. M. Barnett:
Anthropogenic ice: notes on a dramatic ephemeral cryergic landform.

G. Hattersley-Smith & H. Serson:
Reconnaissance of a small ice cap near St. Patrick Bay, Robeson Channel, Ellesmere Island, Canada.

R. Taylor & R. J. Greenfield:
The effect of glacial cross-section on vertical resistivity depth soundings.

L. A. Rasmussen & W. J. Campbell:
Comparison of three contemporary flow laws in a three-dimensional, time dependent glacier model.

R. Vivian & G. Bocquet:
Subglacial cavitation phenomena under the Glacier d 'Argentière, Mont Blanc, France.

T. O'D Hanley & A. H. Weber:
Freezing potentials and currents in potassium fluoride solutions at constant growth rates.

B. D. Alkire & O. B. Andersland:
The effect of confining pressure on the mechanical properties of sand-ice materials.

R. A. Souchez & others:
Refreezing of interstitial water in a subglacial cavity of an alpine glacier as indicated by the chemical composition of ice.

J. R. Moravek:
Some further observations on the behaviour of an ice-dammed self-draining lake, Glacier Bay, Alaska, USA.

Roger LeB. Hooke:
Structure and flow in the margin of the Barnes Ice Cap, Baffin Island, NWT, Canada.

Short Notes

R. H. Goodman:
Time dependent intraglacier structures.

K. Kikuchi:
On the use of telephone poles for the observation of areal snow depth distribution.

THE LIBRARY

BOOKS RECEIVED

Adams, W. P. *and* Hellereiner, F. M., ed. *International geography 1972. Papers submitted to the 22nd International Geographical Congress, Canada . . . . Montréal, 1972* Toronto and Buffalo, University of Toronto Press, [c1972].
2 vols.: xii, 694, xiii-xxvi p.; xii, 695-1354, xiii-xxvi p.

Ladurie, E. Le R. *Times of feast, times of famine: a history of climate since the year 1000. Translated by B. Bray*. London, George Allen and Unwin, [c1971] [xxiv], 428p.
[Original approach to history of climate in Europe, studied by reference to records of glacier fluctuations and dates of vintages.]

Laursen, Dan. The place names of north Greenland. *Meddelelser om Grønland,* Bd. 180, Nr. 2, 1972, 443p., 18 maps in end pocket.

Price, R. J. *Glacial and fluvioglacial landforms.* Edinburgh, Oliver and Boyd, [c1973]. viii, 242p. (Geomorphology Text 5).
[Textbook, referring to many examples from northern Europe and North America.]

COUNCIL MEMBERS 1973-1974

			Date first elected to Council (in present term of service)
PRESIDENT	W. F. Weeks	1972-75	1969
VICE-PRESIDENTS	A. Higashi	1973-76	1973
	E. R. LaChapelle	1972-75	1971
	M. de Quervain	1972-75	1969
IMMEDIATE PAST PRESIDENT	V. Schytt	1972-75	1967
TREASURER	*J. A. Heap	1970-73	1967
ELECTIVE MEMBERS	*W. Ambach	1971-74	1971
	*W. Dansgaard	1971-74	1970
	G. de Q. Robin	1971-74	1970
	*W. F. Budd	1972-75	1972
	*A. Corte	1972-75	1972
	*V. M. Kotlyakov	1972-75	1971
	*W. S. B. Paterson	1972-75	1971
	*R. Vivian	1972-75	1972
	*B. Kamb	1973-76	1973
	*D. Kuroiwa	1973-76	1973
	*H. Oeschger	1973-76	1973
	*O. Reinwarth	1973-76	1973
CO-OPTED	*C. Lesca	1973-74	1973
	*O. Orheim	1973-74	1973
	*E. R. Pounder	1973-74	1973
EDITORS appointed to serve on the Council:			
	J. W. Glen	1973-74	1966
	C. W. M. Swithinbank	1973-74	1973

*No previous service on the Council

Appointments to Posts & Committees

(made by the Council 4 May 1973, under Rule 10 of the Constitution)

Library Committee: J. W. Glen, B. B. Roberts, Treasurer (ex-officio), Secretary as secretary.

Awards Committee: W. Ambach, J. W. Glen, M. de Quervain, President (ex-officio), Secretary as secretary.

Research & Education Fund Committee: L. W. Gold, J. F. Nye, H. Röthlisberger, V. Schytt, President and Treasurer (ex-officio), Secretary as secretary.

Nominating Committee: J. W. Glen, M. de Quervain, G. de Q. Robin, President (ex-officio), Secretary as secretary.

1974 Symposium Committees:

Local Organising Committee: G. de Q. Robin, C. W. M. Swithinbank, President & Treasurer (ex-officio), Secretary as secretary.

Papers Committee: W. J. Campbell, S. Evans, M. F. Meier, J. W. Glen (Journal of Glaciology), President (ex-officio), Secretary as secretary.

Both these committees were given power to co-opt.

