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ICE

INTERNATIONAL GLACIOLOGICAL SOCIETY

JAPAN & CHINA 1984

(See pages 21-24 for information about the Symposium on Snow and Ice Processes at the Earth's Surface and the Field Study Tour of NW China)

The Symposium will take place in Sapporo, Hokkaido, 2-7 September, preceded by a one-day meeting in Tokyo with the Japanese Society of Snow and Ice and followed by an 11-day tour of China visiting establishments of the Chinese Academy of Sciences. This tour is open only to participants in the Symposium and their accompanying persons.

PACKAGE TOURS have been arranged from London and Los Angeles, using Japan Air Lines scheduled services. These offer good value, and we urge members in Europe and North America to use them. Registrations for the symposium and tour should be made with the Society's office. Payments for the travel packages and tour should be made with Traveller's World (see pp. 21-24), who will also be pleased to make alternative individual arrangements for your return journeys by Japan Air Lines routes (any extra costs to be borne by you). Extra days within China, after the completion of the official tour in Beijing, can also be arranged by Traveller's World.

INDIVIDUAL TRAVEL, for those members who cannot avail themselves of the above arrangements (e.g. members in Australia, Japan) bookings for registration, accommodation in Sapporo, and the China Tour should be made with the Society's office and Traveller's World. (Note that the price for the China Tour includes everything within China but does *not* include the air travel to and from Beijing.) You should make your own arrangements for travel to and from Sapporo, though Traveller's World will be pleased to advise and guide with individual requirements.

PLEASE NOTE: It is important that we keep to the deadline date of 1 May 1984, which is in accordance with the requirements of China International Travel Service and Japan Air Lines.

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ICE

NEWS BULLETIN OF THE

INTERNATIONAL GLACIOLOGICAL SOCIETY

NUMBER 71 1st ISSUE 1983

CONTENTS

The Society is pleased to announce that an Honorary Membership in the Society has been awarded to Dr. Richard P. Goldthwait, Professor Emeritus at The Ohio State University.

Following a recent decision by Council, the 2nd and 3rd Issues of ICE for 1983 will be combined into a double issue. National Correspondents have been asked to submit their reports to the Editor by November. Members wishing to have reports of their recent work included in this combined issue should forward them to their respective Correspondents as soon as possible.

This issue of ICE profiles the British Antarctic Survey within which our President, Dr Charles Swithinbank, heads up the Earth Sciences Division.

COVER PICTURE: A thin wet snow sheet that slid down a 4 m long children's slide in January at Strengelbach, Switzerland. The snow fell during the night with the temperature just above freezing. Photo by Edi Blatter reproduced by Koni Steffen.

CANADA

GLACIER STUDIES — GENERAL

*For abbreviations see ICE, No.59, 1979,p.15

GLACIER INVENTORY OF CANADA
(C.S.L. Ommanney and J.W. Clarkson, S&ID/NHRI/EC*)
Some 6,500 glaciers of the Stikine River basin were inventoried in 1982 and the data, including that compiled in 1981 for the Iskut River basin, keypunched. It includes the area of ice cover within 100 m elevation bands for each glacier. Bibliographies on Ellesmere Island glaciers and ice shelves and on ice islands in the Arctic Ocean were published.

GLACIER STUDIES — ARCTIC

NORTHERN ELLESMERE ISLAND, COAST,
(M.O. Jeffries and H. Serson, GEOG/CALGARY)
In order to understand the dynamics of Arctic ice shelves, ice cores were obtained from seven locations including the Ward Hunt Ice Shelf, Ayles Fiord and the Milne Ice Shelf, and water samples were taken from Lake "A" and Disraeli Fiord both of which remain stratified. Observations of ice conditions from Ward Hunt Island to Cape Evans were also made. The lake and fiord samples have already been the subject of chemical and isotope analyses (salinity/conductivity, $SO_4^=$, ^{18}O, ^{2}H and ^{3}H). The ice cores will also be analysed as above in addition to thin section study of textures and structures, and ice density determination.

AGASSIZ ICE CAP - LABORATORY STUDIES OF ICE CORES AND FIELDWORK
(R.M. Koerner, D. Fisher, B. Alt, M. Parnandi and J. Bourgeois PCSP/EMR)
Reduction of filter samples to slides for pollen analysis of a 100,000 year time series from the Agassiz Ice Cap in northern Ellesmere was completed. This procedure is now considered satisfactory for ice core/pollen studies. Differences between type, number and size distribution of microparticles between ice deposited during the last glacial period and since have been recognized from metallographic studies of the ice cores. Oxygen isotope time studies from ice cores and the glacial geology record are being compared and the oxygen isotope/climate relationship is being investigated. The Devon isotope study has been completed and the one on the northern Ellesmere record (with J. England) should be completed in 1983. The lag response of a northern Ellesmere ice sheet to a change of mass balance is being studied. Synoptic analogues (developed from the study of extreme mass balance seasons) were applied to fluctuations of various parameters such as oxygen isotopes, melt percentage, and pollen concentrations in the core, on a paleoclimatic time scale.

Mass balance profiles on the Meighen, Melville, Devon (NW side) and Agassiz (northern Ellesmere) ice caps were measured. Balances were more negative than the long period mean. Down borehole photography, and borehole tilt and diameter of the two surface-to-bedrock Agassiz Ice Cap boreholes were made. Bulk samples were collected on the top of 10 ice caps by PCSP and others from three widely separated locations on the Arctic Ocean. These samples are being analysed for pollen concentration and type. Mass balance poles set up by DRB 25 years ago were located on the Gilman Glacier and remeasured.

GLACIER FLOW MODELLING
(E.D. Waddington, GPHYS/UBC)
Flow and temperature modelling of the Agassiz Ice Cap are being undertaken using finite-difference and finite-element methods to assist the PCSP in determining the climate record.

GLACIER STUDIES — YUKON & N.W.T.

ICE CORING PROJECT
(G. Holdsworth, S&ID/NHRI/EC)
Ice core site reconnaissances were carried out on Flint Ice Cap (NWT) and icefields at the head of Donjek Glacier (YT). Shallow cores, 11-16 m deep, were obtained for stratigraphic and oxygen isotope analyses. Temperatures at 10 m depth ranged from near temperate to -6°C and total ice depths from 270-500 m.

The electro-mechanical drill has now been tested to over 200 m depth and some modifications will be made. An electro-thermal drill is being constructed for use below the firn/ice transition to core in warm ice to depths of about 450 m.

The following analyses of the Mt. Logan ice core are proceeding: oxygen isotopes by R. Krouse, University of Calgary, chemical by R. Delmas, gross β-activity by M. Pourchet, and total gas content and CO_2 content by D.Raynaud (all of CNRS, Grenoble, France)

DONJEK GLACIER, YUKON TERRITORY
(P.G. Johnson, GEOG/UofO)
The long-term photographic record of changes in the Donjek Glacier terminus was continued. Little change was apparent.

TRAPRIDGE GLACIER, YUKON TERRITORY
(G.K.C. Clarke and M.G. Maxwell, GPHYS/UBC; S.G. Collins, Dartmouth)
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 ma^{-1}. The bulge is at the boundary between warm-based (upstream) and cold-based (downstream) ice. At a site immediately downstream from the bulge the basal temperature has increased 0.5°C in one year - suggestive of some form of thermal instability. Ice samples from Trapridge Glacier will be analysed to determine their fabric and isotopic composition ($^{18}O/^{16}O$ and D/H).

