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ICE

INTERNATIONAL GLACIOLOGICAL SOCIETY

1976 SYMPOSIUM

Applied Glaciology

Have you registered for this Symposium? The Second Circular was published in ICE 48, 2nd issue 1975, pages 22—24.

Many summaries were submitted and members of the Papers Committee have selected 50 for presentation. In addition, there will be 12 invited speakers, covering various aspects of the subject.

Registrations are coming in fast: make sure of your accommodation by booking soon.

Scotland Tour

The number of places is limited to the capacity of one medium-sized coach. Bookings will be made on a "first come, first served" basis. So make sure of your place by booking soon.

1977 SYMPOSIUM

Physics & Chemistry of ice

For the First Circular, see page 26 of this issue of ICE.

ICE

NEWS BULLETIN OF THE

INTERNATIONAL GLACIOLOGICAL SOCIETY

1st ISSUE 1976 NUMBER 50

CONTENTS

1976 DUES. Please note that those members who have not paid their dues will not receive Nos. 76 and 77 of Volume 17 until they do. The "bonus" volume this year (Vol. 16, Number 74, Proceedings of the Symposium on Thermal Regime of Glaciers and Ice Sheets) will also be held until payment is received. As in 1975, we shall have to charge for the extra costs involved in handling these late mailings separately from the bulk mailings at the time of publication: so please pay promptly, to make everyone's life easier!

COVER PICTURE. View of Piz Morteratsch, Bernina Biancograt, Switzerland. Photograph by André Roch.

RECENT WORK

ARGENTINA

Glaciological research in Argentina is being studied in three places in 1976:

1) At the Instituto Argentino de Nivologia y Glaciologia (IANIGLA) in Mendoza, Western Argentina.

2) At the Instituto Antartico Argentino located in Bs As Address Cerrito 1248, Buenos Aires, Argentina.

3) At the Fundacion Bariloche, Dept. of Natural Resources Bariloche Rio Negro, 8400 Argentina.

At IANIGLA the following projects are in hand: a) inventory of glaciers and rock glaciers, b) paleoclimatology, c) nival and glacial hydrology, d) rock glaciers hydrology, e) avalanches.

a) For the inventory the basin of the rio Mendoza was completed with more than 16,000 km^2. At the present time the areas of uncovered ice and rock glaciers are being computed.

b) Paleoclimatology. In this project two areas are being covered: palynology and denrochronology, with the main emphasis on understanding past climates. Old Araucaria Patagonica trees of more than 800 years have been sampled and also some peat deposits, located behind and in front of till deposits, have been sampled. These projects are being carried out in co-operation with the University of Arizona Tree Ring Research Laboratory and Dr Vera Markgraf at the Geoscience Department of the University of Arizona, USA.

c) Snow and glacial hydrology. In this project a basin located between 3,200 and 5,000 m is being instrumented in order to understand the meteorological factors responsible for snow and ice run-off.

e) Avalanches. A survey of the different types of avalanches is being made along the international highway between Mendoza and Santiago de Chile, and also along the railway parallel to it.

At IANIGLA also some summer courses are being offered with the aim of understanding the basic properties of snow and ice, and specifically their hydrological significance in this dry region. This summer Dr Benito Colqui is offering a seminar on Snow and Ice in San Juan and also in Mendoza.

IANIGLA is preparing a first volume, "Progress in Argentine glaciology", which will include besides the above mentioned topics papers by Flint, Mercer, Post, Corte, and several papers by the research team of IANIGLA. This volume will be issued in 1976.

The work accomplished in the other two institutions (see paragraph one) will be described in our next report.

Arturo Corte

AUSTRIA

Since the last report on Austrian activities in snow and ice research appeared in ICE (No. 26, April 1968), many projects have been carried out by an increasing number of investigators. A trend towards technical applications and basic physics of glaciological problems may be noticed in the summary of activities. At the same time, however, the fields of classical glaciology experienced a revival by improved technology and funding, as is seen, e.g., in the more frequent air reconnaissance for glacier inventories and new maps, in the increasing number of seismic investigations, or in the improvement of glacial morphology by numerous new C^{14} data.

This summary is by no means complete since modesty or work load prevented some of the investigators from communicating their activities. It is hoped that these will be incorporated in a future report.

AVALANCHES

At Wildbach- und Lawinenverbauung, Sektion Tirol, E. Hanausek is surveying the catastrophic events that came in the wake of unusual heavy snowfalls in April 1975 in the area of Stubaital, Gschnitztal and Lanersbach.

At Forstliche Bundesversuchsanstalt, Institut IX für Wildbach- und Lawinenverbauung (G. Kronfellner-Kraus) an inventory of avalanche damage has been kept since 1967/68, the year after this institute was established. Experiments include the measurement of mechanical forces of avalanches and their stress on buildings. Studies also concern the reforestation of subalpine areas.

Tiroler Wasserkraftwerke AG cooperate with Lawinenwarndienst der Tiroler Landesregierung (O. Schimpp) in a study of the potential of artificial avalanche release.

SNOW COVER

At the Zentralanstalt für Meteorologie und Geodynamik in Vienna studies of the snow cover ranged from physical and climatological aspects to economic implications. F. Steinhauser investigated the influence of the Central Alpine Divide on the snow cover in the Sonnblick area, snow conditions on the Großglockner-Highway and secular variations of the snow cover in Austria; compiled a snow climatology survey for the period 1901-1950; and produced maps with several statistical parameters of the snow cover. F. Steinhauser and A. Lauscher studied maximum snow depths and the time of their occurrence in the Eastern Alps and investigated synoptic influences on the growth and decay of the snow cover at the Sonnblick (3100 m). Records of snow temperature at the Sonnblick were analysed by W. Mahringer. L. Binder evaluated the density of snow in Vienna since 1951.

The Hydrographisches Zentralbüro in Vienna (H. Schimpf, director) collects daily reports of depth of snow cover and of fresh snow from 700 stations. At selected stations density and water equivalent are determined. Statistics of duration of snow cover, maximum depth, and yearly sum of fresh snow depth were evaluated for this century and mapped on a scale 1:50,000. These data are now being prepared for computer analysis.

For obvious reasons hydroelectric power plants survey the snow cover in the catchment areas of their respective reservoirs. Tiroler Wasserkraftwerke records snow depth and density in the areas of Achensee, Kühtai, and Kaunertal. Vorarlberger Illwerke maintain 13 stations in the Silvretta, 8 in the Rhätikon, and 6 in the Verwall area in order to determine the water equivalent of the areal snow cover.

H. Rott at the Institut für Meteorologie und Geophysik, Innsbruck, initiated a study of remote sensing of snow covered areas as part of the IHP-project. From images of the multispectral scanner on Landsat (ERTS) the extent of spring and summer snow cover in the central Tirolean Alps is being mapped. The transient snow line on glaciers is determined from pictures taken close to the end of the ablation period. For selected glaciers the results are compared to air reconnaissance and ground based observations.

HYDROLOGY OF SNOW AND ICE

Under the direction of the late H. Hoinkes, staff members of the Institut für Meteorologie und Geophysik continued the measurements of precipitation in the drainage area of Rofenache (98 km^2, 1900-3774 m) with 13 storage gauges. In addition the water equivalent of winter snow cover was measured. Run-off was recorded at the stream gauging station Vent-Rofenache operating since the summer of 1967. The influence of the discharge-regime will be evaluated after final calibration of the gauge. This work was sponsored by Österreichische Akademie der Wissenschaften and Hydrographisches Zentralbüro.

The following studies have been carried out in the period 1968 to 1975 by the staff of the Abteilung Physik von Schnee und Eis des Physikalischen Instituts, Innsbruck, under the direction of W. Ambach, who became head of the Division for Physics of Snow and Ice at the Physical Institute in 1974:

Studies of the discharge of a glaciated drainage area (Rofental, Ötztaler Alpen) using dye tracers (with O. Jochum and M. Elsässer). Measurements of discharge of glacier streams by dye dilution, comparison of the methods of continuous and instantaneous injection to vane current meters (Rofenache). Measurements of hydraulic parameters of meltwater in the internal drainage system of the ablation area (Hintereisferner). Measurements of run-off times of meltwater from the accumulation area and their relation to climatological parameters (Hintereisferner).

Studies of the concentration of Deuterium, O^{18}, and Tritium in snow, ice, and water (with O. Jochum and U. Löschhorn).

Measurements in water samples from glacier streams, spring water and snow and ice samples. Seasonal and diurnal variations of isotope content were analysed in order to determine the contribution of melt water and spring water to the total discharge of a glacier stream (Hintereisferner, Kesselwandferner, Vernagtferner, Rofenache). Measurements of the variations of Deuterium, O^{18}, Tritium concentrations in precipitation under differing weather conditions. Changes of Deuterium concentration in the snow pack during springtime metamorphosis.

Studies of the water table in the accumulation area of Kesselwandferner (with U. Löschhorn, M. Blumthaler, and P. Kirchlechner). The variations of the water table were investigated in a 30 m pit as well as in additional boreholes in the accumulation area and were correlated to ablation conditions. The horizontal transport of meltwater was derived by injection of dye tracers in the water table.

The above mentioned projects were carried out in co-operation with the Institut für Radiohydrometrie der Gesellschaft für Strahlen- und Umweltforschung m.b.H., Munich (H. Moser).

In a study of flood potential in a glacierized drainage area the contribution of the energy balance components to extreme ablation of ice and snow was analysed with respect to micrometeorological data.

In a study of melt water percolation, dye tracers were used to determine the speed of percolation in homogeneous mixtures of snow.

PHYSICS OF SNOW AND ICE

Studies of the electrical properties of the natural snow pack (with A. Denoth): Electronic equipment was developed for the determination of the free water content of snow by measuring the dielectric constant. Its change with frequency was investigated as it depends on free water content, grain size, and density. The models of Debye and Cole-Cole were used for a theoretical treatise of the frequency dependence.

In a theoretical study of the extinction of shortwave radiation in snow (with W. Ott) the equation of radiative transfer was solved numerically for an anisotropic phase function. The results describe the decrease of the shortwave radiation flux with depth and the dependence of albedo on the angle of incidence of direct radiation. The extinction properties of snow layers were determined by laser beams.

With S. Bortenschlager pollen spectra were determined in samples of fresh and old snow from the accumulation area of Kesselwandferner.

The work at the Abteilung für Physik von Schnee und Eis was funded by the Österreichische Akademie der Wissenschaften. A great deal of the field work was supported by the co-operation of H. Eisner. Publication list and reprints are available on request.

SEISMIC STUDIES

This project was operated jointly by the Zentralanstalt für Meteorologie und Geodynamik and the Institut für Meteorologie und Geophysik of the Vienna University. It was initiated in 1966 in IHD and continued in 1975 in IHP. After trial measurements on Vernagtferner in 1966 the following glaciers were studied:

1967/68: Hallstätter Gletscher
Schladminger Gletscher
Gosau Gletscher (all three in the Dachstein)
1969: Gefrorene Wand Kees (Zillertal)
1970: Pasterze (Glockner)
1971/72: Fleißkees
Goldbergkees
Wurtenkees (all three in the Goldberg)
1973/74: Ober- und Untersulzbachkees
1975: Hornkees (Zillertal)

Measurements in 1969, 1970, and 1975 were performed in co-operation with the Vermessungsabteilung der Tauernkraftwerke AG (Leader: E. Kropatschek). The glaciers were selected according to the following viewpoints: Coverage of different types of glaciers from all geographic areas; economic significance, as in the catchment areas of hydro plants; and easy access.

The size spectrum of the investigated glaciers ranges from Schladminger Gletscher (area 0.9 km^2, mean ice thickness 9 m) to Pasterze (19.3 km^2 and 63 m). Among them, all stages of dynamic behaviour are represented. The strongest symptoms of decay were exhibited by the glaciers of the Goldberggruppe; Untersulzbachkees is relatively large and nearly stationary, while Hornkees is significantly advancing.

The results of these investigations have been published by O. Bittmann, E. Brückl, G. Gangl, P. Steinhauser, and F. J. Wallner (in alphabetical order) and can be obtained at the Zentralanstalt für Meteorologie und Geophysik, Vienna.

GLACIAL METEOROLOGY

In the combined studies of water, ice, and heat balance of the Rofenvalley near Vent, Tirol, H. Hoinkes and the staff of the Institut für Meteorologie und Geophysik der Universität Innsbruck continued climatological and micrometeorological investigations on and around Hintereisferner.

Basic climatological data were observed at Vent (1900 m). Beginning in 1969 several auxiliary stations were in operation during the ablation period at 2450 m in front of the terminus of HEF, at 2800 m on the ice, at 3030 m on the left bank of HEF above the equilibrium line, and at 2960 m in the firn region. At the latter station in the summers of 1970 and 1971 heat balance was studied by recording all four components of radiation balance as well as vertical profiles of wind, temperature and humidity. The evaluation of these data is in progress. Ice temperature was measured regularly with thermocouples at Station 28 in two profiles which showed the interesting result that negative temperature persisted over nearly the whole of the profiles during summertime. This programme was extended and four new profiles (16 m) of resistance thermometers were drilled in the firn area in autumn 1975. Meteorological observations concentrated on the mesoscale approach. A successful attempt was made to relate the parameters for mass balance data with selected climatological data observed on or near the glacier and with atmospheric circulation patterns. This new method will eventually make it possible to estimate changes in the mass balances of the glaciers from observed changes in the meteorological environment.

POLAR METEOROLOGY

At the Abteilung für Physik von Schnee und Eis des Physikalischen Instituts der Universität Innsbruck, W. Ambach analysed the results of energy balance measurements carried out on the Greenland Ice Sheet during EGIG 1959/67 with co-operation of G. Markl. All components of the energy balance were examined, especially the interrelation of net radiation balance with cloudiness, and of ablation with altitude.

The field work of an extensive micrometeorological investigation of the Antarctic inversion, started in 1966 by the co-operation of USWB,

USA Natick Laboratories (P. Dalrymple, L. Stroschein), University of Wisconsin (H. Lettau, W. Schwerdtfeger), University of Melbourne (U. Radok), and University of Innsbruck (M. Kuhn) was continued in the austral summers 1968/69 at Plateau and 1973/74 at South Pole Station. Ice crystal precipitation, optical phenomena, spectral radiation fluxes, illumination, radiation balance, and the glaciological parameters determining surface albedo were analysed at the Institut für Meteorologie und Geophysik in Innsbruck. With the co-operation of A. Riordan and I. Wagner in 1972/73 the climatology of the inversion layer and the influence of stable stratification on the statics and dynamics of wind and temperature profiles were evaluated.

MASS BALANCE AND VARIATIONS OF GLACIERS

The survey of variations of glacier lengths of the Österreichischer Alpenverein (H. Kinzl) covers about 100 Austrian glaciers; results are published in Mitteilungen des ÖAV and in Zeitschrift für Gletscherkunde und Glazialgeologie.

On Pasterze glacier, H. Paschinger (Head, Geographisches Institut der Universität Graz) continued his survey of velocity and height on three profiles in the ablation area, one in the accumulation area. He was assisted by H. Aigelsreiter and E. Neuer in 1967/68 and by H. Aigelsreiter in 1968/69. Since 1970/71 the survey has been carried out by H. Wakonigg. Yearly results are communicated in Zeitschrift für Gletscherkunde und Glazialgeologie. G. Patzelt (Geographsiches Institut der Universität Innsbruck) installed a net of ablation stakes on Pasterze in 1967, which are controlled yearly. From the two projects, the vertical component of ice movement is evaluated.

E. Kropatschek (Tauernkraftwerke AG) also maintains a limited number of stakes on the upper part of Pasterze as well as on 3 glaciers in the Zillertal. His main project, however, is a yearly geodetic survey of Schmiedinger Kees (1967: 1.5 km^2, 23 stakes) and Gefrorene Wand Kees. Apart from estimates by H. Tollner (Zentralanstalt für Meteorologie und Geodynamik, Vienna, Wetterdienstselle Salzburg) no data on the mass balance of these glaciers have been published.