SECRETARY: Mrs Hilda Richardson

RECENT MEETINGS (of other organizations)

THE FIFTH ALL-UNION GLACIOLOGICAL SYMPOSIUM IN TASHKENT

From 25 September to 8 October 1972 Tashkent was the scene of the Fifth All-Union Glaciological Symposium. Over 225 scientists from all parts of the USSR took part in the sessions. 114 reports were made at 8 plenary and 14 theme sessions. The following topics were discussed: overall investigations of glaciers and glacier regions — 21 reports; glaciohydroclimatology and glacier run-off — 19; movement and tectonic structure of glaciers — 8; physical methods of glacier investigation — 7; glaciology of Antarctica — 6; palaeoglaciology — 15; seasonal snow cover — 11; snow avalanches — 20; icings, sea and river ice — 7.

A number of papers presented results of investigations of ice, water and heat balance under the IHD programme on the mountain-glacier basins of the Altay, Caucasus, Tien-Shan and Pamir-Alay. Other papers dealt with the following subjects: the first experience of using the USSR Glacier Inventory material for an investigation of the regime of large glaciated regions; possibilities of using surveys from satellites to study snow-glacier landscapes in the mountains; the results of development of mathematical models for snow storage in the mountains, accumulation, ablation and internal nourishment of glaciers, and glacier run-off; methods and results of radar investigations of mountain glaciers and ice caps; and experience in thermo-drilling of ice.

Great attention was attached to the seasonal snow cover in mountain regions. Papers were presented on the mechanics of mountain snowstorms and in particular, the influence of pulsation of wind velocity on snow transport; investigation of movement of snow avalanches; formation of the air wave; impact of avalanches; methods of selecting parameters used for calculating the design of anti-avalanche structures; and forecasting different types of avalanches.

In palaeoglaciology, several reports were presented on mathematical modelling of global changes in Pleistocene glaciation and transfer functions of ice sheets. Other papers included: a concept of two big late Pleistocene glacier cycles, based on data of glacioeustatic variations of sea level; reconstruction of the ancient glaciation of the East Pamirs; preliminary chronological record of the Antarctic ice sheet; and a very original explanation of the origin of glacio-dislocations on the West Siberian plain.

The following Soviet glaciological achievements (1968-1972, since the 4th symposium) were recorded in the resolution of the Tashkent symposium: 1) work on the systematic approach and in particular, methods of mathematical modelling of regime and development of snow cover, movement of avalanches and glaciers, formation of glacier run-off, interaction of glacier with atmosphere and ocean; 2) sharp increase in the use of geophysical methods of glacier investigations (including radar and laser investigations) which permitted extensive measurements of glacier thickness and development of physical modelling of avalanches, organization of thermal drilling of glaciers together with coring; 3) work on remote sensing methods in the study of snow cover and glaciers from the atmosphere or cosmos; 4) continuation of the study of ice, water and heat balance in the IHD representative mountain glaciers; 5) work on the Glacier Inventory of the USSR: 2/3 of the Inventory has been compiled and 1/3 has been published; 6) development of field investigations of surging glaciers; 7) preparation of the first national report on glacier variation in the USSR; 8) compilation of a monograph and a set of maps on avalanche regions in the territory of the USSR; 9) recognition of palaeoglaciology as a science using the results of modern glaciology for the reconstruction of ancient conditions.

The next symposium is to be held in September 1976 in Alma-Ata.

V. M. Kotlyakov

FUTURE MEETINGS (of other organizations)

INTERDISCIPLINARY SYMPOSIUM ON ADVANCED CONCEPTS AND TECHNIQUES IN THE STUDY OF SNOW AND ICE RESOURCES

(Monterey, California, USA, 2-6 December 1973)

The study and management of snow and ice resources is a rapidly expanding field with tremendous opportunities for the use of new and innovative concepts and techniques for basic data gathering, data accumulation systems, and information dissemination. Tremendous potential exists for the application of advances made in such other areas as nuclear instrumentation, aerial remote sensing, telemetry (including the use of satellite relays) and seismology. The need for modern, computerized data handling systems, and for systems integration is also great.

Snow and ice, however, is a very complex medium that imposes many constraints on measuring devices. In most instances, water is present in all three phases and thus affects the use of some of the proposed equipment. The ambient conditions under which the equipment is expected to operate are among the most severe encountered in field operations, imposing a severe limitation on the use of some devices. Moreover, many of the constraints imposed by the medium on the measuring devices are not well known, particularly to those outside of the snow and ice field.

Thus, the U.S. National Committee for the International Hydrological Decade (USNC/IHD) is organizing an Interdisciplinary Symposium on Advanced concepts and techniques in the study of snow and ice resources, for the purposes of exploring those areas of technology that offer potential solutions to present and future needs in the study and management of snow and ice. Participants are expected to represent two broad groupings: (a) those already engaged in the study or management of snow and ice resources; and (b) workers in other fields of science and technology who are familiar with concepts and techniques that may also be applicable to the needs of the snow and ice field.

