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CONTENTS

It was with some trepidation that your Editor embarked on this his first issue. The Society and its members have been so well served by the previous Editor, our accomplished and efficient Secretary General, that it will be no easy task to follow in her footsteps. This news bulletin highlights our common interests and activities and fosters our sense of community as glaciologists. On behalf of all readers of Ice, your new Editor expresses deep appreciation to Hilda Richardson for the excellent job she has done as Editor of the last, and first, 63 issues of Ice and looks forward to trying to serve you equally well.

1981 DUES. Reminders have been sent to all members, with a plea for donations. Already many members have responded most generously and the Society is extremely grateful for these gestures of support. Would you please remit your 1981 dues as soon as possible to ensure that our cash flow is maintained and that clerical time and postage for processing additional reminders is kept to a minimum.

STOP PRESS. Mark F Meier elected to Honorary Membership of the Society. Details in next issue.

COVER PICTURE. Rime formation on tree branches. Photographed by Makoto Shinoki.

SOUTH AFRICA

SUB-ANTARCTIC MARION ISLAND

(K.J. Hall, University of Natal)

In 1975 a major investigation into the Quaternary glacial geology and the periglacial geomorphology was undertaken by Kevin Hall as part of a long-term, multidisciplinary programme initiated by Prof. E.M. van Zinderen Bakker (Institute for Environmental Sciences, University O.F.S., Bloemfontein). Early geological work (1965-1971) had shown, by means of striated surfaces, that glaciers had existed over most of the island at some stage and palynological data indicated a shift from a cool glacial climate to warmer conditions c. 14 000 years ago.

Work during the period 1975 to present has shown that the island was subject to 3 glacials, each composed of an identified series of stades and interstades. The former glacier distribution for the eastern side of the island and paleotemperatures for the last glacial, during the glacial maximum, have been reconstructed. Temperature reconstructions agree well with those from palynological and ocean core investigations. A relationship between isostatic readjustment during deglaciation and initiation of the interglacial volcanic events has been found. A number of palaeosols produced during the interglacials have been identified.

Both active and fossil patterned ground have been recognised on the island but no evidence for permafrost has yet been found. Detailed work has been undertaken on the, now mostly fossil, stone-banked lobes and the active, sorted stripes. The sorted stripes are of particular interest in that they show a clear relationship to orientation with the dominant wind direction (NW) and that in some instances stripes have been produced on slopes of less than 1° where particularly exposed to the wind. Some preliminary work on the role of penguins, seals and burrowing birds as major agents of erosion has been undertaken.

Currently it is planned that L.Scott (University O.F.S.) will be undertaking peat borings within the moraine sequences for pollen analysis and with a view to obtaining datable material. Prof. van Zinderen Bakker (University O.F.S.) continues with the study of pollen samples from glacial and postglacial sediments. Work on the volcanics, glacial sediments and periglacial features is currently under review with respect to formulating new lines of research.

U.S.A. (ALASKA)

INTRODUCTION

Alaska and its surrounding oceans provide an ideal glaciological "laboratory". Glaciers cover about 73,000 km² of the State (followed in the United States by the State of Washington with 400 km²). Some Alaskan glaciers are huge; the McKinley, Wrangell, Chugach and St. Elias Mountains contain the most magnificent array of mountain glaciers outside of the polar regions. The area of the Bering Glacier alone exceeds 5000 km². Although Alaska is justly famous for its glaciers and their perennial snow cover, it is also especially well suited for the study of seasonal snow cover. Snow covers the surface of most of Alaska for one-half to three-fourths of each year and is distributed across three distinctly different climatic zones as 1) dry, hard, windpacked "tundra snow" in the north; 2) low density, dry, largely recrystallized "taiga snow" in the interior; and 3) thick, often wet "maritime snow" along the Gulf of Alaska. Ice in the soil occurs in annually frozen ground, and in both land and subsea permafrost. Permafrost is distributed over 85% of the State and subsea permafrost underlies much of the continental shelf areas in the Beaufort and Chukchi Seas. River and lake ice occur throughout the State most of the year. Finally, Alaska's coastline is longer than the combined coastlines of the other 49 United States and sea ice occurs along more than half of this coastline, influencing virtually all physical and biological processes in arctic and sub-arctic seas.

Glaciological research in Alaska on all the ice forms listed above therefore presents a plethora of opportunities and problems. Much of the research carried out is directed towards solving practical problems of construction, transportation and resource exploitation. It is not practical, however, to list all these studies here, unless they are of a more "fundamental" nature. The annual "research profile" published by the Arctic Environmental Information and Data Center of the University of Alaska in Anchorage lists over 100 separate projects on ice-related research in Alaska during 1979,

many of them of an "applied" nature. That list does not include research projects conducted by the petroleum industry.

GLACIERS

VARIEGATED GLACIER

(C. Raymond, R. Crosson, S. Malone, R. Bindschadler, University of Washington; W. Harrison, University of Alaska; B. Kamb and H. Engelhardt, California Institute of Technology)

A study of the Variegated Glacier, a surge type glacier expected to surge within the next 5 years, has been going on since 1973 in an effort to understand the causes of surges. The measurements include temperature, geometry and dynamics and their evolution with time, basal sliding, morphology and water pressure, strain rates, and outflow stream characteristics. Short episodes of fast motion accompanied by uplift of the glacier, have been observed to propagate down the glacier. Water seems to be the key factor in surge initiation.

MOUNT WRANGELL

(C. Benson, R. Motyka and P. MacKeith, University of Alaska)

Glaciological-volcanological research has been conducted on Mt. Wrangell since 1960. In recent years volcanic activity has increased substantially and the studies have concentrated on determining the response of glacier ice to the increased heat flux. The research has included detailed photogrammetry to measure changes in the volume of glacier ice; radio echo sounding, to determine ice thickness; and measurements of snow and ice temperature, accumulation, and glacier flow, combined with volcanic heat flux measurements. Between 1965, when the ice volume changes were first noticed, and 1980 about 50 million cubic meters of ice have melted from within and around one of the three active craters along the rim-crest of the summit caldera. The melting glacier ice is being used as a calorimeter to estimate heat flux.

WOLVERINE GLACIER

(L.R. Mayo and D.C. Trabant, U.S. Geological Survey [USGS])

Continuous measurements of precipitation, air temperature, glacier surface altitude, ice flow, balance, and streamflow at this maritime climate zone glacier are made to study the response of glacier dynamics to climatic variables. The glacier bed is being mapped from monopulse radar measurements and a new map of the basin is being compiled from 1979 photography.

SNOW GLACIER

(L.R. Mayo and D.C. Trabant, USGS)

Outburst floods from a lake dammed by Snow Glacier occur every 2 to 4 years. Ice dam height and lake stage are measured periodically. Lake volume and peak flood flow are measured each outburst. A precision survey net has been installed in preparation for ice dynamics studies of the ice dam. The lake stores runoff from only the accumulation zone of the glacier, providing unique runoff information.

KNIK GLACIER

(L.R. Mayo and D.C. Trabant, USGS)

Knik Glacier ceased damming the largest glacier dammed lake in Alaska, Lake George, in 1967. A minor climatic change or flow instability could reform Lake George and renew the cycle of outburst flooding onto a floodplain that is subject to economic development. Measurements of surface profile change, balance, and ice thickness will contribute toward eventually formulating a prediction of future flood hazards from Lake George.

COLUMBIA GLACIER

(M.F. Meier, L.R. Rasmussen, A. Post, C.S. Brown, W.G. Sikonia, USGS; R.A. Bindschadler, NASA; L.R. Mayo and D.C. Trabant, USGS)

Columbia Glacier is predicted to continue retreating from a submarine terminal moraine, and experience an increased calving rate, which will, by 1982 to 1985, be 6 to 8 times greater than at present. The retreat will be irreversible and will continue for several decades, opening a new fiord in Prince William Sound. The prediction is based on measurements of thickness change, balance, ice flow, glacier thickness, and water depth at the terminus. Numerical models of the glacier behaviour provide predictions and the glacier is being monitored for verification of the prediction.

GULKANA GLACIER

(L.R. Mayo and D.C. Trabant, USGS)

The same type of long-term study as on Wolverine Glacier is maintained in the drier, higher altitude environment of the Alaska Range to detect changes in glacier zone climate and the response of the glacier to these changes.

BLACK RAPIDS GLACIER

(L.R. Mayo and D.C. Trabant, USGS)

The 43 km-long glacier surges vigorously with an unknown period. The Delta River, the Richardson Highway, and the Trans-Alaska pipeline cross the path of surges which have occurred within the past 100-300 years. Surface speed, calculated basal sliding speed, balance, changes in horizontal and vertical

strain rate, emergence speed, surface gradient changes, and ice thickness changes are being measured during the present period while the glacier is building for the next surge. The winter cold wave penetrates 10-15 meters into the glacier, but the rest of the ice is temperate. This study will be continued through the next surge.

AERIAL PHOTOGRAPHY OF GLACIERS
(Austin Post and L.R. Mayo, USGS)

A major number of Alaskan glaciers are photographed both seasonally and annually. Studies of the photographs determine the surge history of individual glaciers, the extent of surging glaciers, the occurrence of ice dammed lakes, the general history and changes in glacier behaviour. The photographs are available to all scientists and can be used for glacier inventory investigations or for research on individual glaciers. Occasionally, photography is obtained of floods, faults, landslides, volcano activity, and other transient phenomena.

CENTRAL BROOKS RANGE
(J.M. Ellis and P.E. Calkin, State University of New York)

One hundred and thirty-three glaciers and rock glaciers in the east-central Brooks Range have been geomorphically classified and their exposure, aspect and altitude distribution evaluated in terms of the orientation and distribution of Pleistocene glaciers (*Arctic and Alpine Research*, Vol.11, No.4, 403-420).

ALASKAN VALLEY GLACIERS
(D.E. Lawson, Cold Regions Research and Engineering Laboratory [CRREL])

Matanuska Glacier, Nelchina Glacier, Nuku Glacier, Kachemak Glacier, and Spencer Glacier have been studied to determine processes of subglacial debris entrainment and deposition through direct observation in subglacial caverns and through indirect analyses, such as quantitative study of debris and ice of the glacier and of the deposits formed subglacially. Oxygen and hydrogen isotope analyses are to be made of ice in the terminus region and in the upper ablation area. Temperature profiling will begin in 1980.

MATANUSKA AND NELCHINA GLACIERS
(D.E. Lawson, CRREL)

Matanuska Glacier and Nelchina Glacier have been examined to define the depositional processes and characteristics of the deposits of these active glaciers. Results from each glacier will be compared for development of regional models of glacial sedimentation.

GLACIATION LEVEL IN SOUTHERN ALASKA
(G.Østrem and N. Haakensen, Norway Water Research and Electricity Board)

To determine the minimum height of a mountain which is required to obtain (or maintain) a glacier in that area, maps of this height — with contour lines for the "glaciation level" — have been produced.

MULDROW GLACIER, MOUNT MCKINLEY
(B. Washburn, Boston Museum of Science)

Very precise maps of the Muldrow Glacier with 10 m contours are in preparation for the purpose of providing an accurate data-base for studying surges of the glacier. Field work started in 1976 and was completed in June-July 1977. Photogrammetry is completed and publication is awaiting additional funding.

GLACIER BAY
(R.G. Goodwin, Ohio State University)

The chronology of neoglacial ice advance in Glacier Bay was studied by obtaining C^{14} dates, paleomagnetic data, varve chronologies, and palynological data from Neoglacial glaciolacustrine beds in Muir, Wachusett, and Adams Inlets and in the Beartrack Valley. These data will be used to chronicle ice advance and to reconstruct vegetation composition at the time of the advance.

(G.D. McKenzie, Ohio State University)

A recently deglaciated environment in Glacier Bay National Monument was studied in order to understand the mechanisms and determine the rates of collapse of an ice-cored fan delta and associated kame terrace.

Burroughs Remnant and Glacier Bay were examined to determine the rates of formation of speleothems and the rates of changes of glacier caves in a wasting ice mass; and to estimate the importance of inflowing streams to wastage of a stagnant ice mass in a mountain environment.

SEASONAL SNOW

SNOW SURVEY FOR ALASKA
(G.P. Clagett, U.S. Soil Conservation Service plus other cooperating agencies)

A statewide cooperative snow survey program has been in operation for several years now, collecting data on snow depth and water content at approximately 140 locations in Alaska. Monthly data tables are published during the winter months.

SNOW COVER – SEWARD PENINSULA
(J.D. Swanson and G.P. Clagett, U.S. Soil Conservation Service)

Snow surveys were conducted on the Seward Peninsula to evaluate snow depth, distribution, density and crusting factors. Major impetus was directed towards making interpretations on the range for forage availability and use by

the various local reindeer herds. Snow crusting was checked with ram and spring penetrometers. An automated data recording facility will be installed near Nome to record on-site snow data.

PHYSICAL PROPERTIES OF SNOW
(C.S. Benson, University of Alaska)

Research that has been underway for nearly two decades continues to define the physical characteristics of arctic and subarctic snow and the processes within the snow, including those which form very low density ($0.20\ g\ cm^{-2}$) depth hoar in interior Alaska and the transport of blowing snow on the Arctic Slope of Alaska.

SNOW COVER PROPERTIES
(M.A. Bilello, CRREL)

Research has been conducted on snow cover properties and ice conditions and thickness on lakes, rivers and landfast sea ice at locations throughout Alaska.

SOIL DESSICATION UNDER A SNOW COVER
(C.S. Benson and J.D. Fox, University of Alaska)

The potential for wind erosion and drying of the soil through a winter snow pack was investigated by correlating the distribution of wind blown, drifted snow, and measurements of the wind field, temperature and moisture at two sites in Delta and one in the Fairbanks area.

SNOWMELT INFILTRATION AND RUNOFF
(D. Kane, University of Alaska)

The role that soil moisture content within the seasonally frozen layer plays in controlling infiltration and movement of snowmelt water was examined. In a separate study, the mechanics of groundwater flow in a discontinuous permafrost environment were studied by use of existing groundwater models.