The dynamic behaviour of Untersulzbachkees and Obersulzbachkees is being investigated in a co-operative effort by Institut für Kartographie und Reproduktionstechnik and Institut für Photogrammetrie, both of Technische Hochschule, Vienna, and Zentralanstalt für Meteorologie und Geodynamik, Vienna. E. Brückl reports maximum ice thickness between 250 and 300 m, based on seismic work in the firn area, and a mechanical model was derived by P. Steinhauser and E. Brückl that links the topography, elasticity and plasticity of a glacier. A photogrammetric survey was begun in 1974, and a net of 52 stakes for geodetic survey was installed in 1975.

H. Slupetzky (Geographisches Institut der Universität Salzburg) continued mass balance studies of the Stubacher Sonnblickkees (1974: 1.76 km^2) as part of IHD and IHP, supervised till 1973 by H. Spreitzer (Geographisches Institut der Universität Wien). The following values of specific mass balance were found:

1967/68	+23.6 g/cm^2
1968/69	−24.7
1969/70	+14.4
1970/71	−39.2
1971/72	+12.8
1972/73	−72.1
1973/74	+57.6
1974/75	+39.7

Climatological observations were carried out at Rudolphshütte each year from May through October, precipitation was measured in storage gauges. The discharge measurements at the reservoir Weißsee were continued by Österreichische Bundesbahnen. Sonnblickkees was covered by air photography in 1953, '59, '63, '69, '73.

Ödenwinkelkees was surveyed yearly by terrestrial photogrammetry with the exception of 1971, resulting in maps on a scale of 1:5,000 for the years 1967, '68, '74, '75. Surface movement was determined yearly on three transverse profiles; the vertical component was gained by additional ablation measurements in a longitudinal profile.

Air photographs from the end of the ablation season were evaluated for the maximum extent of ice-free areas on the glaciers of the Glocknergruppe and eastern Granatspitzgruppe (1967, '69, '73, '74) and of the central Hohe Tauern (1975).

This research was sponsored by Österreichische Akademie der Wissenschaften and by Hydrographisches Zentralbüro, Vienna.

J. Goldberger carried on his investigations of the mass balance of Hochkönniggletscher (1.7 km^2), started in 1965. Excluding Ostgletscher the following values of specific mass balance were found:

1967/68	−10 g/cm^2
1968/69	−6
1969/70	−3

H. Hoinkes and staff of the Institut für Meteorologie und Geophysik der Universität Innsbruck evaluated the mass balances of Hintereisferner (9 km^2) and Kesselwandferner (4 km^2) from 100 ablation stakes and 60 snow pits per year. The following specific net mass balance values were found:

1967/68	Hintereisferner	+34 g/cm^2
1968/69		−43
1969/70		−55
1970/71		−60

1971/72		− 7
1972/73		−123
1973/74		+ 6
1974/75		+ 6
1967/68	Kesselwandferner	+46
1968/69		−15
1969/70		0
1970/71		+ 5
1971/72		+35
1972/73		−38
1973/74		+57
1974/75		+37

The five years with negative mass balance on Hintereisferner had been preceded by four positive balances. The tongue is continuing its recession. The predominantly positive mass balance of Kesselwandferner resulted in an advance of its terminus by 90 m since 1966.

H. Schneider (Institut für Mathematik der Universität Innsbruck) continued the precision survey of 20 stakes on Kesselwandferner and 90 stakes on Hintereisferner.

ALPINE GLACIERS AND ICE AGES

At the Geographisches Institut der Universität Innsbruck, F. Fliri, H. Heuberger, and G. Patzelt investigated the following problems in order to derive a quantitative analysis of the climate during the past 40,000 years:

The chronology of late glacial readvances in the area of the Inn and Salzach valleys, with paleobotanical investigations by S. Bortenschlager (Institut für Botanische Systematik und Geobotanik der Universität Innsbruck).

The study of quaternary sedimentation and Würm-chronology in the Inn valley.

Post-glacial variations of glaciers in Ötztaler and Stubaier Alpen and correlation with the chronology of those in the Venedigergruppe.

G. Patzelt's study of the course and extent of post-glacial glacier variations in the Venedigergruppe was terminated in 1973.

GLACIER MAPS AND INVENTORY

In autumn 1969 all Austrian glaciers were covered by air photography. The flights and evaluation of pictures were funded by Hydrographisches Zentralbüro and Österreichische Nationalbank.

For the IHD glacier inventory, G. Patzelt and G. Gross (Institut für Meteorologie und Geophysik der Universität Innsbruck) are evaluating air photographs of autumn 1969. For each Austrian glacier, maps are produced on a scale of 1:10,000. Mapping and statistical evaluation of the glaciers of Dachsteingruppe, Großglocknergruppe, and Zillertaler Alpen are finished, work on Ötztaler and Stubaier Alpen is in progress.

In 1975 the Institut für Meteorologie und Geophysik der Universität Innsbruck issued a 1:5000 map of Kesselwandferner based on triangulation by H. Schneider and elaborated by Amt der Tiroler Landesregierung, Photogrammetrisches Institut (W. Giersig) with funds of Österreichische Akademie der Wissenschaften and Hydrographisches Zentralbüro. A similar map is being prepared of Hintereisferner.

In 1969 H. and W. Slupetzky (Geographisches Institut der Universität Salzburg, Geographisches Institut der Universität Wien) issued a 1:5000 map of Stubacher Sonnblickkees as of 1963, based on triangulation by L. Rentsch, cartography by E. Kopecky, with funds of Österreichische Akademie der Wissenschaften.

Since 1975 work has been in progress to produce orthophoto maps with 10 or 20 m isohypses of the glaciers of Goldberggruppe, Obersulzbachkees and Untersulzbachkees in a joint effort of Zentralanstalt für Meteorologie und Geodynamik, Institut für Kartographie und Reproduktionstechnik, and Institut für Photogrammetrie, Technische Hochschule Wien.

M. Kuhn

CANADA

GLACIER STUDIES—GENERAL

SUBCOMMITTEE ON GLACIERS
(G. K. C. Clarke, Chairman)
A new Subcommittee on Glaciers, under the Associate Committee on Hydrology, was formed in 1975 to replace that previously disbanded with the Associate Committee on Geodesy and Geophysics. It will sponsor a Symposium on 'The ice-rock interface: beds of glaciers and ice sheets' in Ottawa in 1978. Details will be announced in ICE.

ADVISORY COMMITTEE ON GLACIOLOGICAL AND ALPINE NOMENCLATURE
(C. S. L. Ommanney, Chairman)
This Committee was formed in 1975 to advise the Canadian Permanent Committee on Geographical Names. Priority will be given to guidelines on delineation of glacier features, on the usage of specific glaciological terms and the preparation of a list of glacier names.

GLACIER INVENTORY OF CANADA
(C. S. L. Ommanney, GD*)
On Ellesmere Is. glaciers have been identified and indexed in 80% of the basins and some 17 maps compiled for the Glacier Atlas; only the area north of Greely Fiord/Lake Hazen remains. Recent photos of the Coast Mts have been obtained from Austin Post for the archives. Some 1700 references are now included in the main bibliography. Bibliographies on rock glaciers and on Canadian glacier studies since 1960 are almost complete. A comprehensive list of glacier names has been compiled. The glacier inventory of the St. Elias Range, being carried out by the Arctic Institute of North America, will be completed by April 1976.

GLACIER STUDIES—ARCTIC

AERIAL PHOTOGRAPHY (K. C. Arnold, D. M. Christian, D. A. Sherstone, A. C. D. Terroux, GD)
With PCSP support, 110 air photo hours were flown over the Mackenzie River and Queen Elizabeth Islands. Breakup was studied along the lower Liard and Mackenzie rivers and excellent coverage obtained of ice jams. In the High Arctic coverage of the following glaciers was obtained—South Cape Fiord, Jakeman, Ekblaw, Leffert, Eugenie, in Makinson Inlet, d'Iberville, Otto Fiord, Mokka, Thompson, White, Iceberg, Cape Stallworthy central ice cap, Canon Fiord, Parrish, Sven Hedin, Benedict and Stygge. Niche glaciers and semi-permanent snow patches near Simmonds Bay and several ice-dammed lakes on Ellesmere Is. were also photographed. Ground control is not usually available. Flight charts and photos are available from the National Air Photo Library. Stakes, that can be read from the air, are being developed.

GLACIATION LEVELS (J. T. Andrews, G. H. Miller, C. Wright, INSTAAR)
A map of glaciation levels in the Northern Hemisphere has been compiled.

GLACIER FLUCTUATIONS: E. ARCTIC CANADA AND N.W. GREENLAND (W. Blake, Jr., GSC)
During the 1974 cruise of the C.S.S. Hudson many glacierized areas along the ship's route were photographed: Northumberland Ø, Smith Sound, Pim Is., the S coast of Buchanan Bay in Kane Basin, the E and S coasts of Devon Is., the NW corner of Bylot Is. and the N coasts of Borden and Brodeur Peninsulas. Photos were also taken of the Greenland Ice Cap margin near camp TUTO, previously visited in 1954.

In 1975 numerous glaciers in E. Axel Heiberg Is. and near Yelverton Pass (N. Ellesmere Is.) and the small ice caps near Muskox and Baad fiords (S. Ellesmere Is.) were photographed from the air.

LAIKA GLACIER, COBURG ISLAND
(F. Müller, ETH/MU)
The mass balance was determined using standard and photogrammetric techniques. A mass loss was observed in the lower part and a slight gain in the upper part. The accumulation area is all within the superimposed ice zone.

NORTHERN ELLESMERE ISLAND
(H. Serson, DREO)
The Ward Hunt Ice Shelf and Ice Rise ablation networks were remeasured; also the stakes on the small ice cap north of St. Patrick Bay. All areas indicate a net loss for the 1974-75 season: −205, −140 and −124 mm H_2O respectively. On 29 September the equilibrium line on Per Ardua Glacier was at 936 m, the highest since measurements started in 1964 when it was 750 m.

CALVING GLACIER STUDIES, ELLESMERE ISLAND (G. Holdsworth, GD, F. Müller, ETH/MU)
Leffert and d'Iberville glaciers, with discharges of $7 \times 10^6 m^3/a$ and $1.5 \times 10^8 m^3/a$ respectively, are being used to study calving processes and ice/sea water interaction. Terminal ice thicknesses are in the order of 60-100 m. The former glacier was visited several times by the North Water party to determine intensity of melt and mass balance.

HYDROLOGICAL INVESTIGATIONS IN SOUTH-CENTRAL ELLESMERE ISLAND (S. B. McCann, M-K Woo, J. G. Cogley, C. K. Ballantyne, S. P. Blachut, GD G/MC)
Studies centred on the hydrologic regime of two principal rivers draining from the ice cap into Vendom Fiord and the drainage behaviour of a series of ice marginal lakes that contribute to these rivers.

*This and subsequent abbreviations listed at end

AXEL HEIBERG ISLAND (F. Müller, ETH/MU)
The englacial temperature regime of White Glacier is being studied to provide input data for a two-dimensional thermodynamic and movement model of a sub-polar valley glacier. The modified Kasser, Röthlisberger and Iken drill achieved drilling rates of 25-50 m/h. Due to heavy summer snowfalls the equilibrium line was low. Glacier structures (crevasses, foliations and shear planes) were mapped by M. Hambrey and the relationship between the structures, glacier movement and strain magnitude studied.

MEIGHEN ISLAND (R. M. Koerner, PCSP)
The 1973-74 annual mass balance was -5 g/cm^2 and the winter 1974-75 balance was 10 g/cm^2.

MELVILLE ISLAND (R. M. Koerner, PCSP)
The 1973-74 annual mass balance on the southern ice cap was −18 g/cm^2 and the winter balance, 1974-75, was 17 g/cm^2.

DEVON ISLAND (R. M. Koerner, PCSP)
The annual mass balance on the NW side of the Devon Island Ice Cap for 1973-74 was −8 g/cm^2 with a winter balance for 1974-75 of 8.6 g/cm^2. The NW side strain net at 1300 m was re-measured to determine long-term mass balance. A profile across the Sverdrup Glacier at 300 m was levelled for comparison with similar surveys in 1961 and 1971.

Analysis continues of particulate content, chemistry and crystallography of 3 cores taken at 1800 m in 1971, 1972 and 1973. The first has revealed annual layers but the record is discontinuous due to random particle fallout during some periods. Crystal sizes show a gradual increase to about 15 m depth but irregular variations below that. A strong c-axis orientation develops from 150-200 m depth but does not strengthen below that. Pollen samples were collected for analysis by Dr Lichti-Federovich on this and the Meighen, Melville, Axel Heiberg and Ellesmere island ice caps.

BYLOT ISLAND (R. M. Koerner, PCSP)
A 12 m core taken on the ice field at 1800 m showed a surprisingly shallow firn cover of 6 m and a 12 m temperature of −8°C. Both facts indicate unexpectedly high melting in this area.

NEOGLACIAL SNOW COVER AND GLACIER INCEPTION, BAFFIN ISLAND (J. T. Andrews, C. Wright, L. D. Williams, INSTAAR)
Areas of retarded lichen growth or kill have been plotted from LANDSAT-1 imagery and the data used to construct paleoglaciation levels for the area N of Barnes Ice Cap; the level averaged 300 m lower than present. The neoglacial snow cover can be matched by lowering summer temperature 1-1.5°C, by decreasing solar radiation 5% or by increasing accumulation by a factor of 2. M. A. Mahaffy's three-dimensional numerical ice flow model has been used to examine the rate of glacierization.

BARNES ICE CAP SURGE STUDY, BAFFIN ISLAND (G. Holdsworth, GD)
The 35 stakes, 300-1000 m apart, along a 25 km flow line in the surge portion of the South Dome were resurveyed. The traverse incorporates two large strain nets, and one on the divide. D. Classen (University of Victoria) sank three strings of 7 thermistors each to depths of 88, 120 and 200 m (20 m short of bedrock). Near the margin the basal ice temperature is about 1°C lower than pressure melting but in the deepest hole is at pressure melting 20 m above bedrock. Mass balance measurements are being continued along this and the northern lines.

BARNES ICE CAP, BAFFIN ISLAND
(R. LeB. Hooke, GG/UM)
A 52 m hole, 1 km from the ice margin, was drilled and cased; the ice is about 115 m thick here. After penetrating over 10 m of dirty ice drilling stopped at 52 m due to excessive sediment accumulation. Temperature and deformation measurements were made. The bottom 30 m were in unusually fine grained (25 crystal/cm^2) white ice of Pleistocene age and suggested a high rate of deformation. The temperature gradient in a 110 m hole, 17 km S of the first, is consistently 2/3rds that at comparable heights above the bed at the 52 m and another hole, both the same distance from the margin. Preliminary K analyses of bedrock samples suggest higher radioactive heat production in the area of the hole with the steeper basal gradient but recent local thinning of the ice could also explain the differences in gradient.

RATE OF CIRQUE GLACIER EROSION, BAFFIN ISLAND (L. Anderson, INSTAAR)
Rates of erosion at ten cirque glaciers near the head of Pangnirtung Fiord are approximately 50 mm/1000a.

GLACIER STUDIES—YUKON TERRITORY

YUKON RESOURCE ATLAS (F. F. Slaney & Co. Ltd., Karl E. Ricker Ltd.)
An Atlas at a scale of 1:250,000 is being prepared for the Department of Indian Affairs and Northern Development. Studies of glacier and snow physics, chemistry and climatology will be included in an Hydrology Section with full reference to available information.

NEOGLACIAL EVENTS, KLUANE NATIONAL PARK (V. N. Rampton, GSC)
Debris-covered glaciers, ice-cored moraines, rock glaciers and lateral moraines were examined in 1974. It seems that the Neoglaciation here was limited to the last 2800 years. Most glaciers were expanding around 2800 years B.P., from 1050-1250 and during the last 450 years. Synchronous advances of many glaciers appear to have occurred from 200-250, 120-150, 40-70 and from 25 years B.P. to the present. Lakes formed 5-6 times through damming of the Alsek River by the Lowell Glacier.

RADIO ECHO SOUNDING YUKON GLACIERS (G. K. C. Clarke, B. B. Narod, GA/UBC)
Airborne radar surveys were made on a number of surge-type glaciers in the St. Elias Mts as a field test of the prototype UBC 840 MHz sounder. Best results were obtained over Klutlan Glacier (up to 550 m depth) and sounding over Kluane Lake yielded encouraging results. The radar transparency of lakes is largely dependent on the free ion concentration and this lake may be exceptionally transparent.