The Symposium will be held at the Asilomar Conference Grounds, Monterey, California, on 2-6 December 1973. The outline programme is as follows:

Monday 3 December

The expanding managerial needs for snow and ice information.

Distinguishing characteristics of snow and ice —

a. seasonal snow cover
b. permanent snow cover
c. sea ice
d. freshwater ice
e. effect on weather circulation patterns.

Tuesday 4 December

New concepts and techniques from allied fields (2 sessions).

Wednesday 5 December

New concepts and techniques from allied fields (third session).

Integration of information systems.

Thursday 6 December

How do we make the transition from the equipment we have to the equipment we shall need in the future?

(Adjourn following lunch.)

For further information contact: Dr Henry S. Santeford, Jr., US National Committee for the IHD, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, DC 20418, USA.

SYMPOSIUM ON METEOROLOGY OF THE POLAR REGIONS

(Melbourne, Australia, 14-25 January 1974)

During the First Special Assembly of IAMAP (International Association of Meteorology and Atmospheric Physics), to be held in Melbourne, Australia, from 14 to 25 January 1974, there will be a Symposium on meteorology of the polar regions. Three half-day sessions will be organized, and the symposium will concentrate largely on Antarctic problems, including fluxes of heat, water vapour and momentum over snow, sea-ice and land-ice, and on POLEX problems. (The relation of POLEX to the First GARP Global Experiment will be covered in a separate GARP session.)

Abstracts of contributed papers should be concise and informative and should occupy one typed page with a margin of 4 cm on the left-hand side and 3 cm at top and bottom. Such abstracts should reach the co-ordinating convenor by **1 August 1973**. Notification of acceptance or rejection will be mailed about 1 September 1973, with necessary details of session and time allocated, etc. Abstracts should be accompanied by information about projection equipment required.

Coordinating Convenor: Dr S. Orvig, Secretary, ICPM, Department of Meteorology, McGill University, Burnside Hall, P.O. Box 6070, Montreal 101, Quebec, CANADA.

GLACIOLOGICAL DIARY

1973

16-28 July
Conference on Permafrost. USSR Academy of Sciences, Yakutsk. (Institut Merzlotovedeniya, Yakutsk, USSR.)

23-27 July
Symposium on the Hydrology of lakes. Otaniemi, Helsinki, Finland. (Organizing Committee, P.O. Box 436, 00101 Helsinki 10, Finland.)

27-30 August
Conference on Port and ocean engineering under arctic conditions. University of Iceland. (Secretary of Conference, "Port and ocean engineering under arctic conditions", P.O. Box 645, Reykjavik, Iceland.)

7-9 September
International Glaciological Society, Western Alpine Branch, Annual Meeting, Zermatt, Switzerland. (Dr R. Vivian, President, Western Alpine Branch, Institut de Géographie Alpine, Rue Maurice-Gignoux, 38-Grenoble, France.)

10-15 September
Societé Hydrotechnique de France, Section de Glaciologie. Glaciology Excursion in the Tyrol and Vorarlberg areas of Austria. (Dr L. de Crécy, Societé Hydrotechnique de France, 199 Rue de Grenelle, 75007 Paris, France.)

24-28 September
First World Congress on Water Resources, Chicago, IL 60411, USA. (G. M. Karadi, Secretary-General, IWRA, Science Complex Bldg., University of Wisconsin, Milwaukee, WI 53201, USA.)

25-28 September
IEEE International Conference on Engineering in the Ocean Environment, Washington Plaza Hotel, Seattle, WA 98100, USA. (Technical Program Chairman: Mr Gil Raudsep, Marine Systems Center, Honeywell, 5303 Shilshole Avenue NW, Seattle, WA 98107, USA.)

2-5 October
Symposium on Remote sensing in Oceanography. ASP/ACSM. Contemporary Resort Hotel, Walt Disney World, Orlando, FL 32800, USA. (Dr Byron R. Ruth, Dept. of Civil-Coastal Eng., University of Florida, Gainsville, FL 32601, USA.)

2-6 December
Symposium on Advanced concepts and techniques in the study of snow and ice resources. Monterey, California, USA. (Dr H. S. Santeford, Jr., US National Committee for the IHD, National Academy of Sciences, 2101 Constitution Avenue, Washington DC 20418, USA) (See p. 24 of this issue of ICE.)

2-10 December
International Union for Quaternary Research, Congress, New Zealand. (Dr Jane M. Soons, Secretary-General, Department of Geography, University of Canterbury, Christchurch, New Zealand.)

1974

14-25 January
Symposium on the Meteorology of the polar regions. Melbourne, Australia, IAMAP. (Dr S. Orvig, Dept. of Meteorology, McGill University, Burnside Hall, P.O. Box 6070, Montreal 101, Quebec, Canada.) (See p. 24 of this issue of ICE.)

