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ICE

CONFERENCE ON THE USE OF ICEBERGS SCIENTIFIC & PRACTICAL FEASIBILITY

1 — 3 April 1980

Cambridge, U.K.

The First Circular has now been published and issued to all members of the Society and other groups. Further copies may be obtained from the Secretary General of the Society, at the address given on the back cover pages of this issue of ICE.

The Conference is sponsored by:

Iceberg Transport International Limited,
King Faisal Foundation,
Abdul-Aziz University.

The Scott Polar Research Institute is hosting the Conference.

The International Glaciological Society is the organizer of the Conference.

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ICE

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CONTENTS

1979 DUES. Please pay these promptly! By doing so, you save us much clerical time and postage that would otherwise be spent on sending you reminders. Also, you will receive your copies of the Journal and Ice on time, because we do not send the June and October issues of the Journal and September and December issues of Ice to those members who have not paid. 1979 rates: £15 (Junior Members £6).

COVER PICTURE. "Feather" frost on window in Laramie, Wyoming. Temperature was −1°F. Photograph by Brooks Martner, University of Wyoming, Department of Atmospheric Science, P.O. Box 3039 University Station, Laramie, Wyoming 82071, U.S.A.

RECENT WORK

AUSTRIA

APPLIED SNOW AND ICE STUDIES

Institut für Wildbach– und Lawinenverbauung, Universität für Bodenkultur, Vienna
(H. Aulitzky)
Zones of avalanche danger are being mapped on the basis of past damage. A global survey of the state of avalanche research, prevention, warning and protection was made by the Delphi method.
(G. Fiebinger)
The interaction of forest and avalanches is being studied with special regard to avalanche release in forests that are decaying because of disturbed dynamics of development. A study of interpretation of avalanche danger from aerial photographs and correlated field work will be finished by the end of 1978.
(N. Diera)
Studies and experiments are carried out on the effect of sliding of the snow cover in stocked areas on the standing growth as influenced by the type of stock and by local conditions.

The Institute publishes at irregular intervals a series "Mitteilungen des Instituts für Wildbach- und Lawinenverbauung an der Universität für Bodenkultur in Wien". So far, 9 reports have been issued.

Vorarlberger Illwerke AG
(F. Brugger)
As in catchment areas of other power plants, operational snow surveys are used to forecast run-off from an area of 511 km^2. The influence of snow fences on the settling and the stability of the snow pack was investigated at a site at 2000 m a.s.l.

Institut für Elektronik, Technische Universität, Graz
(W. Fritzsche)
Several types of radar systems are being investigated for glaciological application. A pulsed radar of 5 km range may be used for monitoring avalanche release near roads early enough to stop traffic momentarily. This device was also used to measure avalanche speed.

A single pulse radar with pulses of 2 ns duration was developed for measurements of the water table in glacier firn. This method is being tested at Untersulzbachkees (Venediger Gruppe) in cooperation with Institut für Kartographie, Technische Universität, Vienna.

Automatic snow gauges are being developed and tested for use in avalanche slopes.

For the search of avalanche victims, targets without battery and a radar system with approximately 1 GHz with adapted target, similar to a secondary radar, are being investigated.

A meeting "Electronics and Avalanches '79" is to be held at the institute, 24-28 April 1979.

Hydrographisches Zentralbüro, Vienna
(H. Schimpf)
The hydrographical service continues observation of the snow cover at 700 sites. Records of snow depth and water equivalent of selected stations are published in "Hydrographisches Jahrbuch".

GLACIER STUDIES

Geographisches Institut der Universität, Graz
(H. Wakonigg)
In a survey of Pasterze glacier from 10 to 13 September 1977 a mean retreat of the terminus of 10.9 m was found. The average sinking of the surface of the tongue was 0.85 m based on 26 points, implying a loss of 4.85 x $10^6 m^3$ of water on an area of 6 km^2. Spot checks in the accumulation area revealed an increase of surface elevation since 1975 of 0.7 m in 2800 m and of 0.9 m in 2900 – 3000 m a.s.l. The velocity of the tongue as measured in 3 profiles did not change significantly since 1976, the maximum being 64.3 m y^{-1}.

Zentralanstalt für Meteorologie und Geodynamik, Vienna
(F. Steinhauser)
Heat balance studies of the snow pack were initiated near the Großglockner road in order to determine evaporation from snow by indirect methods. The thickness of Schlattenkees was seismically determined and the dynamics of Untersulzbachkees were further studied.

Geographisches Institut der Universität Salzburg
(H. Slupetzky)
Of the 14 years of mass balance studies at Stubacher Sonnblickkees 1976/77 was the tenth with a positive balance (14.8 g cm^{-2}). Net mass gain was determined also for Fillach and Weißseekees. The central part of Hohe Tauern was documented by oblique aerial photography and Sonnblickkees was surveyed by terrestrial photogrammetry. The velocity of Ödenwinkelkees was measured in two profiles; a map of this glacier 1:5000 is nearing completion.

Physikalisches Institut der Universität Innsbruck
(W. Ambach)
On Kesselwandferner (Ötztaler Alpen) glacial hydrological studies of meltwater flow in the water table were continued in the accumulation area. Fluctuations of the water table were recorded during the entire hydrological year and were correlated to the weather situation during the summer period. The water table was measured in a 30 m pit and in drill holes in its vicinity. (Cooperation with H. Eisner; H.Moser,

Institut für Radiohydrometrie der Gesellschaft für Strahlen- und Umweltforschung m.b.H., Neuherberg, Germany.)

On Schaufelferner and Daunferner (Stubaier Alpen) experiments concerning the melt water flow in wet snow were continued with homogenized snow. This project was funded by the European Research Office of the U.S. Army (cooperation with A. Denoth and W. Seidenbusch).

Measurements of the dielectric constant of wet snow were continued and related electronic equipment was improved. Electronic sondes were developed for the investigation of physical processes in the snow-ski interface during sliding.

Ice cores from the Arctic provided by F. Müller (ETH, Zürich) and cores from Vernagtferner were analysed for gross beta activity in order to use the highly active 1963 horizon as dating reference.

(H. Eisner)

The 30 m pit which was dug in the accumulation area of Kesselwandferner is now moving through a crevassed zone. Deformation of the pit is recorded continuously throughout the year. In July 1977 markers in the pit walls were resurveyed with high precision.

The water table in the area of the pit was found to be 25 to 28 m below the glacier surface. Continuous records of the water-level were supplemented by records of vertical distance of selected points in the pit walls. A relation between water level fluctuations and crevassing is being investigated.

Within a distance of 20 m from the pit 12 holes were drilled thermally down to 35 m, 7 of which reached crevasses 8-12 m below the surface. By the installation of pipes the holes will be kept open through the winter and the water level in holes and crevasses can be checked by optical methods.

Methods are being refined by which stratigraphy and aquifers can be inferred from the sinking speed of a drill. A 45 m hole was used for testing.

Institut für Meteorologie und Geophysik der Universität Innsbruck

(G. Kaser, M. Kuhn, G. Markl, H. Rott, L. Siogas, H. P. Wagner)

In the region of Hintereisferner three weather stations were operating all year. Mass balance was determined by direct methods for Hintereisferner and Kesselwandferner.

1976/77	HEF	KWF
mean specific balance (g cm^{-2})	76	70
net accumulation ($10^6 m^3$)	9.24	4.13
net ablation ($10^6 m^3$)	2.48	1.13
accumulation area ratio	0.78	0.87
mean elevation of equilibrium line (m)	2840	3060

Englacial temperatures were measured in ten vertical profiles to 16 m depth. The transient snow line was monitored by an automatic camera. Dust fallen in March and May was chemically analyzed and its changes in the snow pack were registered through the season. Surface temperatures of moraines and periglacial sites were measured by IR thermometer. Data analysis concentrated on climatic records, ice temperatures, satellite images and heat balance.

(H. Schneider)

In cooperation with Institut für Mathematik der Universität Innsbruck the precision survey of Hintereisferner and Kesselwandferner was continued. In 1977 Kesselwandferner continued its advance, covering now an area comparable to that of 1957.

Michael Kuhn

CANADA

GLACIER STUDIES—GENERAL

GLACIER INVENTORY OF CANADA

(C. S. L. Ommanney, GD/EC) (*for abbreviations, see end of report*)

35 new basins were added to the Yukon inventory, the first phase of which will be completed in 1979 (S. G. Collins). A special inventory of Glacier National Park, B.C., for Parks Canada, will be based on 1978 aerial photography.

GLACIER STUDIES—ARCTIC

AERIAL PHOTOGRAPHY

(A. C. D. Terroux, GD/EC)

Glacierized areas on Ellesmere and Axel Heiberg Islands were photographed in early August. In early July the Tweedsmuir, Steele, Lowell and Donjek glaciers were photographed.

QUEEN ELIZABETH ISLANDS

(R. M. Koerner, PCSP/EMR)

The mass balances of the Meighen, Devon and Agassiz ice caps were measured in April and May. Strain nets, bore-hole diameters and temperatures were remeasured on the Agassiz Ice Cap. A new device was successfully constructed to measure down-bore-hole ice conductivities to detect major volcanic events present as H_2SO_4. The results complement similar ones made on the core extracted in 1977.

AXEL HEIBERG ISLAND

(F. Müller, GEOG/ETH-McG)

Mass balance data and equilibrium line observations were obtained for the Baby and White glaciers, a methodological study on ice ablation completed (K. C. Arnold), and the snout positions of the White, Thompson and Crusoe glaciers resurveyed. Two automatic weather

stations are still being maintained. The heat balance and meso-climatic data has been analysed (A. Ohmura) and a study of the empirical relationship between melt on the glacier and some synoptic parameters completed (R. J. Braithwaite).

Data generated from Digital Terrain Models of the glacier surfaces and their immediate surroundings (M. C. van Wijk, PHOTO/NRC) is being used at the Dept. of Photogrammetry, Technological Univ. of Vienna, to produce stereo-orthophotos. Cartographic and glaciological applications will be studied.

NORTH WATER

(F. Müller, GEOG/ETH-McG)

Mass balance studies of a number of Coburg Island glaciers continue.

BATHURST ISLAND GLACIERETS

(K. C. Arnold, GD/EC)

Glacierets in the Stokes Range have been photographed from 3000 m and 1500 m a.s.l. The landscape suggests the former existence of cirque glaciers.

BYLOT ISLAND

(R. N. W. DiLabio, W. W. Shilts, GSC/EMR)

Geochemical and mineralogical data from lateral moraines and debris bands of glaciers indicate that the latter contain significant amounts of debris from the base of the glacier and that compositions of the former vary systematically with distance from source or with relationship to tributary ice streams. Sediment carried by each of the five glaciers studied is geochemically distinct. (For Baffin Island studies, see USA report for Universities of Minnesota and Wisconsin-River Falls.)

GLACIER STUDIES—YUKON

MOUNT LOGAN

(G. Holdsworth, GD/EC)

A short field operation was carried out on the NW Col (5340 m) prior to the planned core drilling in mid 1979. Measurements were made of accumulation rate (1.5 m of snow), ice flow rate (0–2 ma^{-1}) and ice depth; the latter using two sounders — a 620 MHz system and a 5 MHz monopulse system. Thicknesses varied considerably up to about 360 m within a 0.5 km^2 area around the col. An 18.5 m SIPRE hole provided isotope data for about the last two decades. The 10 m temperature was about −29°C.

ROCK GLACIERS

(P. G. Johnson, GRP/OTT)

Emphasis has been placed on the rates of movement or collapse of the forms and their age (with W. G. Nickling, GEOG/GUELPH). Data on morphometric parameters has been obtained for modelling and engineering testing of materials has continued. Work was started on the drainage system of rock glaciers. A thesis on catastrophic origins of rock glaciers is in the final stages of completion.

ICE-DAMMED LAKES

(G. J. Young, M. Perchanok, S. G. Collins, GD/EC)

Detailed field work was undertaken at the Donjek Glacier snout and at Haines Junction to reconstruct the chronology of glacier lake formation and outburst floods.

(G. K. C. Clarke, GPHYS/UBC)

The 1978 drainage of Hazard Lake was recorded with a pressure sensor and cassette data logger. A levelling survey of the staircase-like set of 30-60 beaches of Recent Lake Alsek was carried out (R. W. May, GEOL/ALTA and S. G. Collins); from this it may be possible to reconstruct the history of formation and destruction of the Lowell Glacier ice dam. Photogrammetric control was established on the giant ripple marks in the lake bed for an analysis of the drainage hydraulics. Till-like diamictons, in glacial lake deposits, may result from drawdown failures during the winter drop in lake level. This model will be tested on an ice-dammed lake which drains annually (R. W. May, GEOL/ALTA).

LOWELL GLACIER

(G. K. C. Clarke, GPHYS/UBC)

A USGS-type monopulse radar was used to measure ice thickness at 60 locations near the divide with Cathedral Glacier. The maximum ice thickness along the flow line is probably over 800 m, but the radar transmitter had insufficient power to sound ice thicker than 650 m.

GLACIER STUDIES—CORDILLERA

BERENDON GLACIER

(W. H. Mathews, GEOL/UBC)

With the closing of the Granduc Mine at the end of June field work on Berendon Glacier has been terminated. A report reviewing work over the past decade has been prepared for the GD.

ISKUT RIVER GLACIERS

(O. Mokievsky-Zubok, GD/EC)

Studies of two glaciers (102 km^2) in heavily glacierized watersheds have been initiated to assess the impact of glacier variations and runoff on a proposed reservoir. "Andrei" and "Yurl" glaciers had negative balances of −0.83 and −0.05 mH_2O respectively.

MASS BALANCE, WESTERN CORDILLERA

(O. Mokievsky-Zubok, GD/EC)

Measurement of winter and summer balances, meteorological variables and meltwater flow continued on Sentinel and Place glaciers for the 13th and 14th years respectively and of mass balance only on Helm Glacier for the 4th year. Hydrochemical balance studies were continued on the former to determine sources of discharge and sediment load from glacierized areas (with J. L. Zeman, WQB/EC).

"SNOWCAP ICEFIELD" AND LAKE, GARIBALDI PARK

(RICKER)

From "Snowcap Icefield", south of Snowcap Lake, 3 of the outlet glaciers extend north.