STEELE GLACIER (G. K. C. Clarke, GA/UBC with T. Ahern, S. G. Collins)
Near-surface ice and water samples were collected from boreholes for O^{18} analysis. A single 110 m hole at a new site was instrumented with thermistors. The network of tetrapods, established in 1974, was resurveyed giving post surge ice motion ranging from 0.61-10.45 m/a depending on site; annual ablation ranged from 1.57-2.77 m/a.

RUSTY GLACIER (G. K. C. Clarke, GA/UBC)
Three radioglaciology experiments were carried out — (a) an attempt to measure **in situ** the electromagnetic birefringence of glacier ice, to sense the state of stresses within a glacier, (b) studies of the depolarization of waves reflected from the rough glacier bed, and (c) studies of the fading patterns and statistical properties of radar echoes from the bed. These last two may lead to remote sensing of bed roughness.

MORAINE GLACIERS AND ROCK GLACIERS (P. G. Johnson, GRP/UO)
Drainage tracing experiments were tried on rock and moraine glaciers of Grizzly Creek to obtain data on their internal structure. It appears that ice and sediment are being added to these landforms today. Under low flow conditions no resurgencies occur on most of them implying accretion of the ice surface. On moraine glaciers all the sediment load is deposited inside as it does not appear in the resurgent streams.

ABLATION IN ICE-CORED MORAINES, GRIZZLY CREEK (P. G. Johnson, GRP/UO)
Rates of ablation were 5-10 times greater than in 1974 but average climatic conditions showed little difference between the two seasons. One contributing factor might have been a 9-day warm spell but even during the 20-day cold spell ablation rates were still twice those of 1974.

HYDROLOGY OF A GLACIER-FED STREAM, GRIZZLY CREEK (P. G. Johnson, GRP/UO)
The stream regime was dominated by basin snowmelt and glacier meltwater; the former contributing the greatest work potential to the stream. High discharge from the glacier occurred during a period when drainage changed from a predominantly lateral system to a subglacial one with resurgence under hydrostatic pressure at the glacier snout.

MOUNT LOGAN (G. Holdsworth, GD)
Control points were established around the NW col area (5400 m) for a 1:10,000 scale map and as a reference for movement and strain measurements. A 15.8 m snow/firn core is being analyzed for tritium and O^{18}. The 10 m temperature of −28.9°C corroborates stratigraphic evidence that the site is within the dry snow facies; recent accumulation rates are 1.3-1.5 m/a of snow. Radio echo sounding at 620 MHz yielded a probable snow/firn depth of 120 m at the Arctic Institute camp, 700 m from the col. Evaluation of the drill site and a 1977 drilling operation continues. The accepted height of Mt. Logan is 5951 m, ca. 19520 ft (note error in Ice, No. 47, p. 2).

GLACIER STUDIES—CORDILLERA

TWEEDSMUIR GLACIER, ST. ELIAS MTS, B.C. (G. Holdsworth, GD)
Final terrestrial photos were taken in August and map compilation is progressing. Parts of the land-based margin show the effects of wasting though further up glacier slight thickening may still be continuing. The Alsek River margin is still cliffed but about the same as last year; the 2 year surge is essentially over.

BERENDON GLACIER DEBRIS SYSTEMS (R. J. Rogerson, N. Eyles, GEOG/MUN)
Extensive debris sampling was carried out on the glacier with debris sites, such as extraglacial avalanche-swept bedrock walls and subglacial cavities, being given special emphasis. Sequential development can be delineated. Preliminary results indicate the passivity of ice transport in generating debris characteristics for all but subglacial loads. The importance of rock wall processes is emphasized. Cationic denudation rates were estimated. Those bedrock areas contributing daughter debris products have been better defined. Recent recession has been fitted into the northwestern North American chronology.

BERENDON GLACIER, B.C. (W. H. Mathews, GEOL/UBC, G. J. Young, GD)
Buried accumulation markers were relocated by sextant observations and electromagnetic detectors. Ablation was measured on the S. Berendon Glacier and a set of signals painted on the valley walls to facilitate future surveys to be based on angles measured from the stakes themselves.

INVENTORY OF GLACIERS SUITABLE FOR SUMMER SKI RESORT DEVELOPMENT, PEMBERTON AREA, COAST MTS (Karl E. Ricker Ltd, Howard Paish & Assoc. Ltd.)
Available glacier and climate data have been gathered to determine the physical suitability of some sites near Pemberton for year-round ski facilities.

TCHAIKAZAN VALLEY GLACIERS, COAST MTS, B.C. (Karl E. Ricker Ltd.)
Rates of glacier retreat from 1951-75 were established for the Tchaikazan and Friendly glaciers and the condition of the Hourglass, Pathetic, Monmouth and Miserable glaciers

noted. Moraine positions were plotted from aerial photos and crude estimates made of the rate of retreat from ca. 1900-1951. Results have been compared to retreat curves for the Canadian Rockies and Garibaldi Park. Cairns marking the 1975 snouts of the Tchaikazan and Friendly glaciers and notes, in waterproof canisters, have been left for others to repeat the survey.

WEDGEMOUNT GLACIER AND LAKE, COAST MTS, B.C. (Karl E. Ricker Ltd. with W. Tupper BCIT)
Moraines and related features are being mapped in Wedgemount Creek basin. Historical photos of Wedgemount Glacier and Lake, since 1927, are being used to study rates of recession and the growth of the ice marginal lake. Computerized photogrammetric contouring from the photo sequence is being used to calculate volumetric rates of glacier wastage and estimate the future health of parts of the glacier. Glacier retreat from 1951-75 was ca. 13 m/a. A 1:5000 scale map has been made.

GLACIER SLIDE, MEAGER CREEK, B.C.
(O. Mokievsky-Zubok, GD)
A brief investigation was made of the Capricorn and Job glaciers from which an estimated 2 x 10^9kg of ice were contributed to a fatal ice and debris slide of over 91 x 10^9kg that covered 5 km over an elevation range of 12000 m.

GLACIER MASS BALANCES: EASTERN CORDILLERA (G. J. Young), **WESTERN CORDILLERA** (O. Mokievsky-Zubok)
Measurement of winter and summer balances continued on Ram, Peyto, Woolsey, Place and Sentinel glaciers. Specific net balances were −0.62, −0.57, +0.36, −0.24 and +0.88 m H_2O respectively. From Sentinel measurements were extended to Helm and Warren glaciers and to others from Peyto.

A system for mapping mass balance data is now operational and has been used in the preparation of the summary data reports on IHD glaciers (G. J. Young).

At Sentinel and Sphinx glaciers the bottom topography of Garibaldi Lake was studied for sublacustrine ridges to determine the maximum extent of alpine glaciation (O. Mokievsky-Zubok).

HYDROCHEMICAL MODEL OF GLACIER MELTWATERS (O. Mokievsky-Zubok, GD)
In co-operation with J. Zeman, of the Water Quality Branch, the hydrochemistry of the Sentinel basin is being investigated to determine the characteristics of various glacier meltwaters and develop a regional classification.

GLACIER SURVEYS, WESTERN CANADA
(I. A. Reid, J. O. G. Charbonneau, AHD)
Reports and maps of the surveys of the Bugaboo, Nadahini, Sentinel, Sphinx, and Kokanee glaciers (B.C.) and the Athabasca and Saskatchewan glaciers (Alberta) from 1970-75 are in various stages of preparation and printing. The Alberta glaciers were resurveyed in 1975. The Bugaboo Glacier is advancing, all others are retreating.

MT. SIR SANDFORD AREA, SELKIRK MTS, B.C.
(J. S. Marsh, CEG)
The Sir Sandford and Silvertip glaciers were surveyed and a 1:10,500 map produced by the Canadian Exploration Group. A chain survey of the Haworth Glacier snout was completed. Comparison with Howard Palmer's 1911 survey shows the Sir Sandford has retreated about 1.3 km; 18.1 m/a from 1911-61 and 30.4 from 1961-75. There is no evidence for any advance comparable to the Illecillewaet Glacier. Microclimate studies included testing a model for the onset of a glacier wind, measurement of temperature and wind profiles across the Haworth Valley and Glacier and temperature transects of the Silvertip and Palmer Creek valleys.

SCATTERING OF RADIO FREQUENCIES IN GLACIERS (J. R. Rossiter, PHY/UT)
Radio interferometry soundings, at frequencies from 1-32 MHz, have been made on the Athabasca Glacier (Alberta) and the Juneau Icefield (Alaska). The data from both sites are dominated by random scattering at and above 8 MHz (20 m wavelength in ice). Analogue scale model experiments and theoretical studies are being made to elucidate the nature of the scattering mechanisms. Preliminary results indicate that dielectric contrasts must be quite large to cause significant volume scattering. Scattering from the ice-bedrock surface is only important if the typical roughness height is above about 0.3 wavelengths.

SNOW STUDIES

SNOW CHEMISTRY (P. Clement, LGP/US)
The chemical composition of the snow cover and its contribution to soil moisture and surface water were studied. The most important role of the snow is to concentrate dust and debris carried by the wind and in particular that coming from the vegetation cover. The products are then released in large quantities during the melt period. In the forests one observes relatively high concentrations of potassium, nitrates and sulphates.

THERMAL ROLE OF SNOW (F. Bonn, LGP/US)
The influence of the snow cover on the reflected and emitted radiation was studied for its application to remote sensing. Ground truth over glacial till, where the radiation sensors were installed, is being provided.

REMOTE SENSING OF THE SNOW COVER
(H. L. Ferguson, AES)
The Atmospheric Environment Service is coordinating the efforts of several agencies in analyzing LANDSAT and NOAA imagery and simultaneous data collected on the ground for estimating basin snow cover. International experiments are being undertaken in the Saint John, Lake-of-the-Woods, Souris and Columbia basins.

GAMMA SNOW SURVEYS (H. L. Ferguson, S. Lapczak, B. E. Goodison, AES)
A portable gamma spectrometer is being used for determining point and/or areal snow water equivalent. Comparisons with standard measurement techniques will be made and the accuracies of each method assessed; special emphasis will be given to the sensitivity of such equipment for monitoring snowpack changes at a point.

STANDARDIZATION OF SNOW COURSE DATA (B. E. Goodison, AES)
Initial steps have been made to standardize the reporting and publishing of snow course data and to provide accurate site descriptions of courses in Canada and the United States.

SNOW SAMPLER ASSESSMENT (B. E. Goodison, AES)
Field studies have been initiated to determine absolute accuracies of snow cutters and tubes used for sampling the variable shallow snowpacks of Eastern Canada. Experimental cutters are being compared to standard equipment and are showing great promise of providing more consistent and accurate measurements; the effects of compression and blocking are being given special study.

SNOW GAUGE ASSESSMENT (B. E. Goodison, E. I. Mukammal, H. L. Ferguson, AES)
An intensive snowfall/snowpack measurement programme was initiated in 1974 to evaluate the methods and equipment used in Canada. Gauges being tested include the MSC Nipher shielded snow gauge (Canadian National Standard), Fischer and Porter Recording, Sacramento Storage and Wyoming shielded snow gauges. Gauge catch is being compared to snow on the ground and snow course measurements to determine the relationship between gauge catch and wind speed and the densification of freshly fallen snow. The Nipher shielded gauge seems to have a much greater gauge catch/ground 'true' ratio at all sampled wind speeds than all others except the Wyoming shielded.

D'IBERVILLE FIORD (J. P. Chyurlia, GD)
A comprehensive study including snow melt hydrology was undertaken in a small watershed of d'Iberville Fiord.

SOMERSET ISLAND AND BOOTHIA PENINSULA (D. K. MacKay, B. J. Grey, GD)
Snow surveys and aerial photography began prior to spring snow melt. Areas of semi-permanent and permanent snow and ice on Somerset Island were identified and their character and distribution noted.

SNOW COVER IN CENTRAL ONTARIO (W. P. Adams, GEOG/TU)
The programme to investigate the stratigraphy and distribution of the snow cover and the lake cover was continued.

AVALANCHES (P. A. Schaerer, DBR)
Avalanche impact pressures of two flowing and two powder avalanches were measured on loading surfaces of 1 and 10 sq. inches. The flowing avalanches produced numerous short, strong blows which caused high local stresses and vibrations in small members of the structure in the avalanche path. The observed pressures of powder avalanches agreed with calculated pressures.

Observations were continued on the mass of avalanches at Rogers Pass and the variation with elevation of the snow on the ground at 15 sites in southern B.C.

A comparison with runout distance theory of large avalanches indicated that a greater distinction must be made between different types of avalanches and the condition of the ground surface.

AVALANCHE RESEARCH, CALGARY (R. Perla, GD)
In co-operation with Parks Canada the following topics are being investigated at the Sunshine Ski Area (Banff National Park) — avalanche conditions, mechanics of initiation of slab avalanches, properties of the mountain snowpack, avalanche control and the scientific aspects of skiing. Studies are in progress with the National Research Council on avalanche impact pressures at Rogers Pass with experimental and theoretical emphasis on the moving avalanche as a collection of particles of various sizes and energies. In the Coast Mts, studies with the Garibaldi Lift Corporation are underway on the mechanics of avalanche initiation.

FLOATING ICE

SURVEY OF RADAR TECHNIQUES FOR MEASURING ICE THICKNESS (D. Eyre, SRC)
Various methods for measuring ice thickness and the history and development of radar techniques have been reviewed to determine the best methods for rapid scanning of ice thickness at several proposed river crossings.

ICE CUTTING (R. C. Parson, ENG/MUN)
A portable system for surface melting, drilling and cutting of ice has been developed; with a $\frac{1}{4}$ inch nozzle penetration rates of 2.54 cm/s have been attained.

RIVER ICE FORMATION (B. Michel, UL)
Research is being done on the growth and movement of river ice. The various mechanisms for nucleation and growth of surface ice have been studied in a laboratory tank.

ICE DEFLECTION UNDER MOVING LOADS (D. Eyre, SRC)
An experimental programme was set up at a public ice crossing on Lake Diefenbaker to establish safety procedures and obtain comprehensive information on the response of floating ice to vehicles of different loads moving at different speeds. A new design of deflectometer permitted identification and systematization of several types of wave-like motion in the ice sheet. As vehicle speed increases there is a gradual 2-stage transition from a dish-like depression to a forced wave. The variation of ice

deflection amplitude with vehicle speed is completely different from theoretical predictions and proves that the 'critical velocity' is not critical in a safety sense.

ICE-PUSH ON GILLIES LAKE, ONTARIO
(W. P. Adams, GEOG/TU)
A study of ice-push on Gillies Lake was completed.

RIVER REGIME AT BREAK-UP (B. Michel, UL)
The break-up of a solid ice cover has been simulated with an artificial material having the mechanical properties of ice. It has been possible to describe the beginning of break-up with two dimensionless numbers, one representing the hydraulic and strength characteristics of the flow and the ice cover, and the other a geometric ratio.

RHEOLOGICAL BEHAVIOUR OF FRESH WATER ICE (B. Michel, UL)
Long-term studies on the mechanical properties of river and lake ice are continuing. Some experimental work has been done on the deformation behaviour of beams of columnar ice. A thesis has been completed on the indentation of plates of columnar ice at various strain rates with a flat indentor where the effects of many variables were ascertained. Tests are now being done in uniaxial compression and tension in the transition zone from ductile to brittle behaviour where the yield strength of ice is the highest.

ICE DAMMING, DISTRICT OF MACKENZIE
(T. J. Day, P. A. Egginton, GSC)
Field studies suggest that ice damming may cause water levels of the Mackenzie to rise 9 m or more above normal spring water levels. Dendrochronology is being used to gain information on flood and ice frequency.

MACKENZIE VALLEY (D. K. MacKay, GD)
The physical characteristics and processes of ice jam formation on the Mackenzie River are being studied. Snow melt peaks are being assessed at culvert sites along the Mackenzie Highway.