GLACIER STUDIES — CORDILLERA

ISKUT RIVER GLACIERS AND FLOOD LAKE
(O. Mokievsky-Zubok, S&ID/NHRI/EC)
Mass balance studies were continued on three representative glaciers (106 km^2) in the Iskut River basin. The vertical height loss of ice on Yuri and Alexander glaciers was 2.1 m and 3.1 m respectively. On Andrei Glacier it was 4.1 m and the glacier retreated 19.5 m. All three glaciers had negative mass balances of -0.965, -1.182 and -1.097 m H_2O respectively.

Observations were continued on the glacier-dammed Flood and Natavas lakes in the Stikine and Iskut river watersheds. Flood Lake was filled to capacity (approx. 200 x $10^6 m^3$) and discharged partially twice during August

TIEDEMANN AND BENCH GLACIERS, B.C.
(O. Mokievsky-Zubok, S&ID/NHRI/EC)
Studies to determine the mass balance and glacier melt contribution of the Tiedemann and Bench glaciers to flow regimes downstream entered their second year. Their potential influence on proposed dam sites in the Mt. Waddington area will be assessed. Vertical ice losses were 7.2 m and 4.4 m at the snouts with negative balances of -1.33 and -0.89 m H_2O respectively.

BRIDGE RIVER GLACIERS, B.C.
(O. Mokievsky-Zubok and S. Fogarasi, S&ID/-NHRI/EC)
Investigations continued on the Bridge River glaciers in order to determine their effect on basin runoff and to evaluate seasonal and operational forecast models in conjunction with J.R. Gordon of BC Hydro. A data collection platform (DCP) provided hydro-met data. Bridge and Sykora glaciers had a combined negative specific balance of -0.30 m and Zavisha one of -0.52 m H_2O.

WEDGEMOUNT GLACIER, GARIBALDI PARK
(W.A. Tupper, BCIT and Karl E. Ricker Ltd.)
A 1:10,000 scale map of the entire glacier basin, contoured at 20 m intervals on an orthophoto base using high level aerial photography is under preparation. A resurvey of the glacier showed a slight advance of the snout on the S margins and retreat on the exposed N margins; but the advance is coming to a close. Velocity of the E arm was only a few tens of cm/a, though increasing as the medial moraine is approached to 70 cm/a. The velocity on the main ice stream is about 1.4 m/a, or 10% of that clocked at the snout.

TCHAIKAZAN VALLEY GLACIERS
(Karl E. Ricker Ltd & Alpine Club of Canada)
During 1982 the main Tchaikazan Glacier and adjacent Friendly Glacier were resurveyed. Recession has continued unabated on both. Glacier advances over the last one or two decades appear to be restricted to the southern Coast Mts, mainly to those located on the maritime front. The effect of the recent Mexican volcanic eruption on this general pattern will be studied and other glaciers in the Coast Mts will be surveyed.

MASS BALANCES, SW COAST MOUNTAINS, B.C.
(O. Mokievsky-Zubok, S&ID/NHRI/EC)
Measurements of winter and summer balances, meteorological variables and meltwater flow continued on Sentinel and Place glaciers with mass balance only being measured on Helm Glacier. Balances were positive at Sentinel at 0.86 m H_2O and negative at Place (-0.64 m) and Helm (-0.34 m H_2O). Since 1979 Sentinel Glacier has retreated 24 m.

CATHEDRAL GLACIER, B.C.
(G. Holdsworth, S&ID/NHRI/EC)
A site survey of Cathedral Glacier has been made for Parks Canada. The glacier has a summer supra-glacial lake which empties down unstable slopes above the spiral railway tracks at Kicking Horse Pass. This causes alluviones (mud slides) which damage the railway tracks and the Trans Canada Highway in some years.

EMERALD GLACIER, YOHO PARK, B.C.
(R.J. Rogerson, GEOG & EARTH SCIENCE/MUN)
Further measurements of the push moraine indicate continued readvance averaging 1.5 m since 1981. A nearby rock glacier showed no measured readvance.

PEYTO AND SENTINEL GLACIERS
(B.Yarnal and R.B. Sagar, GEOG/Simon Fraser)
The relationship between synoptic-scale atmospheric circulation and glacier mass balance was studied using glaciometeorological data from Peyto Glacier, Alberta, and Sentinel Glacier, B.C., and climatological data from nearby weather stations. The mass balances of Peyto and Sentinel glaciers were related to the 500 mb synoptic patterns passing over the area. Accumulation and ablation at Sentinel Glacier are controlled by high wave number synoptic patterns. Conversely, Peyto Glacier accumulation is more closely related to large-scale synoptic patterns, suggesting that much of the short wavelength variability imbedded in the long-wave atmospheric flow may be dampened by the rough topography of the Canadian Cordillera. Ablation is predicted poorly by both synoptic scales at Peyto.

ROCKY MOUNTAINS, ALBERTA AND B.C.
(J.Power, Surface Water Division <SWD>/NHRI)
Ottawa University students (P.G.Johnson, under contract) collected mass balance data at Peyto Glacier (Alta), and streamflow, meteorological and hydro-chemical data at Peyto

Glacier and in the adjacent Kicking Horse River basin in B.C. G.J. Young has derived the proportions of total runoff from glacier ice, firn, seasonal snow-packs and summer precipitation based on the 1967-74 records.

D.S.Munro and Young described a net shortwave radiation model for mapping radiation distribution, under clear and cloudy skies, over the basin. A.J. Stenning and others have demonstrated the degree of control exercised by synoptic-scale meteorological conditions on the development and characteristics of a katabatic layer above a melting glacier.

A hydrochemical program was undertaken by D.N. Collins (GEOG/Manchester University) to separate components of flow in rivers arising from different sources at various elevations. Discharge, electrical conductivity and pH were recorded on Amiski River, Kicking Horse River at Cathedral Mtn, Twin Falls Creek and Peyto Creek. The structure, behaviour and functioning of the internal drainage system of Peyto Glacier was examined indirectly using an additional site for monitoring conductivity, suspended sediment concentration in meltwaters at the snout, and fluorometer dye-tracer tests, and shows that transit times for tracer flow-through decreased markedly with increasing discharge. Average flow-through velocities ranged from 0.13-0.35 ms^{-1}.

ATHABASCA AND SASKATCHEWAN GLACIERS
(L.A. Warner, WSC/EC/Calgary)
A report on the biennial surveys carried out in 1978 and 1980 to determine the toe position and plaque line movement and ablation has been prepared.
(J. Menzies, GEOG/Brock)
A project to study the englacial, supraglacial and basal debris was carried out. An analysis of the debris in relation to characteristics of Quaternary tills was made. Geochemical and geotechnical parameters were obtained.

GLACIER STUDIES — LABRADOR

TORNGAT MOUNTAIN GLACIERS
(R.J. Rogerson, GEOG & EARTH SCIENCE/MUN)
Mass balance,ice movement and snout measurements were continued and extended on four cirque glaciers south of Nachvak Fiord during the summer in 1982. Preliminary results for 1981-82 indicate negative mass balance in the order of -1 m. One glacier snout readvanced 1.5 to 2 m since 1981.

ROCK GLACIERS

ROCK GLACIERS - YUKON TERRITORY
(P.G. Johnson, GEOG/OTT)
The role of low frequency high magnitude events in the formation of rock glaciers with a variety of trigger mechanisms is becoming apparent in the St. Elias Mountains and Ruby Range, Yukon Territory.