15-17 January
Symposium on River and ice. Budapest, Hungary. Hungarian Committee of International Association for Hydraulic Research, and Inland Navigation Section of the Permanent International Association of Navigation Congresses. (Dr Z. G. Hankó, Secretary, Local Organizing Committee, IAHR/PIANC Symposium, Budapest 1974, VITUKI, Rákóczi út- 41, Budapest VIII, Hungary.)

1-5 April
Symposium on Snow mechanics. Grindelwald, Switzerland. (Int. Commission of Snow and Ice, IAHS, Dr F. Müller, Secretary, Geog. Inst. der ETH, Sonneggstrasse 5, Zürich 8006, Switzerland.)

20-24 April
1st Symposium on the Geological action of drift ice, Québec, Canada. (Jean-Claude Dionne, Environment Canada, C.P. 3800, Sainte-Foy, Québec, Canada.)

9-12 September
Celebration of Tercentenary of Scientific Hydrology and Symposia to mark end of I.H.D.: Effects of man on the interface of the hydrological cycle with the physical environment. Flash floods—measurement and warning, (Director, Division of Hydrology Unesco, 7 place de Fontenoy, 75700 Paris, France.)

15-21 September
Symposium on Remote sensing in glaciology. Cambridge, England. (International Glaciological Society, Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

1975

8-10 April
Symposium on the thermal regime of glaciers and ice caps. National Research Council of Canada, Simon Fraser University, Vancouver, Canada. (Dr R. B. Sagar, Dept. of Geography, Simon Fraser University, Burnaby, B.C., Canada.)

18-21 August
International Association of Hydraulic Research Committee on 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. (Dr G. Frankenstein, IAHR Symposium, P.O. Box 282A, Hanover, NH 03755, USA.)

1976

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

September
Symposium on Problems of applied glaciology. Cambridge, England. (International Glaciological Society, Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

REVIEWS

The Mechanics of Erosion, by M. A. Carson, London, Pion Limited, 1971, 174 pp.

One cannot but agree with the author, a physical geographer, who "suspects that geomorphology will emerge as a reputable discipline only when its students have become well-versed in the established principles of natural sciences". His aim is to explain to the average undergraduate doing an earth science course the basic principles underlying theoretical geomorphology at an appropriate mathematical level and to provide some unity between the various ideas involved.

Topics covered in different chapters are the concepts of stress, the mechanics of fluid erosion, stress—strain—strength relationships, mass movements in rock and soil masses and the mechanics of glacial erosion. Of the four processes of erosion, weathering, solution, corrasion and transportation, he emphasizes transportation although corrasion under glaciers is also discussed.

Of the 41 pages dealing with the mechanics of glacial erosion, including an appendix, over half are concerned with the flow law of ice, its application to a laminar model of glacier flow and Weertman's and Lliboutry's models of glacier sliding. There is a somewhat limited discussion of how material is incorporated into the sole of a glacier, but no discussion of the role of bottom melting in keeping the rock load in contact with bedrock. The less effective role of longitudinal stresses in keeping material in contact with or removing it from the base of a glacier receives more attention. Erosion of cirques by glaciers is treated in terms of the theory of rotational failure in soil mechanics. One may well query the value of a "unified" approach in this case, since during cirque development the arc of failure is made to run through the ice mass leaving stagnant ice masses above and below the rotating sector in an unlikely fashion.

In dealing with corrasion by glaciers, both shear forces and vertical crushing forces on ice and rock are treated in an elementary fashion. Deposition of glacial debris is not considered.

Overall, there is a need for an authoritative book on the mechanics of glacial erosion rather than one chapter plus background material. It is perhaps as much a criticism of physical glaciologists who have failed to get effectively to grips with the main problems in this field as it is of the author to say that the treatment is not very penetrating. In any case one cannot do very much in one chapter, and the author is candid about the state of knowledge on this subject.

G. de Q. Robin

Numerical Analysis in Geomorphology: An Introduction, by John C. Doornkamp and C.A.M. King, London, Edward Arnold. 372 pp.

It is not easy to characterize the place that this book should hold in university teaching and research because of its unique problem solving approach to the elucidation of statistical manipulations. The term "numerical" is in fact somewhat misleading as "numerical analysis" has a distinct meaning in mathematics that involves the iterative solution of equations using a high-speed computer, whereas the authors are clearly dealing with statistical analysis.

The majority of texts on quantitative methods begin with problems of scale and measurement and proceed in orderly fashion through descriptive statistics, distribution-free methods into multi-variate analysis of one form or another. Doornkamp and King, however, tackle the problem of introducing the equivalent concepts and techniques through case studies involving four discrete sets of landforms, namely: drainage basins, slopes, coastal forms, and glacial forms.

In proceeding through the four major sections the reader encounters most of the material he or she would require from a text aimed at the senior undergraduate/graduate although not necessarily in a systematic fashion. Over forty specific approaches are outlined throughout the four main topical sections that comprise the book and these indeed cover much in the way of introductory to advanced statistical methods—basically from descriptive statistics to such "sophisticated" approaches as Factor Analysis and Multiple Discriminant Analysis.