"Thunderclap Glacier" now extends into the west lake basin and has thickened quite noticeably (since 1972) at the snout showing a slightly advanced position relative to 1951. At its maximum it filled the entire west lake basin causing a 15 m water level rise and drainage reversal into the Lillooet River. After an intervening period of dramatic ice recession "Griffin Glacier" has advanced hundreds of metres since 1951, has thickened considerably at its two-pronged snout since 1972 and is overriding vegetation. Neighbouring "Glacier de l'Escalier" continues to retreat from its 1951 position at an average 2.8 ma^{-1}. Field work in 1978 included the levelling and mapping of various strandlines of Snowcap Lake. Tree ring samples were collected and cairns established for long-term monitoring.

WEDGEMOUNT GLACIER AND LAKE, GARIBALDI PARK

(RICKER, W. A. Tupper, BCIT)

Topographic maps at 1:5,000 have been produced from 1964, 1969 and 1972 vertical air photos, and glacier tongue planimetric maps from 1947, 1976 and 1977 oblique aerial and terrestrial photography. A composite map and cross section, showing glacier tongue positions over several years, ice thicknesses and tree ring sample sites with dates, has been published (Canadian Alpine Journal 1978). 1978 field work was limited to collection of a few additional tree ring samples and a terrestrial resurvey. A slight advance and retreat is indicated for 1977-78. The slump behind the snout suggests a much reduced extension of the lake under only the central axis of the glacier if retreat by calving continues. The advance is on the south side under a 200 m high rock wall.

WATER MANAGEMENT IN REMOTE BASINS

(O. Mokievsky-Zubok, GD/EC)

Further studies to determine the effect of glaciers on basin runoff in the Bridge River headwaters were made. A Data Collection Platform was installed below Bridge Glacier for continuous monitoring of hydrological and meteorological parameters.

GLACIER SURVEYS

(I. A. Reid, J. O. G. Charbonneau, AHD/EC)

The Nadahini, Sentinel, Sphinx, Kokanee and Bugaboo glaciers were resurveyed by terrestrial photogrammetry. Maps and reports from these and previous biennial surveys are in preparation.

YOHO NATIONAL PARK

(G. J. Young, GD/EC)

Monitoring of the hydrology and climatology of non- and glacierized catchments continues.

TEMPERATE GLACIER SEDIMENTATION

(R. J. Rogerson, GEOG/MUN)

Field work focussed on collecting samples from the supraglacial, englacial and subglacial sediments of Vice-President and Emerald glaciers, B.C., and from the large Neoglacial maximum moraines in their vicinity. All samples are presently undergoing textural analysis. The Neoglacial moraines contain complex stacked and stratified units which probably represent the intercalating of sediments from the different glacial transportation zones and extraglacial slopes. Subglacially precipitated calcium carbonate is common between the moraines and present ice implying warm-based ice during deposition. Comparisons are being made with Wisconsinan 'bay-head' tills on the Avalon Peninsula, Newfoundland, which may also have been formed from warm-based ice.

COLUMBIA ICEFIELD

(Glaciology Division/EC) (*See also USA Report for University of New Hampshire*)

The control survey was completed in August using an inertial survey system and orthophotos of the Athabasca and Saskatchewan glaciers compiled for a comparison of mapping accuracy between these and conventional maps.

(L. Warner, WSC/EC)

The biennial survey of the snout, movement profile and glacier lowering on the Athabasca and Saskatchewan glaciers was completed.

PEYTO GLACIER

(G. J. Young, GD/EC)

The basic monitoring of mass balance, meteorology and hydrology continued. A detailed radiation balance study to determine topographic variation of net shortwave was initiated (D. S. Munro, GEOG/UofT), a water and sediment study undertaken (D. N. Collins, GEOG/Manchester) and snow pack densities investigated (J. Edworthy, GEOG/CARL). Ten students participated in a graduate hydrology course given by Dr. Gunnar Østrem (CARL).

GLACIER STUDIES—LABORATORY

(R. M. Koerner, PSCP/EMR)

The origin of lichen-free areas in the High Arctic has been examined and the effect of instant glacierization on feedback processes studied.

A fabric and textural analysis of the Devon Island ice cap cores was completed. They were also analysed for elemental concentrations, chiefly of Al and Na but also for Si, Mg, Ca, and K, as was a suite of samples from the Agassiz Ice Cap. While levels of Al are higher on Agassiz than Devon, the reverse is true for Na. Volcanic layers in the cores are being studied for micro-particle concentrations, chemistry, electrolytic conductivity, and pH. The Thera event which ended the Minoan civilization has been identified by its high sulphate content but no similar increase is apparent in micro-particles (>0.5 μm) or the six elements listed above. Camp Century, Greenland, micro-particle concentrations and $\delta^{18}O$ profiles have been compared to those for Devon Island and used to infer surface level changes of the Camp Century locality of the past 100,000 years. Noise levels in the time series of $\delta^{18}O$ values derived from ice cores have been studied.

B. Alt, under contract, has studied the relationships between synoptics and ice cap mass balance in extreme warm and cold summers to obtain a better understanding of climatic change and ice cover fluctuations in the High Arctic during the Holocene.
(W. H. Mathews, GEOL/UBC)
Studies on simulated glacial abrasion are continuing.
(S. H. Watts, GEOL/SSFC)
Research continues on the processes and products of weathering under cold climates.

GLACIAL GEOLOGY

SKEENA RIVER BASIN, B.C.
(J. J. Clague, GSC/EMR)
Reports in preparation will emphasize patterns of deglaciation, the chronology of late-Quaternary events and sea-level fluctuations.

GEORGIA DEPRESSION, B.C.
(J. J. Clague, J. E. Armstrong, S. R. Hicock, GSC/EMR)
The distribution and genesis of glacial and non-glacial sediments of late-Quaternary age have been determined and the glacial history of the area reconstructed.

SOUTHERN KEEWATIN
(C. M. Cunningham, W. W. Shilts, GSC/EMR)
Results of mapping the dispersal of distinctive lithologies indicate that the Keewatin Ice Divide migrated E-SE, had an E extension at its S end that parallels the Manitoba border almost to the present coast of Hudson Bay and is tens of thousands of years old.

GEOLOGICAL SURVEY OF CANADA AND OTHERS
Reports of work on Quaternary geology are published annually in "Current Research" (GSC/EMR). Information on the work of the following can be made available on request— R. W. May and L. V. Hills (Alberta, Rockies, Yukon, Lake Erie), J. England (Ellesmere Island), B. R. Rust (Ottawa), H. B. S. Cooke (Maritimes), J. T. Andrews (Baffin Island).

SNOW STUDIES

SNOWCOVER MONITORING
(B. Dey, H. Moore and A. F. Gregory, GREGORY)
NOAA and LANDSAT images were used for monitoring snowlines in the Yukon and NWT from 1975 to 1977. A snowmelt model was developed using AES temperature and snow depth data. Engineering applications have been identified for the DBR.
(B. E. Goodison, CCC; E. J. Langham, GD; T. Alfoldi, CCRS)
X- and L-band SAR data for the discrimination of snow conditions at a test site near Ottawa are being evaluated.
(W. I. Pugsley, CCC)
Work was begun on the creation of a computerized archival-retrieval facility for Canadian snow course data to provide better accessibility, easier SI conversion and cheaper publication.
(W. Hogg, CCC)
Snow cover over the Saint John Basin, N.B., and its sub-basins will be mapped on a weekly basis during the 1978-79 winter. NOAA-5 visible and infrared imagery are used for the analysis.
(H. S. Loijens, GD)
Aerial Gamma-Ray Spectrometry was used to measure snow water storage in the Lake Superior Basin. Two surveys (November 1977 and March 1978) were flown. Studies were conducted on the effects of snow drifting on gamma snow survey results and on the influence of soil water on natural gamma radiation.
(L. Warner, WSC/EC)
Results of the last year's snow surveys have been published in the 1978 Snow Data Summary for Alberta, Saskatchewan, Dist. of Mackenzie and the St. Mary River. Provincial agencies will be carrying out and reporting on future surveys.
(M.-K. Woo, GEOG/McM)
Snow distribution and melt have been studied on Cornwallis Island, N.W.T. Models to evaluate changes in basin snow storage during the Arctic summer are being developed.
(R. B. B. Dickison, FORRES/UNB)
A six-year study of the variation of snowcover in the Nashwaak Experimental Watershed has been completed. An experimental clearcut harvest is now underway and an assessment of the effect of this treatment on snow cover distribution will commence in 1979.

SNOW MEASUREMENT
(B. E. Goodison, V. Turner, D. J. McKay, CCC)
Some projects carried out to improve snowfall and snow cover measurement were — development of a Nipher-type shield for recording precipitation gauges, research and development work to incorporate a built-in processing facility to correct Fischer and Porter measurements for gauge catch deficiency, new snow sampler cutter designs, particularly for sampling shallow snowpacks.
(B. E. Goodison, CCC)
Testing of correction procedures for gauges used to measure snowfall and of the accuracy of new types of snow samplers, cutters and a gamma spectrometer continued.

To assess problems in low snowfall regions a special observation program was initiated at Resolute, Saskatoon and Regina. Wyoming shielded recorded precipitation gauges were also tested in these regions. Initial results indicate totals are low. Consideration of trace amounts and differentiation of blowing and falling snow are necessary to improve snowfall totals.
(W. P. Adams, GEOG/TRENT)
Study of the effectiveness of the Nipher and Tretyakov snow gauges, under operational conditions, continued.

SNOW IN MOTION
(J. de Krasinski, T. Szuster, MECH/CALG)
Reports have been prepared for ESSO on snow and sediment transport with and without cohesive forces in real fluids and their mathematical and computer modelling.

SNOW UNDER LOAD
(R. Yong, GRS/McG)
The properties and characteristics of snow under load, in particular the various environmental and thermodynamic factors, are being studied.

POLLUTANTS IN SNOW
(C. Delisle, CINEP)
A study of mercury and other heavy metal pollution of snow has been completed. It shows that mercury concentration in the snow 10 miles around Rouyn-Noranda is 10 to 20 times the normal, and extends towards the James Bay area due to prevailing S and SW winds.

AVALANCHE MAPPING
(RICKER)
Most passes in the Tantalus, Earle and other ranges encompassed by Howe Sound, Squamish-Ashlu Rivers, Jervis and Schelt Inlets were reconnoitered for avalanche conditions in 1976-77. One safe route was identified for BC Hydro. In 1978 avalanche conditions between Chickwat Creek and Vancouver River, Chickwat and Perketts Creek and Ashlu River and Stackawus Creek were mapped at 1:50,000.

AVALANCHE HAZARD EVALUATION
(A. A. Salway, DBR/NRC)
Meteorological and snowpack structural variables have been identified which are closely correlated with avalanche activity at Rogers Pass. These are being used to generate time series models for avalanche hazard evaluation. 1965-1976 data from two observatories provide samples for model development and simulated forecasts. The relationship between density, hardness, strength, temperature and crystal size and type in snow profiles from 1965-73 will be studied.

AVALANCHE ENGINEERING
(P. A. Schaerer, DBR/NRC)
Load cells and geophones at Rogers Pass recorded six avalanches in the winter 1977/78, but the data were incomplete for any event. The observations allowed analysis of the speed, flow depths, and density distribution of the moving snow and impact pressures on 650 mm^2 and 6500 mm^2 surfaces. Observations were continued on the amount of snow in avalanches at Rogers Pass. B. B. Fitzharris determined the frequency of occurrence of large avalanche events and the weather responsible for them by analyzing data from Rogers Pass collected by the CPR and the NRC.

The case histories of 40 avalanche accidents, assembled by C. J. Stethem, are in press.

SNOW PHYSICS
(R. I. Perla, D. M. McClung, GD)
Theoretical and experimental investigations were continued on shear failure mechanisms of stratigraphic discontinuities in the mountain snowpack and on the characteristics of moving avalanches. Avalanche studies are projected for completion August 1979 when studies will shift towards hydrological applications. Preliminary studies of flooding in mountain communities of Western Canada are in progress.

Theoretical work on snow gliding continued and was applied to the problems of the release of full depth wet slab avalanches and snow pressure on structures. An analytical model for snow pressure was developed and checked by finite element calculations.

FLOATING ICE—RIVER & LAKE

BREAK-UP AND FREEZE-UP
(B. Dey, GREGORY)
NOAA and LANDSAT imagery was used to examine the usefulness of satellite imagery for break-up and freeze-up of river ice in the Arctic. Dates provided by the WSC were used as ground truth. For 1975-78, dates of break-up along the major Arctic rivers from satellite images correlated very well with the dates from ground stations but for freeze-up dates it was poor.

MACKENZIE & LIARD RIVERS
(D. A. Sherstone, A. C. D. Terroux, GD)
In cooperation with PCSP, the progress of break-up and the location of ice jams in the Lower Liard Basin and along the Mackenzie River were photographed in April and May, 1978.

Thermal infrared imagery of Liard and Mackenzie River stretches were obtained with the assistance of CCRS.

CORNWALLIS ISLAND
(M.-K. Woo, GEOG/McM)
An energy balance approach is being used to study the break-up of a lake ice cover on Cornwallis Island. Included will be studies of lake ice fabric and the thermal regime of lake water.

UNGAVA BAY
(M. G. Perrier, MEP)
Data on ice movement in Ungava Bay and tributary estuaries were compiled and ice thickness on the rivers analyzed for Hydro Quebec.

At Fort Chimo the ice season is September to mid May and mean thickness of river ice 1.5 m in mid April. On other rivers ice begins to form in October and break-up in May. In western Ungava Bay break-up occurs 2-3 weeks later (Hudson's Strait influence). For the Bay the moving ice starts to move out from the SW and N side in early July. It disappears by the end of July or beginning of August. Main estuaries are free in early June but a return of ice may block them again until early July.

ALBERTA
(S. Beltaos, TSWED/ALTA RES)
Ice freeze-up and break-up phenomena, particularly causes, behaviour and consequences of ice jams, have been documented at selected river reaches in Alberta. Engineering estimates of jam

stages are possible given river hydraulic characteristics.

PRAIRIES

(M. Mowchenko, HYDR/REE)

For the 4th year a study to estimate ice thickness and its variability month-to-month and year-to-year on 40 dugouts in the prairies has been carried out. Thickness is measured on the 15th of each month from October to April and will be related to temperature, snow cover, dugout orientation, exposure and water depth.

ONTARIO

(W. P. Adams, D. S. Lasenby, GEOG/TRENT)

The study of the snow and ice cover of lakes in Southern Ontario (Coon, St. George, Big Cedar), with special reference to spatial variability, continued. A major facet of the study is oxygen loss in temperate lakes in winter.