GLACIAL GEOLOGY

MOUNT TATLOW MASSIF, CHILCOTIN RANGES, COAST MOUNTAINS, BRITISH COLUMBIA
(Karl E. Ricker Ltd.)
A cirque and former valley glacier system on the eastern side of this massif was studied. Erratics, glacial grooves, etc. suggest Late Pleistocene Cordilleran ice flow to the N. The E draining valley below the ridge crest contains recessional standstill moraines. Periglacial features upvalley include active and inactive rock glaciers, protalus, nivation ridges, sorted stone stripes, nets, polygons, and a vast carpet of solifluction lobes draped over the Pleistocene morainal features.

LAKE SEDIMENT RESEARCH GROUP, UNIVERSITY OF MANITOBA
(J.T. Teller and W.M. Last (ES); C.T. Shay (Anthropology); T.A. Jackson, B.C. Kenney, W.F. Warnick (Freshwater Institute <FI>/EC); G.J.Brunskill, R. Hecky, R.H. Hesslein, R.W. Newbury, D.Poveledo and J.W.M. Rudd, FI/FOC)
The Lake Sediment Research Group conducts interdisciplinary research in geological, biological and environmental limnology and related sedimentological topics. The Group specifically seeks new approaches to lacustrine sedimentation research and encourages participation from graduate students and post-doctoral fellows who are interested in lake sediment research.

SOUTHERN INDIAN LAKE RESERVOIR, MANITOBA
(R.W. Newbury and G.K. McCullough, FOC)
20 sites were surveyed annually to observe the processes and rates of permafrost melting, solifluction and erosion. The sequence of shoreline erosion in permafrost materials was found to be cyclical, consisting of melting and undercutting of the backshore zone, massive faulting of the overhanging shoreline and removal of the melting and fractured debris. In fine-grained frozen silts and clays, rates of retreat up to 12 m/a were observed. The total volume of shoreline materials removed varied from less than 1 m^3/m length of shoreline per year. The average index of erosion based on the hindcast wave energy component perpendicular to the shoreline was 0.00035 m^3/m length of shoreline per tonne-m of wave energy. The minimum period of restabilization of the shoreline was estimated to be 35 years for over 80% of the shoreline. Clearing of the forested backshore prior to flooding did not affect the erosion rates.

LAKES AGASSIZ/SUPERIOR CONNECTION
(J.T. Teller, ES/Univerity of Manitoba)
Recent results show catastrophic discharges from Lake Agassiz approaching 2 x 10^5 $m^3 s^{-1}$ for months at a time. About 4000 km^3 of Lake Agassiz water (about 9 times the volume of Lake Erie) discharged on a number of occasions between 9500 and 8500 B.P. Seventeen

channels have been mapped in the eastern outlets of the lake. The influence of these catastrophic outpourings on the Great Lakes' systems must be significant, although the effects have not yet been evaluated.

GLACIAL GEOLOGY AND LANDFORMS, ONTARIO
(J.P. Coakley, J.A. Richard, P.F. Finamore, L. Kerr-Lawson, P.F. Karrow, R.N. Farvolden and J.P. Greenhouse, ES/Univ. of Waterloo)
The projects on Long Point (Coakley), the Cochrane glacial advance (Richard) and the Orillia-Fenelon Falls area (Finamore) have continued. Kerr-Lawson is doing an M.Sc. on the paleontology of the Don interglacial beds in Toronto. Karrow's work has included mapping St. Joseph Island (near Sault Ste. Marie) for the Ontario Geological Survey and continued study of mollusc assemblages from glacial lake deposits in the Huron basin. Efforts to correlate aquifers of the Waterloo area with glacial stratigraphy using geophysical logs and continuous coring are continuing.

PLEISTOCENE GLACIAL SEDIMENTS
(C.P. Gravenor, University of Windsor)
Chattermark trails on garnets from glaciogenic deposits from widely separated areas that were under different glacial environments, such as Nova Scotia, Denmark and south-central Ontario were examined. After the local anomalies in the percentage of chattermarked garnets were averaged out by recycling and dispersion, a crude correlation was obtained between their average percentage in glacial deposits and the type of glaciation. Results showed the importance of mass transport of sediments in the shelf environment, similar to recent reports on sedimentological studies made on glaciomarine sediments in the shelf environments of Antarctica.

SOUTHERN ONTARIO
(J. Menzies, GEOG/Brock University)
The stratigraphic and sedimentary properties of till in the Dunnville and Caledonia areas and characteristics of the drumlin tills in S. Ontario drumlin fields are being studied.

WATERFORD RIVER BASIN, NEWFOUNDLAND
(M.J. Batterson, Nfld Mineral Dev. Division)
Three distinct glacial deposits were identified. A very compact, light grey, lodgement till of local origin was located above the bedrock which is subsequently overlain by a supraglacial (melt-out?) till in the western half of the basin and on the South Side Hills, or a subglacial melt-out till in those parts of the basin where the supraglacial unit is not exposed. In general, the evidence within the basin conforms with the accepted ideas of the glacial history of this part of the Avalon Peninsula - a thin ice cover over the St. John's Peninsula which followed the preexisting bedrock topography in a roughly SW-NE direction.

BUCHANS MAP AREA, NEWFOUNDLAND
(B.G. Sparkes, Nfld. Dept. Mines & Energy)
Mapping was conducted in this area during 1982 as a continuation of the Surficial and Glacial Mapping Program in Central Newfoundland. Geomorphic features in the eastern part of the map area indicate ice flow to the northeast. Elsewhere, there are few apparent features (other than striae) to indicate the latest direction of glacial transport. The stratigraphically lowest till observed within the map area is grey, with a silty matrix, and usually lacking in fissility. This unit is always overlain (where observed) by a red till which generally has a more sandy matrix and contains clasts of more distant provenance. The Buchans map area was affected by three distinct pulses of ice movement: a flow to the SE followed by ice flows to the NE and SW, probably during a period of glacial retreat.

GREAT GULL POND MAP AREA, NEWFOUNDLAND
(D.G.Vanderveer, Nfld. Dept. Mines & Energy)
Initial reconnaissance of this area suggests two glacial flows; an early NE to E flow followed by a later N to NE flow. Glacial stratigraphy in the sand and gravel pit at the Gullbridge Mine site reveals 4-6 m of compact lodgement till overlying 8-10 m of sand and gravel of glaciofluvial or glaciolacustrine origin. Similar stratigraphic sections have been confirmed at Buchans (45 km SW) and Tulks Brook (75 km SW) that may represent a large proglacial lake. The (re) advance of ice masses that deposited the upper till unit(s) may have been related to a widespread glacial event, and similar stratigraphy may be expected to occur in other areas of central Newfoundland.

QUEBEC AND EASTERN CANADA
(J.-M. Dubois, M. Parent, Q.H.J. Gwyn, A. Poulin, P.Boissonnault, C. Dubé, G. Laroque, J.-C. Dionne, R. Cadieux, G. Tremblay, S. Perras, A. Morin, D. Brouillette, A.Painchaud, P.Bigras, D.Gratton, B.Lauriol, GEOG/Université de Sherbrooke)
Studies undertaken were - collection of data for a Quaternary map of Québec, history of glaciers in the Appalachian piedmont and in the Memphrémagog region, preliminary study of a morainal complex in a region between Baie Comeau and Goose Bay, englaciation and deglaciation in the Wisconsinan, history of the Quaternary of the southwest region and Saint Pierre and Miquelon Islands.
(M.Bouchard, C.Hillaire-Marcel, M.Lamothe, S. Occhietti and G. Prichonnet, GEOG/Université du Québec à Montréal)
Stratigraphy of glacial deposits in southern Québec, of interperiod deposits in Cape Breton Island, and models of englaciation and deglaciation in Québec during the Wisconsinan, were studied. Hillaire-Marcel and P. Pagé are studying the isotopic geochemistry (^{18}O and ^{14}C) of ice caps, lakes, fjords, and ocean samples to reconstitute paleotemperatures and,failing that, paleosalinities.