For the reader who wishes to "dip" into the book in order to see how a specific technique might be applied to his/her research problem, then the "index" of the book will be critical. Two indexes are provided. The "General Index" covers authors quoted in the text and the main subject headings used in the book; examples are: *drumlins,* density, distribution . . . , or *deposits,* glacial carbonate content . . . . . There is also an "Index of numerical techniques" that covers four pages and hence provides the main retrieval system for the reader interested in a particular technique.

The book is heavily weighted toward the application of parametric statistics although there are useful discussions of appropriate distribution-free methods such as the Kolmogorov-Smirnov test for differences between sample distributions, and the Sign Test which compares paired measurements in terms of relative magnitude. As may perhaps be expected, correlation analysis in one of its various guises is perhaps the single most used approach illustrated in the text.

Although the authors have broken new ground in their approach to illustrating quantitative methods applied to geomorphology, their approach does cause the reader some problems. There is, for example, little weighing of one method against another for some specific problem, and a technique may be used in one section but hardly mentioned in another, despite some reason to suspect that the method might have had an equal applicability in this other area. I am thinking here, for example, of the application of time-series in coastal studies, whereas they would seem to have interesting uses in slope analysis. Orientation is a fundamental property of landforms but it received scant attention and that primarily in the section on "Glacial forms".

Despite these criticisms, the book is a welcome change from the "cookbook" presentation that has become partly embedded in the geological/geographical literature. The book can be profitably read by most people with an interest in the subject and it would be a useful text for a course on statistical methods in geomorphology. Only five statistical tables (e.g. the F distribution) are included and this indicates that the authors expect the book to be used for ideas and concepts rather than as a statistical reference source.

J. T. Andrews

Polar Geomorphology (compiled by R. J. Price and D. E. Sugden), Institute of British Geographers, Special Publication No. 4, 1972. 214 p.

This volume contains 14 papers presented at a Symposium on Polar Geography held at the University of Aberdeen, January 1972. Most glaciologists will only be interested in some of the papers. Two articles deal with subglacial conditions and serve to emphasize how little we know: Hope, Lister, and Whitehouse describe laboratory experiments, which need to be continued under more controlled experimental conditions, to measure rock wear by cold sliding ice; whereas Boulton maintains that little or no erosion occurs under a glacier frozen to its bed. Boulton draws on the result of many workers to give a comprehensive review of the role of thermal regime in glacial sedimentation.

Four papers treat glacial history and landform development. Funder describes the postglacial deglaciation of the Scoresby Sund fjord region, and John relates evidence from the South Shetland Islands to a glacial history of West Antarctica. Le Mausier discusses a volcanic record of Antarctic glacial history and its implications to Cenozoic sea levels, and Drewry uses the new tool of radio echo sounding to investigate Cenozoic tectonics and glaciation in Antarctica.

O. Orheim

RESISTOGRAPH

Dr C. C. Bradley makes the following offer to members of the Society.

The purpose of this letter is to discover if you have a need or desire for a Bradley Snow Resistograph M4. The reason I ask is we have more work than our one M3 can handle so we have decided to tool up and make one or two more for our project plus one which has been requested. While we are at it, we could just as well make several more and thereby cut the pre-unit cost which will probably be somewhere between $500 and $800.

Before you explode at the price let me say that if you now use a rammsonde and count your time as money you will make back the cost of the resistograph before the first winter is over. Bill St. Lawrence and I made a study of the comparison of the two instruments and have a paper in press in the **Journal of Glaciology.** In brief, it shows that in their overlapping ranges the resistograph and rammsonde produce snow profiles with essentially a one to one relationship, so the two instruments are probably measuring the same parameters.

A resistograph profile takes about 30 seconds to complete from the moment the assembled instrument touches the snow until the functional graph is in hand. The equivalent rammsonde profile takes from one to two man hours to complete because of data reduction and drafting time. Usually the data reduction is done later under shelter and hence the rammsonde does not generally give as useful on-the-spot field information.

In other respects each instrument has its own relatively minor points of advantage and disadvantage. M4 is now on the drawing board: if you want one please let me know immediately, so we know how many to make and can estimate the pre-unit cost more accurately.

Dr Charles C. Bradley,
Dept. of Earth Sciences,
Montana State University,
Bozeman, Montana 59715, USA.

ICE STREAMLINE COOPERATIVE ANTARCTIC PROJECT (ISCAP)

The Ohio State University Institute of Polar Studies has sent the following report:

The ISCAP field program proposes a ten year study of the glaciology and glacial geology of the Ross Sea ice drainage basin, with studies concentrated in Marie Byrd Land. ISCAP Bulletin 1 advanced the proposition that the West Antarctic ice sheet is inherently unstable, and ISCAP Bulletin 2 outlines a comprehensive plan to prove or disprove this proposition. Various aspects of this plan will be elaborated in future ISCAP Bulletins.