RIVER ICE THICKNESS

(S. Beltaos, TSWED/ALTA RES)

Measurements were carried out at selected sites to determine how large ice thicknesses can be generated by processes such as aufeis growth, fall jamming and frazil ice accumulation. Initial results indicate that local ice formations much thicker than the general ice cover can occur frequently; this has implications for selecting design ice forces for bridges.

ICE FORCES ON STRUCTURES

(S. Beltaos, TSWED/ALTA RES)

Measurements over 12 seasons on two river bridge piers in Alberta have shown maximum effective pressures of up to 2.4 MPa on a vertical cylindrical pier and 1.2 MPa on a pier inclined 23° to the vertical. Preliminary analysis shows that effective pressure is not a suitable parameter for the latter as failure may be by bending rather than crushing.

LOAD BEARING CAPACITY OF FLOATING ICE SHEETS

(S. Beltaos, TSWED/ALTA RES)

25 prototype tests with stationary loads have shown that a failure criterion can be formulated in terms of the work performed by the external loads (test data from ice up to 0.7 m thick) and ice deflection can be approximated by application of a linear superposition principle. Using the output of a sensitive slope transducer and the definition of slope as the gradient of deflection the ice deflection-time, variation due to moving loads is being studied to understand better the resonance phenomenon between structural deformation and water wave action that occurs under certain conditions.

(B. Michel, IML-CIVIL/LAVAL)

A laboratory study has been completed on the ductile deformation of an ice beam under a constant load. An experimental study is being made on the time dependent deformation of a circular ice plate, loaded at the center.

MECHANICAL PROPERTIES

(B. Michel, IML-CIVIL/LAVAL)

The program of uniaxial testing of ice samples in the brittle and ductile range is completed. A study has been made on biaxial behaviour of an ice plate of columnar ice tested with a square edge indentor. The program is being extended to other types of ice, including sea ice, and other forms of indentors.

INDENTATION

(B. Michel, IML-CIVIL/LAVAL)

A program of tests to study indentation at different rates on floating ice sheets of various types and temperatures with various forms of edges has started.

ICE COVER MODIFICATION

(L. Robillard, CINEP)

A numerical simulation method is being developed to predict the velocity field, the temperature and the modification of ice covers under natural conditions, and under conditions of thermal pollution.

FRAZIL ICE

(B. Michel, IML-CIVIL/LAVAL)

A new project is under way to study the temperature of nucleation of frazil particles. A theory has been developed that explains frazil formation by surface nucleation, taking into account the effects of the three-dimensional boundary layer, long wave radiation and evaporation.

FRAZIL ICE HANGING DAM

(S. Beltaos, TSWED/ALTA RES)

Field investigations are in progress to elucidate the mechanics of formation and break-up, evaluate the effects on break-up in the Smoky and Peace Rivers and assess possible action of large frazil ice accumulation on structures. Time-lapse photography has been used to study the mode of formation of a hanging dam about 300 m long with a maximum thickness of some 13 m. Shear strength, bearing capacity and density of the saturated frazil accumulation increases with height above the bottom of the accumulation and varies from year to year. A maximum backwater of some 4 m has been observed.

AUFEIS

(J. J. Veillette, R. D. Thomas, GSC/EMR)

Three icings developed from spring water emerging on dry land, and one developed from spring water flowing on river ice were examined in north-central Keewatin. Seepage occurring through pseudo-taliks was observed at several locations in frozen glaciofluvial deposits. One pseudo-talik through which all-year-round groundwater flow occurs was studied in detail using drilling and ground temperature measurement techniques.

(D. A. Hodgson, GSC/EMR)

Very large icings at two locations in west-central Ellesmere Island (78°N) were observed. Multi-year ice to 8 m thick results from piping(?) from lakes dammed by early Holocene ice-contact fluvial gravel.

ICEBREAKING

(R. Wade, ACVD/CCG)

The CCG Voyageur ACV can break ice up to 1 m thick at speeds in the order of 20 knots at a rate approaching 20 km $2h^{-1}$, over water of minimum depth for ice movement. Grounded ice can also be cleared at lower rates. The Voyageur was operated on tributaries of the St. Lawrence to clear ice jams and relieve flooding. The rate of ice clearance and high transit speeds allow 7 or 8 rivers to be cleared in less than 2 weeks. The St. Lawrence Seaway Authority tug "La Prairie" with an air cushion icebreaking bow performed very well in the sheet ice cover at the E entrance to the S. Shore Canal, breaking ice up to about 65 cm thick.

FLOATING ICE—SEA

MONITORING AND MODELLING

(V. R. Neralla, CCC)

Enhanced NOAA-5 (TIROS-N) visible and infrared imagery is provided to ICECEN for operational ice reconnaissance and forecasting. The Aerospace Meteorology Division is preparing an "Ice Status System", to develop automated techniques for the assimilation of satellite data for ice reconnaissance.

A real-time, short-range small-scale ice prediction model based on a balance between air to ice stress, water to ice stress, Coriolis force, pressure gradient force due to tilting of the sea surface and internal ice resistance has been developed. Another model calculates the compactness (% ice-covered area) using continuity and momentum equations. Both have been tested using Beaufort Sea data. The use of SEASAT-A data for modelling ice dynamics is being evaluated.

(B. Dey, GREGORY)

New models are being assessed and techniques developed for the study of dynamics, climate and monitoring of sea ice.

(R. M. Koerner, PCSP)

Sea ice reconnaissance flights were made as in previous years for the next edition of the Sea Ice Atlas to be published by EMR.

(U. Feldman, P. J. Howarth, GEOG/McM)

Surface weather charts and LANDSAT imagery are being used to predict the motions of drifting open pack ice and to determine wind fields and ice parameters associated with these motions. The procedures, which are independent of ice-based measurements, have been tested using data from the Beaufort Sea.

REGIONAL STUDIES—NORTH WATER

(F. Müller, GEOG/ETH & McG)

The program to measure the energy, mass exchanges and wind stresses, to assess the amount and position of open water and ice types, to assess on a meso-scale the air mass modification induced by the open water and to identify the origin of air moisture is being continued and a program for remote sensing during the dark period being implemented.

BEAUFORT SEA

(A. R. Milne, IOS/FOC)

15 air-droppable RAMS (Random Access Measurement System) buoys were deployed around the rim of the Beaufort Sea, in December 1977 and January 1978, to track the drift pattern. All functioned initially but only two remained in operation by December 1978. Drift patterns relative to meteorology and satellite imagery are being analyzed.

(V. C. Larson, ESSO)

Ice condition monitoring and in-situ stress measurements were performed around an artificial island. In a related laboratory investigation the stress distribution across a relatively wide indentor was measured as a function of indentation for various ice thicknesses and penetration rates. Oriented sea ice was observed in the Mackenzie Delta region of the Southern Beaufort and around an artificial island both in cores and with a polarized impulse radar system.

ARCTIC ISLANDS

(A. R. Milne, IOS/FOC)

In eastern Parry Channel, ten RAMS buoys were set adrift in early summer 1977 to track surface water and ice movements. A radar on Griffith Island in Barrow Strait was used to track sea ice movements in August 1977. A similar radar was installed during the summer of 1978 on the S.E. corner of Devon Island to track ice and iceberg movements in a cooperative IOS-Petro Canada program. A satellite imagery study of seasonal ice movements in the Lancaster Sound region was completed in 1977. A review of the Arctic Pilot Project, put forward by Petro Canada, is due for completion in December 1978. This project would use year-round Liquid Natural Gas (LNG) icebreaking vessels to extract gas resources from the Melville Island region. The review covers effects on sea ice and biota.

DAVIS STRAIT—BAFFIN BAY

(V. C. Larson, ESSO)

A survey of southern Davis Strait ice conditions was performed in November and December 1977 with a ship as a base of operations. Ice conditions were recorded during the incursion period and ice stations, with Nimbus-6 transmission capability, were deployed to measure ice movement and wind velocity.

Historical east coast pack ice data was analyzed to obtain dates for break-up and freeze-up from northwestern Baffin Bay to offshore Newfoundland. Composites of LANDSAT imagery were analyzed to obtain information on large floe sizes and movements for the Davis Strait area.

(B. Dey, A. F. Gregory, GREGORY)

Digitized, enlarged and geometrically corrected NOAA-VHRR images for summer 1977 have been used to observe ice motion. The observed velocity and direction of 52 floes were compared with the predicted values obtained by applying existing ice floe models. The comparison shows

large deviations in all models. These may be due to other variables not included in the models. Linear multiple regression equations have been used to narrow the gap between observed and predicted values of ice drifts.

MICROSTRUCTURE FROM GEOELECTRIC SOUNDINGS

(G. W. Timco, MECH/NRC)

The results of 66 Schlumberger soundings of first year sea ice at Pond Inlet, N.W.T. in May-June 1972 have been analysed to obtain the brine volume dependence of the DC resistivity both parallel and perpendicular to the long brine cell direction. This has been used in conjunction with a mixing formula for two-phase heterogeneous systems to calculate values of the average brine cell lengths (ℓ) for relatively warm sea ice. This treatment yields $\ell \sim 1.6$ cm for $40\% < v_b < 70\%$ with a rapid extension of brine cell lengths for brine volumes above 70%.

MECHANICAL PROPERTIES

(B. Ladanyi, CINEP)

A field study has been completed at Igloolik, N.W.T., on the in-situ determination of short-term and creep properties of sea ice by means of a borehole dilatometer (Ménard pressure-meter). Some dilatometric relaxation tests have been performed on fresh water ice in cold room. The two types of tests can furnish basic creep parameters for ice, necessary for establishing its constitutive equation.

(V. C. Larson, ESSO)

Esso's large scale ice test basin was used to study the interactions of model multi-year ice ridges with a Caisson Retained Island. Refrigeration equipment was used to locally thicken the ice sheet to model a multi-year ridge.

Flatjacks were used to test large in-situ S-2 ice samples of lake ice in unaxial compression. The in-situ samples were 0.3 m wide, 0.5 m thick and 1.5 m long and the measured strengths were comparable to strengths of 0.1 x 0.1 x 0.2 m samples of the lake ice tested in the laboratory.

BEARING CAPACITY

(R. Tinawi, J.-R. Murat, CINEP)

A laboratory study and theoretical simulation by the finite element method of the short- and long-term bearing capacity of sea ice plates has been completed. The study is being extended to cover other temperature and loading conditions.

ICE MOTION STATION

(R. D. Hoare, SEATECH)

An acoustically referenced ice motion station, capable of operating down to −55°C and giving hourly readouts of sub-metre accuracy, has been developed. An acoustic pinger is anchored to the sea bed and a hydrophone array laid out on the sea ice. The received time differential data is stored on magnetic tape. During the winter 1977/78, 6 stations were deployed in the Sverdrup Basin, interfaced to GOES transmitters for real-time monitoring. All 6 operated effectively, giving displacement data up to 1.5 km from the initial site. Subsequent controlled field tests at Bridport Inlet, Melville Island, resulted in an improved system.

C-CORE

(D. M. Grenville, C-CORE/MUN)

An extensive program of research on sea ice and icebergs, mainly in the Labrador Sea, Grand Banks area, is underway. Details are available in "Current Research Project Summaries, October 1978" and in the issues of "C-CORE News", available on request.

ICEBERGS

(B. B. Narod, G. K. C. Clarke, GPHYS/UBC)

In a cooperative experiment with C-CORE and the CCG, the UBC 840 MHz radar sounder was used to sound 3 icebergs in the Labrador Sea. Radar returns were sampled and recorded on magnetic tape to enable replay and computer enhancement of the complicated echograms.

(B. Sukhov, NORDCO)

Studies are continuing on iceberg characteristics and hazards to marine operations.

ICE PHYSICS/LABORATORY STUDIES

MECHANICAL PROPERTIES

(S. J. Jones, GD/EC)

Triaxial testing (uniaxial compression + hydrostatic pressure) of polycrystalline ice continued. Results have been obtained at −10°C in the strain-rate range 10^{-6} to 10^{-1} S^{-1}. Creep tests on polycrystalline ice at −10°C under triaxial conditions have commenced. Similar tests on frozen, saturated sand have been started in collaboration with the DBR/NRC.

(N. K. Sinha, M. Nakawo, DBR/NRC)

A phenomenological viscoelastic model, satisfying experimental creep observations in columnar-grained ice (S-2) of average grain of 3 mm, has been modified to incorporate the grain size effect. Procedures for computing the dependence of stress-strain curves on strain rates have also been developed using the above model.

Dependence of compressive strength of S-2 ice on cross-head displacement rates (nominal strain rates) has been investigated at −10°C. Examinations of the stress, strain and cracking activities during the tests showed that the stiffness of the testing systems influence the experimental results. A method has been developed to determine accurately the density and porosity of ice.

Several vertical and horizontal cores of first year sea ice were recovered from Pond Inlet, N.W.T. during the winter of 1977/78.

Samples of ice from a pressure ridge in the Beaufort Sea have been analyzed to determine their origin and strength.

(N. Morgenstern, D. Sego, CIVIL/UofA)

The mechanical behaviour of ice under low stresses is being studied to get a flow law for use in foundation design. The experiments are being conducted in the following configuration:

constant unaxial stress, constant strain rate (triaxial), simple shear, and constant displacement rate punching tests. Test temperatures are between $-0.5°C$ and $-4.0°C$. The best fit through all the data is a Glen type law with $n = 4.0$. Tests under low axial stress are not achieving a constant strain rate over long periods. They appear to still be in primary creep after 11,000 hours.

ICE ENGINEERING

(R. Frederking, DBR/NRC)

The effect of beam length on the behaviour of elastically supported cantilever beams was analyzed and compared with the results of field measurements made in a sea ice cover.

A mathematical model has been developed to describe the dynamic forces associated with ice action on an inclined structure.

Assistance was given to the Canadian Armed Forces and the Atomic Energy Control Board in investigating a possible impact site of COSMOS 954. The site was a ruptured ice mound.

MECHANICAL AND MORPHOLOGICAL PROPERTIES

(G. W. Timco, MECH/NRC)

An experimental investigation into the growth mechanisms, mechanical strength and Young's Modulus of ice grown from melts containing up to 2% by weight of various organic and inorganic dopants is being undertaken. The results indicate a correlation between strength reduction and average particle weight within individual homologous series (e.g. chlorides, acetates) such that the greatest strength reduction occurs for the lower members of the series. However, there does not appear to be a general, overall pattern which fits all of the dopants. The amount of solute trapped in the ice (C_i) is a function of both the amount and type of dopant in the melt. For any given solution concentration C_i can be significantly increased by adding a small quantity ($<0.1\%$) of a surfactant to the melt before the freeze.