AVALANCHE ACTIVITY
(S.W. Hackett, R.D. Reger and J.T. Kline, Alaska Division of Geology and Geophysical Surveys)

Available data have been compiled to summarize snow avalanche activity in Alaska and map potential avalanche areas. Among the results are investigations of slushflow avalanches in the Atigun Pass area of the Central Brooks Range and their effects on transportation systems crossing the range.

AVALANCHE FORECASTING (CHUGACH STATE PARK)
(D.S. Fesler and M. Rodak, Alaska Division of Parks)

The location, frequency, severity, intensity and size of avalanche paths located in high use/high hazard areas of Chugach State Park have been determined, and the probability of avalanches has been studied as a function of a number of physical conditions relating to the snowpack, weather and slope characteristics.

RIVER AND LAKE ICE

ARCTIC COASTAL PLAIN
(D.K. Hall, NASA)

Studies on the Arctic coastal plain were conducted to develop a technique of determining ice thickness of the thaw lakes using passive microwave remote sensing data; and to study variations in the melt dates and aufeis extent of major North Slope rivers during the years since the launch of LANDSAT-1. Also, the chemical characteristics of aufeis water were studied.

INTERIOR OF ALASKA
(T.E. Osterkamp and J. Gosink, University of Alaska)

Observations and measurements of freeze-up and break-up phenomena have been carried out sporadically for many years. Recent work has focused on the dynamics of individual frazil ice crystals and a criterion for mixing of frazil in the flow has been obtained. Break-up studies on the Yukon River have shown that stage controls the time of first ice movement and the dynamics of the break-up processes. Efforts are being made to apply the results of these studies to the problems of hydroelectric power generation in the state.

HYDROLOGIC REGIME
(P.E. Calkin, State University of New York)

Atigun Pass in the Brooks Range was investigated to work out Holocene and current hydrologic regimes of the small cirque glaciers of the Atigun River Valley and of the headwaters of the Atigun River and North Fork Chandelar River on opposite sides of the Continental Divide. The study also maps the surficial/glacier deposits of the Atigun River Valley as far as Galbraith Lake and records the slope forms in this area of the basin.

LAND PERMAFROST

MASSIVE GROUND ICE
(D.E. Lawson and J. Brown, CRREL)

The purpose of this study is to determine the distribution of massive ground ice at various sites in Alaska, to examine physical and chemical characteristics of representative ice types, (including oxygen and hydrogen isotope composition), date organics adjacent to and within the ice, and determine the origin of

each ice type. Also, the processes and controlling factors causing thermokarst of permafrost terrain were studied.

MODELING PHYSICAL AND THERMAL DISTURBANCES
(S.I. Outcalt and C. Goodwin, University of Michigan)

The objective of this study was to model in detail natural and man-disturbed thermal regions in the near surface zones in the area of Prudhoe Bay and along the Haul Road.

FROST HEAVE
(G.L. Guymon, University of California)

A two-dimensional model of frost heave in freezing soil was developed. The model is based upon known physics, and numerical algorithms are based upon the finite element method.

SUBLIMATION OF PERMAFROST
(N.L. Johansen, University of Alaska)

To understand the sublimation of permafrost silt and also methods to retard the sublimation, studies were conducted in the permafrost tunnel near Fox, Alaska.

ELECTROMAGNETIC SURVEYS OF PERMAFROST
(S.A. Arcone, P. Sellmann and A.J. Dalaney, CRREL)

Studies near Fairbanks and Prudhoe Bay were conducted to study the response of surface impedance and magnetic induction methods to local ground ice conditions and seasonal temperature changes.

GEOPHYSICAL METHODS
(T.E. Osterkamp, University of Alaska; R. Jurick, Department of Transportation)

A variety of geophysical methods for detecting permafrost, massive ground ice and ice-rich soils are under investigation. These include electromagnetic, seismic and gravity methods. Measurements are conducted at the sites of future road cuts to determine the soil and ice conditions before and after the cuts are made. This information furnishes ground truth for evaluating the methods. All methods tested are capable of detecting permafrost and ground ice although magnetic induction measurements of the ground resistivity are the simplest to use and the easiest to interpret.

FREEZING POTENTIALS IN PERMAFROST SOILS
(W.M. Sackinger, University of Alaska)

The electrical voltages produced in the upper layers of the soil by the freezing process were measured, and the effects of auroral activity upon soil potentials were estimated.

CREEP OF SOIL ON PERMAFROST
(T.H. Wu, Ohio State University)

Creep movement of soil on subarctic, permafrost-underlain slopes has been investigated, and the applicability of existing theoretical models of soil creep for permafrost conditions have been evaluated.

DYNAMIC PROPERTIES OF FROZEN SOILS
(T.S. Vinson, Oregon State University)

The dynamic properties of frozen soils were studied. Test parameters included temperature, confining pressure, strain amplitude and frequency. The material parameters included soil type and composition, soil structure and density (or void ratio), ice content, water content and anisotrophy.

SUBSEA PERMAFROST

SHORELINE HISTORY
(D. Hopkins, USGS)

Surveys have been conducted of the lithology, stratigraphy, geochronology, paleoecology and ice content of rocks and sediments exposed in coastal bluffs and recovered from boreholes along the northern coast of Alaska. This has provided data for the prediction of horizontal and vertical distribution of bonded permafrost on the continental shelf.

THERMAL REGIME
(T.E. Osterkamp and W. Harrison, University of Alaska)

Temperature and salinity data at the ocean bottom and in the sediments of the ocean floor have been analyzed. Simple water jetting techniques were used to insert the temperature and salinity probes into the sediments. A coupled heat and salt flux model has been developed to study the thermal regime and the degradation rates of subsea permafrost; convection of highly saline water in the sediments substantially increases the thaw rate.

SEISMIC METHODS
(J. Rogers and J. Morack, University of Alaska)

Seismic refraction and reflection techniques were used to determine the presence and depth of subsea permafrost in the vicinity of Prudhoe Bay. Ice-bonded permafrost within 40 m of the ocean surface is quite widespread, although former lake-beds (e.g. Prudhoe Bay) and paleovalleys (e.g. the extension of the Sagavanirktok River) do not have subsea permafrost close to the surface.

(P. Sellmann, CRREL)

A systematic analysis of seismic data collected by industry has been carried out for the Beaufort Sea. A model of seismic veloci-

ties in various types of permafrost was developed and applied. The thickness of the thaw layer generally increases with distance from shore but there are many irregularities. Subsea permafrost appears to be widespread, underlying most of the continental shelf.

GEOTECHNICAL PROPERTIES
(G. Shearer, USGS)
By drilling and recovering cores from a number of boreholes in the nearshore area of the Beaufort Sea, the depth of permafrost, presence of ice-rich zones in permafrost, gas hydrates and shallow gas, salinity of pore fluids, availability of gravel, and the geotechnical properties of the soil were determined.

SEA ICE

SATELLITE MAPPING OF SEA ICE FEATURES
(W. Stringer, University of Alaska)

Mapping of major sea ice features, including the extent of shore-fast ice, polynyas, grounded ice and pressure ridges, primarily from LANDSAT satellite imagery, has been completed for the entire Alaskan coastline for the years 1973-1977. A systematic evaluation of ice movement in the Bering Sea has begun.

SEA ICE HABITATS
(J. Burns, Alaska Department of Fish and Game; L. Shapiro and F. Fay, University of Alaska)

The relationship between the annual cycle of movements and activities of marine mammals and the characteristics of sea ice in space and time were investigated, using satellite imagery, surveys from ships and aircraft and records of past, historical ice observations. A final report has been published.

PRESSURE RIDGES AND KEELS
(W. Weeks, CRREL)

From systematic aircraft overflights with a laser profilometer, sea ice roughness has been determined over several years at transects across the Alaskan continental shelf. The number of pressure ridges as a function of distance from shore, time of the year and location have been determined. From the examination of side-scan sonar records (see next entry) statistics of ice gouging of the sediments of the Beaufort Sea have been computed in terms of probabilities of gouges occurring to certain depths across the shelf.

ICE GOUGING OF THE OCEAN FLOOR
(P. Barnes and E. Reimnitz, USGS)

Ice gouges in the sediments of the Alaskan continental shelves in the Beaufort and Chukchi Seas have been studied by using side-scan sonar. Data on the depths of gouging, location, direction and recurrence intervals have been collected, and the effects of ice on submerged shoals, islands and the coastline have been studied. A paper on gouging statistics (see previous entry) is presently in preparation, jointly with W. Weeks.

ICE PILE-UP AND OVERRIDE OF BEACHES
(A. Kovacs, CRREL)

Ice pile-up and ride-up are frequently occurring phenomena along the Alaskan coast. For example, sea ice has mounted the steep, 9 m high bluff at Barrow, destroying structures and taking lives. The frequency and location of pile-ups and ride-ups have been determined over a few years now. A review of the literature on the processes has also recently been compiled and published in *Cold Regions Research and Engineering*.

MECHANICAL PROPERTIES OF SEA ICE
(L. Shapiro, University of Alaska)

In-situ shear, indirect tension and uniaxial compression tests have been performed on sea ice samples by using flat jacks frozen into the ice. A non-linear viscoelastic stress-strain law has been derived with which to analyze the test results. Biaxial compression tests and studies of the variation of mechanical properties with depth and crystal orientation continue.

SEA ICE CRYSTAL ORIENTATION
(W. Weeks and A. Gow, CRREL)
Field observations at numerous sites in the fast or near-fast ice along the northern coast of Alaska have shown that the great majority of the ice samples (95%) exhibit striking c-axis alignment within the horizontal plane. The general patterns of the alignments support a direct correlation between the preferred c-axis direction and the current direction at the ice/water interface.

GRAVITY WAVES IN SEA ICE
(H. Bates and L. Shapiro, University of Alaska)

This theoretical study is an examination of the propagation of gravity waves in a system consisting of a continuous ice sheet under in-plane compressive stress, overlying an ocean of any depth. Solutions have been obtained for both elastic and linear viscoelastic plates, and the results have been extended to the problem of the stability of ice sheets under moving loads.

SEDIMENT-LADEN SEA ICE
(T.E. Osterkamp and J. Gosink, University of Alaska)

Sea ice in the nearshore areas of the arctic coasts of Alaska often contains sediment concentrations up to several orders of magnitude higher than in the water column. Thin

section analysis of sea ice cores from Norton Sound and from the Beaufort Sea near Lonely and Prudhoe Bay shows that the sediments are incorporated into the crystal grain boundaries of frazil ice. Work is continuing on processes responsible for incorporating and concentrating sediments in the sea ice cover.

ICE EDGE – ATMOSPHERIC CIRCULATION
(G. Wendler, University of Alaska)

The sea ice edge in the Bering Sea during the winter 1979-80 was related to various meteorological parameters. Good correlations were found between deviations of the position of the mean ice edge and the additional wind field to the normal circulation which was derived from the deviation of the height of the 700 mb level.

OIL SPILL BEHAVIOUR ON ICE: LABORATORY STUDIES
(L. Schultz, ARCTEC)

Tests in an ice flume have given the threshold velocities for various ice roughnesses to move oil along the underside of ice. Scale tests seem to indicate that even deep ice keels are not an obstacle to the transport of spilled oil if the current velocities under the ice are more than about 20 cm/sec.

OIL SPILL TRANSPORT BY ICE
(M. Coon and R. Pritchard, Flow Research)

From the drift tracks of buoys and satellite-identifiable fragments of sea ice, generalized monthly trajectories and rates of movement have been calculated for the sea ice in the Beaufort and Chukchi Seas. Based on these, oil spill scenarios for various locations and seasons could be constructed. Similar efforts to determine ice movement in the Bering Sea are now underway.

Reports collected by Gunter Weller

U.S.A. (UNIVERSITY OF WASHINGTON)

LARGE-SCALE HEAT EXCHANGE AND ICE PRODUCTION IN THE ARCTIC
(G.A. Maykut)

Differential motions within an ice pack cause the formation of leads and pressure ridges. Continual deformation and ice growth give rise to a distribution of ice thickness. Because the energy exchange between the atmosphere and ocean depends strongly on ice thickness, large-scale estimates of the heat balance must take into account contributions made by all the thicknesses of ice which occur within a given region. This has been accomplished by using strain data (100 km scale) taken in the Beaufort Sea during the Arctic Ice Dynamics Joint Experiment (AIDJEX), together with theoretical models of ice growth and thickness distribution. The results indicate that ice dynamics is responsible for a much more vigorous heat exchange than previously estimated from ice station data. Winter rates of ice production, turbulent heat loss to the atmosphere, and salt input to the ocean were all greatly enhanced. The large amounts of shortwave radiation which enter the ocean through leads in the summer caused substantial bottom melting and lateral ablation on lead walls. Similar results have also been obtained using strain observations taken on a 500 km scale. Sensitivity studies are presently underway to learn more about how ice velocity characteristics and assumptions embedded in the models affect large-scale heat exchange estimates.

LATERAL MELTING IN SUMMER LEADS
(G.A. Maykut and D.K. Perovich)

The summer decay and retreat of a sea ice cover is generally believed to be greatly accelerated by lateral melting on lead walls. Previous calculations have suggested that ice concentration should show an approximately exponential decrease during the summer as a result of this process. These calculations, however, did not take into account heat loss from the water to the atmosphere and assumed that all the shortwave radiation absorbed in the lead went into lateral melting. We have constructed a relatively simple model which includes: 1) turbulent heat exchange between water and air, 2) ablation on the underside of the ice due to radiation absorbed below the ice, 3) surface ablation, and 4) temperature dependent lateral ablation rates determined through laboratory experiments. Our results indicate that when ice concentration is large, lateral melt rates increase rapidly with lead width only up to a width of a few hundred meters, above which the rates remain essentially constant. In this case thinning is the dominant decay mechanism. When the ice concentration is low, heat entering the surface layer of the lead from below becomes important and results in more rapid lateral melting. We are continuing to improve the model and hope to obtain a more realistic picture of how shortwave radiation interacts with the summer ice pack.

