NUMBER 77

1st ISSUE 1985

ICE

INTERNATIONAL GLACIOLOGICAL SOCIETY

SECOND SYMPOSIUM ON REMOTE SENSING IN GLACIOLOGY

Cambridge, England

7–12 September 1986

(IGS Council Meeting – 6 September)

COMBINED WITH THE SOCIETY'S

50th ANNIVERSARY CELEBRATIONS

To be held in Cambridge on
10 September and in
Switzerland 13–20 September

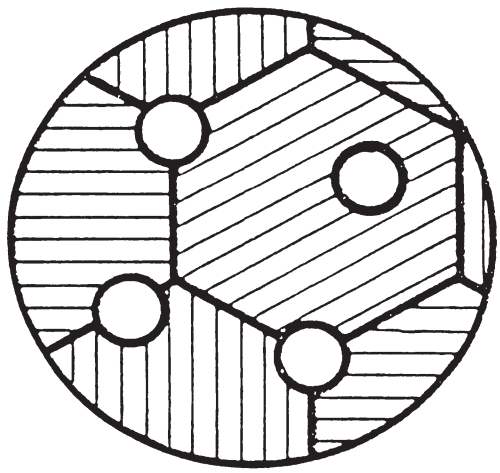
SECOND CIRCULAR

MAY 1985

SYMPOSIUM ON ICE-CORE ANALYSIS

Bern, Switzerland

30 March – 4 April 1987



FIRST CIRCULAR

May 1985

These circulars were sent to members on 3 June 1985, and will be reprinted in Ice later this year. Further information may be obtained from the Secretary General.

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ICE

NEWS BULLETIN OF THE

INTERNATIONAL GLACIOLOGICAL SOCIETY

NUMBER 77 1st ISSUE 1985

CONTENTS

DEATH OF VALTER SCHYTT: It is with deep regret we report the sudden death of Valter Schytt earlier this year at the Tarfala Research Station. He was well known to Society members as a Past President and Honorary Member of the Society and for the leading role he played in glacier mass balance research through the longest existing programme on Storglaciären. He was a leading figure in Swedish and International scientific circles. Last year he participated in the IGS tour to China.

DEATH OF BØRGE FRISTRUP: We are also very sorry to have to report the recent death of Børge Fristrup. For many years he was the Danish IGS Correspondent and had been a long standing editorial advisor to the Society. He was well known for his work in Greenland.

JAPAN AND CHINA TOUR: This issue contains a photo story on last year's meeting in Japan. If space permits, photos of the tour in Japan and China will appear in subsequent issues of **ICE**.

COVER PICTURE: Sea ice in the North Water. Grey ice (approx. 15 cm thick) with finger rafting. Small white floes (Ø = 10 m) broken up under the influence of strong winds and then re-frozen. Altitude 300 m a.s.l. Scale 200 m x 170 m. Photographed by Koni Steffen.

CANADA

GENERAL

In April 1984, the Snow and Ice Division of the National Hydrology Research Institute, Environment Canada, was disbanded and the remaining elements merged with the Surface Water Division. The Division, previously known as the Glaciology Division, created in 1967, at one time had a staff of 33.

GLACIERS

(For abbreviations used see ICE, No.59, 1979, p.15)

GLACIER INVENTORY OF CANADA
(C.S.L. Ommanney, J.W. Clarkson and A. Champoux, SWD/NHRI/EC)
The Stikine/Iskut inventory, 49 basins with some 8196 glaciers, has been completed. The area of Yukon glaciers was measured and the inventory of that region finished with completion of the Lake Tagish area. A tripartite inventory of Glacier National Park, c.a. 1850, 1951-52 and 1978, is drawing to a close. Data reports for 15 basins (> 400 glaciers) will be published shortly. The McGregor River basin on the west side of the Rockies and will be completed by the spring of 1985. At this time, all available Canadian glacier inventory data will be forwarded to the TTS in Zürich. An air photo interpretation study of a section of the Columbia Icefield was completed as part of a guide for future inventory work. Over the past two years, new techniques and procedures for digitizing and processing inventory data have been developed and are now operational.

RADIO ECHO SOUNDING - INTERPRETATION THEORY
(B.T. Prager, G.M. Cross and G.K.C. Clarke, GPHYS/UBC)
Prager and Cross are using airborne radar-sounding data from Ellesmere Island, Mt. Wrangell (Alaska) and Mt. Logan (Yukon Territory) to test various digital signal enhancement methods. These include two-dimensional filtering and wave migration.

ISOTOPE GLACIOLOGY
(M.G. Maxwell, P. Whaite and R.D. Russell, GPHYS/UBC)
Maxwell is studying basal processes in glaciers, particularly the accretion of ice and entrainment of debris at the glacier-bed interface. This involves analyses of water quality, crystal fabric structure, debris properties and isotopic fractionation of D/H and $^{18}O/^{16}O$. More than 400 samples from the Backe and Trapridge glaciers, Yukon, have been analyzed. Oxygen isotope analyses are being performed on the automated system at UBC.

ECOLOGY OF ICE
(M.J. Dunbar, OCEAN/McGill)
Studies on the ecological significance of sea ice and glacier ice (both as glacier facies and icebergs), and on biota living in the ice, have been carried out for several years.

GLACIERS — ARCTIC

ARCTIC ICE SHELVES, NORTHERN ELLESMERE ISLAND
(M.O. Jeffries, GEOG/ Calgary; H.V. Serson)
A snowmobile traverse was completed from Point Moss to Nansen Sound, northern Ellesmere Island, to gather ground truth data on ice shelves and landfast sea-ice margins along a 450-km survey line. The ice conditions vary from 2 m thick first-year sea ice to ice shelves up to 100 m thick. In M'Clintock Inlet, Ayles Fiord, Milne Fiord, Yelverton Bay and Nansen Sound, there are large areas of old sea ice which are more than 20 years old and up to 10 m thick. Ice cores were obtained for salinity, stable isotope and tritium analysis. In late July 1984, an air photo survey of the Ward Hunt Ice Shelf, Milne Ice Shelf and most of Ayles Fiord was undertaken to complement the ground survey. In addition, single flight lines were flown from Point Moss to Cape Albert Edward and across the mouth of Yelverton Bay.

ICEBERGS AND ICEBERG-PRODUCING GLACIERS OF SOUTHEASTERN ELLESMERE ISLAND
(T.E. Keliher and J.C. Lewis, PHYS/MUN)
An aerial survey of iceberg-producing glaciers on SE Ellesmere Island showed significant changes in the glacier fronts as compared to a similar survey made 18 months earlier. Activity was especially high for Talbot Glacier, which appears to be rapidly disintegrating. Significant activity was also observed on the Tanquary and Ekblaw glaciers and the tidewater glaciers around Cape Mouat. Signs of surge behaviour were also observed. Further field programs will include radio-echo sounding of the glaciers and drift studies of the icebergs.

QUEEN ELIZABETH ISLANDS, N.W.T.
(B.T.Alt, J.Bourgeois, D.Fisher, R. Koerner, M. Parnandi and K. Langley, PSCP/EMR)
Pollen analysis of samples melted at more than 100-m depth in an old bore hole revealed relatively high pollen concentrations near the bottom of Agassiz Ice Cap, N Ellesmere Island. An oxygen isotope/vapour transport model was developed, which contributes to an understanding of major isotope changes in ice cores. The ice core record shows that Franklin experienced some of the severest

climatic conditions of the past 800 years. Some glacier mass balance records for the past 20 years, in particular Meighen Ice Cap, were studied in relation to areal and volume changes. Work continued on the three-dimensional model of the Laurentide Ice Sheet, in terms of accumulation and ablation rates on its surface and temperatures at its base.

The mass balance of four High Arctic ice caps was remeasured. A 127-m surface-to-bedrock core was drilled from the top of a flowline on Agassiz Ice Cap and 80 litre samples were melted from more than 100-m depth in a five-year old borehole one kilometre away.

WHITE GLACIER, AXEL HEIBERG ISLAND
(W.P. Adams, GEOG/Trent)
Mass balance measurements were completed on White Glacier in May 1984. Stakes were redrilled and extended over the glacier.

GLACIERS — YUKON TERRITORY

SEWARD GLACIER
(G. Holdsworth, SWD/NHRI/EC)
Shallow core sampling was carried out on Seward Glacier, in the vicinity of Mount Logan, for trace chemical studies. Temporal and spatial data are being acquired to support the long-range transport of atmospheric pollutant (LRTAP) studies.

LOWELL GLACIER
(G. Holdsworth, SWD/NHRI/EC)
Lowell Glacier was visited to obtain ground truth information for correct interpretation of LANDSAT 4 and 5 images covering the last surge (April 1983 - June 1984).

MOUNT LOGAN
(G. Holdsworth, SWD/NHRI/EC)
The analyses of the Mount Logan ice core are continuing. Results are relevant to studies of the Gulf of Alaska climatic regime over the last c.a. 250 years, LRTAP and atmospheric CO_2 content (last 150 years).

TRAPRIDGE GLACIER
(G.K.C. Clarke, S.G. Collins, F.H.M. Jones and J. Schmok, GPHYS/UBC)
Trapridge Glacier last surged around 1945 and its next surge is expected to occur within several years. A large wave-like bulge has formed in the middle region of the glacier and is propagating downglacier at 25 m a^{-1}. The bulge is at the boundary between warm-based (upstream) and cold-based (downstream) ice. The glacier was resurveyed and measurements made of the fluid permeability of basal till in the 1 km^2 region of thick till deposits downstream from the bulge.

ICE-DAMMED LAKES, RECENT LAKE ALSEK
(J. Schmok and G.K.C. Clarke, GPHYS/UBC)
In 1984, J. Schmok visited 23 small lakes situated within the basin of former glacier-dammed Lake Alsek. Cores from these lakes contain a record of past fillings and outburst floods from the lake.

RADIO ECHO SOUNDING, TRAPRIDGE GLACIER
(F.H.M. Jones, B.B. Narod and G.K.C. Clarke, GPHYS/UBC)
Jones successfully tested a new impulse radar transmitter on Trapridge Glacier in 1984. He is completing work on a microprocessor-controlled back-portable system that records data on digital cassettes.

GLACIERS — BRITISH COLUMBIA

EAST ARM GLACIER, ST. ELIAS MOUNTAINS, B.C.
(St. Joe Canada Inc. and others)
Estimates of surface velocity near the equilibrium line were made by comparing the positions of looped moraines (due to surging prior to 1949) on 1949 and 1976 aerial photos. A rate of 39-52 m a^{-1} was later corroborated by measurements of a line of cairns placed across the glacier in 1983. Detailed studies of morainal debris near and on the snout of the glacier, show that the sulphide boulders which lay downstream originated from a subglacial source, thus concluding 30 years of controversy. Geological, glacial geological and geophysical reports on the glacier are available as Assessment Files #5841 and #9516 through the Publications and Sales Office, BC Ministry of Energy, Mines and Petroleum, Parliament Buildings, Victoria, BC.

ISKUT RIVER GLACIERS, COAST MOUNTAINS
(O. Mokievsky-Zubok, SWD/NHRI/EC)
For 1984, the mass balance results and vertical height loss of ice at the termini were as follows: Andrei Glacier +0.14 m H_2O and 2.5 m; Alexander Glacier +0.09 m H_2O and 2.1 m; and Yuri Glacier +0.14 m H_2O and 1.1 m. These studies will terminate in 1985.

GLACIER-DAMMED LAKES
(O. Mokievsky-Zubok, SWD/NHRI/EC)
There was no impounded water in Natavas Lake during the 1984 summer, though Flood Lake was filled to capacity (approx. 200 x 10^6 m^3) and fully discharged in July. Large icebergs which blocked the exit tunnel slowed the discharge, thus minimizing major flooding of the Stikine River valley. No further monitoring is planned for the future.

TIEDEMANN AND BENCH GLACIERS, COAST MTS
(O. Mokievsky-Zubok, SWD/NHRI/EC)
Tiedemann Glacier had a substantial vertical ice loss of 7.5 m on its snout, while the loss on Bench Glacier was 4.5 m. Bench Glacier had a negative mass balance of -0.19, while Tiedemann showed a positive balance of +0.21 m H_2O. As BC Hydro is withdrawing its logistic support for these studies, no continuation is foreseen after 1985.

NATURAL HAZARDS, COAST MOUNTAINS
(J.J. Clague, GSC/EMR/Vancouver)
On July 19, 1983, the toe of Cumberland Glacier collapsed into Nostetuko Lake, generating a series of waves that overtopped the Neoglacial end moraine damming the lake and precipitating a catastrophic release of about 6 x 10^6 m^3 within the next few hours. The flood swept down Nostetuko and Homathko valleys to the head of Bute Inlet 100 km away, eroding and transporting large amounts of sediment and devastating tracts of forest. Because of the remote location and lack of development, there were no casualties.

FYLES GLACIER AND APE LAKE JØKULHLAUP, COAST MOUNTAINS
(K. Ricker; D. Jones and J. Desloges, GEOG/UBC; M.Maxwell and G.K.C. Clarke, GPHYS/UBC)
On October 20, 1984, an outburst flood from Ape Lake, dammed by Fyles Glacier, released about 46 x 10^6 m^3 of water in less than 24 hours generating an estimated peak discharge of at least 1500 $m^3 s^{-1}$, which caused more than $1 million in downstream damages. The size of the Fyles Glacier snout had been decreasing since the turn of the century,while the full pool level of Ape Lake (c.a. 2.47 km^2) increased in extent at the expense of a calving and thinning ice front. Although the tunnel will likely seal this year, the recurrence of jøkulhlaups is highly probable. In six to 24 years the events will be smaller because the water will be able to escape along an ice-front channel.

BRIDGE RIVER GLACIERS, COAST MOUNTAINS
(O. Mokievsky-Zubok, SWD/NHRI/EC)
Bridge, Sykora and Zavisha glaciers all had positive mass balances of +0.23, +0.75 and +0.31 m H_2O respectively. A Data Collection Platform (DCP) provided meteorological data and river flow levels.

MASS BALANCES, SOUTHWEST COAST MOUNTAINS
(O. Mokievsky-Zubok, SWD/NHRI/EC)
Measurements of winter and summer balances and meltwater flow continued on Sentinel and Place glaciers. Only mass balance was measured on Helm Glacier. Sentinel showed a positive balance of +0.85 m H_2O, while Place and Helm had negative balances of -0.24 and -0.32 m H_2O respectively.