OPTICAL PROPERTIES

(H. A. M. Chew, G. P. Johari, GD/EC)

Light scattering measurements on polycrystalline and impurity-contaminated ice are being made at low temperatures and high pressures. Two reports have been published; one in Nature, 1978, Vol. 275, 524-525, the second in the Journal of Chemical Physics, 1978, 69(12), 5557-5560.

ELECTRICAL BEHAVIOUR

(G. P. Johari, GD/EC)

The dielectric properties of polycrystalline ice containing dissolved gases as impurities are being measured. Theoretical calculations of the dielectric constant of the various forms of ice are being done. One abstract has appeared in the Abstracts of papers presented at the 61st Annual Meeting of the Canadian Institute of Chemistry, 1978, 97-98.

(G. P. Johari, GD/EC; E. Whalley, CHEM/NRC)

The dielectric constant and the dielectric relaxation time has been measured to 133 K. The Arrhenius plot of the relaxation time is s-shaped. The three regions have been identified as due to, in order of decreasing temperature: intrinsic orientational defects; impurity-generated defects, the impurities being fully reacted; and impurity-generated defects, the impurities being only slightly reacted.

HIGH PRESSURE ICES

(G. P. Johari, GD/EC; E. Whalley, CHEM/NRC)

A very slow phase transformation has been recognized in ice VI. It was followed for 275 days and was still far from completion. There is evidence for a very slow ordering transformation in ice VI. The orientational correlation parameter g, which is important in the theory of the orientational polarization of ice, has been calculated for ice VI.

ICE GROWTH

(A. W. Gell, GD/EC)

Impurity rejection during ice growth is being studied. Gas bubble growth and subsequent migration under temperature gradients, in simulated permafrost and aufeis conditions, will be investigated.

PERMAFROST AND GROUND ICE

DISTRIBUTION—GENERAL

(R. J. E. Brown, DBR/NRC)

Regular ground temperature observations are being taken in northern Manitoba and District of Keewatin for information on permafrost conditions in the discontinuous and continuous permafrost zones. Similar measurements are underway in the mountains of Western Canada and the Gaspé to obtain information on alpine permafrost. These data are analyzed on a continuing basis to determine the ground temperature regime of the permafrost at all these locations in relation to climatic and terrain influences.

A revised version of the Permafrost Map of Canada was published in the Hydrological Atlas of Canada (EC).

Long-term ground temperature and in-situ thermal conductivity measurements in the active layer and in permafrost in both peat and mineral soil are continuing.

(P. M. D. Bradshaw, BARR)

Radar sounding has been used to measure ice thickness on lakes and rivers, to map lithology and permafrost soils, and to determine water depth and sub-bottom structure in shallow lakes and rivers. Successful surveys have been carried out at numerous sites in the Mackenzie Valley, Yukon River Valley, Arctic Islands, and Northern Quebec. Bore hole radar has been applied to mapping structure and estimating ice content between adjacent drill holes.

(A. S. Judge, EPB/EMR)

In the reconnaissance programme of permafrost

distribution using deep mining and hydrocarbon exploration holes, over 100 wells have been logged. A further volume in the data collection is in press.

(HARDY & NORENG)

The following investigations have been carried out by staff of the two groups—permafrost mapping of the southern fringes of the discontinuous zone using air photo and electromagnetic resistivity techniques (occurrence is strongly influenced by the presence of an insulating organic layer and/or shading), permafrost occurrence in channels of the Mackenzie Delta and pipeline design implications, formation of thermal contraction cracks in massive ground ice, the effect of interrupting the flow of water on the active layer, and the effects of snow road construction and use on surface elevation, active layer depth and plant cover near Inuvik, N.W.T. No significant changes in surface elevation occurred but plant cover decreased by 43% during the first year.

(G. H. Johnston, DBR/NRC)

Field observations at insulated road test sites on the Mackenzie Highway near Inuvik, N.W.T. (polystyrene—installed 1972) and at Mile 237 on the Dempster Highway, Y.T. (polyurethane—installed March 1977) were continued as were those of ground temperatures at the Eagle River Bridge, Dempster Highway, Y.T.

Observations were continued at a gravel surface test site at Thompson, Manitoba to evaluate "n-factors". A literature survey and evaluation of "n-factor" information relative to northern engineering needs was completed under contract to DBR by Professor V. Lunardini, University of Ottawa, and several reports were prepared.

BEAUFORT SEA

(A. Judge, EPB/EMR)

A spring jet-drilling programme was carried out in the Beaufort Sea bringing to 32 the total number of holes drilled across the Delta Front to maximum depths of 60m. Several papers were published on the results of the joint study with the GSC.

MACKENZIE DELTA, N.W.T.

(J. R. Mackay, GEOG/UBC; A. S. Judge, EPB/EMR; J. A. Hunter, W. J. Scott, GSC/EMR; J. C. Ritchie, GEOL/UofTT)

A natural experiment on permafrost growth has been started 50 km west of Tuktoyaktuk by draining a 300 x 600 m lake. Prior to lake drainage (13 and 14 August 1978), geophysical and thermal studies, along with lake bottom coring were carried out. Subsequent work included examination of the lake bottom stratigraphy and installation of temperature cables and pressure transducers. The objective is to carry out permafrost and related investigations as permafrost aggrades on the drained lake bottom.

(J. C. Anderson, GD/EC)

Monitoring of the active layer thermal regime continued within a small drainage basin south of Inuvik as part of a program to obtain basic hydrological data in an area of continuous permafrost.

ELLESMERE ISLAND

(A. S. Judge, EPB/EMR)

Several 60 m holes were drilled and instrumented at Alert in conjunction with DND and NRC. The objectives are to investigate the subsurface response to climatic changes in the past 100 years and to examine the shallow thermal regime in a High Arctic environment.

DISTRICT OF KEEWATIN

(P. Egginton, GSC/EMR)

Various types of patterned ground in the Henik—Kaminak lakes area of Keewatin were instrumented. Internal lateral movements of 10 cm have been measured on slopes of less than 1° in mudboils (non-sorted circles) and 60 cm of downslope movement on a beach remnant rafted on till on a slope of $>10°$. Several cm of vertical, diurnal, heave were measured in the early thaw season.

UNGAVA BAY

(J. T. Gray, GEOG/UofM)

The active layer on the SW coast of Ungava Bay was studied from 1976-1979 to assess its development in response to the heat and moisture flux in a variety of sediment and vegetation cover types, and to study the spatial continuity, thickness and thermal regime of the permafrost bodies.

JAMES BAY

(B. Ladanyi, CINEP)

A cold room and field study of freeze and thaw behaviour and the resulting changes in mechanical properties of glacial tills from the James Bay area is underway to improve the prediction of the frost behaviour of glacial tills when used for construction of dams and embankments in the North.

TECHNIQUES

(J. D. Card, SUNOCO)

Reports have been prepared on "velocity modelling" a technique that provides for the correction of distortions in seismic data and a detailed description of permafrost characteristics.

FROST HEAVE

(O. J. Svec, DBR/NRC)

Weekly observations of ground temperatures and periodic surveys of movements were continued on a steel post and 3 steel piles at Thompson, Manitoba.

A two-dimensional computer program based on finite-difference approximation of heat and mass transfer has been completed. A frost heave parametric study including suction potentials induced by soil freezing is underway. The influence and importance of various parameters will be compared to published experimental results by other authors.

(L. Dyke, GSC/EMR)
Observations of heave, in gneisses of District of Keewatin and sedimentary rocks of the central Arctic Islands, suggest that freezing of standing water in otherwise vacant bedrock cracks may result in relatively large and rapid vertical displacements where the active layer is deep. The confinement of water by a downward-advancing freezing zone may be capable of developing excess pore water pressure. Where free water is not present, water retained in soil infillings may be capable of causing smaller, more gradual displacements in bedrock masses by the formation of segregated ice.
(E. Penner, DBR/NRC)
Laboratory frost heave studies designed to explore further the conditions leading to shut-off pressures showed that the influence of cold side temperature, T, and overburden pressure, P, on total heave rate $\frac{dh}{dt}$ could be expressed by the equation:

$$\frac{dh}{dt}_{TOT} = ae^{-bP/T}$$

This relationship has been advanced in a recent paper as a basis for normalizing frost susceptibility tests carried out under different conditions.

GROUND THERMAL REGIME

(L. E. Goodrich, DBR/NRC)
A paper describing a technique for treating latent heat in numerical models for the ground thermal regime has been published. One describing a numerical study of the snow/ground thermal interaction is being revised. Laboratory evaluation of the NRC soil thermal conductivity probe is proceeding. Two conductivity measurement readout apparatuses were completed. A Solartron data logger was interfaced to a Cypher tape recorder and set up to measure undisturbed ground temparatures at the Ottawa test site.

An embankment on the Mackenzie Highway at Wrigley has been instrumented to measure seasonal temperature patterns and thermal properties in permafrost.

FOUNDATIONS

(V. R. Parameswaran, DBR/NRC)
Measurements of adfreeze strength of frozen sand to model piles have been carried out on 6 different piles—natural BC fir, natural spruce, creosoted BC fir, painted steel pipe, unpainted steel pipe and steel II-section.

Creep tests have been carried out by studying the displacement of piles under constant loads, in frozen sand and a frozen natural soil.
(B. Ladanyi, CINEP)
A laboratory model study of the behaviour of a deep circular load in frozen sand has been completed. The study, directly related to the design of piles in permafrost, has shown the effect of loading history on the settlement rate and given a method of predicting that rate from frozen soil properties determined by triaxial compression tests.

GENERAL

(Hardy & Noreng)
The results of research by these two groups into the following areas has been reported on in the Proceedings of the 3rd International Conference on Permafrost.

- the behaviour of a chilled, large diameter pipeline buried in unfrozen, frost susceptible ground.
- methods of providing a stable foundation for heated structures placed on a grade in permafrost areas.
- thaw settlement studies on soil samples from the discontinuous permafrost zone.
- thaw consolidation effects in thawing permafrost at two test sites in the Mackenzie Valley where pore water under pressure had been measured.
- creep of ice rich silt. Tests were conducted for periods up to 100 days at stresses of 70-300 kPa and temperatures ranging from 1-3°C.

ENERGY BALANCE

(W. R. Rouse, GEOG/McM)
Radiation and energy balance parameters were monitored continuously between late winter and fall 1978 at Churchill, Manitoba over tundra and open woodland sites, both underlain by continuous permafrost. Despite melt of the much deeper snow pack in the open woodland lagging 2 weeks behind that of the tundra and the ground ice content in woodland soils being greater, by the end of the summer period, the depth of the active layer was about the same at each site at 1.8 m and soil temperatures in the active layers were approximately equal.

MECHANICAL PROPERTIES

(B. Ladanyi, CINEP)
Earlier work on the use of borehole dilatometers and static penetrometers for determining the creep properties of frozen ground in the field, was extended to cover borehole relaxation tests. Two field studies of this method were carried out at Inuvik, N.W.T. Dilatometers can be used successfully under most field conditions to determine strength and deformation characteristics of frozen soils.

A study of the effect of specimen shape and the end restraint conditions on creep behaviour of frozen sand observed in laboratory creep tests has been completed. It is postulated that the end conditions in the tests should be adapted to the expected behaviour of the frozen soil or ice, resulting in different requirements in the brittle and ductile range, respectively.

A study of mechanical properties of undercooled (−165°C) rocks and soils is underway. The study relates to problems encountered in underground transport and storage of LNG.

DEFORMATION, STRENGTH AND MICROMECHANICS OF FROZEN AND THAWING SOILS

(T. H. W. Baker, V. R. Parameswaran, DBR/NRC)

Rate controlled tests using various platen configurations, and deformation rates of 1.0 mm/min. to .001 mm/min., showed that the effect of total moisture content variability had a greater influence on the compressive strength of frozen sand than the end effects. This was particularly true for specimens close to being fully saturated.

Triaxial tests were carried out on frozen sand, at −10°C, for hydrostatic pressures varying between 0.1 and 50.0 MPa. At low hydrostatic pressures (<0.5 MPa) little effect of confining pressure on the compressive strength was noted. With increasing pressure, the effect on compressive strength became more marked. The value of the angle of internal soil grain friction calculated according to Mohr-Coulomb criterion was 10.3°. This is considerably smaller than the value of 37° usually reported for dry sand. The ice content in the frozen sand lowers the value considerably.

OTHER LABORATORY STUDIES

(M. S. King, GEOL/SASK)

The laboratory program has concentrated on determining the influence of pore water salinity on the acoustic wave propagation and electrical resistivity properties of saturated sedimentary rocks, the latter's thermal properties and that of permafrost itself, and on interpreting seismic and electrical resistivity measurements from northern Canada.

(B. D. Kay, LRS/GUELPH)

Studies on the flux of heat, water and solutes in soils during the formation of ice lenses continue. A dual energy gamma beam scanner is being used for nondestructive measurement of ice accumulation over time. The role of overburden pressure is being examined experimentally and theoretically.

ATMOSPHERIC ICE AND CLIMATE

MASS CONCENTRATION OF SNOW IN AIR

(J. R. Stallabrass, MECH/NRC)

The only significant correlation found between snow mass concentration and other conventional meteorological measurements was with visibility, which gave the following relationship: $C = 2\,100\ V^{-1.29}$ with a correlation coefficient of −0.94, where C is in g/m^3 and V is observed visibility in m. The maximum mass concentration so far recorded at Ottawa is 2.66 g/m^3, and concentrations in excess of 1 g/m^3 have been recorded for periods of up to 1.5 hours. Some discrepancy exists between concentration probability distributions derived from the actual measured values and from 20 years of visibility measurements during reported snow converted to concentration values using the above formula. It is expected that this discrepancy will be resolved by measurements over the next few winters from an automatic snow measuring device. Should the results from the converted visibility data be confirmed, then snow concentration probabilities may be derived for any location where climatological records are available.

ACCRETION ON CYLINDERS AND HELICOPTER ROTOR BLADES

(E. P. Lozowski, GEOG/UofA; J. R. Stallabrass, MECH/NRC)

A numerical model of the ice accretion process on a cylinder is being developed for eventual application to the case of a helicopter rotor blade. Two cases are considered, that of flight through a cloud wholly composed of supercooled water droplets, and that of a mixed cloud of supercooled droplets and ice crystals. The model is tested against actual ice accretions grown on a cylinder in an icing wind tunnel. Wind tunnel tests are also being made on a representative aerofoil section. Results strongly suggest that accretions resulting from mixed cloud conditions are aerodynamically less serious than those resulting from wholly supercooled droplet conditions.