LABORATORY STUDIES OF THE OPTICAL PROPERTIES OF YOUNG SEA ICE
(D.K. Perovich and T.C. Grenfell)

Samples of young sea ice were grown in a 1 m diameter cylindrical tank whose walls were made of mirrored plexiglas to increase the effective extent of the ice sheet. Measurements of incident, reflected, and transmitted irradiance from 450 to 1000 nm were used in conjunction with a two-stream photometric model to determine spectral albedos and extinction coefficients. Ice was grown at temperatures ranging from -10°C to -37°C with water salinities of 0, 16 and 31 $^{o}/_{oo}$. Extinction coefficients were substantially larger than for thick summer ice, and albedos were much larger than expected for thin ice based on predictions using the optical properties of thick summer ice. The dependence of the optical properties of young ice on temperature, growth rate, bubble density, and surface conditions were determined. Surprisingly, differences in ice salinity from 4 to 14 $^{o}/_{oo}$ appear to have caused almost no changes in the optical properties of the ice.

A four-stream radiative transfer model including anisotropic scattering and refraction at the boundaries was constructed to interpret the measured albedos and transmittances in terms of variations in volume scattering. The model was then used to investigate the depth dependence of radiative energy absorption, to determine the effects of various surface types on the spectral dependence of albedo and transmittance, and to compare the radiative energy balance under clear and cloudy skies.

SPECTRAL ALBEDOS AND INCIDENT RADIATION OVER SEA ICE AND SNOW
(T.C. Grenfell and D.K. Perovich)

A visible and near infrared scanning photometer was constructed to observe spectral albedos and incident irradiances over sea ice and snow from 400 nm to 2750 nm. The instrument has a spectral resolving power ranging from 25 to 46 and will detect irradiances of less than 0.1 microwatts/cm^2/nm. The system is readily portable weighing less than 35 lbs, and can be carried easily in a backpack. Testing has been carried out over first-year sea ice near Point Barrow, Alaska, and in the Cascade Mountains. Sequences of spectral albedo changes of the sea ice have been obtained during the arctic summer, together with data on the dependence of incident irradiance on arctic cloud conditions. Measurements of spectral albedos of an alpine snowpack have also been obtained.

ICE EDGE STUDIES
(S. Martin)

A field program to study the properties of the Bering Sea ice edge was carried out in March 1979 in cooperation with NOAA and the Scott Polar Research Institute (SPRI). Of particular interest were the origin and movement of ice bands which formed at the ice edge during periods of off-ice winds. Analysis of these and other observations made during the cruise is in progress.

We have constructed a 1 m by 1m by 5 m wave tank in which we plan to carry out studies of the melting of ice floes in a wave field. The purpose of this experiment is to discover how the wave-induced boundary layer under the ice floe enhances ice ablation, then to compare the experimental results with theory. In cooperation with V. Squire of SPRI, we are carrying out a laboratory study of the flexural response of a sea ice sheet to water waves.

SNOW AND AVALANCHE RESEARCH

Current work under the direction of E.R. LaChapelle includes data collection on methods of conventional avalanche forecasting throughout the western U.S. and Canada, the analysis of snowpack structure by pattern recognition techniques, development of improved instrumentation for snow structure analysis and measurement of three-dimensional snow deformation patterns around obstacles on mountain slopes. Field work in snow structure analysis has been extended to include work in the New Zealand South Alps, complementing the normal winter snow season in the Cascade Mountains of Washington.

BLUE GLACIER, WASHINGTON STATE

Climate and mass balance measurements continued for the 24th year. Field work, under the direction of Richard Marriott, included a resurvey of ice depths using radio echo-sounding techniques. A definitive study of recent trimline and moraine dates is now underway to determine accurately the glacier fluctuation history over the past few hundred years. The Blue Glacier, with a nearly static terminus for the past decade, now shows some limited signs of thickening and minor advance, presumably reflecting heavy mass balance surpluses in the early 1970's. As in the previous summer, the field station served as a test site for winter and arctic meteorological instruments.

DOME C PROJECT 1979-80, ANTARCTICA

(C.R.Bentley, University of Wisconsin-Madison)

The geophysical survey of Dome C was continued during the 1979-80 field season. Geophysical measurements included radar sounding, seismic shooting, geoelectric sounding, gravity and magnetic surveying, and magnetotelluric recording. In addition to these measurements, a joint program of geoelectric and radar surveying was carried out with a geophysical team from the University of Münster, West Germany, led by F. Thyssen.

Radar sounding

Nearly 100 km of radar sounding profiles were made around Dome C camp using a 35 MHz system. Accurate ice thickness measurements were made at 1-km intervals or less. The glacial bed at Dome C is a poor reflector; signals were enhanced by various instrumental improvements. Several profiles of internal layering were also made; no reflectors were observed below 2.4 km depth, i.e. within 1 km of the bed. At several sites the profiling showed abnormally strong bottom echoes that may represent subglacial water. A common-reflection-point experiment to obtain electromagnetic wave velocities in the ice was also carried out.

D.C. electrical resistivity

The cooperative program with the University of Münster involved deep geoelectric sounding extended to the largest electrode separation yet made on polar ice. Electrode half-spacings reached a maximum of 6 and 8 km, respectively, on two profiles. The yielded data showed the effect of either a highly resistive ice layer near the base of the ice sheet, or extremely high resistivity in a thick subglacial permafrost layer. Because of other evidence for subglacial melting, the former interpretation seems preferable.

Seismic

The main emphasis of the seismic program was on three wide-angle reflection profiles shot at 60° angles with one another and aimed at providing detailed information about P-wave velocity structure within the ice sheet. Following procedures previously used successfully in West Antarctica, we hope to be able to obtain information about the average crystal orientation deep within the ice sheet.

Studies of the subglacial rock

Other measurements at Dome C were related to studying the crustal structure beneath the ice sheet. Magnetotelluric measurements were recorded at periods ranging from 0.5 to 600 sec. A gravity profile was extended to a total distance of 22 km and magnetic measurements were made at 50 grid points. Seismic long-refraction shooting was carried out with two large charges at shot-receiver separations of 30 km.

Field personnel included S. Shabtaie, D.D. Blankenship, R.M. Gassett and J.S. Lovell.

GLACIAL DYNAMICS GROUP

(Ohio State University)

At Dome C, Antarctica, John Bolzan and an assistant, Ron Coffman, completed snow pit studies and temperature profile measurements during 1979-80. A 50 m firn core has been studied for structural features by Richard Alley and the snow pit stratigraphy is being investigated by Julie Palais. The interpretation of the temperature profile and of measurements of firn thermal-conductivity is being undertaken by Richard Ewing, John Bolzan and Ian Whillans.

David Bromwich, a meteorologist, has been investigating the moisture budget of the atmosphere over Antarctica and the resulting net accumulation of snow.

Dominique Raynaud, Grenoble, joined us for one year and worked, mainly with Ian Whillans, on the interpretation of total gas content measurements in the Camp Century, Greenland, and Byrd Station, Antarctica, ice cores. Plans for the International Antarctic Glaciological Project (IAGP) were discussed.

In Ohio, Bob Choate is studying mineralogical and depositional characteristics of the till with a view to better understanding till genesis and the nature of the Laurentide ice sheet.

For Greenland, Cindy Richardson has been analyzing radar data supplied by Søren Overgaard of the Technical University of Denmark. She is testing whether the internal radar layering could be associated with depositional stratigraphy.

During the summers of 1980 and 1981 we plan a field program in southern Greenland involving movement, temperature, and accumulation measurements. This will be part of the Greenland Ice Sheet Program (GISP).

DOME C, ANTARCTICA, ICE CORE MICROPARTICLE STUDIES

(Ohio State University)

Fifty-one sections of the French 905 m Dome C, Antarctica, core were analyzed for microparticle concentration and size distribution at the Ohio State University Microparticle Laboratory. These 5367 samples represent the most detailed microparticle analysis of any core spanning the transition from post-glacial to the last full glacial. The average particle concentrations in late glacial ice exhibit an 800% increase over average particle concentrations in Holocene ice. An excellent temporal correspondence is found between the increase in microparticle concentration and more negative oxygen isotope ratios. This relationship is similar to that found in both

Byrd Station, Antarctica, and the Camp Century, Greenland, cores. In each of the sections analyzed, distinct cyclical variations in microparticle concentration were found. Evidence from shallow pit studies at Dome C suggests that these variations are annual. The annual layer separation estimated from these cyclical concentration variations in each core section suggests that net annual surface accumulation was not substantially reduced near the end of the last glacial. In fact, accumulation appears to have remained reasonably constant over the entire interval represented by the core. These annual layer separation estimates were employed to construct a maximum and minimum time scale for the core. The minimum age at the bottom is 22,000 years and the maximum age is 30,000 years B.P.

The results will appear in the *Proceedings of the Symposium on Sea Level, Ice Sheets and Climatic Change* (Glaciological interpretation of microparticle concentrations from the French 905-m Dome C, Antarctica core, by L.G. Thompson, E. Mosley-Thompson and J.R. Petit).

CONTINUED ANALYSIS OF RIGGS DATA

(C.R.Bentley, University of Wisconsin-Madison)

Analysis of the data collected during the 1973-78 Ross Ice Shelf Geophysical and Glaciological Survey (RIGGS) has continued. Emphasis has been on radar evidence for the distribution of bottom crevasses and their association with ice rises (several previously unidentified have been located), on apparent deviations between the present flow directions and those within the last 1000 years, on variations in the activity of alpine glaciers in the Transantarctic Mountains between Beardmore and Nimrod Glaciers as reflected in characteristics of the corresponding bands downstream across the ice shelf, on the uses of geophysical measurements for determining the characteristics of icebergs, and on the history of glacial unloading in the area. Reports on this recent work have been presented in a Ph.D. thesis by K.C. Jezek and in papers given by C.R. Bentley, L.L. Greischar, C.S. Lingle and S. Shabtaie at meetings of the IUGG in Canberra, of the IGS in Cambridge, of AMQUA in Orono, Maine, and of the American Geophysical Union (midwestern section) in Columbus, Ohio.

U.S.A. (CANADA)

BARNES ICE CAP RESEARCH PROGRAM

(R.LeB. Hooke and P.J. Hudleston, University of Minnesota)

In May 1980 we (1) repeated a surface movement survey and again found vertical velocities that are lower than Holdsworth measured in 1970-71, (2) tied our surface survey to Holdsworth's base line and found a roughly 2 m increase in thickness of the glacier since 1970, and (3) measured hole-parallel strain rates to a depth of 200 m at a place where the ice is about 380 m thick, and found a roughly uniform strain rate with depth.

Analysis of borehole deformation measurements is in progress.

CATASTROPHIC FLOODING FROM ICE-DAMMED LAKES, ST. ELIAS MOUNTAINS, YUKON

(D.E. Thompson, Jet Propulsion Laboratory; G.K.C. Clarke, University of British Columbia)

Processes of subglacial outbreak flooding of Hazard Lake at Steele Glacier are being studied. This includes monitoring the lake drainage, deciphering lake leakage and interconnection to the intraglacial channel network of the Steele Glacier, and recording changes in its response to the rapid removal of Hazard Lake and the influx of flood waters subglacially. The formation and modification of large scale fluvial features such as giant current ripples, longitudinal bars and grooves, and intense scour features which form during flooding both at Steele Glacier and in the Alsek River valley near Lowell Glacier are also being studied. The remnant scour features are analogous to many such features covering the Cheney-Palouse Scabland complex in eastern Washington, formed in response to ice-dam breakup and flooding of Glacial Lake Missoula during the Pleistocene. In addition, the features are very similar to many of those observed in the major outflow channels on Mars.

The glaciological work at Steele Glacier includes radar sounding, oxygen isotope measurements of lake and tunnel water and ice core samples, passive seismic monitoring, electrical changes in the ice around the tunnel during lake drainage, a packer experiment for changes in ice fracturing response following removal of the 100 m deep lake as a hydrostatic support of the ice wall, and remeasurement of thermal profiles from thermistors buried in previous seasons.

In 1979 Soviet glaciological expeditions studied the glaciers of the Caucasus, Central Asia, Altay, Polar Urals and Khibiny, and worked in the mountains of South, Central and East Siberia, Kamchatka and West Siberia, the Arctic and Antarctic.

CAUCASUS

The Institute of Geography, the USSR Academy of Sciences, has continued paleoglaciological studies on the southern macroslope of the main Caucasus. Repeated drilling of the key sections was undertaken in the Sakeni, Adishi and Khalde valleys. A new borehole, which may include all the Holocene and be representative of the whole slope, was drilled in the vicinity of Sakeni. In order to establish the vertical succession of glacioclimatic change a representative section was also drilled in the Kolkhida lowland in the area of Anakli. Lichenometric studies permitted reconstruction of the history of glaciation in the Caucasus for the last 800 years. Synchronism of glacioclimatic indices on both the macroslopes of the main Caucasus was proved. Pollen, lithologic and radio-carbon analyses indicated continuous existence of the Caucasus glaciers during the Holocene climatic optimum together with refugee thermophilic vegetation in cold periods. Variations of accumulation seriously affected glacier fluctuations, which is confirmed by micro-paleontological indication of high snowiness.

Multidisciplinary glaciometeorological observations were continued on the Marukh Glacier, where the motion and mass balance of the glacier were measured. Firn sequence and formation processes of the chemical composition of the glacier and also the structure of the air layer bordering the glacier were studied.

The year under review was remarkable for the beginning of regime studies of ice formations in the karst cave Snezhnaya, situated in the western Caucasus. The studies revealed temperature gradients in the cave, evaluated its water balance, the dimensions and structure of the ice formation as well as the origin of fragmented deposits related to it. In the course of these studies the explorers reached the maximum depth of 1280 m, a record descent in the USSR.