ISCAP Bulletin 1, presenting the scientific justification for a study like ISCAP, was completed in June 1972 and copies are available from The Ohio State University Institute of Polar Studies, 125 South Oval Drive, Columbus, Ohio 43210, U.S.A. ISCAP Bulletin 2, outlining the ISCAP Antarctic field program, is in preparation and will be in circulation this summer.

The ISCAP field study is designed for maximum coordination with the Ross Ice Shelf Project (RISP) and the International Antarctic Glaciological Project (IAGP).

It is proposed that during the 1974-75 austral summer a systematic radio echo aerial survey be made of the West Antarctic ice sheet. This will locate the major ice streams draining Marie Byrd Land so that one suitable to the objectives of RISP can be selected for intensive ISCAP studies. A glaciological investigation of Byrd Glacier will also be proposed for this field season, since Byrd Glacier drains much of the IAGP study area and is the major link between IAGP, RISP, and ISCAP. It also drains the presumably stable East Antarctic ice sheet whereas the selected Marie Byrd Land ice stream drains the presumably unstable West Antarctic ice sheet. Both feed the Ross Ice Shelf. Hence, ISCAP will involve a comparative study of outlet glaciers, their relative stability, and their interaction with the Ross Ice Shelf. A simultaneous study will be made of the glacial geology of the Byrd Glacier portion of the Transantarctic Mountains, as this area links the glacial geology of the central and northern Transantarctic Mountains, already much studied.

Surface elevation, snow accumulation, and mean annual temperature will be recorded at fourteen sites in western Marie Byrd Land during the 1975-76 austral summer. This will fill present data gaps so that reliable mass balance studies can later be initiated.

A glacial geological study of West Antarctic nunataks will be undertaken during the austral summer of 1976-77. The objective is to investigate volcanic eruptions that can be used to date former elevations of the ice sheet, which can then be correlated with studies in the Transantarctic Mountains. This is a major ISCAP objective, as it permits a reconstruction of the history of the ice cover.

Detailed studies of surface strain, velocity, accumulation, temperature, density, and seismicity along the Marie Byrd Land ice stream selected for intensive ISCAP study is proposed for the 1976-80 austral summers. During the 1977-79 austral summers this will include a multi-hole drilling program, where holes 300 m to 500 m deep will be cored to study temperature, deformation, ice fabrics, isotopes, and impurities for signs of climatic change, surges, basal sliding, and diapiric activity in the ice. During the 1978-80 austral summers a section of the Siple Coast grounding line near and on the ice stream will be investigated to determine the stability of the grounding line and the volume, salinity, turbidity, and flow pattern of subglacial water entering the Ross Sea from Marie Byrd Land.

If warranted, a corehole to bedrock will be undertaken in the 1980-82 austral summers in an area of confirmed diapiric activity. This will be useful for testing mantle convection models and for learning how convection affects isotope analyses of ice cores used to reconstruct the climatic history of the ice sheet.

The above research program has been endorsed by the ad hoc Glaciology Working Group of the Glaciology Panel of the U.S. National Academy of Science's Committee on Polar Research at their November 1972 meeting at the University of Wisconsin. That meeting was requested by the U.S. National Science Foundation for the purpose of drafting an Antarctic Glaciology Ten Year Plan. The working group did not endorse ISCAP as such, and the ISCAP objectives may not be administered as a single program. However, The Ohio State Universitiy Institute of Polar Studies is sponsoring ISCAP as a single program to coordinate all these studies, and is actively enlisting the cooperation of other polar research centers in that effort.

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Zwally, Dr H. Jay., Office of Polar Programs, National Science Foundation, Washington, DC 20550, USA.

"NU-GLAS" GLASS FABRIC TUBE USED IN GLACIER FLOW EXPERIMENTS

A steam probe made from **"Nu-Glas"** epoxy resinated glass tube, manufactured by the Composite Components Division of Fothergill & Harvey Limited, has been successfully used in the course of recent drilling experiments carried out to further scientific knowledge of the physical properties of glaciers by the Cambridge Staunings Expedition at the Roslin Glacier in the Staunings Alps region of North East Greenland.

One prime objective of the experiments was to study glacier flow, and in particular to determine the temperature gradient of the glacier near to the ice surface. This was achieved by drilling a series of holes at various depths down to twelve metres into which thermometers could then be inserted.

For the drilling itself a steam jet, devised by Steven M. Hodge of the University of Washington and built by staff of the Cambridge University Engineering Department, was employed. The jet delivered steam produced by a portable generator at a pressure of 0.4 MN/M^2 through a flexible hose, twenty metres in length. But to ensure that the vertical holes thus drilled were sufficiently straight to receive the thermometers, the end of the hose required in addition to be fitted with an attachment in the form of a probe.