CANADIAN ARCTIC ISLANDS

(J. B. Maxwell, CCC/AES)

A 2-volume study of the climatology of the Canadian Arctic Islands and adjacent waters has been completed. Detailed consideration was given to climatic controls, temperature and wind, precipitation and snow cover, sea state and sea ice, aviation-related aspects of the climate, temperature inversions — pollution potential — atmospheric phenomena, synoptic systems, and climatic regions. The study is expected to be published in mid-1979.

BEAUFORT SEA

(B. Dey, GREGORY)

Synoptic positions of pack ice and open water in the Beaufort Sea were correlated with weather maps using NOAA images. Offshore SE winds, higher than normal temperatures, and higher heating degree-day values resulted in maximum retreat of pack ice edge and expansion of open water in the Beaufort Sea. Onshore NW winds and lower than normal temperatures resulted in very small areas of open water.

Reports collected by
Simon Ommanney

ORGANIZATION ABBREVIATION

AINA = Arctic Institute of North America, 2920-24th Ave., N.W., Calgary, T2N 1N4
ALTA RES = Alberta Research Council, Edmonton, T6G 2G7
ARCTEC = Arctec Canada Ltd., 311 Leggett Drive, Kanata, K2K 1Z8
BARR = Barringer Magenta Ltd., 304 Carlingview Drive, Rexdale, M9W 5G2
BCIT = British Columbia Institute of Technology, Vancouver, B.C.
CALG = University of Calgary, Calgary, T2N 1N4
CAMP = Campion College, University of Regina, Regina, S4S 0A2
CARL = Carleton University Ottawa, K1S 5B6
CCG = Canadian Coast Guard, Transport Canada
CCIW = Canada Centre for Inland Waters, Box 5050, Burlington, L7R 4A6
CEG = Canadian Exploration Group, Box 1635, Peterborough, K9J 7S4
DAL = Dalhousie University, Halifax, B3H 3J5
EC = Environment Canada
EMR = Energy, Mines and Resources Canada
ENB = Environment New Brunswick, Box 6000, Fredericton, E3B 5H1
ESSO = Esso Resources Canada Ltd., 339-50th Ave. S.E., Calgary, T2G 2B3
ETH = ETH, Sonneggstrasse 5, CH-8006 Zürich, Switzerland
FOC = Fisheries and Oceans Canada
FRASER = Simon Fraser University, Burnaby, V5A 1S6
GREGORY = Gregory Geoscience Ltd., 1750 Courtwook Crescent, Ottawa, K2C 2B5
HARDY = Hardy Assoc. (1978) Ltd., Box 9355, Calgary, T2P 2W5
INSTAAR = Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado 80309, U.S.A.
LAVAL = Université Laval, Cité Universitaire, Québec G1K 7P4
McG = McGill University, Montréal
McM = McMaster University, 1280 Main Street W., Hamilton, L8S 4K1
MEP = MEP Ltée, Suite 200, 1400 Sauve-Ouest, Montréal, H4C 1C5
MINN = University of Minnesota, Minneapolis, Minnesota 55455, U.S.A.
MUN = Memorial University of Newfoundland, St. John's, A1B 3X9
NORCOR = NORCOR Engineering & Research Ltd., Box 277, Yellowknife, X0E 1H0
NORDCO = NORDCO Ltd., Box 8833, St. John's, A1B 3T2
NORENG = Northern Engineering Services Co. Ltd., 635-6th Ave. S.W., Calgary, T2P 0T5
NRC = National Research Council of Canada, Montreal Road, Ottawa
NWC = Northwest Hydraulic Consultants, 4823-99th St., Edmonton, T6E 4Y1
OTT = University of Ottawa, Ottawa, K1N 6N5
REE = Regional Economic Expansion, Prairie Farm Rehabilitation Administration, Regina, S4P 0R5
RICKER = Karl E. Ricker Ltd., 3369 Craigend, West Vancouver, V7V 3G1
SASK = University of Saskatchewan, Saskatoon, S7N 0W0
SASK RES = Saskatchewan Research Council, Saskatoon, S7N 0X1
SEATECH = Northern Seatech Ltd., No. 8, 2280-39 Ave. N.E., Calgary T2E 6P7
SHER = Université de Sherbrooke, Sherbrooke, J1K 2R1
SSFC = Sir Sandford Fleming College, Box 8000, Lindsay, K9V 4S6
SUNOCO = Sun Oil Co. Ltd, Box 38, Calgary, T2P 2V5
TEMP = Templeton Engineering Co., Box 1490, Winnipeg, R3C 2Z1
TRENT = Trent University, Peterborough, K9J 7B8
UofA = University of Alberta, Edmonton, T6G 2E1
UBC = University of British Columbia, Vancouver, V6T 1W5
UNB = University of New Brunswick, Box 4400, Fredericton, E3B 5A3
UNH = University of New Hampshire, Durham, N.H. 03824, U.S.A.
UofM = Université de Montréal, C.P. 6128 'A', Montréal, H3C 3J7
UofTE = University of Toronto, Erindale College, Mississauga, L5L 1C6
UofTS = University of Toronto, Scarborough College, West Hill, M1C 1A4
UofTT = University of Toronto, Toronto, M5S 1A7
WISC = University of Wisconsin—River Falls, Wisconsin 54022, U.S.A.
WSC = Water Survey of Canada, 110-11th Avenue S.W., Calgary, T2R 0B8

UNIT ABBREVIATION

ACVD = Air Cushion Vehicle Division, Ottawa, K1A 0N7
AES = Atmospheric Environment Service, Downsview, M3H 5T4
AHD = Applied Hydrology Division (Water Survey of Canada), Ottawa, K1A 0E7
BIO = Bedford Institute of Oceanography, Box 1006, Dartmouth, B2Y 4A2
CCC = Canadian Climate Centre, AES, EC
C-CORE = Centre for Cold Ocean Resources Engineering, MUN, A1B 3X5
CCRS = Canada Centre for Remote Sensing, EMR, 717 Belfast Road, K1A 0Y7
CHEM = Department or Division of Chemistry
CINEP = Centre d'ingenieur nordique, Ecole Polytechnicque, UofM, C.P. 6079 Succ. 'A', Montréal, H3C 3A7
CIVIL = Department of Civil Engineering
CNSR = Centre for Northern Studies and Research, McG, 1020 Pine Avenue West, H3A 1A2
DBR = Division of Building Research, Ottawa, K1A 0R6
DREO = Defence Research Establishment Ottawa, Ottawa, K1A 0Z4
DREP = Defence Research Establishment Pacific, Esquimalt, V0S 1B0
ENG = Faculty of Engineering
EPB = Earth Physics Branch, Ottawa, K1A 0Y3
ES = Department of Earth Sciences
FORRES = Department of Forest Resources
GD = Glaciology Division (Snow & Ice), Ottawa, K1A 0E7
GEOG = Department of Geography
GEOL = Geology or Geological Sciences Department or Division
GPHYS = Department or Division of Geophysics
GRP = Department of Geography and Regional Planning
GRS = Geotechnical Research Centre, McG, Montréal, H3A 2K6
GSC = Geological Survey of Canada, Ottawa, K1A 0E8
HRD = Hydrology Research Division (Groundwater), Ottawa, K1A 0E7
HYDR = Hydrology Division
ICECEN = Ice Forecasting Central, 473 Albert St., EC, Ottawa, K1A 0H3
IES = Institute for Environmental Studies, UofTT, M5S 1A4
IML = Ice Mechanics Laboratory
IOS = Institute of Ocean Sciences, Box 6000, Sidney, V8L 4B2
IRP = Ice Research Project, McG, Montréal, H3A 2K6
IRS = Department of Land Resource Science
MECH = Department or Division of Mechanical Engineering
MET = Department or Division of Meteorology
MWO = Maritimes Weather Office, Box 5000, AES, Bedford, B0N 1B0
NRFS = Northern Forest Research Centre, Edmonton, T6H 3S5
NHRI = National Hydrology Research Institute, EC
NWRI = National Water Research Institute, CCIW
PCSP = Polar Continental Shelf Project, Ottawa, K1A 0E4
PHOTO = Photogrammetric Research
PHYS = Department or Division of Physics
SWD = Surface Water Division, NHRI, EC, K1A 0E7
TSWED = Transportation and Surface Water Engineering Division
WQB = Water Quality Branch

U.S.A.

(including work in Canada, Greenland, Peru, Africa, and the Antarctic)

UNIVERSITY OF COLORADO, INSTITUTE OF ARCTIC AND ALPINE RESEARCH

(Director, Jack D. Ives)

Mountain Research Station

Dr Misha Plam assumed the Field Directorship of the Mountain Research Station on 1 September 1978. He is actively involved in the production of an Environmental Atlas for the Indian Peaks of Colorado, which includes the mapping of avalanches in the 64,000 acre area, under a NASA funded project, directed by Dr J. D. Ives.

At the request of the local Eldora Ski Area, Plam has been involved in the design and testing of snow fences for dealing with snow scour problems on the ski runs. During the year 1977/78, a special prototype of the new, flexible, and portable snow fences was designed and constructed, and in 1978/79 several of these will be tested in an operational manner. Precipitation and temperature for the period 1953-78 have been analyzed, in connection with problems of snow collecting on the ski runs.

The first experiments in compacting snow into blocks of a certain density and homogeneity have begun. These blocks have the potential of being used on ski runs, air strips, to protect farm lands from wind erosion and freezing, and to increase moisture retention. The compacting process itself may have far reaching benefits in increasing efficiency of snow removal from city streets.

Glacial Geology, Baffin Island

During the 1978 field season, a total of six field parties worked on the glacial chronology, and on glacial and marine deposits at various sites along the eastern coast of Baffin Island, N.W.T., Canada (supported by NSF grants EAR-77-24555 and ATM-77-17549). W.N. Mode studied the stratigraphy of complex wave-cut sediments along the coast north of Clyde Inlet. Material was collected for 14C and amino acid dating; for palynological investigation of buried peats and soils; and for analysis of the molluscan faunas. Lake cores were also taken to investigate the pollen spectra throughout the Holocene in this region of the Arctic.

Julie Brigham, Fred Hawkins, W. Locke and J. T. Andrews worked on various projects on and south of Broughton Island. Brigham studied the sediments in a series of cliff exposures which revealed a complex of marine, glaciomarine, and glacial units. Dating will be by amino acid methods. Hawkins examined a series of glacial deposits in a large fiord south of Padloping Island. Surficial mapping was used to delimit advances of different ages and to assist in the determination of paleosnowlines. Andrews and Locke conducted surveys on the bathymetry of some of the channels and fiords south of Broughton Island (work in conjunction with Dr R. Gilbert, Queen's University, Canada) and in addition conducted studies on the relative weathering of surface deposits in order to assist in developing a glacial/sea level chronology for the region.

G. H. Miller and Lisa Osterman worked in two separate areas along the northern coastline of Frobisher Bay. In both cases attention was focused on: determination of the direction of glacial movement; mapping the elevation of the local marine limit; collection of shells from marine sediments and from tills for 14C and amino acid dating; and conducting studies on boulder weathering and soil development to aid in regional correlations of undated deposits.

Glacial Chronology, Labrador-Ungava

During the 1978 field season further progress was made on elaboration of the peninsula-wide pattern of Late-Wisconsin/early Holocene retreat and disintegration of the Laurentide Ice Sheet (NSF ATM-77-17549). Lake sediment cores were recovered from a dozen lakes between Schefferville and the Torngat Mountains in the northeast. Selection of drilling sites was based upon the need to provide a more precise chronology for the drainage of Glacial Lake Naskaupi, disintegrations of ice in Ungava Bay and final deglaciation of the Kivivic Lake area north of Schefferville. A preliminary study was also made of cirque glacier moraines in the Torngat Mountains (W. McCoy) and further work completed on the complexities of local versus continental glacier patterns (J. D. Ives). Paleoclimatic implications will be derived from pollen and macro-fossil analysis of the lake sediment cores (H. Nichols and Susan Short).

Offshore Continental Shelf Environment Assessment

Between October 1976 and September 1978, Dr Michael Vigdorchik developed a computerized data management system for submarine permafrost prediction in the Beaufort and Chukchi Seas. About 40 computer generated maps of derived, source, and composite data have been produced which show the development and distribution of submarine permafrost on the Alaskan Shelf.

Dr Roger G. Barry directed a project mapping the regime of shorefast ice along the Beaufort and Chukchi Sea coasts from Landsat imagery. Particular attention was given to the decay season and its climatic controls. Papers on the climatic aspects have been published by Jeffery C. Rogers and others are in press.

Detailed reports on both projects are available in the Principal Investigator's Annual Reports published by the National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder (Offshore Continental Shelf Environmental Assessment Program).

World Data Center A: Glaciology (Snow and Ice)

The World Data Center A for Glaciology (Roger G. Barry, Director) recently began a survey and data inventory of North American ice coring products. This survey will provide an inventory of existing core storage locations, curator agencies, core samples available for destructive analysis, and completed microparticle, trace chemical, and oxygen isotope analyses. The study is designed to combine and supplement existing core inventories and bibliographies and to make this information available to interested members of the scientific community.

In the first phase of the study, the Center will collate existing inventories from the major North American Curator agencies, the State University of New York at Buffalo, and the Polar Continental Shelf Project at Ottawa. Future plans include surveys of Antarctic core data and coordination of data inventories with European, Soviet, Japanese, and Australian sources.

WDC-A is also currently developing an inventory of data on global snow and ice limits. The objectives are: 1) to identify and document existing data sources and products prepared by different agencies/research groups involved in snow cover/sea ice mapping; 2) to seek agreement on approaches to standardizing digital data sets extracted from these sources; 3) to develop computer files of existing or future data sets.

In conjunction with this inventory, WDC-A sponsored a two-day Workshop on Mapping and Archiving of Data on Snow Cover and Sea Ice Limits in Boulder on 2-3 November 1978. The meeting was intended to bring together representatives of the major groups involved in producing map products of the extent and characteristics of snow cover and sea ice on a subcontinental to global scale. There were 25-30 participants and seventeen papers were presented.

The paper sessions and discussions served to exchange information on techniques and products as well as to identify current problems and suggest possible improvements in the future. Discussion groups considered the archiving and digitization of data products. The following questions were addressed:

What data should be archived? (i.e., parameters, 'levels', resolution, coverage, ancillary data sets)

Where should the data be archived?