The North-Caucasian Service of the State Committee for Hydrometeorology carried out summer glaciometeorological observations on the Marukh and Chingurdzhar glaciers (western Caucasus, the Ullukam river basin) and also studied the distribution of atmospheric precipitation and snow cover in the glacierized zone. The annual values of the variations of 26 glacier tongues on the northern slope of the main Caucasus were determined in September. It was established that 6 were advancing and 20 were retreating. The maximum advance of 23.7 m was registered on the Bol'shoy Azau Glacier, while the maximum retreat, 26.4 m, belonged to the Bodorku Glacier. In 1979 melting was everywhere above the norm, while accumulation during the cold period was about average in the central Caucasus, exceeded it in the western Caucasus and was below the norm in the eastern Caucasus.

The Laboratory of Aerospace Observations, Moscow University, performed repeated large-scale photogrammetric surveys of the El'brus glaciers: Bol'shoy Azau, Irik, Terskol and the Dzhankuat glaciers. Since 1976 the Bol'shoy Azau Glacier has advanced by 25 m, its body has become wider than it was in the sixties and it has thickened.

Studies of snow avalanching were continued in the El'brus area by the *Laboratory on the Problems of Snow Avalanches and Mudflows, Moscow University*. The Laboratory obtained data characterising the change of contacts between grains in the process of metamorphism and analysed the effect of structural changes on the occurrence of avalanches and the process of avalanching. Experiments in the physical simulation of drifting snow interacting with model structures were continued on the "Snow Flume" installation. Traces of the impact on the natural environment of the air wave accompanying the avalanche were studied on an experimental polygon. Parameters of this moving wave were studied with the help of special instrumented poles. The graphs of time changes in the velocity and pressure of snow-air flows were plotted and analysed for 5 avalanches in an experimental avalanche catchment. Further development of the telemetric complex and evaluation of models of the occurrence and movement of snow-air flows was carried out by triggering powder materials along the "Snow Flume".

Snow avalanche studies were also performed by the *Alpine Geophysical Institute*. The problem of snow stability on slopes, taking into consideration snow dispersion, was solved numerically. It was established that under the same climatic conditions snow can behave differently, depending on its primary state and on the dynamics of the snow cover at a given moment. Most frequent avalanching occurs when the mean daily temperature exceeds -3°C. It may serve as a feature reliable enough for the prediction of advective avalanching. Since the majority of advective avalanches have a point form of initial movement, a nomogram for the computation of the possible volumes of such avalanches was proposed. It is based on the calculated mean values of the slope angle and the distance from the place of avalanche formation to the zone where this angle is zero. It has been established that precipitation exceeding 20 mm for 24 hours

and temperatures above -3°C will cause large advective avalanches (over $10^4 m^3$). If advective avalanching occurs in some areas, the snow stratigraphy should be taken into account in avalanche predictions together with the temperature conditions.

Kharkov University continued dendroclimatic studies aimed at reconstructing meteorological conditions which existed in the Alpine Caucasus during the last centuries. The method relating meteorological conditions to the density of wood in the annual rings of trees was used. Correlations between mean density of wood and total summer precipitation were revealed in the upper reaches of the Teberda River.

The Transcaucasian Hydrometeorological Institute carried out complex glaciohydrometeorological observations on the Devdoraki Glacier. Ablation, ice velocity and thickness, air temperature and humidity, water level and temperature, and discharge including that of glacier fed rivers, were measured. Stereophotogrammetric large-scale surveys of the Gergeti, Devdoraki, Kolka glaciers (Kazbek Massif) and of the Khalde, Adishi, Tviberi, Kitlod and Korul'dash glaciers (Inguri river basin) have been undertaken. Repeated surveys were performed at a month and a half interval on the Gergeti and Devdoraki glaciers.

CENTRAL ASIA

The Section of Geography of the Academy of Sciences, Kazakhskaya SSR, continued glacioclimatic studies on the glaciers of the Zailiyskiy and Dzhungarskiy Alatau. Observations of accumulation, ablation, mass balance and ice velocity were carried out using profiles and stakes. The Section of Geography also undertook detailed investigations of the dynamics of glacier variations according to the 1st class programme of observations on the Tsentralniy Tuyuksu Glacier in the Zailiyskiy Alatau, and the 2nd class programme on the Igly Tuyuksu, Shakal'sky, Zmeyevidniy glaciers (Zailiyskiy Alatau), and Shumskiy Glacier (Dzhungarskiy Alatau). Twenty-eight dynamic properties of the Tsentralniy Tuyuksu Glacier have been analysed for 1973/74-1977/78 and of the Shumskiy Glacier for 1976/77-1977/78. Mass balance data for the glaciers of the Tuyuksu river basin has been analysed for 1977/78.

The Section continued year-round studies in the avalanche hazard areas of south-eastern Kazakhstan and some areas of Kirgizia and Tadzhikistan. New methods for calculating the duration of the stable snow cover and maximum snow storage in the mountains were worked out. 1:2,500,000 scale maps have been compiled of: 1) the occurrence, disappearance and duration of snow cover in the Pamirs, Gissaro-Alay, Tien Shan and Dzhungarskiy Alatau; 2) the altitude of the seasonal snow line on glaciers of Central Asia and Kazakhstan; 3) annual totals of the accumulation of solid precipitation at the firn line in the mountains of Central Asia and Kazakhstan; 4) the air temperature (mean annual, mean summer, maximum and minimum) in the mountains of Central Asia and Kazakhstan. Larger-scale maps of the averaged estimate of avalanche hazard were also compiled.

In the course of studies of glacial mudflows, in the Zailiyskiy Alatau, new methods were worked out for recording precipitation in the mountains, for correcting precipitation gauge data and for humidity calculations. Precipitation and snow storage averages and the secular variability of humidity in the highlands were determined. The beginning, duration and rate of seasonal freezing and melting were established along with the thermal conditions governing debris formation and the linkage between thermal processes within glaciers and moraines on the one hand and climatic and other physico-climatic peculiarities of the glacio-nival zone on the other. Numerical evaluation of the properties of moraine lakes was carried out together with landscape-morphometric surveys of lakes in the Zailiyskiy Alatau.

The Kazakh Service of the State Committee for Hydrometeorology continued glaciological and avalanche investigations in the Zailiyskiy and Dzhungarskiy Alatau. The regime of avalanches and their impact on the redistribution of snow cover in the mountains were studied. Two methods of wet avalanche prediction were worked out for conditions on the northern slope of Zailiyskiy Alatau. These are based on criteria of snow stability on slopes, according to the state of the loose layer and the temperature-effected crust, and depend on the values of heat advection. The mapping of avalanche catchments in Ugamskiy and Talasskiy Ranges, together with measurements of avalanche-fed snow patches were continued in the spring and summer.

The Central Asia Hydrometeorological Institute continued glaciological studies of the Abramov Glacier under the long-term programme and also undertook field studies of much of the mountainous region of Kirgizia aimed at specifying the extent of avalanche danger and developing methods of avalanche mapping. Studies of artificial stimuli to glacier melting were continued. The Institute also studied the nature of mountain snow packs permitting the development of an airborne snow survey network in the alpine areas of Central Asia based on the statistical properties of the snow cover in relation to topography and climate. Kinetic equations of particle (snowflake) motion in a continuous medium (windflow) have been obtained. They take into account the interaction of snow-flakes in collision, by introducing the collision integral. Expressions have been found for boundary conditions. Wind regime peculiarities in snow drifts were determined with special reference

to the Khangaran River basin. Standard meteorological information and snowdrift gauge observations made it possible to develop a new method of snowdrift discharge computation.

The Institute of Geography, USSR Academy of Sciences, monitored fluctuations of the Medvezhiy and RGO glaciers in the Pamirs. A stake network was established and improved, and the motion and net mass-balance of the glaciers was measured. Phototheodolite surveys were repeated on the Medvezhiy Glacier. Three maps of this glacier were compiled for different dates and the external mass-exchange data plotted. The analysis revealed a 3-4 year delay in the active phase of the Medvezhiy Glacier as compared to its previous surging cycle. An hypothesis that the active phase mechanism after a surge is not accompanied by kinematic waves during the quiescent stage was advanced.

Analysis of the complex glaciomorphological indices for the Tien-Shan has been completed. It revealed the relationship between the evolution and spatial changes of glacierization and the climatic and geomorphological conditions.

The Kirgiz Service of the State Committee for Hydrometeorology continued detailed glaciological observations on the Golubin Glacier, situated on the northern slope of the Kirgiz Alatau in the Alaarcha River basin. In 1978-79 the mass-balance was again negative, accumulation being 790 g/cm² and ablation -1080 g/cm². The centre of the glacier tongue advanced 10-15 m while retreating 15-20 m along the right margin and 5-10 m along the left margin. Observations of glacier fluctuations and surface changes have been undertaken on the Aksu Vostochniy, Aksu Zapadniy and Dolonata glaciers, on the northern slope of the Kungey Alatau, and on the Dugov glacier in the spurs of the Alay Range. During the last 20 years the area of the Aksu Zapadniy Glacier has decreased by 6.2 x 10^3m², while the level of its surface dropped everywhere by 10-20 m, except for its lobe where an uplift of 10 m was registered. The area of the Aksu Vostochniy Glacier increased by 3.3 x 10^3m². The surface level of its lobe dropped a bit but an abrupt uplift of about 30-35 m was observed in the middle of the tongue. The area of the Dugov Glacier diminished by 30 x 10^3m² and its tongue retreated approximately 260 m.

The Tien-Shan station of the Kirgiz Academy of Sciences continued multidisciplinary studies on the Karabatkak Glacier in the Terskey Alatau. The state of the glacier is close to the long-term average, and its lobe continues to shrink. Data on glacier ablation on the southern slope of Terskey Alatau and on the northern slope of Suyek Range have been obtained. The position of a number of glaciers, based on 1977 aerial photography, was compared to data from the IGY. The observations revealed non-uniformity of glacier variations during this time-interval: the Kara-Kol'tor Glacier, in the Koylyu river basin, retreated 810 m, the Sarytor Glacier, in the upper reaches of the Bol'shoy Naryn River, did not change its position, while the Davidov Glacier, in the same region, advanced 260 m.

Glaciological Laboratory of the Institute of Geology and Geophysics, the Uzbek Academy of Sciences, studied the interrelations of glaciers and the geological environment. Investigations were carried out on the Shul'ts Glacier, in the Alayskiy Range, close to the well-studied Abramov Glacier. It was established that the main groups of glaciers coincide with the zones of transverse uplift of the Western Pamirs and Tien-Shan, and the location of the main glacial valleys coincides with fractures and lineaments, particularly in the basins of the Fedchenko Glacier and the Zeravshan River.

Numerical relationships between the extent of glacierization and the morphological properties of the basin were determined. New data on the nature and extent of the influence of surface debris on melting were obtained. A scheme was worked out for calculating denudation rates in rocky environments based on the actual values of accumulation and evacuation of debris. The laboratory also determined formulae for computing the influence of elevation, the nature of the rock environment and peculiarities of the glacier bed structure on the radiation and heat regime of different parts of a glacier. The extent of increase in ablation due to the effect of slope and seracs was determined. Numerical experiments with theoretical models of katabatic glacier winds revealed the role of the morphometric peculiarities of valleys in the regime of these winds.

The Tadzhik Service of the State Committee for Hydrometeorology carried out observations of glacier variations according to the 2nd class programme on the Skogach Glacier, Mazarskiy Range, and the GGP Glacier, Gissarskiy Range; according to the 3rd class programme on some glaciers in the Petr Pervyy, Turkestanskiy, Zeravshanskiy, Darvazskiy and Academiya Nauk ranges.

ALTAY

Tomsk University continued detailed studies of the Aktru Mtn glacier basin. Year-round investigations included observations of snow cover, aufeis, avalanches and the processes of ground freezing. Snow cover for the winter 1978-79 was about average, aufeis was less developed than usual and avalanches were rare. Glacier mass-balances were negative:-52 g/cm² for the Malyy Aktru Glacier and -73 g/cm² for the Vodopadniy Glacier. Areas of active block movement and a small surge of the Malyy Aktru Glacier were identified from repeated photogrammetric surveys. Radio echo soundings were continued on the "Kupol" glacier complex. The first evidence of snow-firn sequence stratification were obtained. Four annual layers

were clearly identified in the most temperate area of the glacier. Transverse observations in the Bish-Irdu mountain group indicate that glacier recession continues but is less rapid. Analysis of sequential aerial photography of the main glaciers shows that during the last 20-25 years it is the glaciers on the southern slopes that have wasted most actively.

Studies of aufeis were continued. A considerable amount of aufeis was found in the river ice cover. Maps showing the number and distribution of aufeis have been compiled. Based on paleoglaciological studies new information on the regime of former periglacial lakes has been obtained.

The Institute of Geography, the USSR Academy of Sciences, evaluated accumulation and precipitation fields of the glacier systems in the Altay-Sayan area. Similarities between mountain glacier basins of the Altay with regard to the conditions of run-off formation were evaluated. In support of this programme, the regimes of the Bol'shoy Aktru, Malyy Aktru, Yan-Karasu and Korumdu glaciers were studied.

The Section of Geography, the Kazakh Academy of Sciences, measured fluctuations of the Malyy Borel'skiy Glacier, according to the 2nd class programme, and also undertook expeditions to representative glaciers of the Altay as part of the International Hydrological Programme.

Kharkov University studied traces of former glaciation in the Severo-Chuyskiy Range, in the Aktru and Korumdu valleys, and found 600-800 year-old trees.

SIBERIA

The Geographical Institute of Siberia and the Far East continued studies on the snow cover of the Minusinskiy Basin, in particular its impact on the vegetation. It was established that moisture stored in the snow, which may cause irreversible changes in vegetation, tends to bring about an increase in more humid species in the composition of the phytocœnosis and depends on the dip angle, the exposure and water-retaining capacity of the soil. The role of solid precipitation as a mechanical agent was revealed. It causes the decay of abnormally developed trees and has a positive effect on the development of the phytocœnosis in general.

Studies of aufeis occurrence in river valleys along the Baykal-Amur railway were carried out. Direct and indirect indicators of aufeis development were discovered. Glacial forms of topography in the mountainous areas of Siberia and the Far East were studied, as well as pseudomorainic formations at the foot of the Khamar-Daban Range, on the southern shore of Lake Baykal. The data obtained confirmed the fallacy of the idea that in the Upper Pleistocene glaciers descended to Baykal.