WEDGEMOUNT GLACIER, NORTHERN GARIBALDI PARK, COAST MOUNTAINS
(K. Ricker; W. Tupper, B.C.I.T.)
The 1947 oblique aerial photos were contoured, thus providing another detailed map of the glacier. Field work in September focused on the resurvey of the snout and two velocity profile lines. An average snout retreat for 1977-1984 is 2.5 m a^{-1}. Photogrammetric work is now being directed to the 1928 terrestrial survey photos used to make the park map. Glacier volumetric change will be computed from this baseline.

DEBRIS FLOWS, FIELD AREA, B.C.
(H. Oldrich, Thurber Consultants, Vancouver)
An engineering study of debris flows, initiated by jøkulhlaup discharges from Cathedral Glacier near Field, has been started.

GLACIERS — ALBERTA

COLUMBIA ICEFIELD, ROCKY MOUNTAINS
(G. Holdsworth, SWD/NHRI/EC)
A reconnaissance was carried out on Snow Dome, Columbia Icefield, for a study of climate change and LRTAP in conjunction with AES and Alberta Environment.

BOUNDARY GLACIER, ROCKY MOUNTAINS
(J. Gardner, GEOG/Waterloo)
Ice surface velocity, meltwater discharge, and bergschrund temperature studies were made at "Boundary" Glacier near the Columbia Icefield. Radiocarbon dating shows that Neoglacial expansion began prior to 4000 years, B.P. and, that throughout the past 4000 years the glacier has been significantly larger than it is at present.

PEYTO GLACIER, ROCKY MOUNTAINS
(J. Power, SWD/NHRI/EC)
Mass balance and meteorological data collection continued at Peyto Glacier under contract to P.G. Johnson, Ottawa University. The annual balance for 1983-84 of -0.58 m H_2O continued a negative series which began in 1976-77. D.N. Collins, Manchester University, collected water chemistry data at Peyto and several surrounding streams to determine the composition of meltwater and its flow paths. G. Holdsworth used a monopulse radar to measure the thickness of the glacier at several points in the accumulation zone. Work continues on modelling the runoff of the glacier using a new version of the UBC watershed model.

FLUVIOGLACIAL AND HYDROCHEMICAL STUDIES, PEYTO GLACIER, ROCKY MOUNTAINS
(G. Binda, GEOG/Ottawa)
Temporal variations in suspended sediment and solute concentrations in glacier-fed Peyto Creek were studied, to determine the seasonal and diurnal fluctuations. Suspended sediment concentrations fluctuated erratically and were unrelated to discharge variations. Subglacial channel reorganization under changing hydrostatic pressures and sediment availability are hypothesised to be the major factors influencing suspended sediment output from Peyto Glacier. Meltwater had low solute concentrations. Divalent cations (Ca^{++}, Mg^{++}) were more abundant than the monovalent ones (Na^{+}, K^{+}), with Calcium (Ca^{++}) being the most abundant and Potassium (K^{+}) the least. Attached cationic concentrations reflected the residence time of the suspended sediment within the subglacial system. Calcium (Ca^{++}) was the most readily adsorbed cation.

PEYTO GLACIER SEDIMENTS, ROCKY MOUNTAINS
(P.G. Johnson, GEOG/Ottawa)
Investigation of the variability of water and suspended sediment discharge from glaciers continued at Peyto Glacier, Alberta, and Kaskawulsh Glacier, Yukon Territory. Extreme variability of sediment concentrations (and total load) and attached ionic loading on sediment during the onset of the ablation season, is unrelated to discharge or discharge regime. The controlling role of the opening of the glacier drainage system makes it difficult to prediction the magnitude and time of maximum sediment load due to variations in winter accumulation, differences in the onset of spring melt conditions and the problems of contact between meltwater and glacier load with the glacier. Variability at the glacier terminus is damped downstream according to the morphological characteristics of the stream channel. High magnitude events dominate the evolution of the proglacial zone, both directly and indirectly (as a trigger of further slope adjustment processes). Measurement of the high magnitude events has been difficult, due to equipment destruction by an estimated order of magnitude greater than normal peak flow. (Peyto Creek flow estimated at 250 $m^3 s^{-1}$ instantaneous discharge transporting 6000 m^3 of sediment).

GLACIERS — LABRADOR

TORNGAT MOUNTAIN GLACIERS
(R.J. Rogerson, GEOG and Earth Sciences/MUN)
Mass balance work continued in 1984 on four cirque glaciers in the Torngat Mountains of northern Labrador, and was augmented by a scrutiny of glacier depths using radio-echo sounding, hammer seismic and resistivity methods. As in 1983,mass balance was strongly negative. The snowline in early July was close to its end-of-season position in 1983 and snow depths in the accumulation basins seldom exceeded 1.5 m. Snowfall in the Torngat the previous winter must have been very slight. The summer was cool and dry and by the end of the season, snow remained only at the foot of couloirs and in shaded gullies.

The glaciers are up to 200 m thick. Superguksoak Glacier, the biggest in the Torngat, had a maximum measured depth of 176 m.

ROCK GLACIER STUDIES
(P.G. Johnson, GEOG/Ottawa)
Investigations in 1984 in the northern Ruby Range demonstrated a combination of landslide, granular flow, debris flow and avalanching in the production of a mass movement dominated landscape (unofficially called rock glacier valley). The major slope adjustments occurred in the post deglaciation period, with minor adjustments continuing to the present. Sections in some valley deposits indicate the occurrence, at irregular intervals since deglaciation, of debris flows caused by extreme snow-melt runoff.

GLACIAL GEOLOGY

SHELDON LAKE AREA, YUKON TERRITORY
(L.E. Jackson, GSC/EMR/Vancouver)
A surficial geology map of the Sheldon Lake area (105 J) was completed. It includes open-system pingos, thermokarst topography and rock glaciers, as well as Neoglacial moraines of the Itsi Range.

DOUGLAS CHANNEL, FJORDLAND AREA, KITIMAT RANGES, COAST MOUNTAINS, B.C.
(K. Ricker, consultant to MacMillan Bloedel Ltd. and Eurocan Pulp and Paper Co. Ltd.)
Glacial, glaciomarine and other Holocene deposits throughout the wood-harvestable glacierized valleys were mapped. Location of recessional moraines and evidence of isostatically higher sea levels was expanded upon to the south of,as well as into valleys of, the Kitimat area. Major moraines near or at the mouths of Kildala and Dala River valleys, as well as marine deposits up to 200 m a.s.l., were noted. Evidence was found of Late Pleistocene valley glacier advance in Raley Creek, Late Neoglacial moraines developed in fresh landslide debris near "Powerline Pass", and a large active rock glacier at the head of Magar Creek near Mt. Madden.

DRUMLINS IN NORTHERN SASKATCHEWAN
(J. Shaw, GEOG/Queen's)
Drumlins of the Livingstone Lake drumlin field, northern Saskatchewan, have been classified according to shape and their internal composition and structure have been described. Their form corresponds to meltwater erosion marks and their sediments are almost entirely water deposited. Conclusions about the formation of drumlins relates them to large outpourings of subglacial meltwater. Flume experiments to model drumlin formation are in progress.

GLACIAL LAKE AGASSIZ, MANITOBA
(J.T. Teller, ES/Univ. of Manitoba)
Research is continuing on the nature and timing of the connection between Glacial Lake Agassiz and the Great Lakes. Coring of sediments in the region between Lakes Superior and Nipigon took place in 1983-84.

GLACIAL GEOLOGICAL STUDIES AT UNIVERSITY OF WATERLOO
(P.F. Karrow, ES/Waterloo)
M.Sc. theses are being prepared on: the Kirkfield outlet of Glacial Lake Algonquin (P.F. Finamore); the history of the Cochrane ice advance near Hearst, Ont. (J.A. Richard); the paleontology of the interglacial Don Fm. at Toronto, Ont. (L. Kerr-Lawson); the Quaternary geology of Mackinac Basin,Lake Huron (A. Zilans); the Champlain Sea limits of the St.Lawrence Lowlands (D.Pair); and the postglacial sediments of the Black River valley, Marathon, Ont.(A. Bajc). A Ph.D. thesis is being prepared on the Quaternary glacial

stratigraphy of the north shore of Lake Erie (P.J. Barnett) and has been completed on the Quaternary history of Lake Erie spits (J.P. Coakley). Karrow has started mapping the glacial geology of the Brampton area, Ont.

MORAN HEIGHTS AREA, LABRADOR
(D.G. Vanderveer, Dept.of Mines and Energy, Govt. of Newfoundland and Labrador)
The Moran Heights area (UTM 368445, 13K/10) has been explored by a number of exploration firms since the mid 1970s. The uranium-bearing boulder concentration was in till (not colluvium as previously assumed). A regional glacial flow regime towards 050 was followed by a later regime that occupied the valley at Moran Heights, with flow to the north. A recessional moraine was built during the retreat of this later ice flow and remnants of lateral moraines can be discerned along the valley sides. The source for the uranium-bearing boulders must lie to the south or southwest of the main boulder concentration.

GANDER-GAMBO AREA, LABRADOR
(D.G. Vanderveer, Dept. of Mines and Energy, Govt. of Newfoundland and Labrador)
Field work in 1984 on NTS 2D/16W showed that early ice flow in the region was to the east while later flow was in part topographically controlled with drawn-down towards Gander Bay and Freshwater Bay.

STRANGE LAKE AREA, LABRADOR
(M.Batterson, Dept. of Mines & Energy, Govt. of Newfoundland and Labrador <MINES/NFLD>)
The recently discovered Zr-Nb-Ta-Be-REE Strange Lake deposit has provided a rare opportunity for studying patterns of glacial dispersal,both geochemical and lithological, from a deposit of known extent. The area was affected by a continental glacial regime advancing towards the east-northeast (070). Initial results confirmed that a lodgement till unit, with geochemical values consistent with those of the underlying bedrock, is overlain by a melt-out till unit with values apparently diluted by glacial debris transported from more distal sources. The well-developed boulder trains trending down-ice from the Strange Lake deposit may reflect geological differentiations related to specific phases of the deposit.

NACHVAK FIORD, LABRADOR
(R.J. Rogerson, GEOG and Earth Sciences/MUN)
Ice last occupied Nachvak Fiord and the adjacent fiords around 20-30 Ka BP, according to soils dating of moraines and a shell sample with a radiocarbon age of 33.7 Ka beneath the associated tills. Extensive highland and lee-side lowland nunataks existed at that time.

VICTORIA AND TALLY POND AREAS, NEWFOUNDLAND
(M.-A. Mihychuk, MINES/NFLD)
Dispersion fans in 2 areas of known mineralization were investigated in detail. Glacial geology, stratigraphy, ice-flow patterns, sedimentology and geochemistry were studied at 200 m intervals. The Victoria study area has a thin, discontinuous complex cover of melt-out and lodgement till facies, while the Tally Pond area has a relatively thick, extensive sheet of lodgement till. Dispersion plumes are expected to have been further complicated by migrating local ice caps and divergent ice flows.

CENTRAL VOLCANIC BELT, NEWFOUNDLAND
(B.G. Sparkes, MINES/NFLD)
Three divergent ice flows have been recognized. The earliest was southern (160-190) and appears to have affected most of the central part of the area. It is the only flow evident in the southern part of the area. In the W and NW, this south flow was succeeded by a SW flow (220-250) and in the central to eastern part of the area by a NE flow. In the Buchans area, a NE flow was succeeded by a SW flow; possibly the latest pulse of ice to affect this area. These distinct pulses of ice flow reflect the growth and shifting of local ice sheets in the Late Wisconsin, but may also represent phases that predate the last glaciation.

PALEOGLACIOLOGY
(J.-M. Dubois, H. Gwyn, M. Parent and D. Gratton, GEOG/SHER)
The Quaternary history of geomorphology and stratigraphy for the Appalachian Mts in S. Quebec is being determined. A study of the history of piedmont glaciers in this area is underway, and work is progressing on the regions of Sherbrooke, Saint-François and Coaticook. A map of the postglacial deposits of Goldthwait at 1:250,000 has been completed for the GSC. A similar study between Tadoussac and Mingan is being carried out. On Anticosti Island, a study of the Wisconsin glacial history has been completed for the GSC, as well as 17 maps at 1:50,000 for the centre-south section.

REMOTE SENSING

MICROWAVE RADIOMETER SNOW COVER MAPPING
(B.E. Goodison, CCAH/AES/EC; E.J. Langham, RADARSAT/EMR)
An initial algorithm for determining snow water equivalent from airborne passive microwave data (18 and 37 GHz) has been developed from data collected over the Canadian Prairies in February 1982. Airborne gamma estimates of snow water equivalent for 25 km segments were used as "ground truth". The algorithm is being tested on satellite data for the same period.

CANADA/U.S. PRAIRIE SNOW COVER RUNOFF STUDY
(B.E. Goodison, CCAH/AES/EC; J. Glynn, SWD/NHRI/EC; E.J. Langham, RADARSAT/EMR)
The experiment has focused on the inter-comparison of airborne gamma systems, the determination of snow water equivalent using

ground, airborne and satellite systems, and the discrimination of snow cover using passive microwave data. The first study began in 1982, followed by a mission in February 1984 with emphasis on airborne gamma determination of snow water equivalent in southern Saskatchewan - particularly the Souris River basin - using an aircraft and spectrometer system belonging to the GSC.

AIRBORNE GAMMA RAY SNOW SURVEYS
(J. Glynn, SWD/NHRI/EC; T.R. Carroll, NWS/NOAA; R. Gauthier, US Army Corps of Engineers; G. Lockhart, RFC/NBE)
From March 6-8, 1984, an airborne gamma ray survey was flown around the Lake Superior basin. An additional survey was flown over the Saint John River basin from March 27 to April 1, 1984.

OPERATIONAL SNOW COVER MAPPING
(K.J. Johnstone, CCAH/AES/EC)
The Hydrometeorology Division has developed photo-interpretive procedures that quickly calculate and map areal snow cover within irregularly-shaped boundaries using, a video device interfaced to a microcomputer. Results of areal snow cover determination compare favourably with those obtained using a digital classification procedure. The latter have been used operationally for forecasting levels of the Saint John River during the spring freshets of 1982-1984.