Occhietti is carrying out historical climatologic studies for the period extending from the 16th century to the present day in eastern Canada.

REMOTE SENSING

RADIO ECHO SOUNDING, NORTHERN ELLESMERE IS.
(B.T. Prager, B.B. Narod & G.K.C. Clarke, GPHYS/UBC)
In June 1981 the UBC 840 MHz radar was mounted in a Canadian Forces Twin Otter and 2000 line-km of ice soundings taken over the Ayles, Milne, M'Clintock and Ward Hunt ice shelves and the Milne and Disraeli glaciers. The digitized sounding results are being plotted and computer analyzed using techniques adapated from seismic signal processing.

REMOTE SENSING OF SNOW AND ICE COVERS
(P.J. Howarth, GEOG/McMaster University)
A study to datermine the usefulness of Landsat images for the study of Canadian glaciers, particularly for the purpose of glacier inventory has been undertaken for NHRI. This work will also contribute to the Canadian submission for the Satellite Image Atlas of Glaciers. Areas being studied are the Steacie Ice Cap (Axel Heiberg Island), the Kaskawulsh, Tweedsmuir and Lowell glaciers (St. Elias Mts), and the Athabasca and Saskatchewan glaciers, forming part of the Columbia Icefield. The experiments being undertaken involve area measurements of snow and ice, enhancement and classification of the Landsat data for mapping snow, firn, ice and debris-covered ice and the possibilities of change detection using resampled and UTM corrected data generated by the Digital Image Correction System (DICS) at CCRS.

REMOTE SEA ICE THICKNESS SENSOR
(S.Y.K. Tam, M.P.B. Technologies Inc.)
An advanced prototype remote sea ice thickness sensor was developed, which consisted of (a) a broad-band VHF antenna for helicopter applications, (b) a microprocessor-based control and signal processing circuit, and (c) an improved VHF radar transmit-receive module.

AIRBORNE REMOTE SENSING, 1981/1982
(Melville Shipping Ltd, Calgary)
For the Arctic Pilot Project (APP), a remote sensing overflight was flown from Søndre Strømfjord, Greenland, to Bridport Inlet, NWT, using the SLAR equipped AES aircraft. Aerial photography was used to determine the extent of multi-year ice compared with SLAR and satellite imagery for the Viscount Melville Sound area. Ridging frequency and floe size statistics were generated from the airphotos. On-ice measurements of ice thickness, strength, temperature, salinity and crystal structure of multi-year ice and the surrounding first-year ice were taken at approximately 12 sites within the survey area. Transit simulation models will evaluate routes from Melville Peninsula to Europe and from Bathurst Island to Nova Scotia.

Data on surface roughness, ice concentration, ice cover make-up, and iceberg populations in an area covered by Davis Strait, Baffin Bay, Lancaster Sound, Barrow Strait, and northern Viscount Melville Sound were collected. APP collaborated with Canarctic Shipping Co. Ltd to investigate the suitability of a marine radar for detecting icebergs, growlers and bergy bits operationally. X- and S-band radars were supplemented with an X-band radar mounted on the bow of the M.V. Arctic. Comparisons between these radars and visual observations will be made for a variety of sea states, visibility, ice concentration, etc., from June to November. Ice thickness, temperature, salinity and confined compressive strengths were measured during M.V. Arctic's first northern voyage to Nanisivik, 1982.

INTERA ENVIRONMENTAL CONSULTANTS LIMITED AND INTERTECH REMOTE SENSING LIMITED
(D.R. Inkster, M.E. Kirby, R.T. Lowry and W.C. Jeffries)
A digital side-looking airborne radar (SLAR) optimized for sea-ice reconnaissance equipped with a motion compensation system, has been developed and tested in the Bering Sea. Synthetic aperture radar (SAR) data have been collected from the Beaufort, Chuckchi and Bering seas and analyzed. Information on floe size distributions, ice deformation and marginal ice zone characteristics have been summarized. A new high-resolution SAR, called STAR-1, is being developed for Dome, for operations in the Beaufort Sea.

Several studies have been conducted on the classification of sea ice by both tonal and textural classifiers, using single- and multi-channel SAR systems. A rapid one-channel combination tone/texture classifier, suitable for operational use, has been evolved. A ridge and rubble estimator, for rapid calculation of ridge size and mass redistribution, has been further tested. Considerable work has been done to simulate satellite-borne SAR imagery of both sea ice and icebergs at C- and X-bands, using SAR-580 data.

INTERA has developed (for Dome) a radar image display system (RIDS) to log and display data from several ships' radars. The heart is a small computer, which takes data from a special interface, logs to tape and/or disk, and produces a colour display.

Ice ridging in the Beaufort, Chuckchi and Bering seas was studied by collecting ice profiles with a pulsed, digital laser profilometer. Ridge heights, widths, spaces and angles of repose were measured and used to describe the severity of ridging and to test theories on the occurrence of first-year pressure ridges. Infrared line scanning and aerial photography enabled the researchers to correlate deformation characteristics to

ice type and coverage.

Thermal infrared scanning techniques were applied to evaluate the thermal properties of approximately 30 icebergs off the coast of Labrador and Newfoundland. The temperature regimes associated with the cold water envelopes around the icebergs were distinguished, as well as three temperature regimes within the icebergs themselves. The data were then considered in relation to iceberg deterioration processes and models.

SIDE-LOOKING AIRBORNE RADAR (SLAR)
(D.Mudry, P.W. Coke, R.Chagnon & F.E.Geddes, Ice Climatology & Applications <ICAD>AES/EC)
Two reports "Imagery catalogue of side-looking airborne radar from the Labrador Sea study area 1978 to 1980" and "Historical side-looking airborne radar iceberg data base criterion (Labrador Sea, 1978 to 1980)" were prepared by INTERA. Iceberg locations on an individual basis have been digitized and analyzed on a flight-by-flight basis using available SLAR imagery and flight logs from the AES. Some 100 reconnaissance flights were flown along the Labrador coast. SLAR imagery was reanalyzed to determine iceberg statistics of population, size, local surroundings and recurrent positions. The final report and the data base are available through ICAD. About 80,000 km of laser tracks have been analyzed for ice ridge heights and frequency on a per km basis. A computer software package for laser data input and archiving was also completed.

MICROWAVE SENSING OF SEA ICE
(R.O. Ramseier, Ice Branch, AES/EC)
A large international experiment was completed at Mould Bay measuring the active and passive microwave (PM) properties of melting ice. In a joint effort with the U.S. Naval Research Lab, icebergs in open water were successfully detected using a 90 GHz PM imager. The Radarsat Project was completed to provide justification for the inclusion of a PM radiometer on its satellite. The use of PM data for determining snow extent and water equivalent seems to be very promising.

SNOWCOVER MAPPING
(K. Johnstone, CCC/AES/EC)
A study to determine the ability of a digital/analogue Linear Measuring Set and microcomputer to map the snowcover of a forested river basin using NOAA/TIROS imagery is continuing. The system appears to be capable of providing coarse estimates of basin snowcover with little computation.