The Central Asia Hydrometeorological Institute undertook snow-avalanche studies in the area where the Baykal-Amur railway crosses the Severo-Muyskiy and Baykal Ranges. Avalanche-prone areas along the Abakan-Kyzyl highway were identified and the catchments instrumented. Parameters of the snow cover and avalanches were calculated and the magnitude of the avalanche hazard evaluated.

The Institute of Permafrost formulated basic methods for detecting and mapping underground ice in connection with engineering studies along the Baykal-Amur railway.

Tomsk University carried out observations on the mass-balance and dynamics of glacières (cave ice), situated in the Malaya Syya River basin. The annual balance of the Verkhnesyyysky Glacier was +20 g/cm². Studies were continued in the Kuznetskiy Alatau. Based on archaeological evidence, it was possible to reconstruct the dynamics of the hydrothermal regime and the snowiness of its eastern slope.

The Laboratory on the Problems of Snow Avalanches and Mudflows, Moscow University, continued field and experimental studies on the nature of snow structure changes through metamorphism and under the extreme continental conditions of Udokan. Calculations were made to determine the stressed state of snow in avalanche catchments in this area.

The Institute of Geography, the USSR Academy of Sciences, has completed the analysis of the distribution of the snow cover in the area of the Ob'-Irtysh interfluve, that permitted a forecast to be made of the variations in the snow cover for a river discharge diversion.

The Institute of Permafrost investigated the large deposits of underground ice on the northern slope of East Siberia.

POLAR URALS

The Institute of Geography, the USSR Academy of Sciences, continued investigations in the Bol'shaya Khadata mountain-glacier basin. Observations on the fluctuations of the Obruchev, IGAN and MGU glaciers were continued. Photo-theodolite surveys were performed twice, the stake network was improved and mass-balance constituents were measured. Similarity of the year-to-year changes of the winter and annual mass-balances of the Obruchev and IGAN glaciers was established and that for ablation over short time intervals also confirmed. Turbulent energy exchange for the whole glacier was calculated using the heat-balance method. The Polar Urals Geographical Station studied the distribution of snow storage and the engineering and physical properties of the snow cover. The experiment undertaken with torch-like ice formation showed that the efficiency of this method is an order of magnitude greater than that of previous methods of building-up ice.

KHIBINY MOUNTAINS

The Laboratory on the Problems of Snow Avalanches and Mudflows, Moscow University, carried out topographic surveys and dendrochronological studies in some catchments with snow-melt in the Khibiny. Observations of the snow cover were made at the time of snow-melt in experimental areas of the Koashva River basin. The main factors causing their occurrence were analysed. A number of computations aimed at determining the stressed state of the snow cover in avalanche catchments were undertaken.

KAMCHATKA

The Institute of Volcanology continued long-term studies of present-day glaciers in areas of active volcanism. The main investigations were performed on the Kozel'skiy Glacier in the Avachinskaya group of volcanoes. The structure of the snow-firn sequence, the distribution of temperatures, the densities of snow and firn as well as the value of the autumn-winter component of internal feeding, which was 13.5 g/cm², were determined in pits, dug during traverses. The firn line rose to a height of 1300-1500 m a.s.l. The mean value of the accumulation was 290 g/cm² but the mass-balance was negative, about -130 g/cm².

Studies were also undertaken on one of the glacier groups in the central part of the Sredinniy Range. Since 1964 the Grechishkin Glacier has rètreated about 30 m and there has been considerable lowering of its surface. There are numerous crevasses in the accumulation area. In 1979 the firn line was at 1550 m, 40 m below its position in 1964. The average value of net accumulation in the accumulation area was 55 g/cm². The mass-balance of this glacier was insignificantly negative. On the Andrey Ivanov Glacier, situated in the same group, the firn line lies at 1400 m, the tongue descends to a height of 1000 m, and the value of net accumulation is 19 g/cm².

Studies of glaciers in the Kluchevskaya group of volcanoes were continued. Meteorological observations were undertaken on the Institute of Volcanology Glacier. The Zheltyy Glacier was studied for its morphology. Light was thrown on the climatic conditions during the transitional period between the ablation and accumulation seasons. The values of precipitation for 14 months were 920 mm on the Zheltyy Glacier, 1620 mm on the Budnikov Glacier and 1670 mm on the Institute of Volcanology Glacier. An avalanche of about $10^5 m^3$ from the Ostryy Tolbachik Glacier was investigated.

THE ARCTIC

The Institute of Geography, the USSR Academy of Sciences, calculated the field of mass-exchange for all the Arctic glacier systems (the total mass-balance was about 700 km³). The role of moisture fluxes in glacier nourishment was revealed along with the interrelations between moisture fluxes which feed the Greenland Ice Sheet, and its topography. The role of the Greenland Ice Sheet in the formation of circulation and climatic conditions in the Arctic, and consequently in the regime of ice caps on islands, was proved and numerically evaluated. The role of ice discharge by calving in the heat-balance of the Arctic Ocean was defined. Geological, palaeohydrological and glaciological evidence for the existence of continental glaciation of the Barents-Kara Shelf was revealed. Expeditions to Spitsbergen glaciers were continued. Radio echo-sounding of 65 glaciers of different types and dimensions was carried out: 35 of them being investigated for the first time. The position of the front of 40 glaciers was registered. A number of previously unknown surging glaciers were identified together with their group on the Hellefonna Ice Cap. Snow surveys were made by the air-landing method over vast areas. For the first time radio echo-sounding and geochemical measurements of the internal structure of glaciers were made together. Dating of coastal uplift was done by the absolute method and the relation between moraine and terrace deposits was established.

The Arctic and Antarctic Institute continued the studies of the Severnaya Zemlya glacier regime at the "Vavilov Dome" station. Radio echo-sounding and snow surveys of the Vavilov Glacier were performed. It was established that the mean thickness of snow cover was 60 cm, and snow storage was 22.6 g/cm². During the year 70-90 cm of ice melted from the glacier surface, and about 100-200 cm on the slopes and near the glacier margin. The radio echo-sounding results permitted the preparation of the first map of the bed topography of the Vavilov Glacier, at a scale of 1:200,000. Petrostructural analysis of ice samples from the 556.7 m-deep borehole in the glacier showed that it was possible to distinguish three horizons, at 0-30, 30-340 and 340 m. Polarization and the rate of radio-wave propagation were studied on the Vavilov and Karpinskiy glaciers. Large-scale geomorphological and Quaternary surveys were performed along with studies of the hydrological regime, precipitation and air temperatures in the spring and summer on Ostrov Oktyabr'skoy Revolyutsii.

The Laboratory of Isotope Geology, of the Estonian Academy of Sciences, carried out isotope and geochemical analysis of the ice core from the Vavilov Dome borehole. Reference layers, of β-activity and H^3, show that since 1959 the mean annual accumulation has been 15-20 g/cm² per year. The Laboratory also undertook isotope analysis of the core samples from the Lomonosov Plateau, which provided curves for a 35 m thick glacier sequence in Spitsbergen, reliably identifying seasonal layers. Abnormally high content of SO_4^{2-} corresponds to the periods of active volcanism in 1947, 1956, 1963, 1966 and 1974.

ANTARCTICA

Studies under the programme of the International Antarctic Glaciological Project were continued. *The Institute of Geography, the USSR Academy of Sciences*, completed thermal regime studies of the Antarctic Ice Sheet along two flow lines, crossing the Vostok and Byrd stations. Ice movement and temperature were computed for steady state conditions close to those of the present day. Melting zones were distinguished for different values of geothermal flux and conclusions were made about the possible degradation of glacierization in the central areas of eastern Antarctica. Changes in the thermal regime of the Ice Sheet were studied in relation to climatic fluctuations over the last 100,000 years and to possible climatic warming in the future. Evidence of the climatic minimum, about 18,000 years B.P., were detected in the temperature profile along with temperatures several degrees higher than those of the present day, which existed at the end of the Interglacial about 100,000 years B.P. It was concluded that a climatic warming would not noticeably affect temperatures at the glacier bed nor the pattern of ice flow in central Antarctica for thousands of years but that the state of the ice shelves will play a very important role in the evolution of the ice sheet.

The first core drilling through the Ross Ice Shelf was completed at point J-9, as part of the Ross Ice Shelf Project. Analysis of the core showed that freezing occurs on the bottom of the ice shelf at the rate of 2 cm/year. Where fresh water is available the rate of freezing is much higher. The data obtained and analysis of the heat exchange under the ice shelf show that if the temperature of the world ocean increases due to climatic warming, the heat exchange in the central areas of the Ross Ice Shelf will not change and the flow of fresh water under its rear areas will even increase. This will cause an increase in ice freezing under the ice shelf and a thickening of the rear areas.

Latest results from Soviet and other studies have led to the formulation of certain theories about the former glaciation of the inland and marine parts of the Antarctic Ice Sheet.

The Arctic and Antarctic Institute carried out analyses of moisture, radiation and heat balance components in the boundary layer. Moisture advection to the ice sheet equals 19.0 g/cm² per year, the general discharge of atmospheric moisture is -2.9 g/cm² per year and accumulation is -15.8 g/cm² per year.

Snow surveys were carried out along the Mirny-Vostok-Pionerskaya-Dome C traverse. The thickness and velocity of the ice sheet were measured by radio echo-sounding along the Pionerskaya -Komsomol'skaya-Dome B section. Geophysical measurements were made in the 800 m-deep borehole at Vostok station. Temperature and deformation of the borehole were observed in order to determine the prevailing direction of the horizontal components of the flow rate of the ice sheet. A 750 m borehole was drilled 70 km from the Mirny station. A borehole about 130 m deep was drilled at the Pionerskaya station. The core was extracted and the structural properties of the snow, firn and ice were observed. In the area of the Berkner Highland and abutting parts of the Filchner and Ronne ice shelves geophysical surveys, including seismic and radio echo-sounding, were carried out over an area of 35,000 km².

Among the main scientific results obtained in the area of glaciology in 1979 and not reflected in the regional sections we should mention the following.

1. The plotting of areas of accumulation, solid precipitation and glacial runoff at the level of the equilibrium line has been completed for the whole of the USSR. A method was worked out which evaluated the contribution of different factors of glaciation to its rate by comparing these areas. The glacial runoff from Tien-Shan (5 km³), Gissar-Alay (3.5 km³), the Caucasus (3 km³), Altay-Sayan mountain system (2 km³), and Dzhungarskiy Alatau (1 km³) was computed by interpretation of their accumulation areas.

2. Interpretation of the accumulation areas of glacier systems proved a weak relationship of accumulation, precipitation and runoff with altitude in complex mountain systems, and their dependence on topography at any point. The gradients of the above mentioned parameters indicated the direction of moisture transfer, the sources of glacier nourishment, and demonstrated the stream-like structure of moisture transfer in the mountains.

3. The exchange of ice mass in glacier systems was calculated and the rate of this exchange was related to the possibility of regulating their regime. It turned out that the residence time of ice in mountain glaciers is 100-150 years, in ice caps on islands it is about 1000 years and in continental ice sheets it is 5,000-15,000 years.

4. Experimental studies of snow structure changes during compaction were undertaken. The strength characteristics were shown to be dependent on quantitative properties of its structure. Numerical indices of the relative contact surface coefficient and its changes in the process of snow densification were obtained. The nature of the growth of contacts between the grains of snow and changes of snow structure in isothermal conditions were analysed, which is necessary for the general theory of snow recrystallisation.

5. The exponential nature of glacier demineralisation was confirmed along with the different mobility of micro-elements in glaciers connected with different forms of their migration – in solution and in suspension. The level of intraglacial waters was determined by the hydrochemical method.

6. An hypothesis was advanced stating the link between the internal reflecting boundary of glaciers, detected by radio echo sounding, and glacier surges.

V.M. Kotlyakov

Photographed by Edward Leigh

SCOTT POLAR RESEARCH INSTITUTE

The Scott Polar Research Institute was founded in 1920 as a memorial to Captain Robert Falcon Scott, RN, and his companions who lost their lives on the return journey from the South Pole in March 1912.

Frank Debenham and Raymond Priestley, both members of Scott's *Terra Nova* expedition, were responsible for the concept and establishment of the Institute, and Debenham became its first director, serving until his retirement in 1946.

During its early years in one room in the Sedgwick Museum of Geology in Cambridge, the Institute's modest aim was to provide a place where polar travellers and explorers could meet, and where material of polar interest might be collected and made accessible for future research. In later years it was able to expand in premises of its own, and also to extend its role in polar affairs. In the 1930s it became a base for a number of valuable scientific expeditions to the Arctic. During World War II it served the Government as a centre for research into cold weather warfare, clothing and equipment. Since the war it has developed further to become an international centre for research and reference in a variety of fields: historical, scientific and social.

The Institute became part of the University's Faculty of Geography and Geology in 1957. Before then, a Committee of Management appointed by the University and the Royal Geographical Society was responsible for overseeing the finance, staffing and general organization; a part-time Director, who held other University or College posts, organized the detailed running.

In 1957 staffing was rearranged by the University. It established posts for a full-time Director, two Assistant Directors of Research and a Senior Assistant in Research. The librarianship became a University post two years later. Outside funds have been used to finance other library and research posts. To advise the Director on general policy a committee was established consisting of the Professor of Geography, the Hydrographer of the Navy, six members appointed by the University, and one each by the National Institute of Oceanography, the Royal Society and the Royal Geographical Society.

The running costs of the Institute are met through the University Grants Committee, supplemented from national and other sources. These, at present, include grants from HM Government, the governments of Australia and New Zealand, and from industry. In addition, grants are received for the support of specific research projects from various bodies such as the Natural Environment Research Council.

The Institute houses the secretariats of two international polar organizations, the Scientific Committee on Antarctic Research (SCAR) and the International Glaciological Society, the latter since 1952.