Effective Use of Nu-Glas Tube

For its superior high strength, rigidity and low thermal conductivity "Nu-Glas" epoxy resinated glass fabric tube was chosen for the probe, and Fothergill & Harvey supplied two specimens to the Expedition. A brass adaptor at the top of each tube was used to mate it with the flexible hose, and a brass nozzle approximately 152 mm long set into the bottom.

During the whole series of twenty-two experiments, no problems were encountered in the performance of the "Nu-Glas" tubes, and it was found that a PTFE tube which was fitted inside one probe proved more efficient in carrying the steam with minimal heat loss than the stainless steel lining used in the other probe.

When the Expedition returned to England one of the tubes was unintentionally left behind, permanently frozen in position, and marks the site of the experiments, eleven metres below the surface of the Roslin Glacier.

The picture shows: (foreground) the portable steam generator, and (background) one of the team members with the steam probe preparing to drill down into the ice. During the whole series of twenty-two experiments, no problems arose with the performance of the "Nu-Glas" tube.

Further information from: G. Murray/R. H. Greig (Fothergill & Harvey) 0706 78831 M. Wright/R. O. Hooker (Condor) 01-499 7324.

SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY

15 - 21 September 1974

Cambridge, England

Organized by the International Glaciological Society

First Circular

May 1973

INTERNATIONAL GLACIOLOGICAL SOCIETY

LOCAL ORGANIZING COMMITTEE:

	J. A. Heap G. de Q. Robin C. W. M. Swithinbank W. F. Weeks
Secretary	H. Richardson

PAPERS COMMITTEE:

	W. F. Weeks W. J. Campbell S. Evans M. F. Meier J. W. Glen (representing Editors of the Journal of Glaciology)
Secretary	H. Richardson

All correspondence and requests for information about the Symposium should be addressed to:

The Secretary
International Glaciological Society
Cambridge CB2 1ER
England

The Symposium on Remote sensing in glaciology will be held in Cambridge, England, 15-21 September 1974, and is organized by the International Glaciological Society.

1. PARTICIPATION

This circular includes booking forms for registration and accommodation. The forms should be sent to the Secretary before 1 April 1974 with the appropriate deposits, as indicated on each form. (Registration fees cover organization costs and distribution of preprints of summaries.)

Payment should be made—

by cheque payable to: International Glaciological Society 1974 Symposium, and sent to the Secretary; **or**

by Bank transfer to: International Glaciological Society 1974 Symposium, Account No. 54775302, and sent to the National Westminster Bank Ltd., 67 St. Andrew's Street, Cambridge CB2 3BZ, England; **or**

by Giro transfer to: Post Office Giro Account No. 240 4052.

(Please do not include payments to the International Glaciological Society for other items, such as annual dues.)

Registration Fees:

Participants	£12
Junior Members of the International Glaciological Society	£6
Accompanying persons aged 18 or over...	£3

(There is no fee for those under the age of 18.)

2. TOPICS

The Symposium will be concerned with the application of remote sensing by radiation to the measurement of glaciological parameters. It will include discussion of topics such as:

radio echo sounding
active and passive microwave
infrared techniques
and laser profilometry

of glaciers, ice sheets, snow, ice and ground ice.

The Symposium will **not** be concerned with conventional photographic techniques.

3. PROGRAMME

A detailed programme will be given in the Second Circular. On Monday evening, 16 September, there will be an informal party, and on Thursday evening, 19 September, the Symposium Dinner will be held. Visits to colleges and other buildings will be arranged for those interested in local tours, and may be booked when registering in Cambridge on Sunday, 15 September.

4. ACCOMMODATION

Block reservations have been made in Colleges and some hotels.

Colleges: Single rooms are available for men and women aged 18 and over, at approximately £6.00 per day for room, all meals and service. (Married couples will be allocated a suite of rooms.)

Hotels: Prices will be approximately £5.00 per day for single room without bath, but including breakfast (double room=£8.50); and £9.00 per day for single room without bath but including all meals (double room=£16.00). The extra charge for a private bath is approximately £1.00.

A few single rooms may be available in boarding houses, £2.00 to £2.50 per day, breakfast included.

Deposits for accommodation:

A £5 deposit per person must be paid when booking for any of the above accommodation. This deposit is returnable if notice of cancellation reaches the Secretary before 15 August 1974.

If participants prefer to make their own arrangements for accommodation, please indicate this on the booking form; no deposit will then be required by the Society.

5. PAPERS

(i) SUBMISSION OF PAPERS

Those participants who would like to contribute to the Symposium should first submit a summary of their proposed paper in English; this summary should contain sufficient detail to enable the Papers Committee to form a judgement on the likely merit of the proposed paper, but should not exceed three pages of typescript. Summaries must be submitted on paper of international size A4 (210 x 297 mm) with wide margins and double spaced lines.

Date for submission of summaries

15 January 1974

(ii) SELECTION OF PAPERS

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account scientific quality and relevance to the themes of the Symposium. The Papers Committee will then invite a strictly limited number of papers for presentation and thorough discussion at the Symposium (not necessarily confining themselves to authors who have submitted summaries). It is hoped to notify authors of papers during April 1974.