MULTI-STAGE SNOW COVER EXPERIMENT
(B.E.Goodsion, CCC/AES; T.Carroll, US National Weather Service; J.Glynn, SWD/NHRI; A. Banga, Saskatchewan Environment; R.A.Halliday, Water Resources Branch, EC)
Over 10 Canadian and US agencies are cooperating in a study for mapping areal snow cover (extent, depth, water equivalent) over the Canadian Prairies. In February 1982 a major airborne/ground snow survey experiment was conducted over southern Saskatchewan. Gamma airborne surveys (using Canadian and US aircraft), NASA airborne PM transects and coincident ground surveys were conducted. NOAA satellite and Nimbus-7 PM data were collected.

ATMOSPHERIC ICE AND CLIMATE

SCHEINER'S HALO
(E. Whalley, CHEM/NRC)
An apparent parhelion of Scheiner's halo observed in 1677 is approximately consistent with the prediction of a lateral arc.

ICE CLIMATOLOGY
(Ice Branch, AES/EC, Ottawa)
Ice climatology studies included the analysis and computer archiving of baseline iceberg data from SLAR imagery and drill ship reports. The development of an ice ridge data archiving program was completed as well as a first draft of the data inventory. A catch-up program to publish ice thickness reports was initiated, and the 10-year ice summary and analysis publication was approaching completion.

CLIMATE/METEOROLOGY
(B.F. Findlay and R.A. Treidl, CCC/AES/EC)
A new tabulation "Persistent snow cover" was made giving monthly data on snow depth for the period 1955/56 to 1979/80, and containing information on season length, maximum accumulation and other statistics and is available from the Climate Services Division, AES. A study of four Canadian locations and 20 winter's data has been completed to determine the protective properties of snowdepth on ground temperatures.

ICE PHYSICS/ENGINEERING

METHANE HYDRATE THERMAL CONDUCTIVITY
(J.G. Cook, PHYS/NRC; D.G. Leaist, CHEM/NRC)
A guarded hot-plate cell to measure the thermal conductivity of methane hydrate was constructed and tested with various ice specimens. The conductivity of methane hydrate near -60°C was 0.45 W/mK, a value close to that obtained for other clathrate hydrates. It is much lower than for ice (by a factor of about 5), so that a logging tool based on this property should be of use in identification of gas hydrates in permafrost zones.

ICE PHYSICS
(N.K. Sinha, DBR/NRC)
Rate sensitivity and acoustic emission during compression of fine grained columnar grained ice were studied at -10°C.

ICE PHYSICS

(Division of Chemistry, NRC, Ottawa)
The infrared spectrum of ice VI, VII and VIII have been measured at pressures up to 189 kbar by D.D.Klug and E.Whalley. They and O.Mishima measured the infrared spectrum of single crystals of ice Ih in the range 8-25 cm^{-1}, between 80 and 202°K and extrapolated to 3 cm^{-1} using a detailed theory. The results, and the thermal component of the brightness temperature of Saturn's rings, shows that there is a thickness of 30 ± 10 cm of ice in Saturn's rings on the average.

ELECTROMAGNETIC PROPERTIES

(G.P. Johari, S&ID/NHRI/EC)
The effect of dissolved helium and other gases on the radiofrequency spectrum of ice is being studied over a range of temperature and hydrostatic pressures. The electromagnetic spectrum of ice from sub-audio to ultra-violet frequencies was reviewed in Contemporary Physics (22(6) 613-642, 1982).

A calculation of the electrical properties of all the high pressure orientationally disordered phases of ice has been completed. This involved computation of the orientational correlation factor of the water molecules and the electrostatic field at the molecular site using the known crystal structure of the ices.

MECHANICAL PROPERTIES

(S.J. Jones and H.A.M. Chew, S&ID/NHRI/EC)
The effect of sample and grain size on the uniaxial compressive strength of ice is being investigated. The strength of a sample becomes independent of its size when its size exceeds those of the grains in it by more than a factor of 12. The compressive strength also becomes nearly constant for grain sizes in the range 0.6-2.0 mm.

Creep of polycrystalline ice under a deadweight uniaxial stress is being studied at different hydrostatic pressures. With increasing pressure the creep rate first decreases, becomes a minimum between 15-30 MPa and then rapidly increases.

Triaxial compression tests are being carried out on frozen sand-ice materials in order to determine the effect of composition on their strength.

(D.B. Muggeridge, H. Hamza and A.A. Tehrany, ENG/MUN)
Theoretical and experimental investigations are being conducted on the creep and fracture behaviour of freshwater and saline ice. The creep and bending of ice plates was analyzed by the finite element method and fracture toughness was experimentally evaluated using three point bending compact specimens. The effect of strain rate, grain size and temperature on the linear and non-linear fracture toughness is being investigated.

(R. Tinawi and L. Lainey, CINEP/UofM)
Flexural strength tests on sea-ice beams have been carried out at temperatures between -5°C and -40°C, and loading rates between 25 and 600 kPa/sec (extreme fiber stress), and the elastic modulus and flexural strengths were calculated. Long-term loading at high temperatures (-5°C) showed that tertiary creep developed up to failure of the beams, while at low temperatures (-40°C), brittle failures occurred, especially at high stress levels.

STRENGTH AND FRACTURE OF SEA ICE

(G.W.Timco, DME/NRC; R.Frederking, DBR/NRC)
The confined (plane strain) compressive strength of Beaufort Sea ice has been measured for both granular and columnar ice from the rubble field around Tarsuit. The results were used to determine the coefficients of an n-type yield function for plasticity theory.

Mid-winter tests carried out on Beaufort Sea ice included grain structure determinations, salinity and density of the ice, small beam flexural strength and fracture roughness. Results of the mechanical property tests were compared to identical tests which had been performed on fine-grained freshwater ice. Both the flexural strength and fracture toughness were dependent on brine volume and depth in the ice sheet.

ARCTIC ICE STRENGTH TESTING

(D.M. Masterson, GEOTECH, Calgary)
Field trials on the performance of flat jacks to measure strength of ice in the Ghost River, Calgary, were carried out. Later these jacks were used to measure in situ strength of ice in the Arctic Islands for the design of offshore structures. Uniaxial and triaxial strength of multi-year ice samples under controlled rates between 10^{-5} and $10^{-2} s^{-1}$ are also being studied.

BEARING CAPACITY OF ICE COVERS

(R. Tinawi and L. Lainey, CINEP/UofM)
One of the serviceability criteria for ice covers is to limit long-term deflections to the free-board value. If the material is considered anisotropic, such that the shear modulus $G \neq E/2(1 + \nu)$ (E is the elastic modulus and ν Poisson's ratio), it is then proposed to predict such a deflection by a reduction in the shear modulus. Such a proposition appears to fit fairly well the available experimental data. The advantage of such a proposition is to be able to carry out a simple linear analysis of plates on elastic foundations for the long-term prediction of the deflection of ice covers.

ICE ENGINEERING

(R. Frederking, DBR/NRC)
Field investigations to study the formation and internal deformation within ice rubble have been carried out at some natural and artificial islands in Beaufort Sea. Mechanical properties of the ice recovered from these places were also measured. Cantilever

tests were done on freshwater ice covers in the field. Preliminary measurements of dynamic response characteristics of the Lac St. Pierre light pier were also taken.

ICE FRICTION
(J.Molgaard, P.N.Smith & L.C.Wong, ENG/MUN)
Design work is proceeding on the test equipment for studying the friction between ice and other materials. Ice samples of 10 cm diameter will be tested at temperatures of -40°C to 0°C. Test materials and surface will simulate those similar to icebreakers and other ocean structures.