Money for the first Institute building came from the residue of the Mansion House Fund raised in 1913 to provide for the dependants of the five members of Scott's South Pole party, and from the Pilgrim Trust. The building, opened in November 1934, contained a library, a museum, a gallery and a few offices or research rooms. As the scope of activities increased, so the demand for space far outgrew the resources of this building, threatening to choke progress altogether. Fortunately, a generous grant from the Ford Foundation in 1965, together with assistance from the University Grants Committee, made expansion possible and the second part of the building was occupied in 1968. The Institute now has a library, map room, archive room, fully equipped lecture theatre, museum, two laboratories, cold rooms and dark rooms in addition to offices and rooms for staff and research workers.

THE LIBRARY AND COLLECTIONS

Activities within the Institute, whether concerned with general information services, teaching, or research, are centred on the

library. It holds the world's largest single collection of published and unpublished material dealing with the Arctic and Antarctic. Its interests also extend to snow and ice studies in all glaciated regions of the Earth and to such characteristically polar animals as whales and seals wherever they are found.

The library serves as the focus of the Institute's information services. In the field of snow and ice studies the library administers World Data Centre C, a collection of published and unpublished material covering the world's glaciated regions.

In addition, the Institute holds extensive collections of polar manuscripts, photographs, prints, drawings and paintings, craftwork and expedition relics, stored when necessary in carefully controlled conditions.

Over the years, the Institute has formed an unrivalled collection of polar manuscript material. Most notable, perhaps, are the Franklin papers, which include the journals and correspondence of Sir John Franklin during his Arctic expeditions of 1819-22 and 1825-27. As well as these collections of private papers the Institute holds the more impersonal but equally valuable administrative and scientific archives of many polar expeditions and other ventures. Students from all over the world make use of the manuscrips collection and many books have been written using the material contained in it.

The Institute has a fine collection of pictures, of which the most outstanding are the hundreds of watercolours and drawings by Edward Wilson of Scott's *Discovery* and *Terra Nova* expeditions. A second rich source of illustrative material is the collection of many thousands of photographic prints and negatives. Other collections housed within the Institute include relics of famous expeditions, examples of the arts and crafts of polar native peoples: clothing, hunting gear and bone and ivory carvings of the Lapps, and Eskimo soap-stone sculptures and prints.

THE MUSEUM

The function of the museum is to allow public access to some of the more interesting material in the Institute's collections and, through the material, to provide an introduction to the many historical, cultural and scientific facets of the polar world. There are sections devoted to travelling equipment, to the history of exploration and to manuscripts, relics and paintings of Scott's two Antarctic expeditions. Further items illustrate Eskimo and Lapp arts and crafts, and modern polar research, including work carried out by members of the Institute.

PUBLICATION

Since 1931, the Institute has published *Polar Record*, the oldest of the journals wholly devoted to polar research. It appears three times a year with articles and notes of current and historical interest.

TEACHING AND RESEARCH

Members of the staff holding university teaching posts lecture in undergraduate courses run by other sections of the University, especially the Department of Geography. The most important teaching activities, however, are at graduate level. A graduate course in polar studies leading to the degree of Master of Philosophy is held each year.

The stimulation of research in polar regions has always been an important part through the years but the pattern remains constant — periods of field work alternating with work in the Institute.

In recent years much of the scientific research has been directed at investigation of ice and snow, and international collaboration in mounting field work has been characteristic. Excellent co-operation has been established with research groups in Canada, Denmark, Norway and the USA.

In the Arctic, understanding the distribution, thickness, physical properties and dynamics of sea ice has been the main focus of effort. Experiments have been undertaken in the Bering and Beaufort seas, the waters of Labrador and Svalbard, as well as in the east Greenland current, using a variety of new equipment carried on oversnow vehicles, in aircraft and in submarines. Such studies are of increasing importance to the economic exploitation of ice-infested northern waters. Indeed, some research has been specifically aimed at evaluating such problems as oil spillage in pack ice.

The Institute's staff have also made extensive contributions to the knowledge of the Antarctic ice sheet and the continent beneath the ice. Radio echo sounding techniques developed in the Institute have been used in aircraft operated by the United States Antarctic Program to survey about half the continent. In addition to mapping the surface and bedrock beneath the ice sheet, these studies have helped in understanding the international structure, flow and stability of the ice sheet and ice shelves.

Another research theme is the social and economic development of nothern lands, particularly Siberia, and a comparison of these developments in different Arctic countries.

The value of association with the University is reflected both in the development of research projects in the Institute, and in stimulating the interest of other University departments in opportunities for the study of particular topics in polar regions. Close contact and co-operation are maintained with operational organizations, particularly with the British Antarctic Survey which is also based in Cambridge.

(Abstracted from the new brochure of the Scott Polar Research Institute)

THIRD INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGY

SECOND CIRCULAR

Columbus, Ohio, U.S.A. 7-12 September 1981

SYMPOSIUM DATES CHANGED

TO

7 – 12 SEPTEMBER 1981

STEERING COMMITTEE

C.B.B. Bull, Chairman, U.S. member SCAR Working Group on Glaciology
D.H. Elliot, Director, Institute of Polar Studies, OSU
L.W. Gold, President, International Glaciological Society
F Roots, President, International Commission on Snow and Ice
A.L. Washburn, Chairman, Polar Research Board, NRC
J.H. Zumberge, Chairman, Committee on International Polar Relations, NRC
T.F. Malone, Foreign Secretary, NAS

LOCAL ORGANIZING COMMITTEE

C.B.B. Bull, Chairman
P.J. Anderson
C.R. Bentley (U. Wisconsin, Madison)
D.G. Bull
D.H. Elliot
H. Richardson (IGS)
L.G. Thompson
P.N. Webb
I.M. Whillans

PAPERS COMMITTEE

C.W.M. Swithinbank, Chairman
W.F. Budd
C.B.B. Bull
J.W. Glen
H Kohnen
V.M. Kotlyakov
C. Lorius
O. Orheim
H.J. Zwally

Information about the Symposium and arrangements in Columbus may be obtained from: Institute of Polar Studies
The Ohio State University
125 South Oval Mall
Columbus, Ohio 43210 USA

Telephone: 614/422-6531

The Third International Symposium on Antarctic Glaciology will be held in Columbus, Ohio, 7 September to 12 September 1981 at The Ohio State University. This is a change in dates from the first circular because of conflicts with the University calendar. Registration will take place on Sunday, 6 September, at the dormitory on The Ohio State University campus. Sessions will be held from 7 September to 12 September in the Ohio Union. There will be a guided tour to the area of the southern edge of the Laurentide Ice Sheet in the middle of Symposium week. A related workshop on "Radio-glaciology" organized by the staff of World Data Centre A – Glaciology, will be held on 4–5 September, prior to the Symposium.

1. PARTICIPATION

This circular includes a form for pre-registration and accommodation. The form should be sent to the Institute of Polar Studies as soon as possible. The Registration Fee covers organizational expenses and the mid-Symposium tour.

Deadlines for deposits will be announced in the third circular. Payments should be made in U.S. dollars to "Third International Symposium on Antarctic Glaciology" and sent to the Institute of Polar Studies.

Registration fees:

Participants	$50 US
Students	$25 US
Accompanying persons	$25 US

2. TOPICS

Papers dealing with any aspect of Antarctic glaciology will be welcome. However themes for the meeting are (1) climatic and glacial changes in Antarctica on time scales from 10 to 10 million years, (2) mass and energy balances of the ice sheet and of sea ice, and (3) physical and chemical properties of Antarctic snow and ice. Some sessions of the Symposium may be oriented toward particular geographical regions.

3. PROGRAM

A detailed program will be given in the Third Circular. On Sunday evening, 6 September, there will be an informal party. The Symposium banquet will be on Friday, 11 September. Various local tours will be arranged for those interested.

4. ACCOMMODATIONS

Hotel rooms will be available in the Holiday Inn ($30 and up per night for a single room) and in University dormitories (about $8 per night each for four to a room to about $15 per night for a single room). Dormitory rooms are air conditioned and have private baths and telephones. Meals will be available in the University Commons at a cost of about $10 for three meals and in area restaurants.

5. TRANSPORTATION

Several airlines serve Columbus with frequent flights from Boston, New York, Washington, Chicago and other major cities. Details of transportation between Port Columbus Airport and the University will be provided later.

6. PAPERS

(i) SUBMISSION OF PAPERS

Any participant wishing to contribute to the Symposium should first submit a summary of his proposed paper in English. This summary should contain sufficient detail to enable the Papers Committee to decide on the likely merit of the proposed paper, but must not exceed three pages of typescript. Summaries must be submitted on 8½ by 11 inch or international size A4 (210 x 297 mm) paper with wide margins and double spaced lines; summaries should be sent to the Institute of Polar Studies for duplication and distribution to the members of the Papers Committee.

(ii) SELECTION OF PAPERS

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account scientific quality and relevance to Antarctic glaciology. The Papers Committee will then invite a strictly limited number of papers for presentation and thorough discussion at the Symposium (not necessarily confining themselves to authors who have submitted summaries). It is hoped to notify authors of accepted papers during March 1981.

(iii) DISTRIBUTION OF SUMMARIES

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

(iv) SUBMISSION OF FINAL PAPERS AND PUBLICATION

The Proceedings will be published by the International Glaciological Society. Papers presented at the Symposium will be considered for publication in these Proceedings, provided they have not been submitted for publication elsewhere. Final typescripts of these papers should be submitted to the House Editor, Annals of Glaciology, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England, by 1 July 1981. They should be written in English and prepared in accordance with the instructions that will be sent to authors when they are notified about acceptance of papers for the Symposium. The maximum length for papers will be 5000 words or the equivalent length *including* references and illustrations. The papers will be refereed according to the usual standards of the Society before being accepted for publication. Speedy publication of the proceedings will depend upon strict adherence to deadlines.

LAST DATE FOR RECEIPT OF SUMMARIES:

15 DECEMBER 1980

LAST DATE FOR RECEIPT OF FINAL PAPERS:

1 July 1981

7. SOCIAL EVENTS

(i) Welcome Party

On the evening of Sunday, 6 September, there will be a social hosted by the Institute of Polar Studies.

(ii) "Ohio Night"

On the evening of Wednesday, 9 September, there will be a mid-western U.S. cookout (picnic dinner) in conjunction with the guided tour.

(iii) Symposium Banquet

The Symposium Banquet will be held on Friday, 11 September, in the University Faculty Club. Dress will be informal. If you plan to attend the banquet please indicate this in section C of the pre-registration form.

(iv) Local tours and attractions

The Ohio State University, Columbus, and the central Ohio area have a large number of attractions. University recreational facilities, including tennis and swimming, will be available to participants. Local attractions include The Ohio Village, a reconstruction of a 19th Century county seat, with special emphasis on the crafts of that period, the Ohio Historical Society which specializes in Indian anthropology, The Columbus Museum of Fine Art, The Cultural Arts Center and the Center of Science and Industry. Further afield are Mennonite and Amish communities and outstanding craftsmen, working in jewelry, leather, fiber and other media, many of whom have open studios. Visits to several such places will be organized to accommodate the wishes of our visitors. Respondents to the First Circular who indicated that they will bring spouses or children will be contacted directly. Others will be welcome to join in these activities. Details will be given in the Third Circular.

8. DISPLAY SPACE

There will be a limited amount of space available for displays of photographs and maps related to Antarctic glaciology. Those participants who wish to use such space are asked to write to the Institute of Polar Studies, giving details of the material they wish to display and the area required.

9. SOCIETY AND WORKING GROUP MEETINGS

Formal meetings of the SCAR Working Group on Glaciology and business meetings of the International Glaciological Society and ICSI will probably be held during the Symposium.

10. EXCURSIONS

(i) Mid-Symposium Tour

On Wednesday, 9 September, there will be a guided tour to the area of the southern edge of the Laurentide Ice Sheet in south-central Ohio. Transportation from Columbus will be by air-conditioned chartered coach. Walking shoes should be brought as well as summer field clothing. Temperatures are apt to be 70°–80° F (21°–26° C). The tour will be guided by scientists from the Institute of Polar Studies and the Department of Geology and Mineralogy.

(ii) Post-Symposium Tour

Spectacular glacial grooves occur on Kelleys Island in Lake Erie 180 km north of Columbus. Carved in limestone is a long channel 9 m across with 0.2 m flutes that travel along the channel, sometimes straight, and sometimes twisting and crossing. There are as many different theories for the formation of these grooves as scientists who have studied the site. One theory will be advanced and there will be time for participants to make up their own minds. Perhaps a significant contribution

to the theories can be made. The trip to Kelleys Island involves about 2.5 hours by bus over classic till plain, and moraines, and beaches from former levels of Lake Erie. The ferry takes about thirty minutes and lodging will probably be at the Kelley Mansion which includes a famous wooden spiral staircase. Dinner will be at the "Village Pump", a bar/restaurant with distinct Ohio character. Participants may wish to swim in Lake Erie or in one of the old quarries on the island. The return to Columbus on Sunday will accommodate late afternoon airplane departures. The estimated cost is $40/person. If you plan to participate in the tour to Kelleys Island, please indicate this in Section D of the pre-registration form.

11. RADIO GLACIOLOGY WORKSHOP

A Radio Glaciology Workshop, organized by World Data Center A – Glaciology, will be held prior to the Symposium on 4 and 5 September. Details of the Workshop and pre-registration can be accomplished by writing to

WDC A – Glaciology
Institute of Arctic and Alpine Research
Campus Mail Box 450
University of Colorado
Boulder, Colorado 80309 USA

Telephone: 303/492-5171

12. VISAS

Participants from outside the United States may require visas. Contact the nearest U.S. consulate for information and to file an application.

13. FOOTBALL GAME

The Ohio State University will play Duke University in a football game on Saturday afternoon, 12 September. A limited number of tickets can be purchased by interested Symposium participants at a cost of about $11.00. Please indicate your interest in section E of the pre-registration.

DATES TO REMEMBER

15 December 1980 Last day for summaries to be received at the Institute of Polar Studies.

March 1981 Notification by Papers Committee of those papers selected for the Symposium.