When should data sets be collated, digitized, updated?

How should data be collected from the various sources and subsequently made accessible to users?

A questionnaire on avalanche field stations has been circulated worldwide in an effort to inventory the types and formats of avalanche data being collected.

Results of these three projects, as well as recommendations proposed by the Workshop, will be published in **Glaciological Data.**

A questionnaire on glaciological field stations developed by Dr R. Vivian elicited 42 responses. These will be published in **Glaciological Data** number 4 (2 parts). We hope to update and add to this list in the future.

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, DEPARTMENT OF GEOLOGY AND GEOPHYSICS

(R. LeB. Hooke)

Barnes Ice Cap, Baffin Island

A 300 m hole was completed 2 km from the divide and fabric studies on cores from the hole were completed. A random fabric in fine-grained ice near the surface gives way downward to a small circle fabric at 150 m and then to two or three maximum fabrics below 175 m.

Temperature and deformation measurements were continued in three existing holes along a flowline, and mass balance measurements were also continued along this flowline. Analysis of the data suggests that temperature profiles are adjusted to a velocity field compatible with requirements for a balanced mass budget. The profiles are incompatible with vertical velocities measured by the Glaciology Division, Ottawa, in 1970-71, suggesting that the glacier then was responding to higher than normal accumulation sometime in the past.

Considerable progress has been made on finite-element models of the temperature distribution and flow field along the flowline.

Other computer modelling suggests that the transition from 'random' to single maximum fabrics (in existing boreholes) occurs at cumulative strains with axial ratios, in the vertical plane along the flow direction, of 3-6; the transition from single maximum to multiple maxima fabrics occurs at strains of axial ratio 10-100.

UNIVERSITY OF WISCONSIN—RIVER FALLS, DEPARTMENT OF PLANT AND EARTH SCIENCES

(R. W. Baker)

Barnes Ice Cap, Baffin Island

Creep tests were continued on polycrystalline ice with variations in both grain size and degree of preferred crystallographic orientation. Specimens for these tests were collected from various places within the wedge of deformed-superimposed ice on the Barnes Ice Cap and were deformed in simple shear, both in an ice tunnel in the field and in the laboratory at the University of Wisconsin-River Falls. Results thus far show that ice with a strong single maximum of c-axes perpendicular

to the plane of shear deforms about three times as readily as ice with an isotropic fabric.

A creep apparatus is currently being developed to deform samples in simple shear with simultaneous uniaxial compression.

Detailed fabric investigations were conducted on a recumbent-synclinal fold exposed in a 24m high ice cliff in the margin of the Barnes Ice Cap. The fabric was found to change progressively from isotropic in the lower limb to a reasonably strong single-pole fabric in the upper limb. This suggests that the fold is formed by the partial overturning of initially down-glacier dipping stratification in the wedge of superimposed ice at the ice cap margin and allows for an estimate of the magnitude of shear strains to have affected this wedge. ($\gamma\sim$ 10 to 15).

THE GEOPHYSICAL AND POLAR RESEARCH CENTER, UNIVERSITY OF WISCONSIN—MADISON

(C. R. Bentley)

During the last year, the field work connected with the five-year Ross Ice Shelf Geophysical and Glaciological Survey (RIGGS) was completed. Almost the entire ice shelf is now covered with a network of survey sites on a 55-km ($\frac{1}{2}$° of latitude) grid, with a number of radar flight lines closely tied to the ground stations. Geophysical measurements on the Ross Ice Shelf included radar measurements of ice thickness, seismic studies of water depth beneath the ice, gravity and seismic refraction studies of submarine structure, and seismic, electrical resistivity, and radar studies of the internal structure of the ice shelf. The emphasis of the work in Madison since the end of the last field season has been the preparation of reports on results of the program, leading to the presentation of 3 papers at a RISP/RIGGS Symposium of the American Geophysical Union in April, and 7 reports to the Symposium on the Dynamics of Large Ice Masses in Ottawa in August.

THE OHIO STATE UNIVERSITY, INSTITUTE OF POLAR STUDIES

Antarctica

(Ian Whillans)

A new program on Dome C, East Antarctica, has been initiated this austral summer (November 1978). This program is designed to investigate the surface regime (mass balance and temperature) and flow features of the ice sheet at and near Dome C. Surface data and radio-echo flight data will be used to describe present behaviour, and together with internal radio-echo layering will be used to deduce past behaviour.

Laboratory work

(Ian Whillans)

During the past year, lab studies have been carried out with a number of colleagues in several areas:

a. developing computer techniques for the reduction of radio-echo profile data (Richard Alley)
b. theoretical studies of heat conduction in firn and ice (Richard Ewing)
c. theoretical studies on the petrofabrics of ice (John Bolzan)
d. theoretical studies on bottom roughness of ice sheets (Robert Reynolds).

(Lonnie G. Thompson and Ellen M. Thompson)

Continuous microparticle profiles have now been established for a 101-meter South Pole core as well as a 100-meter Ross Ice Shelf core. A total of 6 218 samples representing the entire South Pole core has been analyzed for microparticle concentration and size distribution. The core has been dated using annual particle variations and represents an accumulation period 1974 to approximately 961 A.D. A total of 2 511 samples representing the entire Ross Ice Shelf (Q_{13}) core has also been analyzed. This core has also been dated using the annual particle variation and represents an accumulation period from 1977 to 1660 A.D. Particles from both cores have been analyzed for morphology and elemental composition using a Scanning Electron Microscope and x-ray energy dispersive system. Results of both studies are now being prepared for publication. We are in the process of analyzing 51 representative sections of ice core from the 900-meter French Dome C core drilled in 1977. The results of the microparticle concentration, size distribution and elemental composition will be very valuable in comparison studies with similar data which we have already obtained from the Byrd Station, Antarctica, and Camp Century, Greenland, deep ice cores.

Climatic ice core records from the tropical Quelccaya Ice Cap

(Lonnie G. Thompson)

The Quelccaya Ice Cap in the easternmost glaciated mountain chain of the Peruvian Andes has been the object of four recent field seasons, the latest being June and July, 1978. Ice cores to a depth of 15 meters have been retrieved at the Summit Dome (5 650 m) and two other locations for purposes of microparticle, isotope, and β radioactivity measurements. Automatic meteorological stations have been established on the summit of the ice cap in order to compare variations in microparticle, oxygen isotope and β radioactivity measurements with variations in meteorological conditions. Results to date call for a revision of the isotope "thermometry" for application in the tropics. However, the seasonality in β radioactivity, microparticle content and isotope ratios offers the prospect of a mass balance chronology for this ice cap. Preparations are underway for drilling 100 meter ice cores from this ice cap for the June-August, 1979 field season.

Shallow ice cores from tropical Mt. Kenya, Africa

(Lonnie G. Thompson)

During our expedition to Mt. Kenya, Africa, in

February and March, 1978, two ice cores (13.35 and 11.41 meters in length) were recovered from the col between Lewis and Gregory Glaciers, 4 870 m. These cores were sampled for microparticle, β radioactivity and oxygen isotope measurements. Location chosen for drilling was on a dome in the snowfield which feeds both Gregory Glacier to the N.E. and Lewis Glacier to the S.W. The ice core samples collected have been analyzed at the Institute of Polar Studies microparticle laboratory and at the Geophysical Isotope Laboratory in Denmark.

CRREL

Continuation of sea-ice research off the north coast of Alaska and of pack-ice studies in Antarctica. A study of the characteristics of brine infiltration in the McMurdo ice shelf will be completed during the austral summer.

STATE UNIVERSITY OF NEW YORK AT BUFFALO

Ten 10 m cores were taken from the Greenland Ice Sheet upstream of the proposed deep drill hole at Dye 3. Horizontal variations in accumulation rate, 10 m temperatures and chemical constituents were measured in order to erase their effects from the deep core measurements. Studies were completed on trace element content of ice from the Milcent core that dates from the Krakatao and Laki eruptions.

UNIVERSITY OF MAINE AT ORONO

In cooperation with Captain R. C. Kollmeyer of the U.S. Coastguard, measurements were made of ice velocity and strain rates on Jacobshavn Glacier in Greenland. With a sustained ice velocity of 8 km a^{-1} this glacier is probably the world's fastest non-surging glacier. Measurements were concentrated about the region where the glacier becomes afloat in order to study the transition from grounded-ice to floating-ice dynamics. The U.S. Coastguard survey of West Greenland outlet glaciers was continued, with measurements on glaciers between Disco Bay and Thule. This survey is providing valuable information on both iceberg productivity and glacier recession.

During the austral summer field programmes will include the investigation of glacial geology in Victoria Valley and the Darwin Glacier area, and a study of the interaction between Byrd Glacier and the Ross Ice Shelf.

(Dr Kollmeyer has produced a report: "West Greenland outlet glaciers: an inventory of the major iceberg producers." His address is U.S. Coast Guard Academy, New London, CT 06320, USA.)

UNIVERSITY OF NEW HAMPSHIRE, DEPARTMENT OF EARTH SCIENCES

(P. A. Mayewski and G. Pregent)

Ablation, meltwater discharge, velocity, surface temperature, ice chemistry, lichenometry, sedimentology and moraine distribution were observed on the Columbia Icefield in August. Detailed ice surface reconstructions are being used to determine volumetric changes of the Athabasca Glacier since 1870 as a key to its mass balance history.

Reports collected by
C. R. Bentley and
R. H. Thomas

POLAND

In 1977, as in the preceding years, systematic snow research was continued in the Karkonosze Mountains and the Tatra Mountains.

THE KARKONOSZE MOUNTAINS

The Meteorological and Climatological Observatory of Wrocław University worked in the Szrenica Mountain region at the Mountain Branch Observatory (1360 m). All factors conditioning the water resources of snow origin were taken into consideration: the snow cover's physical parameters, density, texture, the ground's thermic conditions, freezing degree, moisture and soaking, hypsometry, solar and wind exposure, the species of plants, particularly in the forest.

The Institute of Meteorology and Water Economy worked on Sniezka Mountains (1620 m).

THE TATRA MOUNTAINS

The Institute of Meteorology and Water Economy worked around the Observatory on Kasprowy Wierch (2000 m) and at other places, where also avalanches were taken into consideration.

THE ARCTIC

Scientific research activity in 1977 was greater, mainly on Spitsbergen, than in 1979. Several Polish Expeditions worked there during the summer:

In Oscar II Land, West Spitsbergen, in the Kaffiora region, mainly on Waldemar Glacier, the glaciological and meteorological investigations were carried out by an Expedition from Torun University under the leadership of a glaciologist-climatologist, Dr G. Wójcik.

In the region of Hornsund-fiord, SW Spitsbergen, the area of Polish investigations since IGY 1957-1958, the oceanographical investigations were continued by an Expedition from the Oceanographic Institute of Gdansk University.

In Van Keulen Fiord the oceanographic and partly glaciological investigations were carried out by an Expedition of the High Oceanographic School in Szcecin, as well as by a group from Silesia University and one from Poznan University.

In North Spitsbergen, glaciological investigations were undertaken in the marginal part of two adjoining glaciers, Trygve Glacier and Sander Glacier, in Austfiord (south branch of Wijdefiord), by a group from Poznan University, under the leadership of Dr B. Klysz.

In East Spitsbergen, paleomagnetic investigations of the Polish-USA Expedition, under the leadership of Dr K. Birkenmajer from the Polish Academy of Science, were carried out, as a continuation of previous investigations in West Spitsbergen (see ICE 1976 No. 51, p. 2-6).

The IV Polar Symposium was organized by the Geographical Institute of Poznan University and was attended also by foreign scientists. Sixteen papers were delivered, mainly relating to glacial and periglacial processes and climatology.

Worth mentioning also is the publication of the first Polish monograph of the Arctic Sea, in three volumes, of which the most interesting for glaciologists is volume I, containing the physics of the Arctic Sea.

THE ANTARCTIC

After several years of participation by Polish scientists in the framework of the USSR and the USA Antarctic expeditions in 1961-1962, 1968-1974, the First Polish Antarctic Expedition (independent and aboard a ship of their own) went to the Antarctic for the Antarctic summer 1975/1976; it was organized by the Polish Academy of Science for oceanographic, meteorological and sea-ice investigations in the region between South America and the Antarctic. These investigations were continued by the II Polish Antarctic Expedition during summer 1976/1977. This expedition was also given the task of ostablishing a permanent Polish scientific station in Admiralty Bay, King George Island, in the South Shetland Archipelago. This station was established in February 1977, and was named after Henryk Arctowski, a member of the Antarctic "Belgica" research expedition 1897/1899, the first overwintering expedition in the Antarctic along the west coast of the Antarctic Peninsula.

The summer group of I Polish Antarctic Expedition returned to Poland before the Antarctic winter 1977, but a group of 19 scientists and technical personnel remained there for the winter. In November 1977 a supplementary group arrived at the Arctowski Station for complex investigations during the summer 1977/1978, concerning meteorology, atmosphere and water pollution, glaciology, sea ice, oceanography, geophysics, hydroecology. In these investigations scientists of the Polish Academy of Science, Universities, and other scientific institutes were taking part. During the summer, the death of Dr S. Baranowski, of Wrocław University, occurred.

Reactivation of the Polish Station of the Polish Academy of Science in Bunger Oasis on the East Coast of the Antarctic, taken over by the Polish Academy of Science in 1959, is also planned for summer 1978/1979. Meteorological, glaciological, geophysical investigations will be carried out there during the summer only.

For co-ordination of Polish scientific research in the Antarctic and the Arctic, the Committee of Polar Research was created within the framework of the Polish Academy of Science.