WAVE CHARACTERISTICS IN ICE
(D.B. Muggeridge, V.M. Arunachalam and O. Grande, ENG/MUN)
A direct procedure for the solution of the wave dispersion equation (for the under ice case) has been developed. The properties of infinite series and Pade approximants were employed from which a set of coefficients have been obtained. These were directly used for the computation of the wave characteristics. An experimental program using an artificial ice scaled for its flexural properties is being conducted in a 61 m flume.

FATIGUE ANALYSIS
(M. Arockiasamy, D.V. Reddy and P.S. Cheema, ENG/MUN)
The effect of ice forces on the fatigue life of tubular joints of offshore monopod structures is determined using fracture mechanics corrosion effects. Corrosion fatigue crack growth data are used to determine the material constants. The results are compared with those reported by Det Norske Veritas and U.K. Department of Energy guidelines.

ICE-FORCE RECORDS
(M. Arockiasamy, D.V. Reddy, A.S.J. Swamidas and H. El-Tahan, ENG/MUN)
A procedure for computing structure-independent ice-forces is developed using deconvolution in time-domain. A power spectral formulation for the statistical characteristics of the varying ice-stresses is made using the deconvoluted force record and then artificial ice-force records generated using ice-force spectra.

RESPONSE TO WAVE IMPACT FORCES
(D.B.Muggeridge, M. Arockiasamy, D.V. Reddy, C.C. Hsiung, A.S.J. Swamidas, J. Murray and H. El-Tahan, ENG/MUN)
The semisubmersible is idealized as a space frame model, and its deck discretized using equivalent stiff beam elements and distributed member weights. The Pierson-Moskowitz spectrum for wave and Davenport spectrum for the fluctuating wind speeds are used in the analysis. An experimental study is carried out on a 1:70 model semisubmersible for the selected environmental parameters based on 100-year design criteria in the 58.27 x 4.57 x 3.40 m wave tank. The experimental results agree reasonably well with predicted values.

ISOTOPE GLACIOLOGY
(P. Whaite and R.D. Russell, GPHYS/UBC)
More than 400 ice samples from sites in the Yukon and British Columbia have been analyzed for isotopic composition. Sample preparation, isotopic analysis and data reduction have now been fully automated at the UBC isotope laboratory.

SNOW AND AVALANCHES

WATER MOVEMENT IN ARCTIC SNOWPACK, RESOLUTE
(P. Marsh and M.-K. Woo, GEOG/McM)
The processes controlling snowpack ripening and the movement of meltwater through wet layered snowpacks have been studied at Resolute, NWT. Field observations and computer modelling have demonstrated the importance of premelt stratigraphy and thermal conditions in controlling ice layer and basal ice growth which have an important influence in the timing and volume of meltwater release. A multiple flow path model has been used to demonstrate the effect of small scale variability in meltwater movement.

EFFECTS OF AN ARCTIC SETTLEMENT
(M.-K. Woo and M.-A. Dubreuil, GEOG/McM)
The settlement of Resolute, N.W.T., and its runway produce a considerable amount of pollution and dust which fall onto the Arctic snowpack. There is a rapid drop in the concentration of many trace metals in the snowpack away from the settlement. Dust on the snow alters the energy balance at the snow surface and accelerates melting around the town and runway.

MACKENZIE DELTA REGION HYDROLOGY
(J.C. Anderson, SWD/NHRI/EC)
In May and June data on snow-pack water equivalent, precipitation, air temperature and icings were collected in several drainage basins along the proposed Inuvik Tuktoyaktuk Highway route and is being analysed.

DRY SNOW METAMORPHISM
(R. Perla, S&ID/NHRI/EC)
In cooperation with Parks Canada, snow samples were collected from Sunshine, Alberta, and their density, grain structure, morphology at various temperatures, etc., were studied. The results matched Akitaya's classification of temperature gradient morphologies. Snow of high porosity metamorphosed toward a loosely connected skeleton of "stepped" and "cup-like" grains, whereas low porosity snow metamorphosed toward a strong, crusty texture of interconnected fibers without the above expected skeleton. The temperature-gradient boundary conditions altered the initial crystal morphology drastically by redistributing the ice throughout the pore space. The metamorphism also increased the thermal conductivity of the ice network in accordance with LeChâtelier's principle.

WET SNOW STUDIES

(R. Perla, S&ID/NHRI/EC and E.R. LaChapelle)
For measuring liquid water content of wet snow the freezing point depression method was found to be the simplest. A plastic centrifuge is satisfactory for rough determination of free water but fails to remove all the water. A dye dilution method has been introduced. A dye solution of known concentration at 0°C is thoroughly mixed with wet snow and the resulting decanted fluid compared with the original solution in a spectrophotometer. The results appear reliable and accurate in the lab; field use only requires that the decantate be collected and returned for analysis. D.C. resistivity measurements can readily detect high levels of liquid water in snow but precise determinations are obscured by factors such as metamorphism that affect resistivity.

SNOW RESEARCH, BANFF, ALBERTA

(D.L. Golding, Dept. of Forestry/UBC)
Forest cover manipulation was completed on one subbasin of Marmot Creek experimental watershed near Banff, Alberta, in 1979. The objective of the treatment was to delay the time of peak streamflow and to prolong snowmelt recession flows. For the first three years since treatment, 28% more snow water equivalent accumulated in the man-made clearings than under adjacent uncut forest, with no change in total snowpack on the treated subbasin. For the two complete years since treatment, 1980-1981, annual water yield increased slightly (5%). However, there are insufficient data as yet to evaluate the effect on recession flows.

The 4 small snowmelt lysimeters installed in Vancouver, BC, in 1981 to study snowmelt during rain-on-snow, have been supplemented by two large (28 m^2) lysimeters, and instrumentation to measure energy fluxes during snowmelt. In order to determine, if snowmelt is faster in clearcuts than in forest, if the US Corps of Engineers' equations are applicable to forests, detrimental impact of clearcutting on snowmelt peak flows, and what energy fluxes are responsible.

NASKWAAK WATERSHED PROJECT

(R.B.B.Dickison & D.A.Daugharty, FORRES/UNB)
Snow cover/forest cover and snow melt/runoff relationships between two basins in the above project were derived from basin-wide snow surveys carried out at three week intervals throughout the winter season. Multiple linear regression has been used to relate snow depths and water equivalents to the topographic factors of elevation, aspect and slope and to several descriptors of forest cover. Preliminary results show that snow depths and water equivalents are mainly controlled by the proportion of basal area occurring as hardwoods. At the time of maximum snow depth, gradients of increasing snow depth with elevation ranged from +6.5 to +13.6 cm/100 m. Following clearcutting, gradients of -6.1, -10.7 and -10.3 cm/100 m have been observed indicating a significant change due to redistribution. The water equivalent gradients follow a similar pattern, and timber removal has brought about significant desynchronization of the peak snowmelt events from the two basins.

SNOW GAUGES AND SAMPLERS

(B.E. Goodison, CCC/AES; R.P. Richards, B.C. Ministry of Environment; P.E. Farnes, SCS/USDA; N.Peterson,California Water Resources)
Projects are continuing to assess the accuracy of Canadian snow gauge measurements, particularly in low snowfall regions; to develop a Canadian shield for recording gauges, similar to the MSC Nipher shield; and, to improve the measurement of fresh snowfall at Canadian climate stations. The Western Snow Conference Working Group on Metrication completed its assessment of new metric snow samplers for deep and shallow snowpacks, including recommendations for metric conversion and standardization.