ICE STATUS SYSTEM
(G. Morrissey, ARMA/AES/EC)
The Ice Status System (ISS) has been developed for computer-assisted image analysis of remotely sensed data to aid in sea ice observation and forecasting. It uses AVHRR data from NOAA satellites. The outputs of the system are: 1) resampled AVHRR data; 2) temperature analysis, with the option of an atmospheric correction; and 3) synthetic images, such as ratios or normalized differences, in which the features of interest (e.g. water, sea ice) are more easily distinguished. The test area for the ISS has been the Gulf of St. Lawrence region.

REMOTE SENSING USING SLAR AND RADARSAT
(F.G. Bercha and Assoc. Ltd.)
FGBAL and MARS associated companies provided overflights of ice-infested waters in the south Beaufort Sea and Grand Banks regions using their side-looking real aperture airborne radar (SLAR). MARS monitored ice/berg infestations in the Hibernia and Grand Banks areas during the 1983/84 ice season for Husky/Bow Valley. FGBAL coordinated a COGLA/ESRF research program to assess the capabilities and limitations of airborne radar systems for iceberg detection under a variety of environmental conditions. Studies designed to generate iceberg mass and volume information from analysis of stereoscopic aerial photographs are currently in progress.

FGBAL is managing the research facility for RADARSAT. System specifications for obtaining optimal satellite data on sea ice conditions in Arctic waters have been analyzed and a C-band imaging SAR system selected. Digital enhancement techniques are being developed and evaluated for the system.

ATMOSPHERIC ICE AND CLIMATE

ICE AND WIND LOAD MODELLING FOR ELECTRICAL TRANSMISSION FACILITIES
(L.E. Welsh, CCAI/AES/EC)
The objectives of this five-year project (now in its second year) are to develop an advanced capability for modelling ice accretion and wind loads on electrical transmission facilities for engineering design values; and to develop a methodology for interpolating ice accretion and wind load information into data sparse regions.

ACID SNOW PROJECT (ASP)
(R. Schemenauer, ARPP/AES/EC)
The Acid Snow Project was conducted from January 16 to February 24, 1984, near North Bay, Ont. Two research aircraft, a chemistry laboratory for air sampling and a surface snowpack and precipitation network formed the core of the project. The ASP obtained substantial chemical and microphysical data bases characterizing winter clouds and precipitation and led to major improvements in aircraft snow collection instrumentation.

HYDROMETEOROLOGICAL INVESTIGATIONS, BEVERLY SWAMP, ONTARIO
(D.S. Munro, GEOG/UofTE)
A year-round program of hydrometeorological monitoring, including radiation, temperature, humidity and precipitation, is underway in Beverly Swamp, near Cambridge, Ont. The winter program includes weekly measurements of water level,ice thickness, and the snow pack. Micrometeorological measurements are also conducted on occasion.

REPRESENTATIVENESS OF CLIMATOLOGICAL STATIONS
(B. Findlay, CCAI/AES/EC)
To assess local precipitation fields, use is made of snow surveys where points are stratified according to cover characteristics.

IMPACT OF SEA ICE ON CLIMATE AND PERMAFROST IN THE HUDSON BAY LOWLANDS
(W.R. Rouse, GEOG/McMaster)
Continuous measurements of global solar radiation, net radiation, evapotranspiration, subsurface heat flux and soil temperatures were made at Churchill, Manitoba, at an offcoast, a nearcoast terrestrial and an inland site 60 km from the coast,between May 20 and August 16, 1984. Although global solar radiation and net radiation were similar at the nearcoast and inland sites during onshore and offshore winds, the subsurface heat flux

was substantially greater for offshore than for onshore winds. Evapotranspiration was much larger for offshore winds and the air temperature averaged about 7°C warmer.

The sea ice plays a major role in the summer climate at both terrestrial sites. Air temperature responds to a deep-chilling from an ice-covered or cold Hudson Bay. With cold onshore winds, which blow about 50 percent of the time, the suppressed ground heat flux dampens the melting of the active layer and suppresses evapotranspiration rates.

Preliminary calculations suggest that summer air temperatures would warm an average of 4°C if the sea ice melted 30 days earlier. Any global atmospheric warming would be superimposed onto this value. This has important implications with respects to greater active layer depths in the Hudson Bay Lowlands and the potential for large-scale intensive thermokarst activity.

DATA COLLECTION PROGRAMS
(W.D.Hume & S. Checkwitch, AES/EC, Edmonton)
AES continued monitoring the location of a DCP, incorporating meterological sensors (pressure, wind, temperature) deployed on an ice island off Ellesmere Island in August 1984. The location data, as calculated by the NOAA satellite receiving station at AES Edmonton, was relayed verbally to PCSP.

Two air-droppable buoy deployment exercises were carried out. The atmospheric pressure/temperature/location information from these buoys is incorporated into the AES weather forecast program.

Work continued on upgrading software used in Edmonton to calculate DCP locations. More accurate location calculations are required to track ice and ocean current motions.

ICE TRENDS
(D. Etkin, CCAI/AES/EC)
Regression equations were developed between lake ice freeze-up and break-up dates and meteorological parameters (temperature, cloudiness and wind). They estimate how the dates will vary with climatic conditions.

ICE PHYSICS AND ENGINEERING

ICE MECHANICS
(R. Frederking and N.K. Sinha, DBR/NRCC)
Mechanical properties and microstructure of glacier ice, iceberg ice, fresh-water ice and lake ice were studied at various strain rates and temperatures, using an MTS closed-loop testing machine. Acoustic emission measurements were carried out on columnar-grained sea ice and fresh-water ice. Distinct differences were noticed in the signals, which could be related to the microstructural differences.

ICE ENGINEERING
(R. Frederking, V.R. Parameswaran, M. Sayed, and N.K. Sinha, DBR/NRCC)
Analytical modelling of a rubble field was continued in order to study the interaction between floating ice and a structure and to predict potential failure zones. Laboratory studies of mechanical properties of ice rubble have also been started. Field measurements of ice movements were carried out on Adams Island to study the relation between ice movement and environmental forces. Pressures up to 370 kPa and ice movements up to 0.5 m/d were measured using suitable transducers. Bearing capacity of an ice cover in the Ottawa River was measured by cantilever ice-beam test and the results compared with those predicted by finite element analysis.

Actual forces exerted by the ice cover on the MOT lightpier at Lac Saint-Pierre were measured in the field between December 1983 and May 1984. As part of a study of adfreeze strength of ice to model piles, investigations are now underway in the laboratory using saline ice and various kinds of piles.

ICE AND RARE-GAS SOLIDS
(H. Kiefte & M.J. Clouter, MUN; E. Whalley, CHEM/NRCC)
The relative stability of both the cubic and hexagonal forms of ice and of the rare-gas solids are partly determined by the surface energy and entropy.

HIGH-DENSITY AMORPHOUS ICE
(O. Mishima, L.D. Calvert and E. Whalley, CHEM/NRCC)
Ice I has been "melted" at 77 K and 10 kbar in an apparently first-order transition to a new kind of ice, a high-density amorphous phase. The same phase has also been made in a similar transition of low-density amorphous ice at 77 K and 6 kbar.

(O.Mishima, D.D.Klug & E.Whalley, CHEM/NRCC)
The Raman spectrum of the high density amorphous phase has been recorded.

(O. Mishima, P.Handa & E.Whalley, CHEM/NRCC)
Calorimeter measurements on high-density amorphous ice have yielded heat capacities and heats of transition from high-density to low-density amorphous ice, low-density amorphous ice to ice Ic, and ice Ic to Ih.

PIEZOELECTRICITY IN ICE
(D.D. Klug and E. Whalley, CHEM/NRCC)
Ice has no ordinary piezoelectricity because it has a center of symmetry. But, it has a new kind of piezoelectricity induced by the disorder. It is characterized by the square of a stress. Its value has been obtained from the infrared spectrum of the sound waves.

ICE VIII, FAR INFRARED SPECTRUM
(S.P. Tay, D.D. Klug & E.Whalley, CHEM/NRCC)
The infrared spectrum of the rotational and translational vibrations of ice VIII at approximately 100 K and zero pressure has been obtained and interpreted.

ICE X, EFFECTIVE CHARGE

(D.D. Klug and E. Whalley, CHEM/NRCC)
The effective charge of the O-H stretching vibration of ice X, the centrosymmetric form of ice VII or VIII, has been shown to be about one electronic charge by extrapolating the effective charge in ice VIII.

HALOS

(E. Whalley, CHEM,NRCC)
Halos of ice Ic and other low-melting solids that may occur on the planets and their satellites, have been predicted for the conditions there. They may help to identify the composition and morphological crystals in planetary atmospheres.

INDENTATION, CREEP AND COMPRESSION OF ARCTIC ICE, ICEBERGS AND LABORATORY ICE

(B. Michel, J.P. Nadreau, L. Jolicoeur, J. Lachance, M. Dubé, J.M. Tanguy, CIVIL/LAVAL)
Tests have been completed with vertical face, flat indentor and laboratory grown ice sheets, in a tank 4 m x 5 m. Tests are now starting with inclined face indentors.

Creep tests are being completed on samples of simulated pressure-ridge ice. The ultimate strength of this ice is also obtained under conditions of triaxial loading.

Uniaxial tests have been completed in compression and tension on ice blocks received from icebergs off the Greenland shelf.

CREEP TESTS ON CIRCULAR SEA-ICE PLATES

(R. Tinawi and L. Gagnon, CINEP/UofM)
A number of tests on S2-type sea-ice circular, simply supported, plates have been conducted to study their long-term behaviour under a sustained static load representing 50-75 percent of the instantaneous failure load of the plate. The circular plates were about 100 mm thick, 2 m in diameter and were tested under isothermal conditions; the temperature range was between -5°C and -30°C. Deflections on top of the plate were measured at 10 points along a given diameter. These were stored using an HP85 or HP87 micro-computer. At the same time, plots of the deflection profile and the variation of the central deflection with time, were obtained every few hours over a period of one week.

The results are compared with an in-house axi-symmetric anisotropic solid finite element program. An attempt to evaluate the reduction in transverse shear modulus (due to anisotropy), with the increase of deflections due to creep, is being attempted.

It is hoped to be able to predict the long-term behaviour of these plates by introducing a corresponding reduction in transverse shear modulus. Then, a simple linear analysis could be carried out for the prediction of the bearing capacity of floating ice covers under sustained loads.

FRACTURE OF PROTOTYPE ICE

(B.L. Parsons IMD/NRCC)
Field tests of the fracture toughness of fresh-water ice at the mouth of the MacKenzie River were conducted. The carbamide ice at the NRC test tank in Ottawa was tested for fracture toughness. The influence of grain size on effective flaw size and tensile strength at critical stress in the tensile mode were examined.

A similar study of sea ice of various salinities and iceberg ice is underway. Together with field measurement of fracture roughness, there will be experiments on indentation fracture and cantilever beam strength in various orientations to the surface of the ice sheet, to ascertain the effectiveness of model ice in achieving dynamic similarity in ice-structure interactions.

IMD ICE TANK - ST. JOHN'S, NEWFOUNDLAND

(S.J. Jones IMD/NRCC)
During the past year, the Arctic Vessel and Marine Research Institute (AVMRI) was renamed the Institute for Marine Dynamics. The ice tank - one of three tanks in the institute - was completed in November 1984 and handed over to NRC. Rails and a carriage will be installed during the first half of 1985 so that, by about October 1985, the facility will be fully operational. An opening seminar is planned for November 1985. The facility will be used for research into the design of ice-breaking ships, as well as offshore structures which have to withstand ice loads.

SCALE EFFECTS IN ICE FORCES

(F.G. Bercha and Assoc. Ltd.)
In-depth analyses of scale effects on ice forces within floating ice bodies and on ice failure theories in multi-axial states of stress, have been conducted by FGBAL.

INDENTATION TESTS IN FRESHWATER ICE

(G.W. Timco, DME/NRCC)
A series of indentation tests has been performed, using a flat indentor in columnar freshwater ice at high loading rates (10^{-2} to 10^{1} s^{-1}). The results give the total load and average pressure on the indentor for a range of test parameters, including structure width, ice thickness and interaction rate. The full test results give an ice failure-mode map for this interaction process.

SNOW AND AVALANCHES

NEW SNOWFALL AND SNOWCOVER MAPS FOR CANADA

(R.B. Crowe, CCAI/AES/EC)
The following draft maps have been produced for the National Atlas of Canada: mean annual snowfall; annual snowfall at 10 percent and 90 percent thresholds; median snow depth Sept 30, Nov 15, Dec 31, Feb 15, Mar 31 and May 15; median maximum winter snow depth and time of occurrence; maximum snow depth at a 30-year recurrence interval.

SNOW CREEP ANALYSIS

(C.H. Coulson, Water Management Branch/B.C. Environment)

Snow pillow overloading noted at the Morrissey Ridge station near Fernie, B.C., was investigated. Ministry staff isolated the snow mass on the pillow from the mass on the uphill slope. The overload dropped to zero when the isolation trench was completed, leading to the conclusion that the overload was entirely due to creep.

SNOW STRUCTURE

(R.I. Perla, SWD/NHRI/Canmore)

Photomicrographs of section planes were prepared from a variety of metamorphosed snow specimens. They were converted to video images which were digitized. Computer algorithms were developed to find stereological and topological parameters such as mean intercept length, surface to volume ratio and connectivity. These provided objective descriptions of snow structure and changes in snow structure due to metamorphism.

SNOWMELT STUDIES

(D.L. Golding, FORESTRY/UBC)

The study of snowmelt in forests and clearings during rain-on-snow, initiated on the mountain watersheds near Vancouver, B.C., in 1981, was continued in 1983-84. Instrumentation gave no trouble and there were numerous snowmelt sequences of rain-on-snow, beginning with and without snow in the forest canopy. Twelve events varying in duration from 8 h to 48 h were studied. Energy balance calculations of snowmelt runoff were compared with measured runoff on a half-hourly basis. With snow in the forest canopy at the onset of rain, melt peaked at a higher rate in the forest than in the clearing; without, the clearing had the greater peak melt rate. Maximum rates in the clearing were only slightly greater than maximum rates in the forest. Calculated snowmelt runoff agreed closely with measured values for all events in the clearing, but less closely in the forest for rain that began with no snow in the canopy. With snow in the canopy at the onset of rain, the measured snowmelt runoff in the forest far exceeded that calculated due to the greater energy available for melt at canopy level.