RIVER HYDROLOGY, BANKS ISLAND, N.W.T.
(T. J. Day, GSC, J. C. Anderson, GD)
Snow and ice effects were studied on four streams in the Thomsen River system. Snow redistribution leads to accumulations on lee slopes and in river and tributary channels which result in short run-off concentration and higher discharges. Peak flows occur after the removal of bottom-fast ice. Flood recession resulted in undercut snowbanks which calved into the river directly augmenting flow. In early June, as the river width increased to cover the bottom-fast ice, of up to 2.25 m, the ice cover broke away. The 'ice run' took the form of separate pans, ice pan fields and long ice stringers. Observations indicate that ice plays a minor geomorphic role in these High Arctic rivers.

ICE MECHANICS (N. K. Sinha, DBR)
The stress relaxation process in ice controls the mechanical response of this material to load, load rate, deformation, deformation rate and finally its strength. Preliminary investigations of stress relaxation under constant strain have shown that results of any experiment of this nature depend on the mechanical response of the loading system and the design of the experiments.

A successful method of scanning electron micrography of ice has been developed and used on built-up and natural sea ice. The technique revealed the intimate nature of sea ice which explains some of its peculiarities.

ICE ENGINEERING (R. Frederking, DBR)
Laboratory measurements on vertical ice loads developed on small diameter piles by a floating ice cover are underway. The loading apparatus is capable of developing a constant rate of relative deformation between the ice and the piles, thus simulating the loads generated by fluctuating water levels.

Further experience was gained in the past winter in monitoring the performance of a large ice platform for offshore drilling in the High Arctic. Special instrumentation was developed to measure the performance of the ice cover. A preliminary analysis technique has been developed for determining the safe bearing capacity of an ice cover under long-term loads.

The Department of Public Works is supporting a programme to measure ice forces on a wharf at Strathcona Sound, N.W.T. Initial measurements of ice forces and observations of ice conditions have been completed.

ELECTRICAL PROPERTIES OF SEA ICE
(E. R. Pounder, M. P. Langleben, J. R. Addison, IRP)
A systematic programme measuring the dielectric coefficient and electrical conductivity of artificial sea ice has been underway for several years. Results have been published on this over a temperature range to $-35°C$ and a frequency range from low audio to about 100 MHz. These data are important for remote sensing observations and equipment design. Results are also available for observations at a single frequency (5 kHz) down to $-150°C$; extension from 50 MHz to several GHz is planned.

ICE STRAIN MEASUREMENTS (G. R. Peters, ENG/MUN)
The Centre for Cold Oceans Research and Engineering (C-CORE) has initiated a research programme to measure ice strain using the strainmeters developed by the Cambridge Geophysics Group.

WIND STRESS MEASUREMENTS OVER ARCTIC SEA ICE (E. G. Banke, S. D. Smith, R. J. Anderson, BIO)
Efforts were continued to relate wind stress and heat flux over ice to characteristics of the ice surface, including flat level ice and ice ridges, using a combined total drag coefficient. The relationship should permit prediction of surface

wind stress by surface topography determination remotely with wind speed data from buoys or shore based met stations.

REMOTE SENSING OF FLOATING ICE (R. O. Ramseier, OAS)

Several experiments and test programmes on the microwave properties of sea ice have been undertaken in connexion with AIDJEX. Ongoing work relates to sensor testing and evaluation for SEASAT-A and NIMBUS-G.

AIDJEX (E. R. Pounder, M. P. Langleben, J. R. Addison, IRP)

McGill and Columbia universities are sharing in the oceanographic programme of continuous current recording at 2 and 30 m below the ice surface, daily current profiles to 200 m depth and of salinity, temperature and depth to 750 m. Two series of observations have been made of current measurements in 3 orthogonal directions with a sonic anemometer which permit direct calculation of the Reynold's stress and hence the drag coefficient of the lower surface of the ice.

SATELLITE OBSERVATIONS OF BEAUFORT SEA ICE COVER (J. R. Marko, IOS)

The ice covers of the Beaufort Sea and Canada Basin were studied from NOAA and LANDSAT imagery. Seasonal trends in motion and appearance were identified along with the summer ice pack boundaries. Systematic relationships were observed between major steps in the annual break-up and wind alignments. Rectilinear leads were found to be a common constituent of the ice cover. They were the loci of highly localized shearing motions and were often found to form extensive, long-lived, trellis-like patterns, spatially periodic on a scale of roughly 100 km: they are being interpreted in terms of oceanic planetary waves and the basic rheology of the ice cover. Data on ice movement in the area of a proposed 1976 oil drilling programme has been compiled and the disadvantages of the sites identified.

ENVIRONMENTAL CONSEQUENCES OF LIGHT PENETRATION THROUGH SNOW AND ICE (W. A. Adams, GD)

A field study of the attenuation of solar radiation (300-1000 nm) by the snow and ice cover of the Beaufort Sea has been completed. Work is continuing on lakes in the vicinity of Inuvik. Laboratory studies on the absorption and scattering processes of visible radiation in ice and snow is being conducted using classical laser light scattering, laser Raman spectroscopy and transmission spectrophotometry.

ICE RESEARCH BY IMPERIAL OIL LIMITED (D. J. McEachan, Production Research, Calgary)

A multiyear pressure ridge in the Beaufort Sea was profiled for temperature, salinity and flexural strength and a survey made of its sail and keel.

The condition of landfast ice by the Mackenzie Delta was monitored from aerial photographs which were analyzed to provide statistics on pressure ridge distribution, orientation and sail heights. Its movement relative to the seabed is being monitored and attempts made to correlate it with prevailing weather conditions. Flexural strength and Young's modulus of the landfast ice in the S Beaufort Sea was studied with *in situ* cantilever beams; smaller beams were sampled to determine size effects on strength.

The compressive failure loads for an ice sheet loaded by a cylindrical indentor are being studied as a function of strain rate (from ductile to brittle failure modes), indentor diameter, ice sheet thickness and type of contact (frozen-in or secondary failure once initial breakout has occurred). Larger scale tests on a nearby lake will use modified equipment from a study of the initial breakout of a cylinder and a flat plate (with various boundary conditions).

Extensive theoretical modelling relating observed loads on a conical structure to measured ice properties have been done with data from the Imperial Oil Ice Test Basin. Finite element analysis was used to investigate the problem of the shearing strength of ice frozen to the surface. A model of part of an artificial island is being tested to investigate ride-up and pile-up of an ice sheet on an island.

Around Imperial's present artificial island ice conditions, ice movement and pressures are being monitored. The large area thin sensor used for monitoring ice pressures extends throughout the ice sheet and responds as a variable capacitor to average horizontal stresses present in the ice sheet.

Measurement of contact angles and the mobility of oil under ice have been made to help understand the interactions occurring in the event of an offshore arctic oil spill.

SEA ICE RIDGES, SOMERSET ISLAND (R. B. Taylor, GSC)

Sea ice ridges are commonly found along the N and W shores of capes on N Somerset Is. Ice movement due to NW winds can buckle and raft nearshore ice creating ridges up to 15 m high. In 1974-75 ridge development was studied at a delta E of Cape Anne where ice pushing effects were noted up to 185 m inland. Ice ridges, thought to have formed in July 1973, were found to be 340 x 15-45 x 7.9 m in size when surveyed in August 1974. Ice loss was 31.7 m^3 from July-September 1974 and a further 62.3 m^3 by July 1975. Ridges 15-60 m inland lasted over two years. Ridges were also observed at Pressure Point, Cape Anne and Cape Rennell.

NORTH WATER (F. Müller, ETH/MU)

Field work was carried out at Coburg Is., Cape Herschel and the Carey Islands. Station programmes consisted variously of synoptic weather observations, daily shore/sea ice observations, weekly ice thickness measurements and at Coburg continuous global radiation measurement. Seven automatic weather stations, around the North Water, were recording temperature, relative humidity, wind direction and speed.

Three remote sensing missions, of ca. 1000 km each, observed surface temperature (PRT5), albedo distribution and the distribution of surface, sea ice type, characteristics. Off Pim Is. the following sea ice measurements were made at 6 sites—fast ice deformation, surface wind, ice thickness, ice temperatures, ice salinities and sea water temperatures.

ICE DRIFT IN ROBESON CHANNEL (M. Dunbar, DREO)
To supplement the major field work of 1974 additional tidal data was obtained in April-May 1975 from two tide gauges on either side of Robeson Channel and from one in Kennedey Channel over five weeks. Oceanographic data were obtained at the same time and a ground truth exercise carried out using SLAR imagery flown earlier as a map for a light aircraft. Recognition of individual floes and ice features was easy both for the experienced scientist and the untrained pilot.

FURY AND HECLA STRAIT (M. Dunbar, DREO)
A pilot study of currents and water characteristics began in 1975. The strait is not suited to the radar technique used in Robeson Channel and drift studies will probably have to be limited to current observations through fast ice.

FAST ICE STUDIES IN WESTERN DAVIS STRAIT (R. G. Barry, J. D. Jacobs, R. L. Weaver, INSTAAR)
Surface energy budget components were measured near Broughton Is. The fast ice melt-stage model to evaluate general changes in timing and duration of the fast ice breakup from year-to-year was improved. The greatest variability occurred in the early season stages during melt puddle formation. By grouping synoptic weather types according to ability to advance or retard ice melt 1974 was shown to have had a 12% increase in advancing types and an 11% decrease in retarding types.

ICE STUDIES AT LAKE MELVILLE, LABRADOR (R. Dempster, ENG/MUN)
The evolution and characteristics of ice on Lake Melville has been investigated to determine the most favourable location and method of keeping an extended shipping channel open to Goose Bay.

ICEBERG DRIFT (R. Dempster, ENG/MUN)
Detailed computer analysis of over 250 iceberg tracks commenced with a study of the kinematics of the berg trajectories which display a characteristic form with the arrival and departure of cyclonic weather systems in the study area.

REMOTE SENSING OF THE GULF OF ST. LAWRENCE (D. Bajzak, ENG/MUN)
The ice cover of the Gulf of St. Lawrence was studied from satellite imagery for Environment Canada.

MECHANICS OF ICEBREAKING (F. J. Legerer, ENG/MUN)
The theoretical aspects of icebreaking have been considered. Results indicate that under impact conditions shear stresses are of major importance when inducing fracture of thick and brittle ice; all previous work has been based on quasistatic considerations, ignoring impact and shear fracture.

UNDERWATER PROFILING OF ICEBERGS (J. H. Allen, C. P. Benedict, ENG/MUN)
Measurement of the underwater shapes of icebergs was carried out for Eastcan Exploration Ltd.

ICEBERG SCOUR (J. H. Allen, T. R. Chari, ENG/MUN)
During the past two years the interaction between icebergs and the sea bed has been investigated.

LABORATORY STUDIES

DIELECTRIC PROPERTIES OF POLYCRYSTALLINE D_2O ICE Ih (G. P. Johari, GD)
Final results from these experiments are now available and will be published by the Royal Society.

BRITTLE FRACTURE OF ICE AT 77K (V. R. Parameswaran, DBR)
Work on this has been completed and will be published in the Journal of Glaciology.

MECHANICAL PROPERTIES OF ICE UNDER HYDROSTATIC PRESSURE (S. J. Jones, GD)
Considerable difficulties have been experienced with the apparatus for this experiment so results are not yet available.

DIELECTRIC BEHAVIOUR OF ICE AT 35 and 60 MHz (G. P. Johari, GD)
Available results will be published in the Journal of Glaciology.

EFFECT OF HYDROSTATIC PRESSURE ON AIR BUBBLES IN ICE (S. J. Jones, GD)
Preliminary results, presented to the IUGG in Grenoble, indicate that air bubbles close at the same rate regardless of whether clathrate formation is possible. Experiments are continuing.

PRESSURE EFFECTS OF THE OPTICAL PROPERTIES OF ICE AND WATER (W. A. Adams, H. A. M. Chew, GD)
The refractive index of liquid H_2O and D_2O has been measured from 0-25°C up to 2×10^8 N/m^2 using a laser interferometric method. The system is being adapted to permit measurements on ice samples.

OIL AND ICE RESEARCH (E. C. Chen, CCIW)
The surface tension spreading of crude oil on ice was studied on artificially prepared ice surfaces. The area of an oil slick was found to be proportional to the 0.1 power of the elapsed time. Aging characteristics of crude oil on ice were also investigated. The changes in viscosity, density, surface tension and refractive index were determined as a function of elapsed time. All of these physical parameters were found to increase as the oil aged. A programme on the dynamic behaviour of oil in ice-covered rivers and the interaction of oil with different types of river ice is being considered.

GROUND ICE AND PERMAFROST

PERMAFROST DISTRIBUTION AND RELATED ENVIRONMENTAL FACTORS (R. J. E. Brown, DBR)
Thermocouple and thermistor cables have been installed in N Manitoba and the Keewatin District to investigate the distribution of permafrost at the discontinuous/continuous boundary in different terrain. Ground temperature measurements are being taken at various locations in S Alberta and B.C. to study the characteristics of alpine permafrost. At Thompson (Manitoba) measurements are being made of ground and air temperatures, net radiation, wind speed, precipitation, snow depth and density and ground heat flow to determine the factors controlling the ground temperature.

FROST ACTION (E. Penner, G. H. Johnston, DBR)
The uplift forces and bearing pressures exerted on steel piles and other foundation members during freezing of frost-susceptible soils is being studied in discontinuous permafrost at Thompson. Forces are considerably greater than those observed previously in Ottawa.

GROUND THERMAL REGIME (G. H. Johnston, L. E. Goodrich, DBR)
A one-dimensional finite difference programme for ground thermal problems that considers phase changes, temperature dependent thermal properties, multilayered systems and a variety of surface boundary conditions is being developed. A new thermal conductivity probe is being used for field and laboratory studies. The influence of transportation-related construction and the use of insulation on permafrost is being investigated. Pile foundations continue to be monitored at Inuvik.

STRENGTH OF FROZEN GROUND (T. H. W. Baker, DBR)
A confirmed engineering theory of time-, temperature- and normal pressure-dependent deformation and strength of frozen soils has been developed and compared with theories and available experimental information. The suitability of the Menard pressuremeter for *in situ* determination of the rheological properties of frozen soils was tested at Thompson. A laboratory programme of creep testing of frozen soils was begun to evaluate their behaviour under long-term loading and different temperatures, and to verify theoretical models of analysis previously developed. Artificially frozen soils are being used initially for control but procedures for taking and preserving samples in the field, transporting them at controlled temperatures, and preparing them in the laboratory are being studied.

ACOUSTIC WAVE VELOCITIES OF FROZEN SOIL SAMPLES (P. J. Kurfurst, GSC)
Ultrasonic-pulse equipment has been used in the laboratory to measure shear and compressional wave velocities on frozen soil samples with various ice contents. Samples differed in surficial unit, geographic location and ice content at temperatures ranging from −7 to +1°C. Results show a striking similarity to those obtained with shallow seismic at field sample sites; laboratory ultrasonic methods can therefore be used to determine ground ice content.

TERRAIN PERFORMANCE IN THE MACKENZIE VALLEY AND ARCTIC ISLANDS (P. J. Kurfurst, GSC)
Ice wedges, ice polygons and ice-rich sediments have been studied in detail while evaluating man-induced terrain changes over time.

MACKENZIE VALLEY (W. E. S. Henoch, GD)
Pingo-like landforms with ice-rich silt cores were discovered in the Mackenzie Delta. They appear to grow by a process of ice segregation whereby water migrates to the freezing plane under the influence of thermal gradient.

GROUND ICE OCCURRENCE IN THE MACKENZIE VALLEY, N.W.T. (J. A. Heginbottom, P. J. Kurfurst, GSC)
The local variability of frozen ground and ground ice at shallow depths was investigated at 9 sites between Fort Simpson and Inuvik. The former was essentially continuous in the north and discontinuous in the south. Visible ground ice varied from many large discrete lenses in the north to practically none in the south. Five factors were found significant—latitude, soil texture, slope aspect, surface drainage and surface disturbance—their importance varying from site to site.

INVOLUTED HILL TEST SITE, TUKTOYAKTUK, N.W.T. (W. J. Scott, GSC)
Over 80 holes have been drilled on or near the ice-cored Involuted Hill previously described (Ice, No. 44, p. 7). 10 on the hill are cased and open, 7 bottom in ice at 3-5 m, and 3 extend below the base of the ice core which has a thickness of 30 m. Investigations to date by many agencies have included borehole logging of density, temperature and seismic velocity, borehole wavefront mapping, surface refraction seismic, DC and VLF resistivity, induced polarization, low-frequency EM sounding, audio-frequency magnetotellurics, radio interferometry, impulse radar, time-domain reflectometry and airborne E-Phase surveys.