COMPARISON OF VARIOUS SNOW GAUGES

(K.H. Jones, AES/EC, Regina, Saskatchewan)
Measurements of snowfall water equivalent were recorded by five gauges located in Regina, Saskatchewan, for the winter of 81-82. Three types of shields were used on the gauges for the field tests. The MSC Nipher-shielded snow gauge and the Fischer and Porter recording gauge with a scaled-up Nipher shield showed superior catch efficiency when compared to the Wyoming-shielded Belfort weighing gauge and the Alter-shielded Standpipe and Sacramento storage gauges.

AVALANCHE DYNAMICS

(R. Perla, S&ID/NHRI/EC)
Work continued on numerical solutions of the equation of motion for the centre-of-mass of snow avalanches accelerating down complex terrain profiles. Computer graphics were introduced to show how avalanche motion is influenced by variations of resistive forces. A particle model was developed to study the dispersion of avalanche debris (away from the centre-of-mass) using Monte Carlo simulation of resistive forces.

Avalanche control by helicopter bombing was found to be as effective as the method based on detonating preplanted explosives in Banff National Park (with K. Everts). Avalanche release depended strongly on the mass of explosives.

SNOW AND AVALANCHES

(D.M. McClung and P.A. Schaerer, DBR/NRC)
Microstructural analysis of slow shear failures of alpine snow was studied with samples taken from Whistler Mountain. Fracture patterns and slip surfaces developed under pre- and post-peak stresses were studied. Impact pressures and seismic signals to determine speed of avalanches were measured at Rogers Pass, BC, using cells of different sizes at

different heights. Avalanche speed data from Rogers Pass were used to determine friction coefficients for existing models for avalanche dynamics. A simple model was developed to predict the maximum runout of large avalanches. The masses of 489 avalanches at Rogers Pass were measured, and data collected between 1966 and 1982 for several avalanches have been analyzed. Depth and water equivalent of snow were measured at different elevations on 15 mountains in B.C. Avalanche safety guidelines and operational standards for weather, snow and avalanche observations have been prepared.

PERMAFROST/GROUND ICE/GAS HYDRATES

LABORATORY ANALYSIS AND TESTING OF PERMAFROST - A REVIEW OF METHODOLOGY

(F. Claridge, D.M. Masterson and W.F.Bawden, GEOTECH - Komex Joint Venture for the Department of Supply and Services, Canada)
GEOTECH and Komex Consultants have reviewed existing methodologies for laboratory analysis and testing of permafrost for EMR. This is the first phase of a long-term program to develop a standard test manual for permafrost. The first draft gives an in-depth review of all methods currently used and procedures followed in the sampling and collection of frozen rock and soil materials, including ground ice; the storage, transportation in a frozen state and curation of such samples; and all current methods of testing. The review of testing methods and procedures covers thermal,mechanical, acoustical and electrical properties, frost susceptibility and other tests,whether destructive or non-destructive. Problems encountered in the sampling, storage, testing, etc., are described, and the advantages and disadvantages of all methods assessed.

DEVELOPMENT OF FIELD METHODS

(B. Ladanyi, CINEP/UofM)
Measurement of creep properties of frozen soils and ice by means of borehole creep and relaxation tests was studied. The stress distribution with time, affecting the interpretation of stage-loaded tests, was simulated by the finite element method. A method was developed for the design of piles embedded in permafrost on the basis of static cone penetration tests.

PERMAFROST

(G.H. Johnston, T.H.W. Baker, V.R. Parameswaran and L.E. Goodrich, DBR/NRC)
Ground temperature observations were continued at selected locations in northern Manitoba, in alpine permafrost in the western Cordillera and in the High Arctic at Alert, NWT, and thermal conductivity and ground temperature measurements in a peat plateau at Thompson. Weekly ground temperature measurements were continued at Inuvik and site surveys were conducted in 1981 and 1982. Ground temperature observations and site surveys at Eagle River bridge and at Lower Blackstone River on the Dempster Highway, YT, were contined. Effect on ground thermal regime and embankment geometry due to the construction of a highway on permafrost at Wrigley, NWT, was studied and the data is being analyzed.

Laboratory model studies of pile foundations in ice and frozen soils under static and dynamic loads are being continued. Data collected on the vibrations of loaded and unloaded piles in permafrost at Inuvik are being analyzed. Deformation behaviour and strength of frozen reconstituted soils from permafrost areas were studied under uniaxial and triaxial conditions. Electrical freezing potentials developed during freezing of moist soils were measured in the laboratory and in the field (Inuvik and Illisarvik) using suitable probes. A combined TDR/thermal conductivity probe was made and tested in the laboratory and field, to locate the freezing front in freezing soils. A review of laboratory testing of frozen soils was done by Komex Geotech under a GSC contract. A "Permafrost testing manual" will be compiled by NRC.

MECHANICAL BEHAVIOUR OF FROZEN SOILS

(B. Ladanyi, CINEP/UofM)
The problems of stress transfer and pressure melting under hydrostatic pressure were investigated more thoroughly, and the results compared with the predictions of several existing theories of consolidation. A large number of triaxial compression tests with volume change measurements were carried out in a frozen sand to test a previously proposed theoretical concept based on effective stresses. Mechanical properties of ice-saturated sand and polycrystalline ice were studied at very low temperatures (to -165°C), in connection with the underground storage of liquified natural gas. A cooling method to minimize microcracking damage due to the thermal shock effects had to be developed.

FROST HEAVE

(E.Penner,O.J.Svec and L.E.Goodrich,DBR/NRC)
The freezing front developed in different kinds of soils under constant rates of freezing is being studied. New cells have been developed to study frost heave. A computer algorithm for heat flow and moisture migration towards the freezing front has been prepared; and a one-dimensional computer study concerned with fundamentals of heave has been initiated. A test basement has been constructed and properly instrumented for studying possible adfreeze problems associated with insulated basement walls.

EFFECTS OF MINE TAILINGS

(M.-K. Woo and J.J. Drake, GEOG/McM)
This project analyses pertinent aspects of the Keewatin environment and of tailings disposal and presents a strategy for modelling environmental impact.

NOUVEAU-QUEBEC
(M.K.-Seguin, M. Allard, and G. Tremblay, GEOL and Centre d'études nordiques, LAVAL)
In the summer of 1982 permanent geothermic earth borers with a series of thermistors 20 cm apart were installed at Poste-de-la-Baleine, Lac Eau Claire and Rivière Nastapoka. The temperatures were read irregularly at Poste-de-la-Baleine and Rivière Nastapoka and automatically at Lac Eau Claire. At Nastapoka lateral and vertical extensions of permafrost were determined from electrical resistivity, which increases rapidly in porous materials containing a certain percentage of water as the temperature reaches the freezing point. The average thickness of permafrost was 20 m. The distribution and the nature of the ice in the permafrost as well as the electrical conductivity and the salinity of water were also studied. Similar measurements were carried out in running water and in turbid water in thermokarst swamps. Relationships were established between electrical conductivity and the presence of Na, Ca, Mg, K and Fe.

HIGHWAY DESIGN OVER PALSAS
(J.Hode Keyser and M.A. Laforte, CINEP/UofM)
The Centre for Construction Research and Control (CRCAC Inc.) in cooperation with CINEP, Hydro-Québec and SDBJ, has been studying the design and maintenance problems posed by the presence of palsas in the discontinuous permafrost area of northern Quebec. Nine palsas were investigated in 1980 along the right-of-way of the planned access road to the La Grande Baleine river complex; an instrumented test fill was built in the summer of 1981 over a palsa 5 km north of LG-2; five hard to maintain settlement areas along the Matagami/LG-2 road were investigated in the summer of 1982. Yearly settlements of 15-30 cm were observed both in the test fill and in the settlement areas along the road.