(iii) DISTRIBUTION OF SUMMARIES

The summaries of the accepted papers will be distributed by surface mail to all participants before the Symposium.

(iv) SUBMISSION OF FINAL PAPERS AND PUBLICATION

The Proceedings will appear in the Journal of Glaciology. Papers presented at the Symposium will be considered for publication in these Proceedings, provided they have not been submitted for publication elsewhere. Final typescripts of these papers should be submitted to the Secretary of the International Glaciological Society by 1 August 1974. They should be written in English and prepared in accordance with the instructions for preparation of papers for the Journal of Glaciology to be found inside the back cover of the Journal. Fuller details will be sent to authors with the notification of acceptance of the papers for the Symposium. The maximum length for papers will be 5000 words or the equivalent length including any illustrations. The papers will be refereed according to the usual standards of the Journal of Glaciology before being accepted for publication.

6. SOCIAL EVENTS

(i) INFORMAL PARTY

On Monday 16 September there will be an "Ice-breaker" in one of the Colleges for everyone attending the Symposium. Coffee will be provided and drinks will be available from a cash bar.

(ii) SYMPOSIUM DINNERS

The Dinner will be held on Thursday evening, 19 September. The cost, inclusive of wines, will be £5. Tickets for the dinner may be bought when registering on Sunday, 15 September.

Registration, Accommodation

SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY
15 - 21 September 1974

Mail to:
Secretary, International Glaciological Society, Cambridge CB2 1ER, England
See reverse of this form for methods of making payment.
BEFORE 1 APRIL 1974

A REGISTRATION FORM

(please type or print in black ink)

Name of participant Mr / Mrs / Miss ....

Address ....
....
....

Accompanied by (indicate age if under 18)
Name ....
Name ....

I send registration fee/s as follows:
(i) Participants ....£12 each......
(ii) Junior members ....£6 each......
(iii) Accompanying persons ....£3 each......

(There is no registration fee for accompanying persons under the age of 18.)

TOTAL REGISTRATION FEE/S =£......

B ACCOMMODATION FORM

Please reserve the following accommodation for the nights of 15-20 September 1974, for which I enclose a deposit of £5 per person. (Arrival on 15 September, departure on 21 September.)

(i) Colleges (single rooms only):
.........room/s

(ii) Hotels:
.........single room/s ....double room/s
.........bed & b'fast or ....full pension
With/without bathroom.

(iii) Lodging houses (if available):
.........single room/s

(iv) Own arrangements (delete if not applicable):
I prefer to make my own arrangements:
(No deposit required)

TOTAL DEPOSITS FOR ACCOMMODATION =£......

TOTAL PAYMENT (sections A. B.) =£......
(sent by Cheque/Bank transfer/Giro transfer)

Social events

C SYMPOSIUM DINNER

I hope to attend the Dinner and will wish to reserve .... tickets. (Payment to be made at time of arrival in Cambridge.)

METHODS OF MAKING PAYMENT

By cheque payable to: International Glaciological Society 1974 Symposium, and sent to: Secretary, International Glaciological Society, Cambridge CB2 1ER, England.

By Bank transfer to: International Glaciological Society 1974 Symposium, Account No. 54775302, and sent to National Westminster Bank Ltd., 67 St. Andrew's Street, Cambridge CB2 3BZ, England.

By Giro Transfer to: Post Office Account No. 240 4052.

Your copy

INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY
15 - 21 September 1974

The following reservations were made on the forms returned to the Secretary on ..../ (day) ..../197 (month)

A. REGISTRATION FEES

(i) Participant £ ....

(iii) Accompanying person £ ....

B. ACCOMMODATION DEPOSITS

£5 per person

(i) Colleges £ ....

(ii) Hotels £ ....

(iii) Lodging houses £ ....

TOTAL
PAYMENT (sum of A. B.) ......=£ ....
Sent by cheque/Bank transfer/Giro transfer.

Tickets for Symposium Dinner:

Number required ....

Payment to be made upon registration in Cambridge 15 September 1974.

DATES TO REMEMBER

1974

15 January: Last date for submission of summaries of papers for consideration.

1 April: Last date for reservations: registration, accommodation.

1 August: Last date for submission of final versions of accepted papers for consideration for publication in the Proceedings.

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 1973:

Private members	Sterling: £5.00
Junior members	Sterling: £2.00 (under 25)
Institutions, libraries	Sterling: £10.00

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: Mrs Hilda Richardson

This news bulletin is issued to members of the International Glaciological Society and is published three times a year. Contributions should be sent to Mrs H. Richardson, International Glaciological Society, Cambridge CB2 1ER, England.

Annual cost for libraries, &c, and for individuals who are not members of the Society: Sterling £1.50.

Foister & Jagg Ltd., Abbey Walk, Cambridge