SNOW PREDICTION

(R. Gabison, ARMF/AES/EC)

A Snow Squall Prediction model, originally designed for SW Ontario, has been upgraded as follows:

a) The horizontal resolution of the model has been increased by halving the grid distance from 32 to 16 km.

b) The level at which the differential equation governing the vertical velocity is solved has been lowered to 925 mb, closer to the low cloud bases.

c) Sensible heat flux has been added as a forcing term.

d) An air transformation package has been included to better describe heat and moisture fluxes along the vertical.

Results of both the old and new versions of the model are being analyzed.

DRAINAGE OF SNOWMELT FROM AGRICULTURAL LAND

(A. Wankiewicz, SWD/NHRI/EC)

Snowmelt runoff from agricultural land is being investigated at two field sites near Winnipeg, Manitoba, to determine effects of surface-drainage improvements on downstream flooding. Snowmelt plots were installed in November 1984 to automatically record hydrometeorological and soil frost data. The observations will be used for modelling spring runoff from two 70 km^2 watersheds.

SNOW AND ICE STUDIES: JAMES BAY LOWLANDS

(M.-K. Woo, R. Heron, J. Price, P. DiCenzo, P. Steer, GEOG/McMaster)

Hydrological studies have been initiated in the James Bay area to collect baseline data. They include: determination of snow distribution over a variety of terrain types from flat, grassy, coastal sites to inland spruce forests; investigations leading to the modelling of snowcover and radiation in a spruce forest for runoff prediction; and ice breakup on the rivers which range in size from small streams to medium-sized rivers.

HYDROLOGIC MODEL

(G. Morin, INRS/University of Quebec)

A hydrologic model has been developed which quantifies the amount of snow in a forest and clearings; calculating melting using meteorological data.

REMOTE SENSING OF SNOW

(J.P. Fortin, INRS/University of Quebec)

Using different satellite techniques,studies have continued to estimate the snow fall and the growth of the snow cover as a function of hydrologic parameters.

(B. Lauriol and A. Champoux, GEOG/SHER)

A study has recently been completed on the distribution of the surface snow in Ungava.

RADIATION BALANCE

(P. Adams, GEOG/TRENT)

A study of radiation balance in a subarctic woodland was completed.

IMPROVED SNOWFALL WATER EQUIVALENT MEASUREMENT

(B.E. Goodison & J.R. Metcalfe, CCAI/AES/EC)

Field trials and data analysis continued aimed at improved snowfall precipitation measurements at AES observing stations. A large Nipher-type shield on recording precipitation gauges has been successfully operating for several years at more than ten AES stations. The shield will be used at exposed sites and at remote automatic stations to improve gauge catch efficiency. Analysis of the variations in the density of freshly fallen snow and the impact on calculation of snow water equivalent from ruler snow depth measurements is in progress.

SNOWMELT ACIDIC SHOCK STUDY

(P.Y.T. Louie & B.E. Goodison, CCAH/AES/EC)
A snowmelt acidic shock model, suitable for application to specific basins and providing time series of the snowmelt, snowpack and meltwater chemistry, was developed. A field study was also initiated at Dorset, Ontario, to collect suitable data on melt rate, snowpack and meltwater chemistry to verify the model results, and it will continue through the 1984/85 winter season.

ACID SNOW PROJECT

(R. Schemenauer, ARPP/AES/EC)
The physical and chemical structure of the snowpack near North Bay, Ontario was examined in conjunction with aircraft measurements of the Acid Snow Project. A marked areal uniformity was noted in the layered structure of the snowpack and in the vertical variation of its chemical composition. In late January, 1984 snowpack pH values varied from ≃4.1 at the surface to ≃4.8 near the ground. Nitrate concentrations exceeded those of sulfate in the snowpack. A $SO_4^=$ to NO_3^- equivalent concentration ratio of 0.5 was typical. Precipitation samples at six sites had pH values ranging from 3.4 to 5.2. $SO_4^=$ to NO_3^- equivalent ratios were <1 in snow and near 1 or >1 in rain. The chemical composition of the precipitation was closely related to the air mass trajectory. The one month period from January 20 to February 21 had a $SO_4^=$ wet deposition of 0.2 g m^{-2} and a NO_3^- wet deposition of 0.35 g m^{-2}.

SNOW POLLUTION

(H.G. Jones, INRS, U. of Quebec)
The growth and chemistry of snow covers in both open and forested areas was studied to quantify the chemical and microbiological processes which control the concentration of acidic pollutants in the snow. The results give a hypothesis that in forested regions, the organic materials coming from the forest cover reduce the concentrations of H^+ in the snow through mechanisms of ionic exchange and microbiological activity.

ACCURACY OF SNOW SAMPLING EQUIPMENT

(C.H. Coulson, Water Management Branch/B.C. Environment)
In March 1983, the Western Snow Conference published their final report on "Metrication of Manual Snow Sampling Equipment". The report covers the area of Standard Federal snow tube accuracy which will have the greatest importance to the field of snow measurement. Actual snow depth is approximately 91 percent of that actually measured.

WINTER PRECIPITATION GAUGE

(C.H. Coulson, Water Management Branch/B.C. Environment)
Winter precipitation was measured at snow pillow sites. Capping of standard gauges led to the development of a gauge with a larger catch opening, using standard PVC pressure pipe designed to create an obstruction-free standpipe with a pressure transducer to sense precipitation changes. The output is transmitted. A Belfort type gauge is operated at the Park Mtn snow pillow for comparison.

The use of snow pillow data to supplement winter precipitation recording was studied.

SNOW GAUGES

(R.F. Hopkinson, AES/Regina)
A comparison of different types of shields for snow gauges at Regina was terminated. A scaled-up Nipher shield on a Fischer and Porter recording precipitation gauge provided data compatible with that from the standard AES Nipher-shielded snow gauge.

A study of gauge catch using a fiberglass Nipher shield, as opposed to spun aluminum ones, was initiated at Broadview. Here a slight difference in catch was observed between the two Nipher-shielded gauges. The reason may have been a siting problem so a second year of sampling is underway to determine the source of the bias.

ULTRASONIC SNOW DEPTH SENSOR

(B.E. Goodsion and J.R. Metcalfe, CCAH/AES/EC; B. Wilson, ACSL/AES/EC)
Two ultrasonic snow depth sensors, based on the Polaroid range finding kit, have been developed by AES and are in their second season of field trials. An on-board microprocessor permits automatic compensation for variations in the speed of sound resulting from changes in the ambient air temperature. The sensor would be used for remote polling at manned stations and on automatic stations and on-site data loggers at remote stations.

SNOW AND AVALANCHES, BRITISH COLUMBIA

(D.M. McClung and P.A. Schaerer, DBR/NRCC)
Impact pressure and seismic signals were measured for avalanches at Rogers Pass, BC, to determine the characteristics of snow avalanches. A small test slide (20 m long) was constructed to study debris flow heights, speeds and run-out characteristics on a packed run-out zone below the slide path. Avalanche run-out data were collected from the Coast Range, North Cascades, Interior Ranges and Rocky Mountains. Relationships between mass, debris characteristics and run out were studied.

Data on the annual mass of avalanche snow in 48 paths at Rogers Pass, B.C., were analysed to develop criteria for the prediction of frequency of occurrence and size of avalanches for a given climate and terrain. The amount of sliding snow and terrain characteristics were increased at Rogers Pass to develop design criteria for the control of avalanches from short slopes.

The observations and data collected by NRCC staff between 1967 and 1983 were analysed to find correlations between the amount of snow on the ground and elevation above sea level. Using data obtained from

the field, a simple nonlinear constitutive equation was formulated for a visco-plastic deformation model for snow. Shear tests were performed on snow samples from Rogers Pass to define snow failure characteristics related to avalanche release and prediction. The cold lab was moved from Revelstoke to Rogers Pass.

INVENTORY OF AVALANCHES, KITIMAT RANGES, BC
(K.Ricker, for Eurocan Pulp & Paper Co.Inc.)
Avalanche tracks greater than 5000 m^2 were mapped at a scale of 1:15,000 between Lakelse Lake near Terrace south to Gardner Canal. Yearly or biennial avalanche zones, as opposed to those with significant second growth conifers were differentiated. Avalanches probably cover 20-30 percent of the total area. Those entering salt water are not uncommon.

FLOATING ICE/LAKES, RIVER AND SEA

DUGOUT ICE THICKNESS, PRAIRIES
(F.R.J. Martin, Agriculture Canada, Regina)
The Hydrology Division has analyzed the results of dugout ice thickness measurements on forty dugouts in the Prairies for 1975 to 1980, and has attempted to relate ice thickness to meteorological and site factors.

ICE AND SNOW COVER ON LAKES, EASTERN CANADA
(W.P. Adams, GEOG/Trent)
Studies of the ice and snow cover of Knob Lake (Quebec), Elizabeth lake (Labrador) and Colour Lake (Axel Heiberg Island, N.W.T.) were conducted. These focused on the nature of snow and ice on the lakes and the biological roles of the ice forms. The emphasis was on the roles of the winter cover on the chemical regime of the lakes.

ICE MANAGEMENT ON THE RIDEAU RIVER, ONTARIO
(T. Garnett, Dept. of Physical Environment, City of Ottawa, Ontario)
The Rideau Valley Conservation Authority is studying and identifying the technical and economical feasibility of various ice management techniques applied to the Rideau River in the cities of Ottawa and Vanier.

DYNAMICS OF MOVING ICE, ST. LAWRENCE RIVER
(B. Michel, CIVIL/Laval)
A field study is being made of the dynamics of moving ice in the restricted converging-diverging section of the St. Lawrence River at the Québec bridge.

A computer model is being developed for computing backwater curves in rivers including the formation, growth and decay of the ice covers.

BUILT ICE VEIL ASSESSMENT PROJECT (BIVA)
(G.S.H. Lock, MECH/UofA)
The BIVA Project is a study of the problems encountered in building an ice curtain or veil across a moving body of water, by forming ice on the lower parts of a row of tubes through which heat is removed by thermosyphon action into the sub-zero atmosphere. Preliminary experiments in the Department of Mechnical Engineering Water Tunnel Facility, have shed light on both the growth rate and the mechanism of occlusion.

HYDROLOGIC STUDIES: INUVIK - TUKTOYAKTUK REGION, N.W.T.
(J.C. Andrson, SWD/NHRI/EC)
From May - August 1984, data were gathered on snowpack water equivalent, river channel and culvert icings, precipitation, air temperature and river discharge at a number of taiga and tunda basin sites. Observations for the 1983 season were summarized and compared with those of former years.

RIVER HEAT FLUX DURING SPRING BREAKUP
(P. Marsh, SWD/NHRI/EC)
During the last two years, a study to determine the convective heat flux from the river to the overlying ice cover during the spring breakup period has been conducted near the confluence of the Liard and Mackenzie rivers in the NWT. Field measurements have included water temperature beneath the solid ice cover, water velocity, river discharge and ice roughness. Data analysis is aimed at determining the heat flux to the ice cover and its importance in the removal of ice from the river.

HYDROLOGICAL STUDIES, MACKENZIE DELTA LAKES
(P. Marsh, SWD/NHRI/EC)
A lake hydrology study to determine the relative importance of a number of processes controlling lake level was initiated in the Mackenzie Delta, N.W.T. The lakes have a unique and sensitive hydrologic regime since they are underlain by taliks and receive a large input of floodwater during spring breakup when water levels in the Mackenzie River are controlled by ice jamming. Field work has concentrated on: measuring the volume of water entering the lake from the Mackenzie River; snowmelt and rain; determining the water loss by evaporation and surface outflow; establishing whether the lakes are connected to outflow; and whether they are connected to a subpermafrost groundwater system.

RIVER ICE BREAKUP AND ICE JAMMING
(T.D. Prowse, S. Fogarasi, P. Marsh and S. Watson, SWD/NHRI/EC)
River ice research has been concentrated on the Liard and Mackenzie rivers, particularly a site of recurrent ice jamming at their confluence. The three major components are: 1) photogrammetric interpretation of aerial photographs of breakup to derive quantitative information about specific ice jam characteristics, often practically impossible to obtain by conventional hydrometric techniques. 2) the climatology of river ice breakup. At the basin scale,a synoptic clas-

sification is being made of the major air masses which prevail during the breakup period. At a smaller scale, a micro-meteorological field study will quantify the magnitude and relative importance of atmospheric and river ice flows to the ablation of snow and ice, and to the decrease of ice strength prior to breakup. 3) the field measurement of hydrologic characteristics of river breakup fronts and ice jams. A 35 mm camera system has been constructed for use from light aircraft to obtain measurements of ice and water velocities during breakup. In the design stage is a helicopter-operated current meter assembly to measure water velocity within open water holes of ice jams.

A final draft report on "Guidelines for River Ice Data Collection Programs" was written for the NRCC Working Group on River Ice Jams. The guidelines have been designed to assist in the systematic collection of river ice data in Canada.

LAKE REGIMES, MACKENZIE DELTA, N.W.T.
(S.C. Bigras, SWD/NHRI/EC)
The potential impact of increased flow regulation of the Mackenzie River main stem on lake and channel water levels in the Mackenzie Delta is being investigated. Water levels and the interaction between connected and unconnected lakes and their channel systems are being assessed by monitoring water levels at nine sites along the eastern sector of the Delta. Field measurements of snowpack water equivalents, lake and channel ice thicknesses, and climatic conditions are being collected to establish the importance of break-up to the hydrological regime of the Delta lakes and channels.

GROWTH, MICROSTRUCTURE AND MECHANICAL PROPERTIES OF FIRST-YEAR AND MULTIYEAR SEA ICE
(N.K. Sinha, DBR/NRCC)
Vertical salinity and density profile, fabric and microstructure of first-year sea ice in Mould Bay were examined. A portable mechanical testing machine was installed in the field to correlate microstructure and mechanical properties. In situ bore hole jack tests were also conducted in the sea ice. Microstructural and mechanical properties of multiyear ice were studied in the laboratory, using a closed-loop machine.