A. Kosiba

UNITED KINGDOM

BRITISH ANTARCTIC SURVEY ACTIVITIES 1978/79

The stability of ice sheets grounded below sea level is controlled by their drainage through ice streams into the ice shelves which shield them against decay. The area responding most sensitively to any change in flow regime is the grounding line where ice starts floating on the sea. Theoretical models of the form of ice shelves for given grounding line parameters, topographical constraints and bottom melting rates have been developed by T.J.O. Sanderson and used to argue that ice shelf deterioration by enhanced melting is likely to be a slow process, taking at least several hundred years. Thus climatic warming caused perhaps by increased carbon dioxide levels in the atmosphere should not have a catastrophic effect on raising sea levels. A field programme to study in detail the dynamic behaviour of one of the major ice streams in the Antarctic started in December 1978. Preliminary results show that Rutford Ice Stream, bounding the eastern flank of the Ellsworth Mountains and flowing into Ronne Ice Shelf at the base of the Antarctic Peninsula, has a well defined grounding line. Its position was found by J. L. W. Walton and R. V. Otto using barometric altimetry and more accurately by optical levelling. The grounding line region also generates considerable audible noise. Stake networks have been set out for measuring velocity and strain fields. Ice thicknesses (1700 m) found through surface radio echo sounding by H. E. Thompson are in line with earlier airborne surveys. This is the first direct observation of a grounding line on a major ice stream and any change in position can easily be monitored. It should therefore be possible to check whether theoretical models predicting grounding line retreat rates of 1 km/year on the Ross Ice Shelf are applicable to the similar conditions found on Ronne Ice Shelf. A tiltmeter was successfully used by S. N. Stephenson in the

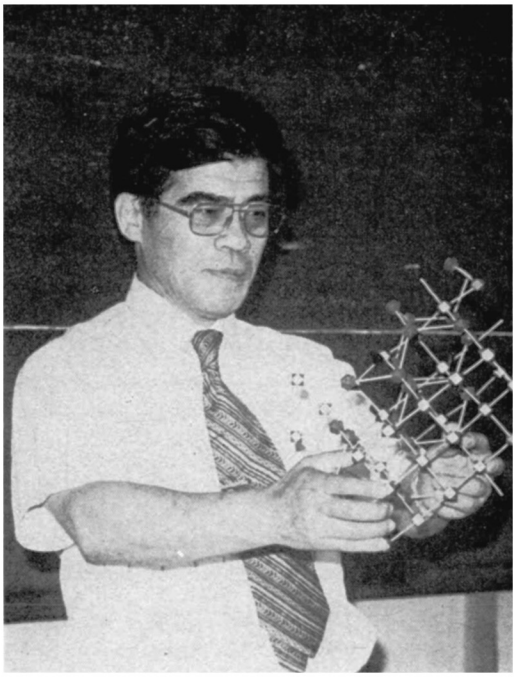
grounding line region to monitor the tidal flexing of the ice shelf. Although these data cannot yet be used to study in detail the ice shelf response to the forcing tidal function, because tidal constants in the Weddell Sea are still unknown, results show that the deformation decreases with distance from the grounding line as expected. It has been proposed by C. S. M. Doake that the flexing of ice shelves along their grounding lines may form one of the major sinks for dissipation of tidal energy in the world's oceans. If this is so then variations in extent of ice shelves may play an important role in secular change in the length of day indicated for the Phanerozoic. In particular there may be a correspondence between those times when the earth's rotation was decreasing at its greatest rate with periods of maximum glaciation.

Melting of ice at the bottom of ice shelves affects not only the dynamic behaviour of the ice shelf but can also influence the oceanographic properties of the sea water. P. W. Lennon has studied the ice/sea water boundary at the northern end of George VI Sound and has shown that residual sea currents after the tidal component has been removed are very small. Variations in current are therefore unlikely to be responsible for the differences in melt rate under George VI Ice Shelf calculated from surface measurements of ice movement and assuming steady state behaviour. Until more detailed oceanographic measurements are carried out through holes drilled in the ice shelf by a hot water drill designed and being tested by J. Loynes, the most reasonable explanation for geographic variation of bottom melting rates must remain as some form of non equilibrium behaviour. Whether bottom melting plays an important role in the production of Antarctic Bottom Water by cooling water at depth below its surface freezing temperature is one of the important questions of global significance that is related to this work.

D. A. Peel is continuing a study of the trace element content in snow and ice cores from the Antarctic Peninsula. The study aims to reconstruct past variations in the aerosol content of the lower atmosphere. An important objective is to identify the extent to which man's activities have perturbed any natural variations. Attention has centred on a series of heavy metals which constitute an important group of potentially harmful pollutants. Near-surface snow samples collected from the Antarctic Peninsula during the 1975/76 field season have been analysed for Pb, Zn and Cd using anodic stripping voltammetry (ASV) and atomic absorption spectroscopy (AA). M. P. Landy has been developing the ASV technique, and his data agree closely with those obtained by E. W. Wolff using AA on samples preconcentrated by adsorption on to tungsten wires. The preconcentration method has been developed during the year and will alleviate the need to return all snow samples to UK, thus easing sample contamination problems. Further comparative work using both techniques will provide an internal check on analytical accuracy. Since ASV is sensitive to the form of dissolved chemical species of trace metals rather than to their elemental nature alone, it may be possible to determine the distribution of chemical forms of these metals in a sample. This will be important evidence for establishing the source of particular trace elements. Samples to date have been collected to test basic analytical techniques and field sampling procedures, as well as to find the extent of seasonal variations and the relative importance of marine sources for heavy metals. However, the overall aim is to relate this information to the atmospheric composition of trace elements since changes in the general circulation of these species are of most interest. A programme is being developed for studying the incorporation of atmospheric trace substances into precipitation and the relationships between trace elemental compositions of the two media. Equipment has been constructed for sampling aerosols during precipitation so that both phases can be investigated under closely monitored weather conditions.

Climate regulates and is in turn regulated by the extent of the ice cover. The island of South Georgia occupies a climatically strategic position in the Southern Ocean and a study of past and present responses of its glaciers to climatic variations is designed to provide a better understanding of such feedback effects. Glacier response to contemporary climate was monitored intensively for 5 years (1972-77) at Hodges Glacier, a small cirque glacier near Grytviken. R. J. Timmis is using these data to establish a descriptive model to deduce past glacier behaviour from the 75-year meteorological record at Grytviken. The history of more general glacier fluctuations around South Georgia has been inferred directly from early observations and from moraines formed at the retreating snouts of land-based glaciers. R. J. Timmis has shown that the moraines indicate that glaciers on the east coast have been in general retreat since the 1880's whereas those on the west coast have retreated only since about 1950. This disparity is surprising because the west coast receives significantly greater snowfall from the prevailing westerly winds, so its glaciers flow faster and should have responded more rapidly to the general climatic amelioration.

C. W. M. Swithinbank



DR GOROW WAKAHAMA

Tokyo-born, Gorow Wakahama went to primary and middle school in that city. At the age of sixteen he entered the Naval College at Eda-jima in Hiroshima Prefecture, and graduated just when World War II ended. He then returned to Tokyo, to attend the Meteorological College of the Japan Meteorological Agency (Ministry of Transportation). The courses in which he graduated included mathematics, physics, meteorology, oceanography, astronomy and vulcanology. In 1951, he entered the third grade of Tokyo Science College, specialising in physics and mathematics. He graduated from here in 1952.

From 1949-1955, he was employed by the Seismological Section of the Meteorological Agency in Tokyo and worked on the determination of the epicentres and depths of earthquakes, on tsunami warnings, and on the relationship between microseisms and surf, in co-operation with Dr K. Wadati.

July 1955 saw a change of environment — Gorow Wakahama moved to Hokkaido University in Sapporo, to work at the Institute of Low Temperature Science as a research assistant in the Meteorological Section. He concentrated on cloud physics, and especially on the relation between snow crystal shape and upper air conditions, sea-salt nuclei in snow flakes and graupels. In September 1958 he joined the Applied Physics Section at the Institute under Professor Zyungo Yosida (now an Honorary Member of the International Glaciological Society).

Microscopic processes of deformation of snow and ice, and plastic deformation of single and polycrystalline ice were studied under the microscope and were named "Microscopic glaciology" by Gorow. This work led a series of studies on microscope processes of deformation of snow revealed by the compression of thin sections of snow. These studies were later presented as his doctoral thesis to the Faculty of Science, Hokkaido University, and gained him a Doctorate of Science in 1962. A later refinement of this work was with time-lapse motion pictures, which demonstrated the detailed processes of plastic deformation of snow and ice. This, with Wakahama-whimsey, was labelled "Cinescopic glaciology".

In 1966, he won the First Science Prize of the Japanese Society of Snow and Ice for a series of studies on internal strain of snow by the use of thin sections. He gave lectures both in Japan and in Alaska on many aspects of snow metamorphism, and took part in several expeditions to further his studies. In 1964, he was a member of the Hokkaido-Alaskan Glacier Expedition, under the leadership of Akira Higashi, and visited the Mendenhall, Kaskawulsh and Gulkana glaciers and the Katmai area. In February and March 1968, he made snow studies in the Point

Barrow, Fairbanks and Anchorage areas and glacier ice studies on the Mendenhall glacier, on the Arctic Hydrosphere Expedition under the leadership of Keiji Higuchi.

Temporary employment by the Antarctic Division in Melbourne, Australia, gave him an opportunity to work on petro-fabric analysis of deep ice cores from the Amery Ice Shelf, Cape Folger and the Law Dome Summit. During this July 1970 to January 1971 period, he worked with U. Radok, W. F. Budd, D. Jenssen and P. Schwerdtfeger.

In the northern summers of 1971 and 1972, he was a member of the U.S.-Japan Scientific Co-operative Programme (JSPS-NSF), with C. S. Benson, K. Mather, G. Wendler, T. Ohtake, W. Harrison, T. Osterkamp, M. M. Miller. He studied snow-ice transition on the McCall glacier and meltwater permeation through glacier ice on the Mendenhall glacier.

1973 saw further travels for Gorow Wakahama, in March to study sea ice in the Bering Sea and at Point Barrow, and in April to lecture at the Department of Biometeorology at Utah State University, Logan, and at the U.S. Naval Postgraduate School, Monterey, California. His first visit to Europe occurred in 1974, when he attended a conference in Switzerland. He paid visits to research institutions in that country and in Cambridge, England. He returned to Britain in 1976, for one of the Society's symposia and participated in the field-study excursion to Scotland. It was in that year that he was first co-opted on to the Society's Council, becoming an Elective Member in 1977 and Correspondent for Japan in 1978. He brings to those duties the same enthusiasm and ready helpfulness that characterise his research and teaching.

His professional expertise encompasses the plastic deformation of snow and ice revealed by the compression, extension or bending of thin sections; the metamorphism of wet snow; petro-fabric studies of snow and ice; permeation of meltwater into snowcover; propagation of plastic waves in snow; and snow and ice accretion on power lines, trains and structures.

But he is an expert also in judo (first grade, black belt) though he claims he has not practised for a long time. He does claim however to be well practised in washing dishes for his wife (who is an excellent cook) and children, in their home which is full of souvenirs of his travels and of a big, well-loved family of cats. Perhaps as an antidote to microscopic techniques, he derives great pleasure from watching clouds and stars. He enjoys classical music and poetry and writes essays, many of which have been published.

INTERNATIONAL GLACIOLOGICAL SOCIETY

ANNUAL GENERAL MEETING 1979

This will take place on Monday, 13 August, during the week of the Symposium on Snow in motion, in Fort Collins, Colorado, USA, 12-17 August. Members of the Society not attending the Symposium will be welcome at the meeting, which will take place at 7.30 p.m.

The Agenda will be published later, giving exact place on the campus of Colorado State University.

BRANCH NEWS

NORTH EAST NORTH AMERICAN BRANCH

The biennial meeting took place in Kingfield, Maine, USA, 2-4 March 1979 at Capricorn Ski Lodge on Sugarloaf Mountain. The new President of the Branch is R. H. Thomas, University of Maine, and the Vice-President is Gordon Young Ottawa. The next meeting will be held in 1981 in Ottawa.

The following papers were presented at this year's meeting:

D. E. Thompson: Galilean ice satellites.

M. Petrin & K. Sivaprasad: Reflections of pulses from polar ice sheets.

E. R. Pounder: Plans for LOREX 79.

D. E. Kellogg, M. Stuiver, G. Denton & T. Kellogg: Fresh water diatoms from perched deltas in Taylor Valley, Antarctica.

D. Raynaud: The total gas content method.

D. J. Johnson: A summer on the Ross Ice Shelf.

W. D. Hibler: Large-scale modelling of sea ice.

N. R. Gadd: Flow patterns and the calving bay concept in Eastern Ontario.

M. S. Perchanok: History of a glacier-dammed lake on Donjek River, SW Yukon Territory, Canada.

G. L. Young: The impact of floods from glacier-dammed lakes, Yukon, Canada.

T. B. Kellogg, R. S. Truesdale & L. E. Osterman: Late Quaternary extent of the West Antarctic Ice Sheet: new evidence from Ross Sea cores.

D. Raynaud & I. M. Whillans: The Byrd question.

P. R. Camp: Grain boundary thickness in ice as determined from dielectric measurements.

S. J. Jones: Triaxial testing of polycrystalline ice.

J. Edworthy: Snow density variations on Peyto Glacier, Banff National Park, Canada.

R. L. Brown: Propagation and attenuation characteristics of shockwaves in snow.

L. G. Thompson: Ice core records from tropical regions—Mt. Kenya, Africa and the Quelccaya Ice Cap, Peru.

P. A. Mayewski, P. A. Jeschke & G. P. Pregent: Himalayan and trans-Himalayan glacier fluctuations and a correlation with changes in atmospheric circulation.

D. E. Thompson: Stability of channelized ice stream drainage: progress on the West Antarctic ice drainage model.

J. F. Bolzan: Temperature measurements of Dome C, preliminary results.

D. MacAyeal & R. H. Thomas: The time dependent temperature depth profile of a forming ice rise.

C. S. L. Ommanney: The current status of the world glacier inventory.

J. Hassinger, P. A. Jeschke, T. Trombley, P. A. Mayewski, D. Butler, T. Armstrong & P. Brown: Preliminary results of the 1978 University of New Hampshire Athabasca Glacier expedition.

I. M. Whillans: Dome C field program.

T. Fastook, W. Pfeffer & T. Hughes: Surface velocity field of Byrd Glacier, Antarctica.

H. W. Borns, Jr: The extent of the late-Wisconsin ice sheet over Maine.

I. Zotikov: Preliminary results from the RISP borehole.

GROUP IN OTTAWA

An Ottawa Chapter of the Society has been formed. There are more than 200 people in the Ottawa area involved with or interested in glaciology. Several have active research programmes on snow, ice, permafrost and related topics, but have little opportunity to describe this work to their glaciological colleages. A small group decided to remedy this situation by initiating a local chapter of the North East North American Branch of the International Glaciological Society. In this way it is hoped to provide an opportunity for Ottawa glaciologists to meet periodically in an informal way to exchange ideas and discuss new developments both in the laboratory and in the field. It is hoped that the Chapter will be able to arrange for lectures from visiting glaciologists.

Three individuals have consented to act as the Executive of the Chapter for this winter. They are:

Chairman:	Sivan Parameswaran
Vice-Chairman:	Peter Johnson
Secretary-Treasurer:	Simon Ommanney

The affairs of the Chapter will be placed on a more democratic basis once it has been established.