PERIGLACIAL FEATURES IN E ARCTIC LAKES (W. W. Shilts, GSC, W. E. Dean, USGS)
Studies of processes common to shoal areas on lakes (2-3 m depth) in central Keewatin began in 1973. Significant conclusions to date are: a) permafrost lies just below the lake bottom in shoal areas along shores and around islands; the frost table depth is similar to that for land sediments, the shallow table probably occurring where winter ice (> 2 m thick) freezes to the bottom; b) polygonal patterns are frost cracks;

c) holes are sites of strudel scour; and d) rib-and-trough structures are subaqueous equivalents of mudboils.

GROUND ICE ON BATHURST, CORNWALLIS AND ADJACENT ISLANDS (D. M. Barnett, GSC)
Investigation of near-surface materials over some 28,000 km^2 included seeking indirect evidence for ground ice which was present everywhere. Near-surface materials were not particularly ice-rich compared to Sabine Penin. and Melville Is.

COASTAL ENVIRONMENTS OF BANKS ISLAND, N.W.T. (W. J. Stephen, GSC)
The depth of the active layer on 16 unconsolidated beach deposits was profiled. Preliminary results suggest that broad climatic provinces are more influential in determining frost table behaviour over the summer thaw period than grain size characteristics at individual sites.

GROUND ICE ON BANKS ISLAND, N.W.T.
(J. S. Vincent, GSC)
Massive ice bodies, observed visually and by coring and seismic shot hole logs, occur frequently in Pleistocene lacustrine sediments and in the fine grained Cretaceous and Tertiary formations. Seismic logs reveal that ice bodies from 0.75-9.0 m thick are more frequent close to the surface but are also present at greater depths (maximum observed 27.4 m).

ABBREVIATIONS USED

AES = Atmospheric Environment Service, Hydrometeorology and Environmental Impact Research Division, Environment Canada (D.O.E.)

AHD = Applied Hydrology Division, Inland Waters Directorate, D.O.E.

BCIT = British Columbia Institute of Technology

BIO = Bedford Institute of Oceanography, D.O.E.

CEG = Canadian Exploration Group, Peterborough

CCIW = Canada Centre for Inland Waters, Hydraulics Research Division, D.O.E.

DBR = Division of Building Research, Geotechnical Section, National Research Council of Canada

DREO = Defence Research Establishment Ottawa, Department of National Defence

ENG/MUN = Faculty of Engineering, Memorial University of Newfoundland

ETH/MU = Swiss Federal Institute of Technology, Zürich, Switzerland and McGill University, Montreal

GA/UBC = Department of Geophysics and Astronomy, University of British Columbia

GD = Glaciology Division, Inland Waters Directorate, D.O.E.

GEOG/MC = Department of Geography, McMaster University, Hamilton, Ontario

GEOG/MUN = Department of Geography, Memorial University of Newfoundland, St. John's

GEOG/TU = Department of Geography, Trent University, Peterborough, Ontario

GEOL/UBC = Department of Geology, University of British Columbia, Vancouver

GG/UM = Department of Geology and Geophysics, University of Minnesota, U.S.A.

GRP/UO = Department of Geography and Regional Planning, University of Ottawa

GSC = Geological Survey of Canada, Department of Energy, Mines and Resources

INSTAAR = Institute of Arctic and Alpine Research, University of Colorado U.S.A.

IOS = Institute of Ocean Sciences, Patricia Bay, D.O.E., B.C.

IRP = Ice Research Project, Department of Physics, McGill University, Montreal

LGP/US = Laboratoire de Géographie Physique, Université de Sherbrooke

OAS = Ocean and Aquatic Sciences, Fisheries and Marine Service, D.O.E.

PCSP = Polar Continental Shelf Project, Department of Energy, Mines and Resources

PHY/UT = Department of Physics, University of Toronto

SRC = Saskatchewan Research Council, Engineering Division, Saskatoon

UL = Université Laval, Ice Mechanics Laboratory, Civil Engineering Dept.

USGS = United States Geological Survey

C. Simon L. Ommanney

FINLAND

In March 1975 Finnish-Swedish wide-ranging research on sea ice was undertaken in the Bay of Bothnia to find the best method of recognising the different types of ice situation for winter navigation.

Instruments were used in five different situations:

a) space, b) high altitude, c) low altitude, d) on the ice and e) under the ice.

a) Three sets of Landsatt 2 coverage were received. The pictures have been analyzed and comparison of results with other methods is going on.

b) Tracks with high altitude camera, Wild camera, MS-camera, IR-scanner and IR-radiometer were taken.

c) SLAR-, FLAR- and ODAR-systems were used in an airplane. A comparison of results with those obtained from ship radar was made.

Radar altimeters and microwave radiometers were used for estimating the thickness of ice.

d) A ground-truth programme was arranged using several sets of flags and radar reflectors.

e) An under-water camera, a TV-camera and a narrow beam sonar were used to measure the submarine part of ice ridges.

The winter of 1975 was exceptionally mild and at the time of the expedition the ice field was already broken and drifting. A complete report will be delivered by the Swedish Space Corporation, Tritonvägen 27, S-17154 SOLNA.

Erkki Palosuo

JAPAN

ANTARCTICA

O. Watanabe (Nagoya Univ.), K. Sato (Kyoto Univ.), M. Inoue (Institute of Low Temperature Science, Hokkaido Univ.) and K. Igarashi (ISIS, Nagaoka) joined the 15th Japanese Antarctic Research Expedition (JARE) which conducted glaciological studies in 1974~1975. They stayed at Mizuho Camp, 70°42'S, 44°18'E, in the summer of 1974, to construct a runway for airplanes and new huts from which glaciological observations and core drillings were conducted. The total floor space of the observatory in Mizuho Camp was increased to 74 m^2. After this commission, several inland trips were planned to make glaciological observations on ice sheets. They measured mass balance at Shirase Glacier, and the surface topography and the depth of the ice sheet were surveyed by seismic methods and by radio echo sounding. Many pit works and shallow borings of subsurface snow were made to study stratigraphic and grain structures at various sites between Mizuho Camp and Syowa Station. Many meteorites (more than 1000 in number) were found in the limited area of bare ice surface near the Yamato Mountains. The maximum size of meteorites was 10 cm in diameter. As the origin of the meteorites was not always the same, it can be considered that these meteorites did not originate from a single meteor shower. K. Kusunoki (National Institute of Polar Research, Tokyo) suggested that these meteorites may have been conveyed by glacier flow and subsequently emerged at the surface of ice as the result of ablation. Geological and chemical analyses of the meteorites are currently being made at N.I.P.R., Tokyo.

OTHER EXPEDITIONS

1. Sea ice in arctic regions

The following sea ice reconnaissances in arctic regions have been made:

T. Tabata, G. Wakahama and E. Akitaya (ILTS, Hokkaido Univ.) Point Barrow, Alaska, 3 25 March 1973.

T. Tabata, Y. Suzuki, N. Ono and E. Takizawa (ILTS) Point Barrow, Alaska, 19 Oct. 15 Nov., 1974.

T. Tabata, I. Ishida, Y. Suzuki and N. Ono (ILTS) Gulf of Bothnia, Sweden, 23 Feb. 26 March 1975.

T. Tabata, M. Aota and T. Kawamura (ILTS) Point Barrow and Nome area, Alaska, 27 Mar. 21 April 1975.

2. Permafrost in Alaska and Canada

S. Kinosita, Y. Suzuki, K. Horiguchi, M. Fukuda (glaciologists), A. Sakai, S. Yoshida, K. Tanno (biologists) (ILTS, Hokkaido Univ.) made co-operative investigations in Alaska and North Canada to clarify the relation between geomorphological features and ecological aspects in permafrost regions. Results obtained by the Japanese scientists were compiled and published under the title of "Joint Studies on Physical and Biological Environments in Permafrost, Alaska and North Canada in 1975" (Ed. S. Kinosita, incl. 184 refer., 65 illust., 47 tables and 51 photos).

3. Glaciers

A. Higashi, M. Matsuda, H. Shoji and M. Ohtomo (Faculty of Engin., Hokkaido Univ.) made scientific investigations of the Mendenhall Glacier in Alaska, to obtain large single ice crystals for the use of good quality material in laboratory work. They also made measurements of the strain rate and flow velocity near the terminus of the glacier at the site where large single crystals were obtained.

4. Nepal Himalaya

A glaciological expedition of the Nepal Himalaya was conducted under the leadership of K. Higuchi (Nagoya Univ.) in 1973 to 1975. C. Nakajima (Kyoto Univ.) and three Nepalese

meteorologists joined this expedition. The purpose of this project was to investigate geomorphological, geochemical and geophysical features of glaciers in Nepal Himalaya. Most glaciers in the Himalayas are nourished during the summer monsoons and simultaneously subjected to severe ablation. A thermal drilling was made at Khumbu Glacier (5,300 m) which flows down from Mt. Everest, and the temperature profile was obtained down to 20 m in depth. The temperature of glacier ice at a depth of 2.7 m was −5.3°C. This value was lower than expected. The report prepared in English will appear as one of the special issues of the Journal of the Japanese Society of Snow and Ice.

FIELD WORKS IN JAPAN

Monsoons which come across over the Japan Sea preferentially release much snow along the Japan Sea coast. Since many railroads and highways traverse the central mountains, it becomes very important to survey the distribution and depth of snow in the mountainous regions. Z. Watanabe (Fukushima Univ.) and T. Nakato et al. (Fukui Univ.) have made snow surveys in Tohoku and Chubu Districts in combination with local meteorological conditions and topographies. They showed that the depth of snow was a function of elevation and distance from a reference site. T. Kimura (ISIS, Nagaoka) conducted many observations on snow depth for 100 km along National Highway No. 17, Niigata Prefecture using 10 automatic devices which were developed by himself. Analyzing hourly variation of the distribution of snow, he pointed out the existence of a particular type of snow precipitation which caused a burst of snowfall for a short time in a limited area. S. Abe (Yamagata Univ.) studied physical properties of snow deposited in Mt. Zao (2,000 m) and reported data on the 1) hardness vs. density relationship: $R = k\rho^n$, where R is the Kinosita's hardness (kg/cm^2), ρ the density of snow (g/cm^3) and the numerical constants, k and n which range respectively k = 200~300, n = 4.6~4.7, 2) compressive viscosity vs. time: $\eta(t) = \eta_0 \exp(m \times t^{0.36})$, where t is the time at which the viscosity was measured, η_0 = 4.0 g-wt day/cm^2 and m = 1.0 x $day^{-0.36}$.

A small-sized perennial snow patch is not only convenient to study the relationship between mass balance and meteorological factors and topography, but also useful for glaciological training of students. Mass balance studies of perennial snow patches have been continued in Mt. Daisetsu (Hokkaido) and Tsurugisawa (Honshu) respectively by ILTS (Hokkaido Univ.) and Nagoya Univ. Since the most perennial snow patches are usually found at the leeward of the monsoon, the origin of snow patches may be primarily ascribed to drifting snow. M. Inoue and M. Matsuda (ILTS) found that the maximum thickness of the snow patch was proportional to $(P \times V^3)^{1/2}$, where P is the mean precipitation (water equivalent in mm) and V the daily mean wind velocity (m/sec) at altitude of 800 mb. According to observations made on one of the snow patches in Tsurugisawa during the summer, it was found that the katabatic wind was produced as the result of a temperature difference between the air and the snow patch.

Observations on drifting sea ice have been continued by the Mombetsu Sea Ice Laboratory (T. Tabata in Chief) for 10 years, using three radars. This Laboratory had its 10th anniversary in July, 1975. K. Fujuno (ILTS) conducted a basic study on the resolving power of radar images reflected from sea ice, by putting a metal target on the flat frozen surface of Komuke Lake near Mombetsu. T. Ishida (ILTS) analyzed the flow vector of drifting sea ice by the use of a two-dimensional correlation method and tried to express numerically the surface roughness of sea ice.

AVALANCHES

E. Akitaya (ILTS) has analyzed statistically the number of avalanche accidents which occurred from 1918 to 1974 in Japan, and reported that the total number of avalanche accidents resulting in death was 226, and that 1,555 people were killed. Among the 1,555, 366 were mountaineers or skiers. The percentage of accidents due to avalanches is increasing with the increase in the number of mountaineers and skiers. According to his report, the largest damage which was caused by a single avalanche was that of a surface avalanche, 300 m long and 400 m wide, on one of the villages in Niigata Prefecture in 1918, destroying 34 houses and killing 158 people. The co-operative observation of high speed avalanches which often occur in Kurobe Canyon has been continued by Toyama University and ILTS (Hokkaido University).

SNOW ENGINEERING AND APPLIED GLACIOLOGY

It is well known that when a horizontal beam is buried within snow, it suffers a strong drag force due to creep and subsidence of snow. Even a guard-rail or fence made of steel is often bent and fractured by snow deposited only 2~3 m in depth. Tree branches buried in snow are also frequently torn off the trunk by the drag force of snow. Since ice particles in snow sinter and bond together, a large amount of snow grains around a beam may contribute to create a strong drag force. M. Ishikawa (Forest Exp. Stat., Tokyo) has measured the drag force acting on a horizontal beam, 1 m in length and 10 x 10 cm^2 in cross section, placed at 1 m in height from the ground, as a function of the depth of snow. The total force was 0.5 tons, 1.3 tons, and 2.2 tons for snow depths of 2 m, 3 m and 4 m, respectively.

One of the important problems in a country subjected to large amounts of snow is to keep traffic moving on highways throughout the winter season. T. Itakura (Fac. of Engin., Hokkaido Univ.) has organized a research group to find effective countermeasures to reduce snow disasters on roads. Many scientists and engineers have joined this project. In 1975, results were compiled and published in the form of a book on snow removal, road traffic, slipping of vehicles on icy roads, metamorphism of snow compressed by vehicles, drifting snow and drift-preventing fences. In Japan, NaCl or $CaCl_2$, which are commonly used for melting snow on roads, have been used less to avoid contamination. Therefore, snow which often covers roads is compressed by vehicles and turns to icy hard snow, causing many accidents due to slipping. How to remove the icy hard snow which adheres to the road surface is a difficult problem unless the snow is melted by chemicals. The Shinjo Branch of the National Centre for Disaster Prevention has measured the fracture strength of hard snow formed by compression as a function of the apparent density of snow and reports that the following formula applies for the range of density between 0.56~0.77 g/cm^3 and temperature $-4°C \sim -11°C$: σ (in bar) = $7.75 \times 10^{-2} \times 491\rho$, where σ is the fracture strength and ρ the density of snow. In order to study the compression of snow by vehicles, ISIS, Nagaoka designed an apparatus in which snow could be repeatedly compressed by a wheel revolving at a high speed.

An interesting theory on snow removal by a plough has been presented by Z. Yosida (the President of the Japanese Society of Snow and Ice). Since the construction of a high-speed train which exceeds 200 km/h is now being planned for snowy districts in Japan, this theory may provide useful data for the design of a high-speed snow plough. His theory shows that when snow is being removed by a plough, snow existing ahead of the blade may behave differently due to the relative velocity between the blade and snow. If the velocity is lower than that of the plastic waves which propagate in the snow, i.e. low speed removal, snow ahead of the blade may be compressed for a definite distance and wrinkles or undulations may be created on the surface of snow. However, if the velocity is higher than that of the propagation speed of the plastic wave, snow may be crushed into fine pieces and ejected into the air without any preceding compression.

One of the important problems imposed on the glaciologist in this country is to find an effective method of removing or preventing deposition of snow or ice on transmission power lines. Icing caused by deposition of supercooled water droplets occurs primarily on power lines stretched in mountaineous regions, but snow accretion arises even on power lines in urban areas. Several years ago, in Hokkaido, about 60 suspension iron towers for power lines were crushed due to heavy snow accretion during a snow storm. The Technical Research Institute of Hokkaido Power Co. has been engaged in the study of this problem and found a simple method to protect electric wires from wet snow accretion. In 1973, the Japanese Society of Snow and Ice compiled many papers on icing and snow accretion on power lines and published them in the form of a book. This material is very useful not only to electrical engineers but also to scientists who are interested in applied glaciology.