FAILURE ENVELOPE OF COLUMNAR SEA ICE
(G.W.Timco,DME/NRCC; R.Frederking, DBR/NRCC)
Using confined compression tests, the three-dimensional failure envelope for columnar sea ice has been investigated as a function of loading rate (10^{-5}-10^{-3} s^{-1}) and temperature (-2°C and -10°C). In the tests, both the applied and side confining loads were measured. An analytical expression based on a modified n-type yield function has been derived to represent mathematically the failure envelope in three-dimensional space.

UNI-AXIAL COMPRESSIVE STRENGTH OF SEA ICE
(G.W.Timco,DME/NRCC; R.Frederking, DBR/NRCC)
A series of uni-axial compression tests has been performed on warm columnar sea ice over a range of loading rates for both horizontal and vertical loading directions. The results with those from similar tests at different temperatures, have been analyzed to yield an analytical expression which gives the uni-axial compressive strength in terms of loading rate,loading direction, ice temperature, ice salinity and ice density.

EXPANDED ICE SERVICES PROGRAM
(J. Woods, ACIA/AES/EC)
A fully-equipped DASH-7 IR aircraft has been acquired to supplement the existing Electras currently used by AES, Ice Branch. The program will include the mapping and forecasting of the motion and decay of icebergs along the East Coast, an airborne automated data acquisition and integration system, and a greatly improved communications system between the field, the Ice Centre and users of the service.

BREAKUP OF SHOREFAST ICE IN THE BEAUFORT SEA
(W.D. Hume & S. Checkwitch, AES/EC/Edmonton)
A study was completed on techniques to forecast the breakup of shorefast ice along the Tuktoyaktuk Peninsula. Developed for use by the AES Beaufort Weather Office at Tuktoyaktuk, it incorporates melting degree days and Mackenzie River flow information. The earlier study on landfast ice of the southern Beaufort Sea was updated, using 1983 and 1984 satellite and aircraft data. The work confirms earlier conclusions that a wide natural variability in breakup patterns occurs. There is no clear evidence of the impact of artificial islands on this pattern.

SEA ICE DYNAMICS
(V.R. Neralla and R. Gabison, ARMF/AES/EC)
Two data sets of meteorological, oceanographic and sea ice parameters were gathered to test the sea ice dynamics model developed by AES for regional applications. A data report on the Winter Ice Experiment Beaufort Sea (WIEBS) was prepared. Testing of the model with the data shows good agreement between observed and simulated ice motion.

An improved multi-category version of the sea ice dynamics model has been developed, including a thermodynamic component.

SEA ICE THERMODYNAMICS
(R. Gabison, ARMF/AES/EC)
A one-dimensional sea ice thermodynamic model was developed and used to simulate the yearly cycle of the first-year ice at three Arctic locations which have different oceanic tidal mixing and geographic exposure: Frobisher Bay,Cambridge Bay and Alert. Starting with open water conditions in midsummer,the model simulated the onset of freeze-up, the ice accretion rate, the maximum ice thickness, the melting rate and finally, the

onset of open water conditions. It suggests that tidal and wind-induced waves can be important in the breakup of sea ice, particularly after a period of ice melt and the subsequent deterioration in ice strength.

ICE CONDITIONS AT BEAUFORT SEA DRILLING SITES, 1984
(D.F. Dickins and Assoc. Ltd.)
A detailed statistical description of the physical environment at five potential drilling sites between Point Barrow and Barter Island has been made, emphasizing a realistic approach of the summer drilling window, taking into account ice interruptions, pack ice movements and whale migration - including superstructure icing, ice gouging, sea-state and safe winter mooring.

SUMMARY OF OPERATING ICE CONDITIONS, "KULLUK" AND "MOLIKPAQ"
(D.F. Dickins and Assoc. Ltd.)
These field guides review all available ice information for the southern Beaufort Sea, and present a concise summary of important features affecting operation of Gulf's new drilling system. Maximum use is made of colour maps, to show variations in ice conditions with location and time of year.

BEHAVIOUR OF OIL IN ICE: ICE DYNAMICS
(D.F. Dickins and Assoc. Ltd.)
The pack ice regimes in the Beaufort Sea, Lancaster Sound and offshore Labrador are being evaluated, according to dynamic processes affecting oil behaviour in a moving ice environment. Statistical summaries of potential lead dimensions, spacing, and closure rates as a function of location and time of year, are being developed.

INTERTIDAL SEDIMENTATION IN HIGH ARCTIC FJORDS
(M. Krawetz and B. McCann, GEOG/McMaster)
The fjord system of east-central Ellesmere Island is under the influence of severe sea ice conditions. Open water conditions exist only a few weeks each year; thus, wave action and longshore transport are negated in the shore zone. The morpho-sedimentological development of tidal flats is determined by the interplay of sea ice action and tidal processes. Large clasts (boulders) display the most pronounced morphologies and may occur singly, strewn across the tidal flat surface, or may be arranged in mounds, ridges and barricades. The mobilization of boulders across the intertidal zone is accomplished by sliding and rolling along the bed, and rafting by ice floes.

OCEANOGRAPHIC STUDIES IN HUDSON BAY
(R.G. Ingram, OCEAN/McGill)
The underice entrainment and mixing processes in Hudson Bay, both within a nearshore river plume and offshore waters, are being studied to understand the influence of the dynamics on the production of ice microalgae and the distribution of suspended matter. The importance of sea ice conditions (land-fast vs. mobile ice) to the circulation and mixing of coastal water has been demonstrated in Hudson and James Bays. The most striking influence of a complete ice cover on river plumes is the greatly expanded areas affected by the brackish waters as a result of reduced turbulence in the surface layer.

SEA ICE MODELLING FOR THE LABRADOR SEA PACK
(T.E.Keliher, PHYS/MUN; S.Venkatesh, AES/EC)
Further development was carried out on a numerical model of Labrador Sea ice, to study its utility to "back-fit" the input geostrophic currents from the ice drift data. For the limited amount of data available, the model provided very reasonable estimates of these currents.

OIL SPILL IN PACK ICE, 1984/85
(D.F. Dickins and Assoc. Ltd.)
This project involves experimental design and execution of three to four crude oil spills in Canadian East Coast pack ice of 5 to 9/10 concentration in March and April 1985, to document the physical and chemical interaction of crude oil with moving ice for comparison with previous tank tests and for development of useful countermeasure techniques.

ICEBERG SPEED EVALUATION
(D. Nazarenko, J.D. Miller, D. Pearson, I.S. Hotzel and K. Satterfield, PETRO-CAN)
Iceberg trajectory information, collected as part of offshore drilling operations, was analyzed to assess iceberg speed along the Labrador coast. The study provides a comprehensive data bank of iceberg speed characteristics for the various hydrographic regions in which exploratory drilling has been conducted.

ICEBERG UNDERWATER SHAPE
(D. Nazarenko, J.D. Miller, D. Pearson, I.S. Hotzel and K. Satterfield, PETRO-CAN)
Iceberg underwater profile data were collected on the Grand Banks and offshore Labrador to characterize underwater leading contact surfaces. Approximately 290 side scan sonar records of iceberg profiles were used in the analysis. The study investigated the distribution of the indentors relative to overall draft and also attempted to define typical indentor shapes. The data will be used in engineering design studies for future offshore production systems.

ICEBERG DYNAMICS
(D. Nazarenko, J.D. Miller, D. Pearson, I.S. Hotzel and K. Satterfield, PETRO-CAN)
Various aspects of iceberg behaviour were investigated off the coast of Labrador. The program focused on the collection of short-term iceberg motion data. Attention was

placed on low frequency motion in response to meteorological, oceanographic and sea-state conditions. Three accelerometers with six degrees of freedom were placed on several icebergs for periods of one to three hours. The data are being analyzed and will be used to evaluate iceberg response to forcing environmental conditions. Additional data were collected concerning iceberg acoustic signatures, thermal profiles within the first 4 m of the ice surface and the distribution of freshwater plumes around icebergs.

ICEBERG DRIFT
(D.B. Muggeridge, K. Shirasawa & N.P. Riggs, ENG/MUN)
Non-dimensional solutions for the equation of motion are introduced as an aid to understanding the movement of icebergs. Frictional and drag form coefficients are obtained by postulating the relationship that the product of the initial speed and the time constant for any one object is a constant.

(R.T.Dempster, C.C. Hsiung & A.F. Aboul-Azm, ENG/MUN)
A numerical model has been developed to predict the iceberg drift trajectories using known or derived information regarding iceberg characteristics and environmental forces affecting the motion of an iceberg, such as the forces due to winds, currents, Coriolis effect, geostrophic effect and waves.

(S. Venkatesh, ARMF/AES/EC)
A model has been developed for the drift of iceberg ensembles. Its performance has been tested to a limited extent with data from the Grand Banks. The results can be used in the preliminary stages of tactical support around drill rigs and for transportation in iceberg-infested waters. An Arctic iceberg deterioration model has been developed and tested with available historical data. A field study gathered deterioration data on two icebergs stranded outside the harbour at St. John's, Newfoundland. Comparison of the model simulations with data, show that the model performs very well with wave erosion and calving together accounting for up to 80 percent of the mass losses.

OPTIMAL ESTIMATION AND PREDICTION OF ICEBERG TRAJECTORIES
(M. Booton and N. Hookey, ENG/MUN)
This research involves a new approach to iceberg trajectory estimation and prediction, involving optimal estimation theory.

MONTE CARLO SIMULATION OF ICEBERG SHAPES AND THEIR IMPACT PROBABILITIES
(D.V. Reddy, M. Arokiasamy and P.S. Cheema, ENG/MUN)
The Monte Carlo method is being used to simulate the above-water and below-water profiles based on a set of observed icebergs and iceberg impact probabilities.

ICEBERG-STRUCTURE INTERACTIONS
(F.G. Bercha and Assoc. Ltd.)
FGBAL engineering and systems groups are modelling iceberg-structure interactions and the consequent structural responses. This is part of an ongoing analysis of static and dynamic floating ice feature interactions with offshore structures. Previous studies reviewed first-year sheet ice, pack ice and ridge pile-up around drill ships in the Beaufort Sea/Mackenzie Bay areas.

WAVE-INDUCED MOTIONS OF SMALL ICEBERGS AND BERGY BITS
(J.H. Lever, E. Reimer & D.Diemand, ENG/MUN)
Experimental wave tank studies were conducted to determine the kinematics of the impact of a small iceberg or a bergy bit with an offshore structure and the possible structural damage which might result in storm waves typical of the Grand Banks region.

MOTION ANALYSIS OF AN ICEBERG IN REGULAR WAVES
(V.M. Arunachalam & D.B.Muggeridge, ENG/MUN)
A combined theoretical and experimental study of iceberg motion has been made. The wave exciting forces and hydrodynamic reaction forces are computed via three-dimensional potential flow theory. The motion of the berg is then computed under the assumption of small amplitude linear motion.

ICEBERG DRAFT AND INSTABILITY
(D.W. Bass and G.R. Peters, ENG/MUN)
The possibility of an iceberg rolling to an orientation of deeper draft and colliding with the sea-bed has important implications for the offshore oil and gas industry on the Grand Banks of Newfoundland. An interactive computer program is being used to study a class of icebergs that increase their draft by as much as 50 percent on being perturbed from a position of near unstable equilibrium.

OSCILLATION OF A FLOATING GLACIER TONGUE
(O.G.Vinogradov, MECH/Calgary; G.Holdsworth, SWD/NHRI/EC, Calgary)
A simplified glacier tongue, modelled as a beam interacting with water waves, was analyzed in order to better understand the possible mechanism of iceberg calving. For this model, it is found that there is no critical beam length exhibiting a particular vulnerability to calving.

PERMAFROST/GROUND ICE/GAS HYDRATES

PERMAFROST MONITORING
(D. Etkin, CCAI/AES/EC)
Temperatures in permafrost sites and on-site meteorological parameters are being monitored to develop a set of base-line data for model development and validation. The model will be used to estimate the impact of climatic warming on permafrost profiles.

PERMAFROST-CLIMATE RELATIONSHIPS

(D. Etkin, CCAI/AES/EC)
Climatic parameters or indices are being used to assess how the areal extent of permafrost will vary with climatic warming.

PERMAFROST

(T.H.W. Baker, L.E. Goodrich, G.H. Johnston and V.R. Parameswaran, DBR/NRCC)
Regular ground temperature observations were continued in the Cordillera and Alert, NWT, to determine the distribution and characteristics of permafrost in Canada. Ground temperature measurements were continued at the Inuvik airstrip to monitor its performance and evaluate its design and construction. Ground and air temperature observations were made: (a) at the test sections of Mackenzie and Dempster Highways, NWT, to evaluate the use of insulation in highway embankments constructed on permafrost; and (b) at Thompson, Manitoba, to determine the surface correction coefficient (the ratio of surface freezing and thawing indices to air freezing and thawing indices) for gravel pavement surfaces. Ground temperature observations and site surveys were continued, to monitor the performance of pile foundations for the Eagle River Bridge, Dempster Highway, Y.T.

Data on the vibration of loaded and unloaded piles in permafrost at Inuvik, N.W.T. were analyzed, to obtain some measure of ground stiffness. Static and dynamic tests on model piles in frozen soils were continued in the laboratory. Under low loads, the piles showed prolonged periods of attenuating creep. Effect of dynamic stress on the creep of frozen soil materials (sand and clay) was also studied. Dynamic loads accelerated the creep rate of these materials. Five more sets of electrode probes were installed in Inuvik, to study the electrical potentials generated during freezing and thawing of the ground. The technique was found useful to monitor the freezing front and moisture migration in the soil.

Time-domain reflectometry was used to study the thermal and moisture profile in naturally freezing ground. The method was also used to determine volumetric water contents. Compressive strengths of a frozen saline sand were studied to determine the effect of salinity in reducing the strength. The effect was more pronounced at salinities between 0 and 0.5 ppt. Methods of preparing frozen sand specimens to control density, total water content and ice segregation, and their influence on strength and deformation properties were also studied.

Practical numerical models (2-D finite element heat flow program), for prediction of ground thermal regimes under natural and disturbed conditions, have been made. A portable field thermal conductivity probe logging apparatus, to measure thermal properties of soils in the laboratory and field, has been made.