The first meeting was held on 25 January. The weather was appropriate for glaciologists—there had been a snow storm during the previous 24 hours and only the most dedicated were able to get to the meeting. Even so, it was very successful, with an attendance of about 50. The speaker was Gordon Young—Himalayan glaciers: recent trips to Nepal.

Three other meetings are planned for the remainder of this winter. The speakers will be:

Razek Abdelnour: The hydraulic modelling techniques of intact ice covers.

Stephen J. Jones: Review of recent work on the mechanical properties of ice.

Fritz Koerner: Climatic change and ice caps.

Ron Perla: Avalanches.

BRITISH BRANCH

The 1979 meeting of the British Branch was held in Newcastle-upon-Tyne, on Friday 30 March, at the Department of Geography, University of Newcastle-upon-Tyne. The following papers were presented:

H. Lister: Erosion interpreted from suspended sediment.

E. M. Morris: The European hydrological model snow routines.

D. N. Collins: Hydrochemistry of meltwaters draining from a limestone-based glacier.

M. Landy: Heavy metals in Antarctic snow.

C. J. Talbot: A glacier of halite (NaCl) in southern Iran.

W. B. Whalley: Problems of rock glacier dynamics.

D. J. Goodman: The fracture of sea ice floes by the action of swell.

N. W. Riley: Crack propagation in sub-glacial rocks.

I. Johnson: Steady motion of icesheets.

C. S. M. Doake: The Rutford Ice Stream.

G. S. Boulton: Modelling the climate near former ice sheets.

D. M. Bertie: Glaciological aspects of the Neoglaciation in central Nordland, Norway.

In a short branch meeting, M. E. R. Walford was elected President, E. M. Morris, Vice-President and D. J. Goodman, Secretary. The retiring officers, H. Lister and D. N. Collins, were thanked for their efforts in the last two years. It was determined that next year's meeting would probably take place in Cambridge.

The meeting was followed on Saturday 31 March by a field visit to some exposures on the Northumberland coast, enthusiastically led by N. W. Riley and H. Lister.

WESTERN ALPINE BRANCH

The 1978 meeting was held at La Rosière, Bonneval-sur-Arc, 7–10 September 1978. In addition to the presentation of papers, several excursions were made, to Col du Petit St. Bernard, La Thuile and its valley, and three concurrent ones to la Tsanteleina, glacier de Rheme Golette and the Sassière rock glaciers and lake. Papers covered subjects as diverse as periglacial features in Swedish Lapland, the mass balance of the Greenland ice sheet, and recent work on the glaciers of Mont Blanc and others in the western Alps.

Proceedings concluded in a unique manner—with the playing of the alpenhorn by Louis Wuilloud, a master of that instrument.

The 1979 meeting will be held 7–9 September in the Saas-Almagell valley. The Officers of the Branch were elected: President—Louis Wuilloud, Vice-President—Gérard Soutade, Treasurer—François Valla, Secretary—Gérard Bocquet. The new President congratulated his predecessor J. Y. Bernard on the successful organization of the 1978 meeting and announced that the programme for the 1979 meeting would include visits to the Allalin Horn glacier and the glaciers in the Mattmark region.

JOURNAL OF GLACIOLOGY

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

Ian Allison:
The mass budget of the Lambert drainage basin, Antarctica.

Charles R. Bentley:
In-situ measurements of the activation energy for d.c. conduction in polar ice.

C. J. Waag and K. Eckelmeyer:
Rhombus and rhomboid parallelogram patterns on glaciers; natural indicators of strain.

M. Kuhn:
On the computation of heat transfer coefficients from energy-balance gradients on a glacier.

M. Nakawo:
Supraglacial debris of the G2 glacier in Hidden Valley, Mukut Himal, Nepal.

T. J. O. Sanderson and C. S. M. Doake:
Is vertical shear in an ice shelf negligible?

W. D. Hibler III and W. B. Tucker III:
Some results from a linear-viscous model of the Arctic ice cover.

Thomas C. Grenfell:
The effects of ice thickness on the exchange of solar radiation over the polar oceans.

D. M. McClung:
In-situ estimates of the tensile strength of snow utilizing large sample sizes.

J. E. Gordon:
Reconstructed pleistocene ice sheet temperatures and glacial erosion in Northern Scotland.

J. Ehlers and H.-J. Stephan:
Forms at the base of till strata as indicators of glacier movement.

G. R. Whittecar and D. M. Mickelson:
Composition, internal structures and an hypothesis of formation for drumlins, Waukesha County, Wisconsin, U.S.A.

John Menzies:
The mechanics of drumlin formation.

T. J. O. Sanderson:
Equilibium profile of ice shelves.

G. W. Timco:
An analysis of the *in-situ* resistivity of sea ice in terms of its microstructure.

A. A. Salway:
Time-series modelling of avalanche activity from meteorological data.

P. J. Martin and T. J. O. Sanderson:
Morphology and dynamics of ice rises.

C. Obled and W. Good:
Recent developments in avalanche forecasting by discriminent analysis techniques.

J. A. Matthews, R. Cornish and R. A. Shakesby:
"Saw-tooth" moraines in front of Bødalsbreen, southern Norway.

S. Martin:
A field study of brine drainage and oil entrapment in first-year sea ice.

R. R. Pedersen, J. D. Dent and T. E. Lang:
Forces on structures impacted and enveloped by avalanches.

K. L. Dawson and T. E. Lang:
Evaluation of jet-roof geometry for snow-cornice control.

R. H. Thomas, D. R. MacAyeal, C. R. Bentley and J. L. Clapp:
The creep of ice, geothermal heat flow and Roosevelt Island.

W. Tangborn:
Two models for estimating climate-glacier relationships in the North Cascades, Washington.

T. E. Osterkamp:
Instruments and methods: Mercury-in-glass thermometers for precise temperature measurements near O C.

V. I. Morgan:
Instruments and methods: A system for accurate temperature control of small fluid baths.

C. S. M. Doake and M. Gorman:
Instruments and methods: Performance of VHF aerials close to a snow surface.

SHORT NOTES

A. S. Jones:
The flow of ice over a till bed.

C. K. Ballantyne:
Patterned ground on an active medial moraine, Jotunheimen, Norway.

R. A. Sommerfeld:
Accelerating strain preceding an avalanche.

R. A. Sommerfeld and R. M. King:
A recommendation for the application of the Roch index for slab avalanche release.

FUTURE MEETINGS (of other organizations)

INTERNATIONAL COMMISSION ON SNOW AND ICE

SYMPOSIUM ON SEA LEVEL, ICE SHEETS, AND CLIMATIC CHANGE (IAHS - IAMAP - IAPSO - IASPEI - ICGC)

Canberra, during IUGG General Assembly, 3–15 December 1979

The completion of the Third circular was delayed by late entries needed to close gaps in the symposium programme. The programme has now been constructed and may be obtained from the Secretary of the Commission—Dr M. Mellor, CRREL, Hanover, NH 03755, U.S.A. The papers committee reserves the right to modify the order of the presentations.

INTERNATIONAL WORKSHOP ON REMOTE ESTIMATION OF SEA ICE THICKNESS

25–26 September 1979—Memorial University of Newfoundland

St. John's, Newfoundland. Canada

A recent questionnaire indicated considerable enthusiasm for a research workshop with the following goals:

(i) to review the state-of-the-art of remote ice thickness sounding, including recent field results;

(ii) to summarize current knowledge of the electrical properties of sea ice;

(iii) to review ice sounding technology; and

(iv) to recommend directions for future research and development in this field.

Approximately four to six invited papers will be presented during Sessions 1 to 3. Ample time will be allowed for discussion. It is hoped that during Session 4 discussion will highlight the most important deficiencies in our present knowledge and indicate promising fresh approaches.

Preprints of invited papers will be available at registration, and a summary document will be produced following the workshop. A list of speakers will be distributed in a Second Circular.

Participants are expected from Canada, U.S.A., U.S.S.R., U.K. and other Western European countries. In order to facilitate discussion, the number of attendees will be limited. Those wishing to participate are urged to reply as soon as possible, to the following address: Dr James R. Rossiter, C-CORE, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5, Canada. Phone: 709-753-1200 extensions 3733 or 3872.

GLACIOLOGICAL DIARY

1979

11–15 June
William T. Pecora Memorial Symposium: Satellite hydrology. Sioux Falls, S. Dakota, USA. (D. R. Wiesnet, NOAA/ NESS, S-33, Washington, D.C. 20233, USA.)

6–10 August
Symposium on the Physics and mechanics of ice. IUTAM. Copenhagen. (P. Tryde, Institute of Hydrodynamics and Hydraulic Engineering, Technical University of Denmark, Building 115, DK-2800 Lyngby, Denmark.

12–17 August
Symposium on Snow in motion — Avalanches and blowing snow. Fort Collins, Colorado, USA. Rocky Mountain Forest and Range Experiment Station. Co-sponsored by International Glaciological Society. (Dr M. Martinelli, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO 80302, USA.)

11–14 September
Sixth Annual European Geophysical Society Meeting, Vienna, Austria. (EGS Secretary General, 6 Carlton Terrace, London SW1 5AG, U.K.)

25–26 September
Workshop on Remote estimation of sea ice thickness. St. John's, Newfoundland, Canada. (J. R. Rossiter, C-CORE, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X5, Canada.)

7–8 December
Symposia on Sea level, ice sheets and climatic change, and on Ice, weather and climate. Canberra, Australia. International Commission on Snow and Ice, during General Assembly of I.U.G.G. (3-15 December). (U. Radok, c/o CIRES, University of Colorado, Boulder, CO 80309, U.S.A.)

1980

1–3 April
Conference on Use of icebergs, Cambridge, U.K. Organized by International Glaciological Society, hosted by Scott Polar Research Institute, sponsored by Iceberg Transport International. (Mrs H. Richardson, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.)

24–30 August
Symposium on Processes of glacial erosion and sedimentation. Geilo, Norway, International Glaciological Society. (Mrs H. Richardson, Secretary General, Cambridge CB2 1ER, England.)

1981

Last week July
International Association of Hydraulic Research—Ice Symposium. Quebec City. (B. Michel, Département Génie Civil, Université Laval, Québec 10, P.Q., G1K 7P4, Canada.)

31 August–4 September
Third International Symposium on Antarctic Glaciology. Columbus, Ohio, USA. Scientific Committee on Antarctic Research of ICSU. Co-sponsored by International Commission of Snow and Ice and International Glaciological Society. (Dr C. B. B. Bull, Office of the Dean, College of Mathematics & Physical Sciences, Ohio State University, 164 West 17th Avenue, Columbus, Ohio 43210, USA.)

1982

23–27 August
Second Symposium on Applied Glaciology, Hanover, New Hampshire, USA. Organized by International Glaciological Society, hosted by Cold Regions Research and Engineering Laboratory. (Mrs H. Richardson, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.)

NEWS

AWARDS

Dr W. F. Weeks, a past president of the International Glaciological Society, has been elected to membership in the National Academy of Engineering. Election to the Academy is the highest professional distinction that can be conferred on an engineer and honours those who have made important contributions to engineering theory and practice or who have demonstrated unusual accomplishments in the pioneering of new and developing fields of technology.

Dr Weeks is currently the Office of Naval Research Professor of Arctic Marine Science at the Department of Oceanography, Naval Postgraduate School, Monterey, CA 93940. He will return to CRREL in September 1979.

PUBLICATIONS

ARCTIC INSTITUTE OF NORTH AMERICA

The following publications are available and may be obtained by writing in the first instance to the Institute, University Library Tower, 2290-24th Avenue N.W., Calgary, Alberta T2N 1N4, Canada.
Arctic Bibliography—edited by Maret Martna

Volume 13 1967 $12.50
Volume 14 1969 $20.00
Volume 15 1972 $30.00
Volume 16 1975 $60.00

(Volumes 13–16 are available from McGill-Queens University Press, 1020 Pine Avenue West, Montreal, Quebec H3A 1A2, Canada.)

Reports

Oil and Gas Pipelines in the North. 1974. $2.00.
Jurisdiction over Ice Islands: The Escamilla Case in Retrospect. A. Ronhovde. 1972. $2.00.
The Dilemma: Man and His Environment VS Resource Development. 1971. $2.00.
Report of Arctic Ocean Technology Workshop, April 1971 (quantities limited). 1971. $2.00
Symposium on Remote Sensing in the Polar Regions. 1968. $2.00.
Polar Shiphandling (quantities limited). 1965. $2.00.
A Report on Alaskan Ecology and Oil Development (quantities limited) 1970. $2.00.
Oil and Gas Exploration in Canada's Arctic Islands. 1973. $2.00.
Reports on the On-Site Visit to the Trans Alaska Pipeline System. October 1974. $2.00.
Report on the Second On-Site Visit to the Trans Alaska Pipeline System. April 1976. $2.00.
Report on the Third On-Site Visit to the Trans Alaska Pipeline System. July 1976. $2.00.
Report on the Fourth On-Site Visit to the Trans Alaska Pipeline System. September 1977. $2.00

Miscellaneous Publications

The Coast and Shelf of the Beaufort Sea: Proceedings of a Symposium on Beaufort Sea Coast and Shelf Research. Edited by J. C. Reed and J. E. Sater. 1974. $2.00.
The Arctic Basin. Edited by J. E. Sater. 1969. $10.00.
Proceedings of the Arctic Basin Symposium. October 1962. $4.00.
Arctic Laboratory: A History (1947–1966) of the Naval Arctic Research Laboratory at Point Barrow Alaska. Edited by J. C. Reed and A. G. Ronhovde. $5.00.
Polar Oceans. Proceedings of the 1974 SCOR/SCAR Polar Oceans Conference. Edited by M. Dunbar. 1977. $40.00.
Conference on Building in Northern Communities: 1973. Edited by M. Glover. $7.50. (English or French).

Arctic

The Journal of the Arctic Institute of North America. Limited back issues available from the Arctic Institute. $7.50 per copy after 1975. $5.00 prior to 1975.

Prints

The Canadian Arctic in 1819–1821. A Folio Set of four fine quality Colour Reproductions from the Journal and Paintings of Robert Hood, Midshipman with Franklin. $5.00.

Please note:
Information provided in this listing is subject to revision without prior notification.

Postage and handling charges of $1.00 per item will be charged on all orders which are not prepaid and are available from the Arctic Institute of North America.

NEW MEMBERS

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