LABORATORY WORKS ON SNOW AND ICE

New devices and instruments for measuring physical properties of snow have been proposed by many authors. Two automatic devices to measure depth of snow were developed by K. Sato (Hirosaki Univ.) and T. Kimura (ISIS, Nagaoka). In these devices, He-Ne gas laser or infra-red ray was used to detect the depth of snow deposited on the ground surface. These devices were distributed along main highways to communicate to snow removal agencies the rate of snow precipitation every half hour. As the average air temperature in the winter season in Niigata Prefecture is about $+2°C$, it is common that warm underground water is sprinkled on the roads to melt the snow. In order to control water sprinkling, several automatic devices for identifying snowfall were developed by M. Tamura (Nagaoka Technical High School), K. Masunaga (Japan Road Construction Agency) and Sorimachi and Nakamata (Niigata Univ.).

Z. Watanabe (Fukushima Univ.) improved a device to measure tensile strength of snow by the use of a centrifuge. Two weights were attached to both ends of a snow core to shorten and reduce the radius of revolution and rotational speed of the centrifuge. K. Shinojima (Technical Research Institute of National Railway of Japan) designed a simple and convenient apparatus to measure the hardness of snow. His device looks like a pistol. When the trigger is released, a metal rod is ejected by a spring action to make a depression in the surface of snow, thus allowing the estimation of the hardness of snow.

T. Nakato (Fukui Univ.) proposed an interesting device to measure continuously the density profile of snow in situ. A weighted metal heater suspended by a string was placed on the surface of snow and heated electrically. The heater begins to penetrate into the snow by melting. Since the velocity of penetration of the heater, V, is given by $V = Q/\rho LS$, the density profile of snow is continuously obtainable by measuring the penetration velocity of the heater, where Q is the heat quantity supplied to the heater per second, ρ the density of snow, S the contact area between the heater and the snow. So far,

many devices or instruments have been developed in various countries in the world, but the international standardization of instruments is necessary before one can compare glaciological data.

Characterization of snow is a difficult problem because of the complicated structure and configuration of ice grains. Density, grain shape and size, and specific surface area may be necessary structural factors needed to characterize the physical properties of snow. Z. Watanabe (Fukushima Univ.) calculated statistically the correlation coefficient between a physical property and a structural factor of snow, and showed that the specific surface area of fine-grained snow is closely correlated to the density and hardness of snow. Structural factors of snow are usually derived from a photomicrograph of a thin section of snow, but difficulties arise as to how to discriminate between ice grains and air voids because of the transparency of ice itself. T. Gondaira (Hirosaki Univ.) proposed a processing method of the photomicrograph, to exaggerate the optical contrast between ice particles and the air voids.

Chemical components contained in Antarctic snow were analyzed by M. Murozumi (Muroran Inst. of Tech.). Mercury content in snow obtained from Enderby Land, Antarctica was found to be 0.0010~0.0023 ppb. The flameless atomic absorption spectrophotometer equipped with a gold sponge collection unit has shown a superior accuracy for this element. The annual deposition rate of mercury in Enderby Land was 3.06~6.9 x 10^{-5} $\mu g/cm^2$. This value was less than one-hundredth of the deposition rate of this element found in snow of Hokkaido.

The basic studies on ice are as follows: Sublimation of ice crystal surfaces by a scanning electron microscope has been observed by both S. Suzuki (ILTS) and K. Sato (Hirosaki Univ.). The time lapse movies of photomicrographs taken by these authors showed that the sublimation of ice surface was not uniform and tiny holes (0.5 μm in diameter) appeared in series on the basal surface of ice. Y. Mizuno (ILTS) studied dislocation structures around Tyndall figures in ice, using X-ray topography, and reported that small angle grain-boundaries were formed around the figures as the result of alignment of dislocations. H. Shoji (Fac. of Engin., Hokkaido Univ.) studied internal stresses around air bubbles and cracks in a deep core ice sample obtained from Antarctica by the use of X-ray diffraction and topography and found that butterfly-shaped images due to the diffraction of X-rays by inclined lattice planes appeared around thin lecticular air voids in the ice crystal lattice. T. Hondo and A. Higashi (Fac. of Engin., Hokkaido Univ.) demonstrated migration of grain boundaries in ice, using artificially made bicrystals. The velocity of migration of grain boundaries varies with the misorientation of the two crystals. S. Mae (Nagoya Univ.) studied disc-shaped vapor figures in ice formed by internal melting and found that the figures were modified when the diameter and the thickness of the figures exceeded 100 μm and 10 μm respectively. The migration of vapour figures formed by internal melting in natural lake ice was studied by A. Tokairin (Univ. of Education, Kushiro). K. Tusima (ILTS) studied anisotropy of the coeffecient of kinetic friction as a function of orientation of the principal axis of ice and showed that the coefficient of friction of the prismatic surface is always higher than that of the basal surface.

SYMPOSIUM ON ANTARCTIC GLACIOLOGY

The first Symposium on Antarctic Glaciology was held in Tokyo in May 1975. K. Kusunoki (NIPR, Tokyo) was the chairman throughout the Symposium. The primary purpose of this Symposium was to discuss glaciological data which have been obtained by 10th-15th JARE in Enderby Land, Antarctica. Approximately 50 people participated, including scientists who have joined JARE. The discussion was very active and the following papers were presented: T. Ishida: Glaciological investigations on West Enderby Land and Mizuho Plateau. H. Shimizu: Topography of ice sheets of West Enderby Land and Mizuho Plateau. R. Naruse: Flow of ice sheet of Mizuho Plateau. T. Yamada: Accumulation of snow measured along traverse routes from Syowa Station to Mizuho Camp S. Kobayashi: Meteorological aspects in West Enderby Land and Mizuho Plateau. M. Nakawo and H. Narita: Petrofabric analysis of deep core ice obtained at Mizuho Camp. O. Watanabe et al.: Report on glaciological observations made by 15th JARE. M. Murozumi: Geochemical studies of snow in West Enderby Land and Mizuho Plateau. F. Nishio and K. Kusunoki: Topographies of bed-rock and surface of Mizuho Plateau and accumulation of snow. S. Kawaguchi and K. Sasaki: Solar radiation balance at Mizuho Camp. M. Nakawo: Fabric studies of 1 meter deep snow cores from Mizuho Plateau. K. Kamimura and M. Takahashi: Iceshock swarms observed at Mizuho Camp, Antarctica. These papers will be compiled and published by the National Institute of Polar Research, Tokyo.

The Japanese National Committee of Geodesy and Geophysics of the Science Council of Japan set up a National Commission on Snow and Ice on 24 May 1975. Officers and members of the commission are: Chairman—Daisuke Kuroiwa; Secretary—Kou Kusunoki; Members—Tosio Huzioka, Akira Higashi, Keiji Higuchi, Kenji Ishihara, Seiiti Kinosita, Tsutomu Nakamura, Tadashi Tabata and Gorow Wakahama.

Daisuke Kuroiwa

UNITED KINGDOM

UNIVERSITY OF BIRMINGHAM, DEPARTMENT OF PHYSICS

1. A theoretical study has been undertaken of the purification of temperate glaciers through the flow of water in veins and larger channels.
2. A theoretical investigation of the kinetics of dislocation movement in ice has been started. Based solely on the concept of proton disorder being the process that limits the velocity of a dislocation, models have been derived which predict an upper limit to the velocity. If the mean time between reorientations of a given bond is taken to be twice the dielectric relaxation time, the dislocation velocity deduced from these theories is at least an order of magnitude less than that observed experimentally. It is concluded that bonds near dislocations reorient faster than those in the rest of the crystal.
3. A dielectric study of synthetic snows made by grinding up ice single crystals has been undertaken. The relaxation frequency of the dominant dispersion in the snow stabilizes during firnification, and attains an activation energy of 0.25 eV compared to 0.61 eV in ice single crystals.
4. Comparisons have been made between the published values of spin-lattice relaxation time measured by Nuclear Magnetic Resonance and dielectric relaxation in HF doped ice. In particular the rate of reorientation of H_2O molecules may be found independently, and these agree within a factor of 2. Such a result is needed in the dislocation velocity calculations discussed above.

Personnel:		
	Geoff Camplin	4
	John Glen	1, 2, 3
	David Homer	1, 2
	Julian Paren	2, 3, 4
	Robert Whitworth	2

J. G. Paren

BRITISH ANTARCTIC SURVEY: July 1974-June 1975

(Head of Earth Sciences: C. W. M. Swithinbank)

1. LOCAL GLACIER STUDIES

As part of the British contribution to the International Hydrological Decade, glaciological and related meteorological studies were continued on Spartan Glacier in Alexander Island and Hodges Glacier in South Georgia. These sites represent respectively a polar and a sub-Antarctic oceanic environment. A survey was also conducted in South Georgia of surface elevation profiles and snout positions of selected glaciers; such measurements are baseline values for future monitoring of regional long-term changes in ice cover. A geophysical wire strainmeter was installed on the Fleming and Spartan glaciers for two studies of short-term fluctuation in glacier behaviour.

2. THE CHEMISTRY OF ANTARCTIC SNOW

Studies have continued on the chronological record of impurities stored in deposited snow. Impurities of interest were organochlorine pesticides, polychlorinated biphenyls, and the heavy metals, Pb, Hg, Zn and Cd. A method has been developed which effectively concentrates the residues in the snow, so that samples can be processed in the field; such a technique largely overcomes the problems of unintentional contamination.

3. ICE SHELF STUDIES

Work on George VI Ice Shelf from Fossil Bluff has continued with the aim of understanding the processes controlling the rate of bottom surface melting or freezing. Fieldwork at ten locations covering 150 km of ice shelf was largely completed by the end of 1974. As a result of these studies, two new surface strain and ice movement stake networks were prepared in the autumn of 1975 to give more detailed measurements along flowlines. Two levelling profiles were run on George VI Ice Shelf and another from the Bach Ice Shelf front to obtain information on ice shelf density. Results from radio echo soundings are used in the analysis. Tidal observations and salinity/temperature profiles to 300 m were made from a pool giving access to the sea under the ice shelf off Batterbee Mountains.

4. RADIO ECHO SOUNDING

With a new 60 MHz echo sounder, smaller and more efficient aerials giving improved overall system performance, 214 flying hours were accomplished in a BAS Twin Otter between the South Shetland Islands and the Ellsworth Mountains. Good weather, and the installation of extra fuel tanks in the aircraft, resulted in the flying hours exceeding the combined total of three previous sounding seasons. The sounding in the north of the area was made possible by co-operation with Instituto Antártico Argentino at two Argentine stations. All ice rises and ice domes that could in future provide sites for deep ice core drilling were surveyed. The grounding line of the Ronne Ice Shelf was accurately mapped from flights originating at the United States Siple Station.

Surface velocity measurements were made at three sites on the Fleming Glacier by optical survey and by a radio echo method using the displacement of fading patterns. The difference in the apparent velocity measured by the two methods confirmed previous measurements and was attributed to the sliding of the glacier over its bed.

5. ISOTOPE GLACIOLOGY

Twelve sites in the Antarctic Peninsula have now yielded ice cores from 10 m holes for isotope and ß-activity analysis; the first five of

these have been analysed by Dr W. Dansgaard. Six of the cores were drilled during the year from sites on the ice divide of the Antarctic Peninsula, and a seventh from Adelaide Island. The isotope analysis showed that where mean annual temperatures exceeded −15°C the summer melting obscured the expected annual oscillations in isotope values. The results from the profiles on the cold east coast showed marked seasonal oscillations and these could well be preserved in cores from prospective 500 m drill holes. From these results the most promising areas for drilling for palaeoclimate studies are the east coast and the Antarctic Peninsula ice divide.

Personnel: 1. I. G. G. Hogg, A. W. Jamieson, P. J. Martin, R. J. Timmis, F. G. Tourney, A. C. Wager.

2. D. A. Peel.

3. J. F. Bishop, P. W. Lennon, J. L. W. Walton.

4. C. S. M. Doake, H. Macpherson, P. Skvarča (Argentina), C. W. M. Swithinbank, J. L. W. Walton.

5. J. F. Bishop, C. S. M. Doake, D. A. Peel.

J. G. Paren

DURHAM UNIVERSITY VESTFIRDIR (ICELAND) PROJECT, 1973-75

This Project has now been running for three years, involving six earth scientists from the U.K., Iceland and the U.S.A. The major objective is the clarification of Late-glacial and Holocene climatic oscillations and glacier response characteristics in Vestifiroir, N.W. Iceland. This peninsula supports only one plateau ice cap (Drangajökull) at the present day, but another small ice cap (Glamujökull) was present during the Little Ice Age and possibly during earlier Neoglacial phases also. In addition, there are a number of small cirque glaciers. There appears to have been little synchroneity of glacier response to climatic changes, and fieldwork to date has concentrated on the identification and dating of at least seven retreat or readvance stages. Studies of moraines, strandlines, soil development, plant colonisation, fjord sediments and talus slopes and landslides have all contributed towards the creation of a chronology of glacial stages over c. 13,000 years.

The Project began in 1973 with the North-West Iceland Reconnaissance. This proved that there was great potential for further studies, and a programme of research was put together. Following this, B. S. John was awarded a Royal Society European Fellowship (1973-4) at the Department of Physical Geography, Stockholm University, in order to develop the Project. In the summer of 1974 the detailed fieldwork was begun, and this was continued in the summer of 1975. Each summer to date the Project members have been based at Isafjörður, but other bases at Hesteyri, Nupur (Dyrafjörður), Kluku, Reykjanes, Reykholar and Thingeyri have also been used. The members involved in the Project so far are as follows: B. S. John, M. J. Alexander, P. A. Rafferty and G. Foulger (Durham); E. Larusson (Reykjavík); and R. J. Mednis (St. John's, Newfoundland). The Project has been funded by the U.K. Natural Environment Research Council, the Royal Society, the Royal Geographical Society, the NATO Scientific Affairs Division, the Arctic Institute of North America, and Durham University. If funds allow, the Project will continue for another three years, ending in 1978. Research results from the years 1973-75 are contained in the published Project Field Reports, and the more important findings will be reported in a future issue of ICE.

B. S. John

UNIVERSITY OF EAST ANGLIA, CLIMATIC RESEARCH UNIT

The primary aims of the Unit are:

(i) to build up knowledge of the facts of the past record of climate and a well-archived library of the observational data;

(ii) to analyse those data in such ways as to reveal the nature of past climatic regimes and the processes involved in climatic fluctuations;

(iii) to monitor the current development and trends of world climate, and

(iv) to examine and experiment with possible scientific approaches to the problem of advising on the future development of the climate.

These aims are not directly glaciological, but interest is focussed on, among other things, attempts to explain the development of ice-age regimes in the past and of the Little Ice Age in recent centuries as well as the fluctuations in the global extent of ice and snow from year to year at the present time.

Two members of the staff, H. H. Lamb (Director) and J. Williams, have published in recent years attempted reconstructions of the patterns of atmospheric circulation prevailing over the northern hemisphere during the last (Wisconsin/Weichselian) glaciation. A current research project, funded by the Rockefeller Foundation, is compiling maps of the descriptive reports of weather (mainly in Europe and Iceland) available, season by season, year by year, over the last thousand years and aims at deriving a reasonable scientific analysis of the pattern changes. A large international symposium on long-term climatic fluctuations, sponsored by the World Meteorological Organization and the International Association of Meteorology and Atmospheric Physics and organized by the Unit at Norwich in August 1975, was attended by about 250 scientists from over 30 countries. Papers were contributed by the great majority of leading

scientists actively engaged in the various disciplines concerned. The proceedings have been published by the World Meteorological Organization in book form as well as being briefly summarized in the January 1976 issue of the WMO Bulletin.

H. H. Lamb

UNIVERSITY OF MANCHESTER, DEPARTMENT OF GEOGRAPHY

D. N. Collins worked at the Gornergletscher, Valois, Switzerland during July and August 1975 on suspended sediment transport in, and solute content of the Gornera, draining from the glacier snout. Samples of suspended sediment were collected at hourly intervals, twenty-four hours a day between 15 July and 2 September, whilst specific conductance and stream water temperature were continuously monitored. The results have been used in the interpretation of subglacial hydrology. The work extends results obtained in 1974 by an expedition from the University of Liverpool, and it is intended to extend the observations in 1976.