FROST ACTION

(E.Penner,L.E.Goodrich & O.J.Svec, DBR/NRCC)
Laboratory studies on the nature of ice lens growth in varved clays have been completed. The position of ice lenses depended on the rate of freezing and the thickness of varves. A new cell to study the rate of change of growth during the formation of an ice lens, has been commissioned. A finite element program capable of analyzing heat conduction, phase change (melting), natural convection and consolidation has been developed. To investigate adfreezing problems associated with insulated walls, thermal and moisture properties of the soil and movements of the soil and walls were monitored at a basement site in NRCC campus.

PERMAFROST GEOPHYSICS

(M.K. Seguin, GEOL/Laval)
Most of the research investigations related to permafrost were centred in the Kangiqsualvjjuaq (old Port Nouveau-Québec) area in eastern Ungava Bay and in the Sheldrake River area on the east side of Hudson Bay. It included geomorphology, Quaternary studies and geophysics. Cryogenic features, such as cryogenic mound, palsas, thermokarst ponds, etc. were described. The marine limit, distribution of glacial and fluvioglacial deposits, etc. were determined.

The permafrost geophysics research included determination of the thickness of active layers and permafrost, its distribution and state (dynamics, aggradation, degradation, stagnation, etc.). The discontinuous nature of permafrost was studied, i.e. taliks, naleds and other related cryogenic phenomena. The techniques used included: 1) electrical resistivity (in both profiling and sounding modes) with differing frequencies of emission and different geometrical configurations; 2) induced polarization in the time domain; 3) multiseparation - multifrequency electromagnetic; and 4) geothermal (temperature, temperature gradient and thermal conductivity measurements) - generally using thermocables and thermosondes with thermistors. The main objective is to understand the dynamics of permafrost in these two areas sufficiently to model the evolution of permafrost in northern Quebec.

DEVELOPMENT OF FIELD METHODS FOR MEASURING RHEOLOGICAL PROPERTIES OF FROZEN SOILS & ICE

(B. Ladanyi and J.R. Murat, CINEP/UofM)
Two methods have been investigated: (a) the Borehole Dilatometer (or Pressuremeter) Test and (b) the Static Cone Deep Penetration Test. The measurement of creep properties of frozen soils and ice, by means of borehole creep and relaxation tests, was studied. The performance of the tests in ice and frozen soils was studied theoretically and by the finite element method, to assess the length of stress redistribution time after a stage loading; the knowledge of which is essential for proper interpretation of such tests.

Theoretical development of the Static Cone Penetration Test enabled the results to be used either for the determination of creep properties of frozen soils and ice, or directly for the design of piles embedded in permafrost. The latter method appears to show good promise in connection with offshore permafrost problems. Further field and laboratory studies of the test are underway.

BEHAVIOUR OF FROZEN SOILS AT CRYOGENIC TEMPERATURES

(B. Ladanyi and J. Bourbonnais, CINEP/UofM)

The thermal and mechanical properties of frozen soils and ice at very low temperatures (to -165°C) have been measured in connection with the underground storage of liquified natural gas (LNG). The study involves a uniform sand (including a series of tests with polycrystalline ice), an undisturbed clay from Belgium and includes measurement of both thermal and mechanical properties of these materials. At cryogenic temperatures, the behaviour of soil materials is closely related to their unfrozen water content at these temperatures, which is affected by their grain size and mineralogy. In the clay, the presence of bound unfrozen water was found down to about -110°C, which strongly affected its mechanical properties.

Study of the thermal expansion behaviour of clays down to cryogenic temperatures, revealed that considerable differences in behaviour exist between those containing large quantities of active clay minerals and those composed mainly of inactive ones, such as the kaolinite.

BEARING CAPACITY OF SHAPED PILES IN FROZEN SAND

(B. Ladanyi and A. Guichaoua, CINEP/UofM)

The behaviour under axial load of three different types of piles embedded in frozen sand by slurrying method, was studied under cold room conditions and analyzed theoretically. The tests revealed that under comparable conditions, a corrugated pile had a much better performance than a smooth pile: its ultimate bearing capacity was several time higher and its post-peak behaviour was much less brittle than that of a smooth pile. Tapered piles (with a 3° taper) behaved under load very differently from straight-shafted ones: their bearing strength increased continuously up to large settlements without attaining general failure conditions. Nevertheless, they needed about five times more settlement to reach the same bearing strength as the corrugated piles under similar conditions.

MEASUREMENTS OF MODULI OF FROZEN SURFICIAL MATERIALS

(P.J. Kurfurst, GSC/EMR)

Acoustic (compressional and shear) wave velocities of various types of frozen sea-bottom sediments have been measured. Static and dynamic constants have been measured or calculated with standard geotechnical and engineering parameters measured in situ in boreholes or on samples in the laboratory. Relationships will be correlated with permafrost classifications to allow easier practical applications in the fields of engineering and permafrost geology.

PINGOS ON BYLOT ISLAND

(S.C. Zoltai, N. Forest Research Centre/EC)

Out of a group of nine pingos in the valley of a glacial meltwater river, some have a typical cone shape, but others are linear, apparently centred on ice wedges. The occurrence of most pingos at the junction of oversized ice wedge polygon ridges suggests that injection of water and segregation of ice occurred along pathways provided by the ice wedges.

MODELLING WETLAND HYDROLOGY IN A CONTINUOUS PERMAFROST ENVIRONMENT

(M.-K. Woo and J. Drake, GEOG/McMaster)

A model of hydrological processes is being developed in a wetland of central Keewatin, where continuous permafrost is found about 1-2 m below the surface. It attempts to retain a physical basis, but requires only short-wave radiation, air temperature and precipitation as data inputs. Snow accumulation and melt, evaporation, the freezing and thawing of the active layer and the storage and movement of suprapermafrost groundwater, will all be included. Output includes the position of the water table, the runoff generated and ground temperatures of the active layer.

PERMAFROST HYDROLOGY IN A LOW ARCTIC DRAINAGE BASIN

(N.T. Roulet and M.-K. Woo, GEOG/McMaster)

Hydrological characteristics of a small low Arctic drainage basin (4 km^2) in the zone of continuous permafrost, NWT (64°27'N,97°42'W), are under investigation. Snowmelt, rainfall, evaporation, discharge and storage changes were monitored. The basin can be divided into three broad surface types; valley and lowland wetlands, vegetated and non-vegetated uplands, and lake and stream complex. Surface and subsurface flow were measured from each land type and lake storage-discharge relationships were established, leading to the development of a conceptual runoff model for the snowmelt and summer thaw periods for the drainage basin.

SHORELINE EROSION AT SOUTHERN INDIAN LAKE

(G.K.McCullough & R.W.Newbury, FOC/Winnipeg)

Shoreline erosion has been studied at Southern Indian Lake since its impoundment. The lake was raised into contact with perennially frozen fine-grained lacustrine clays and clayey tills, with ice content of 20 percent to 50 percent of wet weight. Initial erosion rates of up to 12 m/a retreat were observed, with volumes eroded ranging up to 23 m^3/m shoreline length/a. Erosion proceeds by

melting and undercutting, slumping and removal of slumped debris by wave erosion. An index of erosion of 0.00035 m^3/tonne-m of wave energy has been calculated, based on the hindcast wave energy component perpendicular to the shoreline. Up to 90 percent of this eroded material is deposited in 2 to 7 m depths near shore.

CLATHRATE HYDRATES
(D.W. Davidson and colleagues, CHEM/NRCC)
The ice-like gas hydrates formed by such molecules as argon, krypton and oxygen, contain 136 water molecules in the unit cells, not 46 as previously assumed. NMR techniques have been developed, which identify non-destructively the hydrocarbon molecules present in naturally occurring gas hydrates recovered from sub-oceanic deposits.

Garry W. Timco

CANADA — U.S.A.

ALASKAN BEAUFORT SEA ICE ATLAS
(D.F. Dickins and Assoc. Ltd.)
This full-colour atlas maps critical ice parameters on a year-round basis within the geographic area important in planning future lease sale exploration and production.

U.S.A.

SNOW RESEARCH AT MONTANA STATE UNIVERSITY
Bob Brown and Andy Hansen are studying shock wave propagation and attenuation in snowpack, treating the material as an inelastic porous material. The two-pronged approach centers on mathematical modeling of the material, combined with supportive shockwave experiments in the field using explosives. They are also studying the response of alpine snow to high rates of strain under highly controlled experimental conditions. A constitutive thermo-mechanical theory of snow deformation based upon its microstructure is also under development. Application of the above material constitutive laws to vehicular-mobility studies will be started soon by Brown and graduate student George Blaisdell, as an extension of previous work done by Brown with CRREL.

Jimmie Dent continues with research on the motion of particles in the active granular boundary layer associated with snow avalanche motion. Particle interaction and diffusion are being assessed, using computer models. High speed behavior of granular snow layers are under experimental evaluation by Dent and Ted Lang, using weighted skis pulled by a four-wheel drive vehicle.

Bob Oakberg and graduate student Carl Reid, are preparing a series of papers which summarize the results of three years' theoretical and field work on the stress which develops when the shrinkage of a natural snowpack is constrained. Implications are that: the upper layers of a snowpack are in tension; differential shrinkage causes zones of low density to develop; and the zones of low density control the overall tensile strength of a snowpack. Although developed for snow, the theory has been applied to a series of experiments on sintering copper powders.

Bob Brown reports that work is essentially completed on deposition of blowing snow over ridge-crests, as reported by Rand Decker at the Sapporo conference last year. The study involved prediction of snow deposition by a two-phase flow computer simulation in conjunction with collected field data. At a workshop in Aspen, Colorado last year, Renee Lang reported on observed details on surface hoar formation, attributed to strong temperature gradients at the snow surface. The phenomenological event of surface hoar formation is strongly tied to meteorological conditions, as observed by Lang.

U.S.A. — CANADA

BARNES ICE CAP PROJECT, UNIV. OF MINNESOTA
(R. LeB. Hooke and G.W. Johnson, GEOL/GPHYS)
Thirty stakes along a 10.2 km flow line between the margin and divide of Barnes Ice Cap were measured for mass balance (covering the 1981-82 and 1982-83 balance years) and surveyed, to determine vertical and horizontal displacement for the 1982-84 period. Analysis of our and Holdsworth's data from 1970 shows the ice cap is now 2.6 m thinner near the divide and 5.3 m thinner near the margin than in 1970. 4.5 km from the divide there is no detectable change in thickness. The 1981-83 mass balance was -0.38 g cm^{-2}. Most of this loss was in 1981-82, as there was firn beneath the 1984 snowpack. This work will not be continued, thereby ending 14 years of field work on the ice cap.

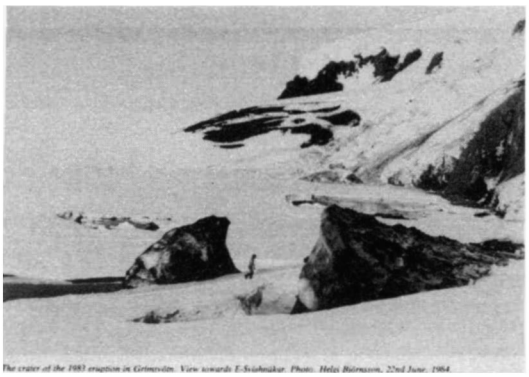
ICELAND GLACIOLOGICAL SOCIETY: JÖKULL

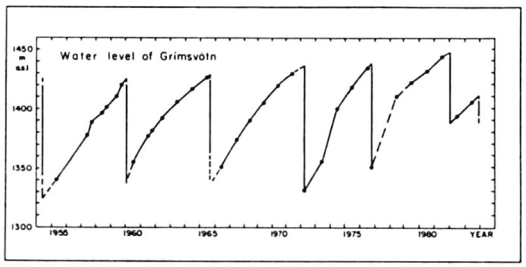
The Iceland Glaciological Society was founded by 41 people on November 22, 1951, with the purpose of furthering research and travel on glaciers in Iceland and to organize lectures about all aspects of glaciology. The first chairman of the Society and its founder, was the meteorologist, Jón Eythorsson (ICE, No.25, 1967, p.8-9) at the Meteorological Institute. After one year, the membership had increased to 150 and in 1985, numbers 550 - volunteers from all professions: carpenters, blacksmiths, plumbers, drivers, mechanics, civil engineers, medical doctors, lawyers, teachers, journalists, farmers, pastors, librarians, geologists, hydrologists and a few who call themselves glaciologists - all who have in common an interest in travelling on glaciers and are willing to lend a helping hand to organize and carry out an expedition. One group takes care of the weasels and another group looks after the food and supplies. For many years, members of a third group have spent their holidays building huts around the glaciers.

This society has been a great supporter of glaciological research in Iceland. Without its help, none of our Vatnajökull expeditions from 1950 to the late 1970s,in particular, would have been possible. In 1951, it organized the French-Icelandic Expedition to Vatnajökull that did seismic shots at about 30 points all over the ice cap. In 1955 this French Icelandic collaboration continued on western Vatnajökull and Mýrdalsjökull. In 1960, gravity surveying was carried out in central Vatnajökull in collaboration with the National Energy Authority. Since 1953, expeditions have been sent to Vatnajökull every spring and sometimes in the autumn. All these expeditions went to Grímsvötn, measured the lake level and did snow pit studies. Many of these expeditions were supported by the Icelandic Road Authority, because of their interest in the jökulhlaups that originate from Grímsvötn. Since 1976, the Society has assisted the Science Institute of the University of Iceland and the National Power Company of Iceland in their

Hofsjökull, central Iceland

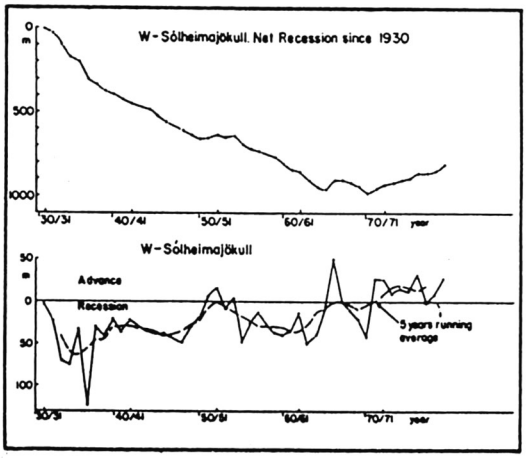
radio-echo sounding on Vatnajökull.