1 May 1981 Registration and deposits to be received at the Institute of Polar Studies.

1 July 1981 Last day for receipt in the International Glaciological Society of final papers.

4-5 September 1981 Radio Glaciology Workshop.

7-12 September 1981 Third International Symposium on Antarctic Glaciology at The Ohio State University.

12 September 1981 Football game between Ohio State University and Duke University.

12-13 September 1981 Possible field trip to the glacial grooves on Kelleys Island in Lake Erie.

YOUR COPY

Registration, Accommodation

THIRD INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGY

7 September - 12 September 1981

A PRE-REGISTRATION FORM
(Please type or print in black ink)

Full name.....

Address.....

.....

Accompanied by
Name.....
Name.....

* * * * * * * *

B ACCOMMODATION FORM

Please reserve following accommodation for the nights of 6 - 12 September 1981.

Holiday Inn Hotel
Shared accommodation .....
Single accommodation .....
University Dormitory:
Shared accommodation .....
Single accommodation .....

C SYMPOSIUM BANQUET

..... I plan to attend Symposium Banquet on 11 September at an approximate cost of $15.00
..... I do not plan to attend Symposium Banquet.

* * * * * * * *

D POST SYMPOSIUM TOUR

..... I am interested in a guided tour to Kelleys Island.
..... I am not interested.

* * * * * * * *

E FOOTBALL GAME

..... I am interested in attending the Ohio State University – Duke University football game on Saturday, 12 September, at a cost of about $11.00.
..... I am not interested.

Registration, Accommodation

THIRD INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGY

7 September - 12 September 1981

Mail to: Institute of Polar Studies
The Ohio State University
125 South Oval Mall
Columbus, Ohio 43210 USA

As soon as possible

A PRE-REGISTRATION FORM
(Please type or print in black ink)

Full name.....

Address.....

.....

Accompanied by
Name.....
Name.....

* * * * * * * *

B ACCOMMODATION FORM

Please reserve following accommodation for the nights of 6 - 12 September 1981.

Holiday Inn Hotel:
Shared accommodation .....
Single accommodation .....
University Dormitory:
Shared accommodation .....
Single accommodation .....

C SYMPOSIUM BANQUET

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..... I do not plan to attend Symposium Banquet.

* * * * * * * *

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..... I am not interested.

* * * * * * * *

E FOOTBALL GAME

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..... I am not interested.

SECOND SYMPOSIUM ON APPLIED GLACIOLOGY

FIRST CIRCULAR

Hanover, New Hampshire, U.S.A. 23-27 August 1982

The Society will hold a Second Symposium on Applied Glaciology in New Hampshire, USA in 1982; the first symposium on this subject was held in 1976 in Cambridge, U.K. Registration will take place on Sunday 22 August, and sessions will be from Monday 23 to Friday 27 August.

TOPICS

The Symposium will be concerned with the following topics:

1. engineering problems associated with river, lake and sea ice;
2. engineering problems associated with ground ice, icebergs and glaciers;
3. properties and behaviour of snow, ice and ice cover;
4. snow removal, control and processing;
5. avalanche control and snow pressure;
6. ice accretion;
7. modelling techniques in applied glaciology.

PAPERS

The Papers Committee will be happy to consider any paper that provides new information on the above topics. Details about the submission of summaries and final papers will be given in the Second Circular, to be published in the summer of 1981. Dates for submission are firm ones and must be adhered to.

PUBLICATION

The Proceedings of the Symposium will be published in the *Annals of Glaciology*. Papers will be refereed according to the Society's usual standards before being accepted for publication.

ORGANIZATION

The main organization is undertaken at the Society's Headquarters office in Cambridge, U.K., while the local organization will be effected by our members in Hanover, with the help of staff of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL). We hope to arrange visits to the Laboratory during the week of the Symposium. Local tours will be arranged for people accompanying the participants. The Society's Annual Dinner will be held during the week.

FURTHER INFORMATION

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

Requests for copies of the Second Circular should be addressed to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

ORGANIZING COMMITTEE

A.J. Gow (Chairman)
B.S. Yamashita
W.F. Weeks
H. Richardson (Secretary General, IGS)

INTERNATIONAL GLACIOLOGICAL SOCIETY SYMPOSIUM ON APPLIED GLACIOLOGY, 1982

Family Name.....

First Name.....Title.....

Address.....

.....

* I hope to participate in the Symposium, 1982
* I expect to submit a summary of a proposed paper on topic no.....
* without obligation

TO BE SENT AS SOON AS POSSIBLE TO:

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

The following papers have been accepted for publication in the Journal:

J. Niewodniczanski, J. Grabczak, L. Baranski and J. Rzepka:
The altitude effect on the isotope composition of snow in high mountains.

H.T. Brady and B. Batts:
Large salt beds on the surface of the Ross Ice Shelf near Black Island, Antarctica.

S.J. Bolsenga:
Radiation transmittance through lake ice in the 400-700 nm range.

K. Hutter:
The effect of longitudinal strain on the shear stress of an ice sheet: in defence of using stretched coordinates.

G. Brugnot and R. Pochat:
Numerical simulation study of avalanches.

V.R. Parameswaran and S.J. Jones:
Triaxial testing of frozen sand.

W. Ambach, M. Blumthaler and P. Kirchlechner:
Application of the gravity flow theory to the percolation of melt water through firn.

R.G. Oakberg:
Variational method for glacier mechanics problems.

I.R. Johnson:
The steady profile of an asymmetric ice sheet.

S.R. Rotman, A.D. Fisher and D.H. Staelin:
Analysis of multiple-angle microwave observations of snow and ice using cluster-analysis techniques.

R.B. Rains and J. Shaw:
Some mechanisms of controlled moraine development, Antarctica.

P. Duval:
Creep and fabrics of polycrystalline ice under shear and compression.

A.T. Wilson and C.H. Hendy:
The chemical stratigraphy of polar ice sheets - a method of dating ice cores.

K. Hutter, F. Legerer and U. Spring:
First-order stresses and deformations in glaciers and ice sheets.

L.Lliboutry and L. Reynaud:
"Global dynamics" of a temperate valley glacier, Mer de Glace, and past velocities deduced from Forbes bands.

M. Nakawo and N.K. Sinha:
Growth rate and salinity profile of first-year sea ice in the high Arctic.

D.K. Perovich and T.C. Grenfell:
Laboratory studies of the optical properties of young NaCl ice.

D.P. Dethier and J.E. Frederick:
Mass balance of Vesper Glacier, Washington.

J.A. Warburton and L.G. Young:
Estimating ratios of snow accumulation in Antarctica by chemical methods.

S. Martin and P. Kauffman:
A field and laboratory study of wave damping by grease ice.

J.F. Bishop and J.L.W. Walton:
Bottom melting under George VI Ice Shelf, Antarctica.

R.J. Braithwaite:
On glacier energy balance, ablation and air temperature.

S. Hastenrath and B. Koci:
Micro-morphology of the snow surface at the Quelccaya ice cap, Peru.

E.M. Shoemaker:
Creep slump in glacier reservoirs - theory and experiment.

A.J. Aristarain and R. Delmas:
First glaciological studies on the James Ross Island ice cap (Antarctic Peninsula).

G.A. Olyphant:
Interactions among controls of cirque development: Sangre de Cristo Mountains, Colorado, U.S.A.

A. Iken:
The effect of subglacial water pressure on the sliding velocity of a glacier in an idealized numerical model.

Instruments and methods:

H. Gubler:
An inexpensive remote snow-depth gauge based on ultrasonic wave reflection from the snow surface.

H. Gubler:
An electronic remote snow-drift gauge.

E.M. Morris:
Field measurements of the liquid-water content of snow.

T.C. Grenfell:
An infrared scanning photometer for field measurements of spectral albedo and irradiance under polar conditions.

D. Bowles and R.L. Brown:
A stress-wave generator for snow and ice studies.

R.D. Watts and D.L. Wright:
Systems for measuring thickness of temperate and polar ice from the ground or from the air.

Short notes:

U.K. Bassi, S. Chopra and A.P. Tewari:
Note on the morphology of Baspa Glacier, District Kinnaur, Himachal Pradesh, India.

J. Fountain, T.M. Usselman, J. Wooden and C.C. Langway, Jr.:
Evidence of the bedrock beneath the Greenland ice sheet near Camp Century, Greenland.

W. Karlen:
Flutes on bare bedrock.

D. Hantz and L. Lliboutry:
The inverse problem for valley glacier flow.

I.J. Smalley:
Conjectures, hypotheses, and theories of drumlin formation.

P. Carrara:
Evidence for a former large ice sheet in the Orville Coast - Ronne Ice Shelf area, Antarctica.

P.A. Mayewski, P.A. Jeschke and N. Ahmad:
An active rock glacier, Wavbal Pass, Jammu and Kashmir Himalayas, India.

R.S. Liebling and H.S. Sherp:
Structure control on cirque-like features in south-east New York State, U.S.A.

W.J. Wayne:
Ice segregation as an origin for lenses of non-glacial ice in "ice-cemented" rock glaciers.

P.F. Karrow:
Till texture in drumlins.

FUTURE MEETINGS (of other organizations)

INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES

IAHS at EXETER 1982

Exeter, Devon, U.K. 19-30 July 1982

At the invitation of the Royal Society, the First Scientific Assembly of IAHS to be convened outside the General Assemblies of the International Union of Geodesy and Geophysics will be held at the University of Exeter. Exeter is an historic city with a population of about 100,000 in south-west England some 275 km from London.

PROVISIONAL SCIENTIFIC PROGRAMME
It is envisaged that during the Assembly the six Commissions will each organize one symposium which may last between 2 and 4 days, some of which will run concurrently. Some of the presentations will be in the form of lectures and others as poster sessions. The topic chosen by the International Commission on Snow and Ice is "Hydrological aspects of alpine and high mountain areas".

PUBLICATIONS
It is expected that the proceedings of the Symposia will be pre-published. A time-table for submission of abstracts and papers will be provided in the 2nd Circular and detailed instructions will be provided to authors. So that a high standard is maintained, all the abstracts will be screened and all the papers that result from them will be screened, so that only a limited number will be finally accepted. All papers will be limited in length, probably to 8 printed pages.

PROVISIONAL REGISTRATION
For further information on the Exeter Assembly write to:

The Organizing Committee,
IAHS Scientific Assembly
Institute of Hydrology
Wallingford, Oxon., U.K.

VI INTERNATIONAL SYMPOSIUM ON THE PHYSICS AND CHEMISTRY OF ICE

August 1982 — University of Missouri-Rolla, U.S.A.

A five-day symposium is planned to bring together workers from different disciplines who are interested in the structure and physical and chemical properties of ice. General topics to be emphasized during the conference include:

- Diffusion and relaxation phenomena
- Electrical and mechanical properties
- Lattice dynamics
- Crystal structure crystal growth
- Amorphous and clathrate ice
- Glaciology and meteorology
- Surface structure and properties

Details concerning abstract deadlines, publication of papers, exact dates, etc. will be forthcoming in subsequent announcements. To receive the first announcement and further information write to the conference organiser.

Patricia L.M. Plummer,
Department of Physics and
Cloud Physics
University of Missouri-Rolla,
Rolla,
Missouri 65401
U.S.A.

SYMPOSIUM ON VARIATIONS IN THE GLOBAL WATER BUDGET

10-15 August 1981 Oxford, U.K.

An international symposium on the long and short-term variations in the global water budget is being organized jointly by the IAMAP Commission on Climate (ICCL) and the IAHS, with the co-sponsorship of the INQUA Palæoclimate Commission, the Joint Scientific Committee for the World Climate Research Programme (JSC), the Royal Meteorological Society, the American Meteorological Society and UNESCO. It will precede the IAMAP Scientific Assembly in Hamburg (17-28 August) and follow the IAMAP Symposium on Dynamics of the General Circulation in Reading, U.K. (3-7 August). To ensure that the meeting is of the highest standard, it is intended to restrict the number of participants to 150.

AIMS

a) To increase understanding of the physical processes that control seasonal and non-seasonal variations of the global water budget.
b) To establish the modes of variation of the hydrological cycle over various regions of the globe and to relate them to changes in the large-scale circulation of the atmosphere and ocean.
c) To discuss recent data on the oceanic water budget.
d) To compare the patterns of variability on different time scales.

SCIENTIFIC PROGRAMME

The programme will consist of ten sessions with coordinated poster displays. The average length of papers will be 30 mins., including discussion. Sessions 1-5 will be devoted mainly to measurements taken in the past century, while sessions 6-9 will cover a range of time periods. Poster papers will be regarded as an integral part of the Symposium and specific times will be allotted for them in the programme. It is hoped that about 40% of the papers will be presented in poster form. There will be no parallel sessions. Session 7 has been convened by M. Kuhn, Institut für Meteorologie, Innsbruck and P.C. Miller, San Diego State University and deals with - Fluctuations in high latitudes and high altitudes - isotopes in ice cores, changes in extent of glaciers, sea ice and snow line, permafrost changes.

SELECTION OF PAPERS

Abstracts submitted for the Symposium will be screened by the Programme Committee, under the chairmanship of Prof. R.E. Newell, which will then invite a strictly limited number of papers for presentation. It is hoped to notify authors of accepted papers by 15 May 1981. Extended abstracts, submitted in the form of camera ready copy, should be received by Dr. F.A. Perrott by 16 March 1981. Copies of the accepted abstracts will be distributed to participants. It is hoped that a special volume will be published after the meeting. The deadline for receipt of manuscripts is 14 August 1981. All manuscripts will be refereed by the Programme Committee before being accepted for publication.

FURTHER INFORMATION

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

Dr F.A. Perrott,
School of Geography,
Mansfield Road,
Oxford OX1 3TB, U.K.