W. M. Theakstone contained observations in two areas of Norway. Photogrammetric studies were undertaken at both Okstindan and Svartisen (in collaboration with N. T. Knudsen [Arhus University, Denmark]) for the preparation of glacier maps. Works on mass balance studies continues at Charles Rabots Bre, Okstindan with Arhus University personnel, and climatic data-logging was undertaken to assess energy exchange at the surface of the glacier.

J. G. Paren

UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY: CLOUD PHYSICS GROUP, PHYSICS DEPARTMENT

We have two rather similar experiments, conducted in our cold rooms, in which two possible mechanisms of thundercloud electrification are being studied. These are the inductive and thermoelectric mechanisms, in which charge transfer accompanies the transient collisions of ice crystals with simulated hail pellets. In each case, the ice target is exposed to a stream of ice crystals and the charge separation is measured as a function of the relevant parameters (temperature difference, surface structure of target, applied electric field, temperature, etc.).

Also we are conducting experiments designed to measure the deposition coefficient for water vapour molecules on ice. Evaporation of ice spheres is being studied, as a function of temperature and ice purity, both at atmospheric and very low pressure. The two approaches yield values of ß in close agreement. The results obtained are being applied to the meteorological problem of cirrus seeding.

Finally, we are studying electrical effects associated with the freezing of water and aqueous solutions. In these experiments supercooled drops impinge with velocities of several metres per second on an artificial hailstone. The associated electrical effects are measured as a function of temperature, impact velocity, collision parameter, impurity content, etc. We hope to apply the results to the problem of cloud electrification resulting from the collision of hailstones with supercooled raindrops. J. Latham

INDIVIDUAL EFFORTS

Paul Barnes (Birkbeck College) is extending earlier work on molecular dynamic simulation of the structure of water and ice, by introducing a polarisation effect into the calculations. The effect of this seems adequately to account for the co-operative strength of the hydrogen bond in simple systems (bulk water, ice and water clusters) and becomes more important in confined system (surfaces and capillaries) and at the vicinity of foreign components. An important implication for ice is that the calculations give potential energies for differently sited H_2O molecules in the lattice which vary by up to 0.12 eV.

Richard Crabtree (British Antarctic Survey and University of Aberdeen) led a party of seven to Myrdalsjökull in southern Iceland operating from a base camp at the head of the Thorsmörk valley. The objectives of the expedition were to record evidence of changes in the extent of the ice cap since its last advance and to correlate this with climatic data, and images from the ERTS-1 satellite.

Ian Evans (University of Durham) is continuing work on the world-wide variations in the direction and concentration of cirque and glacier aspects. One conclusion from these comparisons is that the more glaciated an area is the more symmetrical are the cirque aspects. A research student Jasbir Singh is now developing a mathematical model to relate the factors which affect glacier balance (altitude, aspect, gradient, wind exposure, etc.) in a simulation of glacier distributions.

Dougal Goodman (Cavendish Laboratory, University of Cambridge) will complete his Ph.D. dissertation this year with research on the physics of dislocation movement, a deformation map for ice, and a range of experiments on the fatigue and fracture properties of ice. In the field, experiments have been conducted on the magnitude of strain in sea ice (in collaboration with Alastair Allan of Scott Polar Research Institute) and in glaciers and bedrock using geophysical wire strain-meters developed initially by the Cambridge Department of Geophysics.

Valerie Haynes (University of Strathclyde) is studying possible mechanisms of joint block removal by glaciers: the study is both theoretical and practical.

Hal Lister (University of Newcastle) led an investigation into irrigation systems in the arid Zagros mountains of Iran with a party from the Youth Exploration Trust and Iranian students. The irrigation water is chiefly derived from the meltwater of snow.

In the laboratory, a study of the abrasion of sandstone by sliding ice is being continued, yet difficulties are still being encountered in obtaining repeatable results. Polished facets are observed in some areas of the ice-rock interface with scratching of variable length and cross-section in others. The frictional force varies considerably, but stick-slip motion is uncommon, and when occurring is probably associated with shearing of the wear products.

David Sugden (University of Aberdeen) is spending the 1975/76 academic year at the Institute of Arctic and Alpine Research, Boulder, Colorado, USA, reconstructing the flow characteristics and the basal thermal regime of the Laurentide Ice Sheet at its maximum. The aim is to relate this to broad and local patterns of landform variation on the ground.

J. G. Paren

ERKKI PALOSUO

Erkki Palosuo was born at his father's farm in the eastern part of Finland on 28 June 1912, and was one of a family of five children—three boys and twin girls. Life at a big farm was in those times not easy, but, for a little boy, interesting and with great variety. The distance to the elementary school, to which he went on skis, was four kilometers. At the age of 10 he continued his schooling in the nearest city, Joensuu, a hundred kilometers from home. Even then skiing was more important than studies. But he matriculated in due course (to his own amazement) and went to the University of Helsinki in 1931 to study physics and mathematics.

In 1935 he went into the army to do the military service obligatory for every healthy Finnish man. He started in the artillery, but asked for a transfer to the air force. He found the life of a pilot so fascinating that he applied for a transfer to the military academy, where he graduated as a lieutenant in May 1939, a few months before the Finnish Winter War broke out on 30 November. All in all, with an interval of one year, the war in Finland went on until late spring 1945 and Erkki finished it as the leader of a bomber squadron and had been decorated with four medals for his deeds.

Ice had come into his life during the war. The first three years of the war were extremely cold and the Baltic froze over, which occurs a few times every century. The winter navigation presented enormous difficulties. Information about ice conditions could be obtained from the air and soon Erkki was a specialist in air reconnaissance flights, sometimes going as far as the southern Baltic. In the evenings and at nights he had long discussions with the Chief of the Ice Department at the Institute of Marine Research, Dr Risto Jurva. These sessions were basic to his further career in ice research.

When the war finally ended, he took up the studies he had left ten years earlier In two years he finished his B.Sc. and got a job in the Institute of Marine Research. Soon he started to write his Ph.D. thesis about "Severe ice conditions in the Baltic" which he defended in 1953. Four years later he was appointed the Chief of the Ice Department.

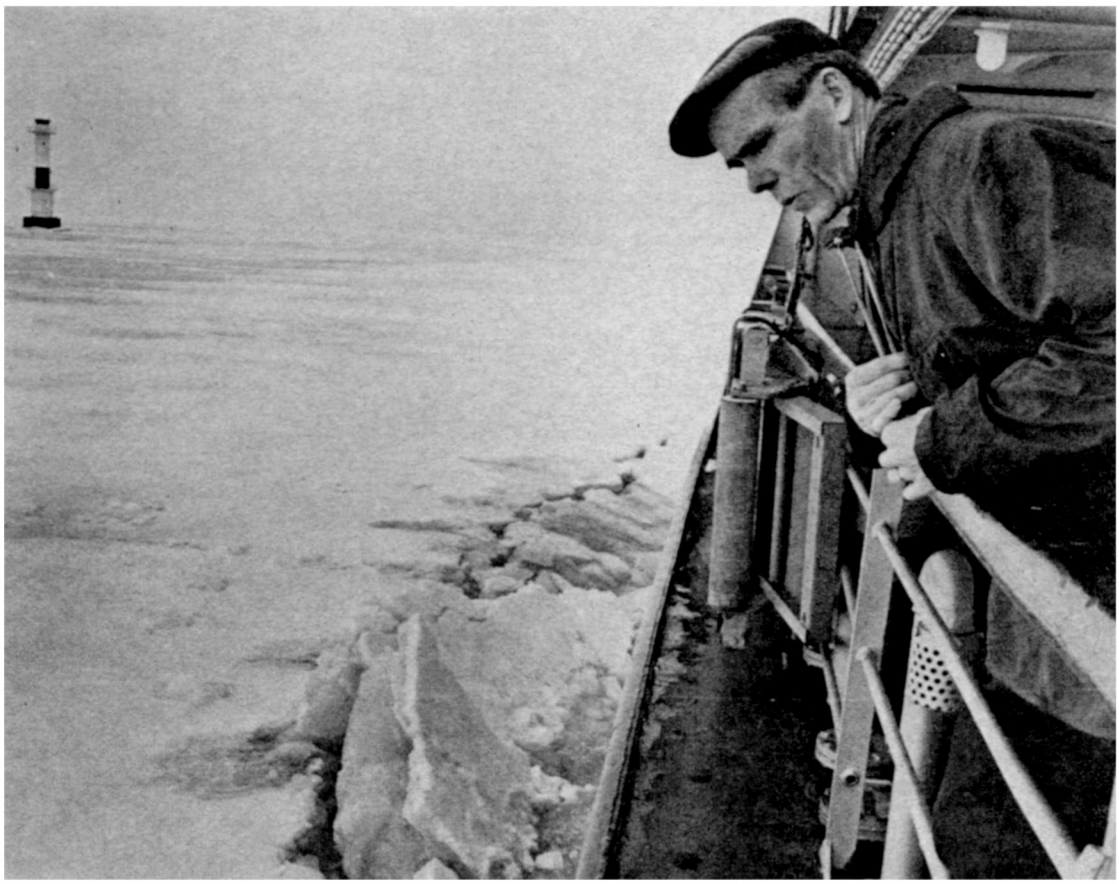
The years from 1953 on marked a new era for Finnish winter navigation. New big icebreakers were built and the yearly period of navigation was prolonged for every harbour. For example, the interruption of traffic to the northernmost harbours in Finland used to be six months, but from the year 1971 navigation became possible all the year round. Behind this development stood three men: the head of the Board of Navigation, the traffic manager and their scientific assistant, Erkki. There was a conference every morning, when the weather and ice conditions and forecast were discussed. Armed with this information Erkki would then hurry to the airport to start the daily air reconnaissance flight. Not much time was left for other routine work, and the scientific work had to be done in summer. But the open sea was not any more *terra incognita:* icebreaker masters could now choose the easiest way to cross it. This notable advance in knowledge and in its dissemination was made possible largely by Erkki's careful studies which had continued over many years.

In recognition of this, he was awarded the Finnish Medal of Navigation. His main contributions concern the structure of sea ice in the Baltic, which he has studied during long periods aboard ice-breakers; the interaction between moving floes as well as how floes interact with landfast ice and skerries; how ice formation depends upon weather conditions; the treatment of both sea ice and slush ice; how the orientation of the c-axes depends on the salinity, and the discovery of vertical axes in the fresh water in estuaries and horizontal axes in the brackish water farther out.

He has also done much proper oceanographical work and written important papers on the water exchange between the different basins in the Baltic, the Bothnian Sea and the Bothnian Bay. He has led several expeditions on the research vessel "Aranda", studying the cooling of water. When he in 1973 was appointed Professor of Geophysics at the University of Helsinki, his subject for teaching was oceanography.

Erkki is very well known and respected in the world of sea ice research, but he has also worked on land ice. In 1956 he met Valter Schytt of Stockholm University who was organizing an expedition to Spitzbergen. Erkki joined it for three months in 1957 and four months in 1958. Several times in the next few years he visited the Stockholm University Research Station at Tarfala, N. Sweden, taking part in glaciological investigations, and also visited the glaciers in Norway. His warm-hearted personality, modesty and kindness make him a welcome companion and colleague on expeditions and at conferences.

Erkki has been married since 1940 and has five children, all grown up now. His charming wife, Maini, says she has learned to live with the truth that a scientist's wife always comes second after the science which is the husband's first love: but she is happy with the silver medal, recognising that it is better than a bronze medal or nothing at all.



INTERNATIONAL GLACIOLOGICAL SOCIETY

SYMPOSIUM ON PHYSICS & CHEMISTRY OF ICE — FIRST CIRCULAR

Cambridge, England, 11-16 September 1977

A symposium on Physics and chemistry of ice will be held in Cambridge, England, in 1977. Registration will take place on Sunday 11 September and sessions will be held from Monday 12 to Friday 16 September.

TOPICS

The Symposium will be concerned with the fundamental physics and chemistry of ice in all its phases, including the clathrate hydrates. This symposium follows earlier ones in Erlenbach (1962), Munich (1968) and Ottawa (1972).

PAPERS

The papers committee will be happy to consider any paper that provides new information on the fundamental physics and chemistry of ice. Details about the submission and summaries and final papers will be given in the Second Circular to be published in the latter half of 1976. Dates for submissions are firm ones and must be adhered to.

ORGANIZATION AND PUBLICATION

The International Glaciological Society has agreed to a suggestion from the international advisory committee that the Society should organize this symposium. Circulars and correspondence concerning the symposium will be refereed according to the usual standards of the *Journal of Glaciology* before being accepted for publication in the Proceedings of the symposium, which will appear as a special issue of the *Journal of Glaciology.*

FURTHER INFORMATION

You are invited to attend this symposium and to return the attached form as soon as possible. The Second Circular will give information about accommodation, general programme, and preparation of summaries and final papers.

Requests for copies of the Second Circular and enquiries about the Symposium should be addressed to:

The Secretary, International Glaciological Society, Cambridge CB2 1ER, England.

COMMITTEES

International advisory committee

J. W. Glen (Birmingham) (Coordinator)
N. H. Fletcher (Armidale)
P.-F. Gobin (Villeurbanne)
H. Gränicher (Zürich)
A. Higashi (Sapporo)
G. L. Hofacker (München)
C. Jaccard (Neuchatel)
W. B. Kamb (Berkeley)
E. Whalley (Ottawa)

Papers committee

J. W. Glen (Chairman)
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W. B. Kamb
H. Richardson (Secretary)
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Organizing committee

M. de Quervain (President IGS)
J. A. Heap (Treasurer IGS)
H. Richardson (Secretary IGS)
J. G. Paren (BAS, Cambridge)

INTERNATIONAL GLACIOLOGICAL SOCIETY

SYMPOSIUM ON PHYSICS AND CHEMISTRY OF ICE 1977

Family name .....

First name ..... Title .....

Address .....

.....

*I hope to participate in the Symposium, 1977 ☐

*I expect to submit a summary of a proposed paper ☐

*without obligation

TO BE SENT AS SOON AS POSSIBLE TO:

The Secretary, International Glaciological Society, Cambridge CB2 1ER, England.

BRANCH NEWS will appear in the next issue of ICE.

JOURNAL OF GLACIOLOGY

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

J. F. Nye:
Water flow in glaciers: jökulhlaups, tunnels and veins.

E. M. Morris and L. W. Morland:
A theoretical analysis of the formation of glacial flutes.

J. B. Sissons and D. G. Sutherland:
Climatic inferences from former glaciers in the south-east Grampian Highlands, Scotland.

W. St. Lawrence and T. R. Williams:
Seismic signals associated with avalanches.

C. Richardson:
Phase relationships in sea ice as a function of temperature.

E. M. Shoemaker:
Temperature-gradient induced mass instability theory of glacier surges.

E. Dorrer and G. Wendler:
Climatological and photogrammeric speculations on mass balance changes of McCall Glacier, Brooks Range, Alaska.

W. Ambach & others:
Deuterium, tritium and gross beta activity investigations on Alpine glaciers.

L. W. Morland:
Glacier sliding down an inclined wavy bed.

D. N. Mottershead and R. L. Collin:
A study of glacier-dammed lakes over 75 years—Brimkjelen, Southern Norway.

S. S. Grigoryan, M. S. Krass and P. A. Shumskiy:
Mathematical model of a three-dimensional non-isothermal glacier.

P. A. Shumskiy and M. S. Krass:
Mathematical models of ice shelves.

C. S. Neal:
Instruments and methods: Radio-echo power profiling.

L. W. Morland:
Glacier sliding down an inclined wavy bed with friction.

THE LIBRARY

(NOTE: No further lists of acquisitions will be published in ICE. The lists will be maintained in the Society's office and copies will be supplied on request.)

BOOKS RECEIVED:

Abele, G. *and* Gow, A. J. Compressibility characteristics of undisturbed snow. *U.S. Army Cold Regions Research and Engineering Laboratory.* Research Report 336, 1975, iv, 57p.

AIDJEX Bulletin (Seattle), No. 29, 1975.

AIDJEX Bulletin, No. 30, 1975.