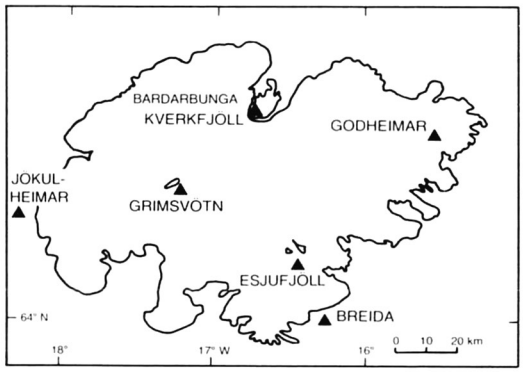
Variations of water level in Grímsvötn

In 1972, members of the Society drilled a 415-m long ice core at Bárdarbunga in NW-Vatnajökull, in collaboration with the Science Institute. Measurements of annual glacier variations are carried out by members of the Society. During the winter, five to six lectures are given in the Society on glaciological research and travels on glaciers.



Variation of Sólheimajökull, S-Mýrdalsjökull

Altogether, the Iceland Glaciological Society has built seven huts. They are in Jökulheimar (675 m a.s.l.) at W-Vatnajökull (5 km from the edge of Tungnaárjökull), in Grímsvötn at 1720 m a.s.l. on the nunatak Grímsfjall, at Kverkfjöll (1700 m a.s.l.) in N-Vatnajökull, in Godheimar (1500 m a.s.l.) in E-Vatnajökull, on the nunatak Esjufjöll in Breidamerkurjökull and at Breidá on Breidamerkursandur. One other hut is situated at the eastern edge of the ice cap Langjökull.



Huts of the Iceland Glaciological Society on and around Vatnajökull

The President of the Iceland Glaciological Society is Sigurjón Rist, a hydrologist at the National Energy Authority. He has been on the Board of the Society since its foundation in 1951. He succeeded the late Sigurdur Thorarinsson.

Since 1951, the Iceland Glaciological Society has published the journal Jökull, which has since 1977 been a joint publication with the Geoscience Society of Iceland. The journal is supported financially by the Ministry of Education. Jökull aims to be an international forum for geoscience research in Iceland, presenting results of original scientific research. Specific areas of coverage include glaciology, glacial geology, physical geography, general geology, petrology, volcanology, geothermal research, geophysics, meteorology, hydrology and oceanography. The specialization of the journal is geographical, rather than one of discipline. The readership of Jökull covers a very broad spectrum and includes scientists in many disciplines, undergraduate students, and a large number of laymen interested in earth sciences. The editors of Jökull, Helgi Björnsson and Leó Kristjánsson, are both at the Science Institute of the University of Iceland.

Helgi Björnsson

NENA '85

The North East North American Branch held its meeting at Auberge Chéribourg, Magog, Quebec on March 1-3 March, 1985. Situated at the foot of Mount Orford, it was a perfect setting for an IGS meeting - if the weather had cooperated! Only a few hardy souls braved the slopes, as the mild temperatures and the rain were not very inviting. The rest of us played Ping-Pong, walked, visited Sherbrooke,or just sat around the bar and talked.

The meeting was very well attended: a total of 50 people, consisting of 30 registrants, 13 spouses and seven children (young adults might be more appropriate). The location was very convenient, with a 3 1/2 hour drive from Ottawa probably the greatest travel time for anyone. And, the food was "formidable". We listened to a total of 16 papers, all of which were interesting, well presented and no longer than 15 minutes. In accordance with tradition, no proceedings of any sort are published, but the titles are listed below. The highlight of the weekend was Simon Ommanney's banquet talk describing his visit to Japan and China with the IGS in 1984. His slides were really magnificent and made everyone wish they had gone on the trip - particularly Sam Colbeck, who had been obliged to withdraw at the last minute.

The next meeting, in 1987, will be organized by Steve Ackley of CRREL - he was late for Saturday lunch and so was the unanimous choice of those present.

Johnson, P.G.: Deglaciation instabilities and debris transport.
Rogerson, B.: Torngat Glaciers.
Schmidt, W. and Pol, S.: An investigation of the effect of bottom crevices on calving from ice fronts.
Hall, J.: Transient and steady state characteristics of water-filled tunnels in ice.
Fastook, J.: Finite-element analysis of a floating ice shelf: variation of ice hardness parameter in the vertical direction.
Colbeck, S.: Classification of snow cover crystals.
Lauriol, B., Beaudet, H., Carrier, Y. and Blinda, G.: Distribution and evolution of snow patches throughout the summer in Arctic Canada.
Weeks, W. and Tucker, W.B.: Simulation techniques as applied to ice-induced gouges in the shelf of the Beaufort Sea.
Jones, S.: The new NRC ice tank in St. John's, Newfoundland.
deHeering, P.: Acoustic remote sensing of sea ice.
Kovacs, A.: Apparent unconfined compressive strength of multi-year sea ice.
Meese, D.: Results of a pilot study of the chemical and physical characteristics of sea ice in the Great Bay Estuary, New Hampshire.
Tucker, W., Gow, A.J. and Weeks, W.: Physical and structural properties of sea ice in the Greenland Sea.
Nixon, W.: Characterizing the fatigue behaviour of freshwater ice.
McComber, P., Druez, J. and Lavoie, Y.: Icing measurements on a cable at Mont Valin.
Ackley, S.: Atmospheric ice accretion.

Stephen J. Jones

BRITISH BRANCH — ANNUAL CONFERENCE

12-14 September 1985, University of Manchester, Manchester, U.K.

The annual conference will be held from Thursday 12 - Saturday 14 September 1985, at the Department of Geography, University of Manchester, Manchester. These dates have been selected since there are several other important meetings in September. The intention is to enable maximum participation in all meetings with minumum travel costs. Registration for the First International Conference on Geomorphology (FICG), also at the University of Manchester, commences on September 15, and the International Workshop on Hydraulic Effects at the Glacier-Bed and Related Phenomena will be held in Switzerland from September 16-19. The International Symposium on Glacier Mass Balance, Fluctuations and Runoff takes place in Alma-Ata, USSR from September 30 to October 6.

The British Branch Conference will commence at 11:00 on Thursday September 12, with coffee from 10:30, to allow arrival from most places that morning. The Annual Dinner will be held on the evening of Thursday September 12. Further sessions will be held on Friday September 13 before the Branch Meeting, which should end in time to allow those who wish to depart to catch trains. There will be an excursion on Satur-

day September 14 in the local area, which will permit departure in mid-afternoon and for which there will be a small charge. It is hoped that presentations will be made of both completed work and work in progress, and there will be display space for posters. The registration fee will be £6.

Accommodation is available in Woolton Hall a short distance from the University campus (£12.50 for B+B, students £7.50). Informal accommodation for those in possession of sleeping bags can be provided free of charge. The registration fee includes coffee and tea, distribution of abstracts and organisational costs. The annual dinner, which all participants are encouraged to attend, will cost about £10. Lunch will be available each day on a cash basis in the Senior Common Room, adjacent to the Department of Geography.

Details will be supplied of British Rail conference travel facilities and Saver tickets to Manchester are available from all major cities.

Monday, September 16 has been set aside for the presentation of papers on the theme of glacial geomorphology. On Sunday, September 15, excursions to the Lake District (glacial) are available in the North West, through FICG. Separate registration particulars and details of the diverse programme are available from Professor Ian Douglas, Department of Geography, University of Manchester, Manchester M13 9PL.

Accommodation in University residences for the nights of September 14-16 can be booked through FICG (£16 B+B+D).

Participants in the British Branch meeting also attending the meeting in Switzerland who wish to transfer from Manchester to Interlaken, may take advantage of a special travel package. Leaving Manchester early in the morning of Tuesday, September 17, by direct Swissair flight to Zürich, followed by train from Zürich Airport station to Interlaken, and returning from Zermatt on Sunday, September 22 to Manchester. At present this special return fare (Manchester - Zürich) is £146. A similar arrangement can be made for those wishing to transfer on Monday, September 16, again returning on Sunday 22. It may be possible to arrange a similar return fare from London - Zürich on Sunday 15, Monday 16 or Tuesday 17,returning on Sunday, September 22. Further details will be sent to those expressing interest or pre-registering. Those intending to participate in the First International Conference on Geomorphology should indicate this.

To register or obtain more information, please contact the following as soon as possible:

Dr David Collins
Department of Geography
University of Manchester
Manchester M13 4PL, U.K.
(061-273-3333 x 3080)

WESTERN ALPINE BRANCH — ALASKA 1984

The excursion of the Western Alpine Branch to Alaska took place from July 16 to August 8, in collaboration with a number of American colleagues. It was organized by François Valla and included the President of the Branch, Guy de Marliave. The 33 French and Swiss participants were blessed with three weeks of exceptionally good weather for the region. The highlights of the trip, a marvellous and unforgettable experience for all of us, were as follows.

Seattle: A visit to the avalanche and glaciology sections of the University of Washington with Ed LaChapelle and Charlie Raymond.

Tacoma: A visit to the Glaciology Project Office of the U.S. Geological Survey and a presentation on the principal features to be seen on the tour by Mark Meier (Mt. St. Helens, Columbia Glacier, etc.).

Mt. St. Helens Volcano: A day spent on the volcano gave us a very good idea of the nature of the disaster and the lessons to be drawn from it.

Inside Passage: A trip from Seattle to Juneau by boat through the extraordinary fjords which indent the coast.

Juneau Icefield: Visit to Camp 17 (1,300 m a.s.l.) of the Juneau Icefield Research Project (JIRP) directed by Maynard Miller.

Mountains and Glaciers of the Fairweather and St. Elias Mountains: An overflight in excellent weather enabled us to see several of the most beautiful glaciers in Alaska including the Malaspina piedmont. A small group saw evidence of the disaster in Lituya Bay occasioned by a massive landslide from Mt. Crillon following the 1958 earthquake.

Columbia Glacier: Two days were spent on Heather Island, our base, with Ed LaChapelle. The fabulous ice front of the tidewater Columbia Glacier has started a spectacular and irreversible retreat.

The return to Paris from Anchorage gave us an opportunity to admire the beauty of Alaska (Deborah Mts), the innumerable glaciers of Ellesmere Island and 100 km of the front of the Humbolt Glacier in West Greenland.

The next meeting of the Branch will take place in Grenoble, November 16, 1985.

François Valla


SYMPOSIUM ON SNOW AND ICE PROCESSES AT THE EARTH'S SURFACE
国際雪氷学シンポジウム
The late Valter Schytt dispensing saké
Banquet centrepiece
Our new President Hans Röthlisberger
Chief Scientific Editor Bob Brown
Fresh tuna, a great delicacy!
JSSI Reception
Tour of ILTS
The meetings were well attended

EIGHTH ALL-UNION GLACIOLOGICAL SYMPOSIUM

28 May - 1 June 1984, Tallinn, U.S.S.R.

Glaciological investigations are now in progress in the USSR Academy of Sciences and Hydrometeorological Service, in many universities, industrial and project establishments. The studies conducted are co-ordinated by the Section of Glaciology of the Soviet Geophysical Committee, which convenes all-union glaciological symposia once every four years. The symposia are intended to review the most important results of investigations and identify directions for future investigations.

The 8th All-Union Glaciological Symposium was held from May 28 to June 1, 1984 in Tallinn. It assembled about 250 leading glaciologists from across the country. Ninety-two papers were presented and discussed in the 17 sessions. Topics covered practically all the aspects of modern glaciology. The theme of the Symposium was "Ice and climate: reconstuction and pediction". The most burning problem of present-day glaciology is how to apply its methodology and data to the interpretation of former and future climates of the earth, and reveal the role of ice in the future of our planet with special reference to the growing man-made impacts on the natural environment.

The numerous papers presented at the Symposium dealt with: mathematical models of glaciers; characteristics of their regime and fluctuations; recent progress in deep core drilling of ice and investigations of glacier boreholes; application of isotope-geochemical methods to glaciology; the genesis of large underground ice masses; paleoclimates and former glaciations; hypotheses of the vast spreading of "marine" ice sheets in the past; processes governing the atmosphere-ocean-polar ice system; mathematical modelling of the snow cover and snow avalanches; multidisciplinary studies of glacio-nival systems; and results arising from the compilation of the World Atlas of Snow and Ice Resources.

Attention was paid to the advances of Soviet glaciology during the last four years. These include the development of methods for calculating snow resources and avalanche hazards in the mountains, using the accumulation fields at the equilibrium line altitude on glaciers; improvement of methods for analysing glacio-nival systems and glacier systems as a whole; a considerable intensification of isotope-geochemical investigations, including studies of the core from deep boreholes in Antartica; determination of the ice balance of the world ocean and the establishment of its relationship with the atmosphere; computation of the mass balance of large areas of the Antartica Ice Sheet and its spatial variation; and continuation of regime surveys on mountain glaciers and the glaciers of Severnaya Zemlya.

Other matters dealt with included experience in calculating and predicting runoff from glaciers,summarized for the whole USSR, which was passed onto the International Commission for Snow and Ice. Developments were noted in the theory of the chemical composition and formation of natural ice; a special theory was described for the avalanche protection of road structures. Data banks for glaciology have been set up, and the collection and processing of avalanche data automated; models of the interactions between ice sheets and the ocean were developed, embracing its energy-active zones during the original growth and decay of the last glaciation on the earth; field studies were made of fluctuations in the near-to-glacier air layer; the relationships of glaciers to the morphology of their containing valleys were revealed.

Improvements in a number of engineering glaciological methods have been developed which include snow-drift prevention along railways, prediction methods for wet avalanches spray-cone freezing of ice masses. The Symposium was especially concerned with underground ice and its connections to the climate of today and of the past.

The comprehensive work of compiling the World Atlas of Snow and Ice Resources, carried out during the last four years, was reviewed. About a thousand maps have been compiled to date and in 1985, the Atlas will be ready for publication. For the first time anywhere, a world Encyclopaedia Glossary of Glaciology covering all the branches of the science of snow and ice, has been completed.