GLACIOLOGICAL DIARY

1981

27 February - 1 March
North East North American Branch, International Glaciological Society. Le Château Montebello, Montebello, Québec, Canada. (Dr G.J. Young, Snow and Ice Division, Environment Canada, Ottawa, Ontario, K1A 0E7, Canada)

2-6 March
Fourth Canadian Permafrost Conference. Calgary, Alberta, Canada. Associate Committee on Geotechnical Research, National Research Council of Canada. (Mrs M.L. Baignée, Conference Services Office, Building M-58, National Research Council of Canada, Ottawa, Ontario, K1A 0R6, Canada)

8-10 April
Second Speciality Conference on Cold Regions Engineering: Northern Communities - the Search for a Quality Environment. Seattle, Washington. American Society of Civil Engineers. (Ted. S. Vinson, Dept. of Civil Engineering, Oregon State University, Corvallis, Oregon 97331, U.S.A.)

14-16 April
49th Annual Western Snow Conference. St. George, Utah. (Bob Whaley, Snow Survey Supervisor, SCS, 4420 Federal Building, 125 South State Street, Salt Lake City, Utah 84130, U.S.A.)

mid April
ACROSES Ice Workshop. Université du Québec à Rimouski, Québec, Canada. Associate Committee for Research on Shoreline Erosion and Sedimentation. National Research Council of Canada. (Mr D. Willis, Secretary ACROSES, Hydraulics Laboratory, National Research Council of Canada, Ottawa, Ontario, K1A 0R6, Canada)

11-13 May
Conference on "Antarctica: Weather and Climate". Melbourne, Australia. (N.A. Streten, Department of Meteorology, School of Earth Sciences, University of Melbourne, Parkville 3052, Australia)

11-15 May
Cold Regions Engineering, American Society of Civil Engineers International Convention. New York, U.S.A. (Albert F. Wuori, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755, U.S.A.)

18-21 May
Symposium on the Mechanical Behaviour of Structured Media. Carleton University, Ottawa, Ontario, Canada. (A.P.S. Selvadurai, Department of Civil Engineering, Carleton University, Ottawa, Ontario, K1S 5B6, Canada)

22-24 May
Quaternary Dating Methods Symposium. Toronto, Ontario, Canada. (W.C. Mahaney, Department of Geography, Atkinson College, York University, Downsview, Ontario, M3J 2R7, Canada)

26-27 May
5th Canadian Hydrotechnical Conference. Fredericton, New Brunswick, Canada. (Dr D.I. Bray, Dept. of Civil Engineering, University of New Brunswick, P.O. Box 4400, Fredericton, New Brunswick, E3B 5A3, Canada)

4-5 June
38th Annual Meeting of the Eastern Snow Conference, Syracuse, New York, U.S.A. (Barry Goodison, Hydrometeorology Division, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, M3H 5T5, Canada)

27-31 July
6th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC-81). Québec City, Québec, Canada. (B. Michel, Département Génie Civil, Université Laval, Cité Universitaire, Québec, G1K 7P4, Canada)

27-31 July
International Symposium on Ice, International Association for Hydraulic Research, cosponsored by IAHS, WMO and the International Glaciological Society. Québec City, Québec, Canada. (B.Michel, Département Génie Civil, Université Laval, Cité Universitaire, Québec, G1K 7P4, Canada)

24-29 August
Atmospheric and Oceanic Transport and Assimilation Processes in the Arctic, 8th Annual Meeting of the European Geophysical Society. Uppsala, Sweden. (Dr C.E. Lund, Box 556, S-75122 Uppsala, Sweden)

24-29 August
An Excursion and Workshop in Gaspésie, Québec, on Weathering Zones and the Problem of Glacier Limits. Gaspésie, Québec, Canada. L'Association Québecoise pour l'étude du Quaternaire (AQQUA) for the Canadian Quaternary Association. (James Gray, Département de Géographie, Université de Montréal, Montréal, Québec, H3C 3J7, Canada)

4-6 September
Western Alpine Branch Meeting, International Glaciological Society. Luchon, Pyrénées, France. (F. Valla, c/o Nivologie CT-GREF, B.P.114, 38402 St Martin d'Hères, France)

7-16 September
International Conference on Hydrology and Rational Water Resources Management, convened by Unesco and WMO. Paris, France. (S. Dumistrescu, Director, Division of Water Sciences, Unesco, 7 Place de Fontenoy, 75700 Paris, France)

7-12 September
Third International Symposium on Antarctic Glaciology. The Ohio State University, Columbus, Ohio, U.S.A. Scientific Committee on Antarctic Research of ICSU. Co-sponsored by the International Commission of Snow and Ice and the International Glaciological Society. (Dr C.B.B. Bull, Institute of Polar Studies. The Ohio State University, 125 South Oval Mall, Columbus, Ohio 43210, U.S.A.)

10-15 September
Symposium on Variations in the Global Water Budget. Oxford, England. (Dr F. Alayne Street, School of Geography, Mansfield Road, Oxford OX1 3TB, U.K. or Prof. R.E. Newell, Department of Meteorology, 54-1520, MIT, Cambridge, MA 02139, USA)

23-25 September
British Branch Meeting, International Glaciological Society. Norwich, U.K. (G.D. Smith, School of Mathematics and Physics, University of East Anglia, Norwich NR4 7IJ, U.K.)

28 September - 3 October
International Symposium on Tracer Techniques in Hydrology. Berne, Switzerland. (Dr Ch. Leibundgut, 4. SUWT, Geographisches Institut, Universität Bern, Hallerstrasse 12, CH-3012 Bern, Switzerland)

1982

March
South-American Regional Meeting on Glacigenic Deposits Neuquen (Neuquen) and San Carlos de Bariloche (Rio Negro), Argentina. (Dr Jorge Rabassa, Departemento de Geografia, Universidad Nacional del Comahue, Av. Argentina 1400, 8300 Neuquen, Argentina)

13-16 April
Joint Meeting, 39th Annual Eastern Snow Conference and 50th Annual Western Snow Conference. Reno, Nevada, U.S.A.

19-30 July
International Association of Hydrological Sciences, Exeter Assembly. Exeter, Devon, England. (The Organizing Committee, IAHS Scientific Assembly, Institute of Hydrology, Wallingford, Oxford, U.K.)

August
6th International Symposium on the Physics and Chemistry of Ice. Rolla, Missouri, U.S.A. (Patricia L.M. Plummer, Department of Physics and Cloud Physics, University of Missouri-Rolla, Rolla, Missouri 65401, U.S.A.)

23-27 August
Second Symposium on Applied Glaciology. Hanover, New Hampshire, U.S.A. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, England)

1-9 September
INQUA Conference. Moscow, U.S.S.R.

16-20 September
4th International Symposium on Antarctic Earth Sciences. Adelaide, Australia. (Dr J.B. Jago, School of Applied Geology, South Australian Institute of Technology, P.O. Box 1, Ingle Farm, South Australia 5098, Australia)

1983

18-22 July
Fourth International Conference on Permafrost. University of Alaska, Fairbanks, Alaska, U.S.A. (Louis de Goes, Executive Secretary, Polar Research Board, National Academy of Sciences, 2101 Constitution Avenue N.W., Washington, D.C. 20418, USA)

15-26 August
18th General Assembly of the IUGG. Hamburg, Federal Republic of Germany. (P. Melchior, Observatoire Royal de Belgique, Avenue Circulaire 3, B-1180 Bruxelles, Belgium)

ROYAL METEOROLOGICAL SOCIETY MARGARY LECTURE 1981

The 1981 Margary Lecture will be given by Dr G. de Q. Robin of the Scott Polar Research Institute on the subject "Polar ice and climate". The meeting will take place on Wednesday 18 March 1981 at 1630 in Lecture Theatre 1, The Blackett Laboratory, Imperial College, London.

NEWS

AWARDS

Dr D. Sugden has been awarded the 1980 Cuthbert Peek Award of the Royal Geographical Society, for his contributions to glaciology and geomorphology.

Dr J Weertman has been awarded the 1980 Acta Metallurgica Gold Medal, in recognition of his ability and leadership in materials research.

RECENT DEATHS

On 14th July, 1980, *Jim Bishop*, a member of the Royal Geographical Society's International Karakorum Project, fell to his death on the Mountain of Kurkun, near Gilgit in north Pakistan, while climbing to erect a survey beacon on the summit. Although only 30 years old, he was a veteran of expeditions to Greenland, Afghanistan, Switzerland and Antarctica. An engineering graduate from St. John's College, Cambridge, he had accompanied the leader of the Project, Prof. Keith Miller, on four expeditions including the first ever traverse of the Staunings Alps of North Greenland in 1975 and had, in 1977, obtained ice-depth profiles of the Vatnajokull Ice Cap to discover underice volcanoes. After graduating from Cambridge he worked from 1972-78 with the British Antarctic Survey and then with Sir Alexander Gibb and Partners, Consulting Engineers.

Dr Roger J.E. Brown, a Research Officer in the Division of Building Research, National Research Council of Canada, died on 4 November, after a long illness. He was well-known for his studies of the distribution and characteristics of permafrost, for his book entitled "Permafrost in Canada", for the Permafrost Map of Canada and, most recently, for his organization of the Third International Conference on Permafrost in Edmonton, Alberta.

INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES

At the XVII General Assembly of the IAHS in Canberra, Australia, the IAHS Bureau approved the organization of an International Committee on Remote Sensing and Data Transmission for Hydrology - to promote, communicate, and coordinate the applications of remote sensing and remote data transmission to hydrologic problems. A.I. Johnson, U.S.A., was elected President of the new group. Members are being appointed to the new Committee by each of the six Commissions of IAHS as well as by National Correspondents from the nearly 80 member countries. Members will represent all disciplines involved in every phase of the hydrologic cycle.

The first major activity planned by the Commission will be a one-week Workshop and Symposium on Hydrologic Applications of Remote Sensing and Remote Data Transmission, to be held during the 1982 Exeter Assembly.

Further details concerning the new International Committee or the planned Workshop and Symposium may be obtained from:

A. Ivan Johnson, President,
International Committee on Remote Sensing and Data Transmission for Hydrology,
Woodward-Clyde Consultants,
2909 West 7th Avenue,
Denver, Colorado 80204, U.S.A.

NEW ORGANIZATIONS

CANADIAN QUATERNARY ASSOCIATION

A new national interdisciplinary organization of Quaternarists was founded on 19 May 1979 to foster cooperation among academic, public service and private sector workers in geology, geography, stratigraphy, geomorphology, climatology, pedology, paleontology, palynology, archaeology, anthropology, ecology, oceanography, limnology, biology, engineering and glaciology.

For further information contact Douglas R. Grant, CANQUA Secretariat, 5 Birchview Court, Nepean, Ontario, K2G 3M7, Canada.

INSTITUTO ESPAÑOL DE GLACIOLOGIA (INEGLA)

In 1979, a number of Spanish glaciologists, concerned at the lack of coordination in the study of Spanish glaciers, joined together to form the Instituto Español de Glaciologia. They hope to publish a news bulletin. Further information may be obtained from:

José Miguel Barbazán Sagasti,
Escuela Técnica Superior de Ingenieros de Caminos,
Cátedra de Geología Aplicada,
Cuidad Universitaria, Madrid 3, Spain.

PUBLICATIONS

PERMAFROST: ENGINEERING DESIGN AND CONSTRUCTION. Edited by G.H. Johnston (Division of Building Research, National Research Council of Canada, Ottawa, Ontario) and published by John Wiley & Sons Canada Limited (22 Worcester Road, Rexdale, Ontario, M9W 1L1). January, 1981, 640 pp., approx. $35 (CAN).

Prepared under the auspices of the Associate Committee on Geotechnical Research, this book describes the principles and methods that can be applied in the design and construction of various types of foundations and facilities in the North. The first four chapters deal with the main factors, such as the climate, terrain features, permafrost conditions and the properties and behaviour of frozen ground that affect engineering operations in the North. The next six chapters deal with the more practical aspects of permafrost engineering such as project planning, excavation and placement, design and construction of various engineering works. Thirty-one contributors present detailed information on Canadian permafrost conditions and engineering practice. Knowledge and experience gained in the U.S.A. (Alaska), and the U.S.S.R. and other countries having similar conditions and problems are also included.

SEA ICE PROCESSES AND MODELS

Proceedings of the Seattle Symposium, September 1977. Paper back edition published as International Association of Hydrological Sciences Publication No.124, 474 pp., $35 (US). (Hard back edition published by University of Washington Press, 1980).

The forty papers in this book were presented at the Symposium on Sea Ice Processes and Models held at the University of Washington, Seattle, September 1977. The Symposium was sponsored by the Arctic Ice Dynamics Joint Experiment (AIDJEX) and the IAHS International Commission on Snow and Ice, and was convened to bring together scientists and engineers studying the atmosphere/ice/ocean system in polar regions. It also served to present and review the results of the AIDJEX project. The papers have been grouped into four sections:

- AIDJEX review papers
- Deterministic ice modelling
- Ice observations
- Boundary layers

The paper back edition may be ordered from the Office of the Treasurer, IAHS, 2000 Florida Avenue NW, Washington D.C. 2009, U.S.A.

NEW MEMBERS

Addison, Ken, St. Peter's College, Oxford, OX1 2DL, U.K.

Aldridge, M.M., "Brookhatch", Lombard Street, Shackleford, Godalming, Surrey GU8 6BH, U.K.

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Blystad, Per, Arkeologisk Museum i Stavanger, P.O. Box 478, Stavanger N-4001, Norway

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INTERNATIONAL GLACIOLOGICAL SOCIETY

Lensfield Road, 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 General. No proposer or seconder is required.

ANNUAL PAYMENTS 1981

Private members	Sterling: £20.00
Junior members	Sterling: £ 6.00
Institutions, Libraries	Sterling: £40.00 for Volume 27 (Nos. 95, 96, 97)

Annals of Glaciology—see inside front cover of this issue of Ice.

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

ICE

Editor: Simon Ommanney

This news bulletin is issued to members of the International Glaciological Society and is published three times a year. Contributions should be sent to Mr C. S. L. Ommanney, Snow and Ice Division, National Hydrology Research Institute, Environment Canada, Ottawa, Ontario, K1A 0E7, Canada.

Annual cost for libraries, etc. and for individuals who are not members of the Society: Sterling £6.00.

Foister & Jagg Ltd., Abbey Walk, Cambridge