AIDJEX Bulletin, No. 31, 1976.

Berger, R. H. *and others.* Holographic technique for measurements of strain. By R. H. Berger, S. J. Marshall, R. H. Munis and M. E. Fourney. *U.S. Army Cold Regions Research and Engineering Laboratory. Special Report* 227, 1975, iii, 9p.

Chang, T. C. *and others. Microwave emission from snow and glacier ice. By T. C. Chang, P. Gloersen, T. Schmugge, T. T. Wilheit and H. J. Zwally.* Greenbelt, Maryland. Goddard Space Flight Center, 1975. 25p. (X-910-75-36.)

Colbeck, S. C. Analysis of hydrologic response to rain-on-snow. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 340, 1975, iv, 13p.

Cragin, James H. *and others.* The chemistry of 700 years of precipitation at Dye 3, Greenland. By James H. Cragin, Michael M. Herron and Chester C. Langway, jr. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 341, 1975, v, 18p. [Concentrations of Na, K, Mg, Ca, Si, Al, Pb and SO_4 measured in surface snow and in individual accumulation layers from 373-m ice core covering time period from 1232 to 1971 A.D.]

Crory, F. E. Bridge foundations in permafrost areas. Moose and Spinach Creeks, Fairbanks, Alaska. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 266, 1975, vi, 30p.

Dunbar, Moira *and* Weeks, W. F. Interpretation of young ice forms in the Gulf of St. Lawrence using side-looking airborne radar and infrared imagery. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 337, 1975, [iv], 41p.

Embleton, C. *and* King, C. A. M. *Glacial and periglacial geomorphology. Second edition. Vol. 1. Glacial geomorphology. Vol. 2. Periglacial geomorphology.* London, Edward Arnold, [c1975]. Vol. 1: [x], 573p. Vol. 2: [x], 203p. [To be reviewed.]

Field, William O., *ed. Mountain glaciers of the northern hemisphere. Vols. 1 and 2, atlas.* Hanover, N.H., U.S. Army CRREL, 1975. 2 vols., atlas. [New version of 1958 report.]

Gloersen, P. *and* Salomonson, V. V. *Satellites—new global observing techniques for ice and snow.* Greenbelt, Maryland. Goddard Space Flight Center, 1974. 13p., plates (X-910-74-309.)

Gloersen, P. *and others. Beaufort Sea ice zones by means of microwave imagery. By P. Gloersen, W. J. Campbell, R. O. Ramseier, W. J. Webster and T. T. Wilheit.* Greenbelt, Maryland. Goddard Space Flight Center, 1975. 17p, plates (X-910-75-80.)

Haynes, F. D. *and others.* Ice force measurements on the Pembina River, Alberta, Canada. By F. D. Haynes, D. E. Nevel and D. R. Farrell. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 269, 1975, iv, 12p.

IUGG—16th General Assembly, (25 August-6 September 1975), Grenoble, France. IAHS and IAMAP Joint Session. International Symposium on Isotopes and Impurities in Snow and Ice, 28-30 August 1975, organized by International Commission of Snow and Ice. Extended abstracts. [1975]. 109p.

King, Cuchlaine A. M. *The geomorphology of the British Isles: northern England.* London, Methuen, 1976. [viii], 213p. £4.80. (Paperback, £2.20). [To be reviewed in *Ice.*]

McFadden, Terry *and* Stallion, Mike. 1974 ice breakup on the Chena River. *U.S. Army Cold Regions Research and Engineering Laboratory. Special Report* 241, 1975, v, 46p.

McKim, H. L. *and others.* Land use/vegetation mapping in reservoir management. Merrimack River basin. By H. L. McKim, L. W. Gatto, C. J. Merry, D. M. Anderson and T. L. Marlar. *U.S. Army Cold Regions Research and Engineering. Special Report* 233, 1975, iv, 17p.

Mellor, M. Cutting frozen ground with disc saws. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 261, 1975, v, 65p.

Mellor, M. *and* Sellmann, P. V. General considerations for drill system design. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 264, 1975, vi, 34p.

Parameswaran, V. R. Work-hardening and strain rate sensitivity of flow stress in high purity ice single crystals. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 342, 1975, iii, 11p.

Sedgwick, J. K. *and* Henoch, W. E. *Peyto Glacier; general information.* Ottawa, Dept. of the Environment, Inland Waters Directorate, Water Resources Branch, Glaciology Division, 1975. 30p., illus., map. $3.00 (map only, $2.50). [English and French versions available. To be reviewed in the *Journal of Glaciology.*]

Sissons, J. B. *The geomorphology of the British Isles; Scotland.* London, Methuen, 1976. [x], 150p. £4.50. (Paperback, £2.00). [To be reviewed in *Ice.*]

Smith, N. *and* D. A. Pazsint. Field test of a MESL (membrane-enveloped soil layer) road section in central Alaska. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 260, 1975, v, 37p.

Stevens, H. W. The response of frozen soils to vibratory loads. *U.S. Army Cold Regions Research and Engineering Laboratory. Technical Report* 265, viii, 98p.

Sugden, David E. *and* John, Brian S. *Glaciers and landscape; a geomorphological approach.* London, Edward Arnold, [c1976]. viii, 376p, illus. £12.00 boards; £5.95 paper. [To be reviewed in the *Journal of Glaciology.*]

Thorarinsson, Sigurdur. *Glacier; adventure on Vatnajokull, Europe's largest ice cap.* Reykjavik, Iceland Review Books, [c1975]. 96p., illus. [Photos by Gunnar Hanneson. To be reviewed in *Ice.*]

Tobiasson, Wayne *and* Atkins, Ronald. Frost penetration measurements at the USAF intrusion sensor site, Rome, New York, 1973-74. *U.S. Army Cold Regions Research and Engineering Laboratory. Special Report* 235, 1975, v, 47p. [Ranged from 13 in to 24 in.]

Ueda, Herbert *and others.* USA CRREL snow and ice testing equipment. By Herbert Ueda, Paul Sellmann and Gunars Abele. *U.S. Army Cold Regions Research and Engineering Laboratory. Special Report* 146, 1975, iii, 14p. [Summarizes information on history, development and application of 3-in. ice coring auger, ice thickness kit, and Rammsonde.]

U.S. Army Cold Regions Research and Engineering Laboratory. Ad Hoc Study Group on Snow Research and Control. *Catalog of snow research projects.* Hanover, N.H., U.S. Army CRREL, 1975. iv, 103p. [Lists snow research projects currently in progress in North America.]

Votyakov, I. N. *Fiziko-mekhanicheskiye svoystva merzlykh i ottaivayushchikh gruntov Yakutii [Physical and mechanical properties of frozen and thawing-out soils of Yakutia].* Novosibirsk, "Nauka", 1975. 176p.

Wright, A. E. *and* Moseley, F., *eds. Ice ages: ancient and modern. The proceedings of the 21st Inter-University Geological Congress held at the University of Birmingham, 2-4 January 1974.* Liverpool, Seel House Press, 1975. [xiv], 320p. (Geological Journal Special Issue No. 6). [To be reviewed.]

Yakupov, V. S., *and* Klimovskiy, I. V., *ed. Regional'nyye i tematicheskiye geokriologicheskiye issledovaniya [Regional and thematic geocryological studies].* Novosibirsk, "Nauka", 1975. 155p. [Twenty articles.]

Yen, Y.-C. Heat transfer characteristics of a bubble-induced water jet impinging on an ice surface. *U.S. Army Cold Regions Research and Engineering Laboratory. Research Report* 335, 1975, vi, 16p.

FUTURE MEETINGS (of other organizations)

CARLETON UNIVERSITY—GEOGRAPHY DEPARTMENT, OTTAWA, CANADA

FIELD COURSE IN GLACIAL HYDROLOGY 1976

Led by Dr Gunnar Ostrem, Head, Glaciology Section, Norwegian State Hydroelectric and Water Resources Board, this is a 2-week intensive field and office course held at a Western Canadian glacier.

Previously given in 1972 and 1974, it will again be offered in summer 1976. It is designed for those with professional or scientific interest in glacial hydrology and related matters. Registrants must have suitable experience in the earth sciences, but previous knowledge of glacial hydrology is not essential. Enrolment is limited and early enquiry is advisable. Further information is available from: Office of Continuing Education, Carleton University, Ottawa K1S 5B6, Canada.

SEA ICE—PROCESSES AND MODELS

ICSI/AIDJEX SYMPOSIUM

Seattle, USA • 4-9 September 1977

First Announcement and Call for Papers

A symposium on sea ice will be held at the University of Washington, Seattle, USA, 4 to 9 September 1977 under the auspices of the International Commission on Snow and Ice (ICSI) and the Arctic Ice Dynamics Joint Experiment (AIDJEX). The meeting is intended to deal mainly with large scale processes, and with the modelling of processes. It is hoped that contributions will cover the various models and roles of sea ice as a component in the ocean/atmosphere system, from the global scale down to the micro-scale, but it is not intended that engineering aspects of sea ice dynamics should be dealt with directly. The symposium will provide the first opportunity for presenting results from the AIDJEX main experiment, and from the developing ship and satellite studies of Antarctic sea ice.

Topics

Possible topics include the following:

- Observations of ice forces and ice movement
- Thermal aspects of sea ice
- Sea ice data obtained by remote sensing
- Ice edge and shear zone phenomena
- Effects of waves and swell on sea ice
- Effects of synoptic weather systems on sea ice and vice versa
- Long term changes in the extent of sea ice
- Role of sea ice in formation of Antarctic bottom water
- Roles of sea ice in numerical models of atmosphere and ocean
- Prediction schemes for sea ice

Associated phenomena such as precipitation and persistent summer stratus cloud may be the subject of a special symposium during the IAMAP Assembly, to be held in Seattle immediately before the ICSI-AIDJEX Symposium.

Papers

The Papers Committee will invite a small number of review papers and will select other papers for presentation and publication. Only those papers actually presented by their authors at the symposium will be published in the symposium proceedings.

Attendance

Prospective authors and others planning to attend the meeting should complete and return the preliminary registration slip below. Subsequent circulars will then be mailed to them. In the first instance, all correspondence should be addressed to: Dr Malcolm Mellor, Secretary, International Commission on Snow and Ice, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755, U.S.A.

Name: .....

Address: .....

.....

Proposed topic or title of paper: .....

.....

THIRD INTERNATIONAL CONFERENCE ON PERMAFROST

Edmonton, Alberta, Canada

10-13 July, 1978

FIRST CALL FOR PAPERS

The Organizing Committee for the Third International Conference on Permafrost wishes to announce the first call for papers for this meeting to be held 10-13 July **1978** in Edmonton, Alberta, Canada. Acceptable topics in permafrost science and permafrost engineering are listed in this announcement. Papers must be submitted no later than 1 January 1977. A quota system has been arranged to ensure that all countries are adequately represented. Papers will be printed in a single volume and distributed to all delegates two months prior to the Conference. This announcement is being sent to all persons and organizations known to have an interest in the Conference. Detailed instructions on preparing and submitting papers will be sent to those persons who write to the Executive Secretary of the Organizing Committee that they intend to make a submission. The First Bulletin containing detailed information about the Conference will be circulated to all interested persons in 1976.

Topics

Topics will be divided into two main fields: Permafrost science and Permafrost engineering, and will include the following—thermal aspects, physics and chemistry of frozen ground, hydrology, geocryology, past and present, regional, ecology of natural and disturbed areas; site investigations and terrain analysis, geothermal considerations, geotechnical properties of frozen, freezing and thawing ground, geotechnical engineering, municipal services, mining engineering, petroleum engineering.

Further information may be obtained from M. K. Ward, Executive Secretary, National Research Council of Canada, Ottawa, K1A OR6, Canada.

GLACIOLOGICAL DIARY

1976

22–26 July
Symposium on the geography of the polar regions, Leningrad, USSR, prior to International Geographical Congress. (A. F. Treshnikov, Organizing Committee of the 23rd International Geographical Congress, symposium: The Geography of the Polar Regions, Staromonetny per.29, Moscow 109017, USSR.)

26–30 July
Cloud Physics Conference, Boulder, CO, USA. Sponsored by International Association of Meteorology and Atmospheric Physics and International Commission on Cloud Physics; co-sponsored by American Meteorological Society. (H. K. Weickmann, NOAA/APCL, Boulder, CO 80302, USA.)

28 July–3 August
23rd International Geographical Congress, Moscow, USSR, (V. Annenkov, Institute of Geography, Academy of Sciences USSR, Staromonetny 29, Moscow 109017, USSR.)

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

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

12–18 September
Symposium on Problems of Applied Glaciology, Cambridge, England. International Glaciological Society. (Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

28 September–12 October
International Workshop on Dynamics of glacier variations and surges, Alma Ata, USSR. Section of Glaciology, Soviet Geophysical Committee. Tour to Tashkent and Moscow. (ICSI sponsorship). (Dr V. M. Kotlyakov, Institute of Geography, USSR Academy of Science, 29 Staromonetny Street, Moscow 109017, USSR.)

7–11 October
Conference and field trips with central theme: "Hot and cold deserts during the last glaciation", Tempe, Arizona, USA. American Association for Quaternary Research. (Dr Troy L. Péwé, Dept. of Geology, Arizona State University, AZ 85281, USA.)

1–3 November
Avalanche Workshop, Banff, Alberta, Canada. (R. Perla, Dept. of Geography, University of Calgary, Calgary, Alberta T2N 1N4, Canada.)

1977

16–18 May
Canadian Symposium on Remote Sensing, Quebec City, P.Q., Canada. (J. Kruus, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario K1A 0E4, Canada.)

16–24 August
International Union for Quaternary Research, 10th Congress, Birmingham, England. Sponsored by the Royal Society. (Dr J. W. Jardine, Dept. of Geology, University of Glasgow, Glasgow G12 8QQ, U.K.)

22–27 August
3rd Symposium on Antarctic Geology and Geophysics, Madison, Wisconsin, USA. Sponsored by Scientific Committee on Antarctic Research, Int. Union of Geological Sciences, & Inter-Union Commission on Geodynamics. Organized by US National Research Council (Polar Research Board of U.S. National Committee for SCAR). (Dr C. Craddock, Dept. of Geology and Geophysics, University of Wisconsin, Madison, WI 53706, USA.)

4–9 September
Symposium on Sea ice — processes and models, Seattle, Washington, USA. Joint AIDJEX and ICSI symposium. (M. Mellor, Secretary ICSI, CRREL, Hanover, NH 03755, USA.) (See p. 29 of this issue of ICE.)

11–16 September
Symposium on Physics and chemistry of ice, Cambridge, England. International Glaciological Society. (Mrs H. Richardson, Secretary, International Glaciological Society, Cambridge CB2 1ER, England.)

End of September (dates to be confirmed)
Western Alpine Branch of International Glaciological Society, Bernina Massif, Switzerland. (G. Bocquet, b.p. 114, 38402 St. Martin d'Hères, Grenoble, France.)

1978

10–13 July
Third International Conference on Permafrost, Edmonton, Alberta, Canada. National Research Council of Canada. (M. K. Ward, c/o National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada.) (See p. 30 of this issue of ICE.)

21–25 August
Symposium on Dynamics of large ice masses, Ottawa, Ontario, Canada. International Glaciological Society. (Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

REVIEW

Glacier: Adventure on Vatnajökull, Europe's Largest Ice Cap. Sigurður Thorarinsson. Iceland Review, Reykjavík, 1975, 96p.

In recent years Vatnajökull has become more accessible both to scientist and tourist. This small book of 96 pages, consisting mainly of colour photographs supported by an interesting but short text by Dr Thorarinsson, provides a very useful introduction to the ice cap and its surroundings. The photographs by Gunnar Hannesson are of a very high quality. The text is primarily concerned with the history of the scientific investigation of Vatnajökull presented by the one man who has probably done more than anyone else to encourage glaciological research in Iceland. His light-hearted treatment of the early work on the behaviour of this ice cap underestimates the difficulties encountered and his own part in overcoming them. We are indebted to Dr Thorarinsson for this brief statement of the development of glaciology in Iceland.

R. J. Price

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NEWS will appear in the next issue of ICE. Many items have had to be held over owing to the great influx of RECENT WORK contributions. *Editor*

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 1976:

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I C E

Editor: 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.

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