The Symposium considered it very important that a high scientific, printing and publishing level be attained by the World Atlas of Snow and Ice Resources. The preparation of the Second Volume of the Atlas (scientific monograph), which should be an important contribution to the development of scientific and applied aspects of glaciology, is to be finished by the end of 1985

At the same time, attention was paid to the development of glaciological instrumentation, particularly with regard to automation for field studies.

The programme for a scientific project on "Interrelations between glaciers, Ocean and the atmosphere" has been approved and will become part of the National Climatic Programme. An Inventory of Surging Glaciers in the USSR is to be finished within the next five-year plan. It was decided to establish a Data Bank for Glaciology with particular regard to the possibilities of automatic acquisition of field data.

At the end of September 1985, the International Symposium on the Glacier Mass Balance, Fluctuations and Runoff will be held in Alma-Ata; this Symposium is a contribution to Phase III of the International Hydrological Programme.

Twelve new members were inducted into the Section of Glaciology at the Tallinn Symposium. The Section now numbers about 100 leading Soviet scientists, representing all the institutions and departments of the USSR involved in glaciological investigations. Activities of the Section are guided by the corresponding members of the USSR Academy of Sciences, G.A. Avsiuk (Chairman of the Section) and V.M. Kotlyakov (Deputy-Chairman).

Texts of the papers presented at the Symposium and the discussions that followed are to be published in the five current issues of the "Data of Glaciological Studies" (Nos 51-55), which will be published in 1984-1986. It is expected that the next All-Union Glaciological Symposium will be convened in Tiblisi, Georgia, in the summer of 1988.

V.M. Kotlyakov

WORKSHOP ON SNOW AND ICE HYDROLOGY IN SOUTH AMERICA

3-8 December 1984, Santiago, Chile

Following the recommendation of the National Committees for the International Hydrological Program (IHP) of South America, approved by the Intergovernmental Council meeting in Paris in March 1984, a workshop on Snow and Ice Hydrology for Latin America was held in Santiago, Chile, December 3-8, 1984. The workshop was organized by the Unesco Regional Office for Science and Technology for Latin America and the Caribbean, in conjunction with the IHP National Committees of Argentina and Chile. The workshop was sponsored by the International Commission on Snow and Ice and the International Development Research Centre (Canada) was a collaborating agency.

The objective of the workshop was to facilitate and encourage exchange of information and ideas concerning snow and ice hydrology between Andean countries; in particular, to concentrate on techniques for hydrological prediction in nival and pluvio-nival zones.

The workshop was well attended with about 70 participants: 45 from Chile; 15 from Argentina; one each from Peru and Bolivia; and there were also participants from outside South America, one each from Japan and Switzerland and four from Canada.

During the five days of technical sessions about 40 reports were presented covering aspects related to general hydrology, glacier inventory, glacier and snowmelt research, snowmelt runoff forecasting, reliability of snow measurements and avalanche studies of the Andes. All of them pointed out the different activities and research that South American countries are developing. In addition to the technical sessions, there were discussion meetings and conferences reporting on studies done in other regions.

On Saturday 8th, following the workshop, a visit to a copper mine high in the Andean mountains that shows interesting problems concerning snow avalanches and glaciers, was organized.

The participants agreed that the workshop had been very successful and that a good exchange of information, ideas and opinions, concerning snow and ice hydrology of the Andean mountains had been achieved. During the meetings, recommendations were made for the development of stronger links between the participants. The attendance of experts from outside South America highlighted the lack of communication between researchers and institutes in South America and their counterparts elsewhere. Thus, within the framework of IHP and ICSI, the meeting proposed the establishment of closer contacts between all the countries involved in snow and ice problems.

The National Committees of Argentina and Chile outlined as their immediate objective, the preparation of a Regional Course on Snow and Ice within the programme of IHP III, to be held in Mendoza, Argentina, in 1986.

Humberto Pẽna T.

FUTURE MEETINGS (of other organizations)

GLACIOLOGY AT THE VANCOUVER 1987, I.U.G.G. GENERAL ASSEMBLY

During the next I.U.G.G. General Assembly, to be held in Vancouver on 9-25 August 1987, the International Commission on Snow and Ice of the I.A.H.S. will convene or co-sponsor three symposia and one workshop. (The last two ones only are listed in the first I.A.H.S. circular, that does not consider inter-association symposia).

1. Physical Bases of Ice-sheet Modelling. This interdisciplinary symposium will deal with: a) the diverse kinds of polar ice and their constitutive laws; b) the parameterization of processes occurring at the surface, at the bottom, or at the periphery of an ice-sheet, in order to obtain boundary conditions or manageable feed-backs in the ice sheet-atmosphere-ocean system; c) hard facts of any kind that any modeller of ice sheets should take into account. The further solving of a well-posed problem in thermomechanics, or mere results from a model that, although tuned, has not been tested yet with independent field data, are excluded: the focus is upstream from this.
Convenors: L. Lliboutry, Laboratoire de Glaciologie, B.P. 96, 38402 St-Martin d'Hères Cedex, France, and E.Waddington, Geophysics Program AK-50,Univ. of Washington, Seattle, WA 98195, U.S.A.
IAMAP and IAPSO co-sponsorships have been requested.

2. Marginal Ice Zone Processes. (IAPSO-IAMAP-ICSI).
Convenors: R.D. Muench, Science Applications Inc., 13400 B, Northrup Way, Suite 36, Bellevue, Washington 98005, U.S.A., and K.Davidson, Dept of Meteorology, Naval Postgraduate School, Monterey, California, USA

3. Large-scale Effects of Snow Cover. (ICSI-IAHS; IAMAP co-sponsorship requested)
Convenor: B.E.Goodsion, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, M3H 5T4, Canada

4. Workshop on River Ice. (IAHR-ICSI)
Convenor: K.S.Davar, Univ. of New Brunswick, Fredericton, N.B., E3B 5A3, Canada

Extended abstracts should be submitted to the convenors before April 1986.

GLACIOLOGICAL DIARY

1985

5-7 August
The Fourth International Symposium on Ground Freezing. Sapporo, Japan. (ISGF 85, Institute of Low Temperature Science, Sapporo 060, Japan)

21-23 August
Symposium on the Paleoenvironmental Reconstruction of the Late Wisconsin Deglaciation and the Holocene. University of Lethbridge, Alberta, Canada. (Dr R.W.Barendregt, Dept of Geography, Univ. of Lethbridge, 4401 University Dr., Lethbridge, Alta,T1K 3M4, Canada)

26-29 August
Symposium on Glacier Mapping and Surveying, Reykjavik, Iceland. (Secretary General, Int. Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK)

6-13 September
POAC 85, 8th International Conference on Port and Ocean Engineering under Arctic Conditions. Narssarssuaq, Greenland. (Danish Hydraulic Inst., Agern Allé 5, DK-2970 Hoersholm, Denmark)

12-14 September
British Branch meeting, International Glaciological Society. Manchester, U.K. (Dr D. Collins, Department of Geography, University of Manchester, Manchester M13 4PL, U.K.)

16-19 September
Hydraulic Effects at the Glacier Bed and Related Phenomena. Interlaken, Switzerland. (Dr A. Iken, Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie, ETH-Zentrum, CH-8092 Zürich, Switzerland)

30 September - 6 October
International Symposium on Glacier Mass Balance, Fluctuations and Runoff. Alma Ata, U.S.S.R. (Prof. V.M. Kotlyakov, Institute of Geography, USSR Academy of Sciences, Staromonetny Street 29, Moscow 109017, U.S.S.R.)

6-8 November
Arctic Land-Sea Interaction, 14th Arctic Workshop. Dartmouth, Nova Scotia, Canada. (ALSI 85, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2, Canada

16 November
Western Alpine Branch, International Glaciological Society. Grenoble, France. (F. Valla, c/o nivologie ct - gref, B.P. 114, 38402 St Martin d'Hères, France)

9-13 December
Symposium on Atmospheric Processes and Snow and Ice Chemistry, A.G.U. Fall Meeting. San Francisco, California, U.S.A. (Dr P.A. Mayewski, Department of Earth Sciences, University of New Hampshire, James Hall, Durham, New Hampshire 03824-3589, U.S.A.)

9-13 December
Symposium on Remote Sensing and Electromagnetic Properties of Snow and Ice, A.G.U. Fall Meeting. San Francisco, California, U.S.A. (Dr J. Dozier, Department of Geography, University of California, Santa Barbara, CA 93106, U.S.A.)

9-13 December
Symposium on Planetary Ice, A.G.U. Fall Meeting. San Francisco, California, USA. (Dr D. Stevenson, Division of Geology and Planetary Sciences, California Institute of Technology,Pasadena, CA 91125, USA)

1986

26 January - 2 February
IHP 6th Northern Research Basins Workshop:River Ice Measurement Techniques. Houghton, Michigan, USA. (Dr H. Santeford, Department of Civil Engineering, Michigan Technological University, Houghton, Michigan 49931, U.S.A.)

13-17 April
Fifth International Symposium on Offshore Mechanics and Arctic Engineering (OMAE). Tokyo, Japan. (Dr V.J. Lunardini, US Army CRREL, 72 Lyme Road, Hanover, New Hampshire 03755, U.S.A.)

4-8 May
Fast Glacier Flow: Ice Streams, Surging and Tidewater Glaciers, A.G.U. Chapman Conference. Whistler Village, British Columbia, Canada. (Dr G.K.C. Clarke, Department of Geophysics and Astronomy,University of British Columbia, 2075 Wesbrook Mall, Vancouver, B.C., V6T 1W5, Canada)

17-20 June
Fourth Workshop on Hydraulics of River Ice and Short Course on Ice Engineering. Montréal, Quebec, Canada. (M. Marc Drouin, Head, Hydraulics Dept, Société d'énergie de la Baie James, 20th Floor, 800 de Maisonneuve Blvd East, Montréal, Québec,H2L 4M8, Canada)

1-10 July
I.A.H.S. 2nd Scientific General Assembly, Symposium on Modelling Snowmelt Induced Processes. Budapest, Hungary. (Dr A. Szöllösi-Nagy, VITUKI, H-1453 Budapest, Pf 27, Hungary)

22-25 July
Cold Regions Hydrology Symposium, American Water Resources Association. Fairbanks, Alaska, U.S.A. (Douglas L. Kane, Institute of Water Resources, Engineering Experiment Station, Univ. of Alaska,Fairbanks, AK 99701, U.S.A.)

18-22 August
8th Symposium of the I.A.H.R. Section on Ice Problems. Iowa City, U.S.A. (Dr R.Ettema, Inst. of Hydraulic Research, University of Iowa, Iowa City, Iowa 52242, U.S.A.)

30 August - 5 September
VII Symposium on Physics and Chemistry of Ice. Grenoble, France. (VII Symposium on Physics and Chemistry of Ice, Laboratoire de Glaciologie,BP 68,38402 Saint Martin-d'Hères Cedex, France)

6-12 September
Symposium on Remote Sensing in Glaciology and 50th Anniversary of the IGS. Cambridge,England. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK)

14-19 September
International Symposium on Avalanche Formation, Movement and Effects. Davos, Switzerland. (C. Jaccard, Symposium 1986, EISLF, Weissfluhjoch, CH-7260 Davos-Dorf, Switzerland)

1987

March
North East North American Branch meeting, International Glaciological Society. Location to be announced. (Dr S. Ackley, U.S. Army CRREL, 72 Lyme Road, Hanover, New Hampshire 03755, U.S.A.)

31 July - 9 August
12th Congress of the International Union for Quaternary Research. Ottawa, Ontario, Canada. (Mrs. L. Baignée, Secretariat, XII INQUA Congress, c/o National Research Council of Canada, Ottawa, Ontario, K1A 0R6, Canada)

9-22 August
Symposium on the Physical Bases of Ice-sheet Modelling, IUGG General Assembly. Vancouver,B.C., Canada. (L. Lliboutry, Laboratoire de Glaciologie, B.P. 96, 38402 St-Martin d'Hères Cedex, France or E. Waddington, Geophysics Program AK-50, Univ. of Washington, Seattle, WA 98195, USA)

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Symposium on Marginal Ice Zone Processes. I.U.G.G. General Assembly. Vancouver, British Columbia, Canada. (R.D. Muench, Science Applications Inc., 13400 B, Northrup Way, Suite 36, Bellevue, Washington 98005, U.S.A. or K.Davidson, Department of Meteorology, Naval Postgraduate School, Monterey, California, U.S.A.)

9-22 August
Symposium on Large Scale Effects of Snow Cover, I.U.G.G. General Assembly. Vancouver, British Columbia, Canada. (Dr B.E.Goodison, Atmospheric Environment Service, Environment Canada, 4905 Dufferin Street, Downsview, Ontario, M3H 5T4, Canada)

9-22 August
Workshop on River Ice, I.U.G.G. General Assembly. Vancouver, B.C., Canada. (Dr K.S. Davar, Department of Civil Engineering, Univ. of New Brunswick, Fredericton, N.B., E3B 5A3, Canada)

7-12 September
Fourth SCAR International Symposium on Antarctic Glaciology. Bremerhaven, Federal Republic of Germany. (Dr H. Kohnen, Alfred-Wegener-Institute for Polar Research, Columbus-Center, D-2850 Bremerhaven, F.R.G.)

1989

21-25 August
23rd IAHR Biennial Congress. Ottawa, Ontario, Canada. (Dr T.M. Dick, NWRI, CCIW, P.O.Box 5050, 867 Lakeshore Rd., Burlington, Ontario, L7R 4A6, Canada)

NEW MEMBERS

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INTERNATIONAL GLACIOLOGICAL SOCIETY

Lensfield Road, Cambridge CB2 1ER, England

DETAILS OF MEMBERSHIP

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

ANNUAL PAYMENTS 1985

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Junior members	Sterling: £11.00
Institutions, Libraries	Sterling: £60.00 for Volume 31 (Nos. 107, 108, 109)

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Note — Payments from countries other than Britain should be calculated at the exchange rate in force at the time of payment. Please ensure that sufficient money is included to cover the bank charges. The Society needs the full payment, so bank charges should be paid by you. Thank you.

ICE

Editor: Simon Ommanney

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All enquiries about the International Glaciological Society should be addressed to Mrs H. Richardson, Secretary General of the International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

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