FLOATING ICE/LAKE, RIVER AND SEA

SNOW AND ICE COVER OF LAKES
(W.P. Adams and D.C. Lasenby, GEOG/TRENT)
Results of 3 years work on Lake St. George in southern Ontario and on Elizabeth Lake, Labrador, were published. Work continued on the snow cover of Elizabeth Lake basin. A study of snowpacks in urban and rural situations is continuing to evaluate energy balance of snow covers in southern Ontario.

LAKE ICE - RESOLUTE, NORTHWEST TERITORIES
(R. Heron and M.-K. Woo, GEOG/McM)
Studies continued on the factors controlling ice melt on a small lake. A model is being developed to predict lake ice conditions.

FRAZIL ICE, SEDIMENTS IN ICE COVER
(G.Tsang, Y.L.Lau and B.G.Krishnappan, NWRI)
An instrument to measure the point concentration of frazil in water has been developed and is being calibrated. Experiments on the formation of frazil and the effects of supercooling and salinity are in progress. The resistance effect of a hanging dam to river flow is being studied. Experiments are in progress to study the effects of ice cover on bed forms and sediment transport. A kinetic energy turbulence model is used to predict the suspended sediment concentration in an ice-covered stream flow and the flow and mixing characteristics in ice-covered and open channel flows.

LAKE REGIMES, MACKENZIE DELTA, N.W.T.
(S.C. Bigras, SWD/NHRI/EC)
In a study aimed at assessing the potential impact of increased flow regulation on the Delta lakes, measurements were made of climate, snow and ice thickness at nine sites. In 1982 as a result of ice jams over 90% of the Delta was flooded by high waters over topping the levees. Ice core/water samples were taken in 10 study areas before and after break-up (April and June) and at low water level (September) to assess water quality characteristics.

MACKENZIE RIVER ICE REGIME
(A.C.D. Terroux, SWD/NHRI/EC)
The ice regime on the Mackenzie from Norman Wells to the Beaufort Sea was observed by aerial photography and on the ground. Large volumes of broken ice and a lack of warmer water from upstream contributed to record or near record water levels throughout the Delta.

BREAK-UP, FORT SIMPSON REGION, N.W.T.
(J.C. Anderson, SWD/NHRI/EC)
Studies of the timing and characteristics of break-up on the Liard and Mackenzie Rivers within a 30 km radius of Fort Simpson were carried out in May, 1982. The progress of break-up was recorded by 35 mm oblique aerial photography. River water temperatures and ice thicknesses were measured.

RIVER ICE JAMS
(T.D. Prowse, SWD/NHRI/EC)
Site specific studies are being undertaken to identify and quantify the major physical processes responsible for spring ice jams along the Mackenzie River system. The 1982 freeze-up was monitored from Great Slave Lake to the Delta and along portions of the Liard River. A cheap 35 mm camera system for monitoring ice jams sites is being constructed and the 'false parallax' technique is being refined to measure river velocities during break-up.

SEDIMENTS ON INTERTIDAL FLATS
(M. Krawetz and S.B. McCann, GEOG/McM)
The effects of sea ice processes on the morphology, sediments and biology of the shore zone and the modes and rates of boulder movement were studied. The work concentrates on tidal flats in the Alexandra Fiord and Cape Herschel areas of east-central Ellesmere Island.

MOVEMENT OF BOULDERS BY ICE FLOES
(J.J. Drake and S.B. McCann, GEOG/McM)
The ability of ice floes to move isolated boulders on tidal flats by flotation and by pushing and/or rolling them along the bed has been considered in the standard format of sediment movement (entrainment, transport, and deposition). A limiting factor in the transportation of large boulders by this mode is likely to be the entrainment mechanism. Analysis of movement of grounded boulders by lateral ice thrusts shows that, on both deformable and non-deformable beds, rolling rather than sliding will occur. Rolling competence depends on floe size, ice roughness, the ice-rock coefficient of friction, and current and/or wind strength. Resistance to movement is a function of the embedment ratio and bed properties. Rolling could account for most of the observed short-distance transport of large boulders.

MICROALGAE IN SEA ICE
(E.H. Grainger and S.I.C. Hsiao, Arctic Biological Station, FOC, Ste-Anne-de-Bellevue)
Several species of microalgae such as diatoms, dinoflagellates, green and blue-green algae, chrysophytes and euglenoids were identified from annual shore-fast sea ice samples collected in Frobisher Bay, Baffin Island. The sea ice microalgae developed in the fall and reached a maximum concentration just before the spring thaw. As the ice melted, the microalgae declined rapidly. There were at least 20 species of animals found within the sea ice of Frobisher Bay, such as nematode worms, copepods, larvae of polychaete worms, and larvae of pelecypod molluscs. At least 13 species were reported for the first time from within Arctic sea ice.

OFFSHORE DRILLING
(F.J. Eley, Gulf Resources Canada, Calgary)
An offshore drilling system consisting of a conical drilling unit,a mobile caisson unit, four Class IV icebreaking supply vessels and a shore base is being built in the Beaufort Sea. At Tarsuit, constructed with concrete gravity caissons on a relatively steep-sided berm, Dome and Gulf are conducting an intensive study of local ice features and their impact on the structure. Theoretical studies and model tests on the effects of ice on the exploratory drilling vessels and icebreakers are underway.

OLD SEA ICE PLUG IN NANSEN SOUND
(H.E. Sadler and H.V. Serson, DREP)
The movement of the multi-year sea ice plug in Nansen Sound was recorded by a time-lapse camera. The water depth varied from about 420-730 m, ice thicknesses from 3-6 m. A further 3 km strip appeared to have become incorporated in the plug since spring 1979. An old crack in the plug,and a new one about 1 km to the NW, both opened and the ice between moved slightly northward,but both were refrozen and snow covered. The plug could extend and grow in thickness to 5-6 m by 1984 or 1985, and increase its area. The causes of the periodic breakup of the plug have not been determined.

SEA ICE MODELLING
(T.E.Keliher,J.S.Foley,G.J.Purcell,PHYS/MUN)
Ocean currents estimated from short-term ice drift in the Labrador Sea were in reasonable agreement with known sea currents. Digitized ice data will now be used for initialization and verification. The model developed by Hibler has been adapted to the Labrador Sea and the effect of a linear drag law for air and water stresses will be studied. Mass balance between in situ melting and outflow through Davis Strait, in Baffin Bay, as a function of climatic conditions, will be studied by a modification of the same model.

ICE AND WATER STUDIES IN NEWFOUNDLAND INLETS
(T.E. Keliher and J.S. Foley, PHYS/MUN)
The ice that forms in inlets contains some characteristics related to the varying water properties due to mixing of fresh and salt water. Ice and water studies in Clode Sound in winter 1981-82, showed that water and ice salinities and ice structure varied rapidly over small spatial scales. In the vertical structure of the ice, layers of regularly spaced bubbles were observed, though the spacing abruptly changed at one depth. The conjecture is that these layers are tidally forced changes in the inlet water.

SEA ICE
(N.K.Sinha, R.Frederking & M.Inoue, DBR/NRC)
Field data on climatology, snow depth, density, thickness, salinity, texture, etc., were collected at Eclipse Sound and Mould Bay in the Arctic. Laboratory growth of saline ice is also being studied. Compressive strength of first-year and multi-year ice has been studied in the field.

STUDIES IN BEAUFORT SEA, POLAR ICE
(D.F. Dickins Associates Ltd, Vancouver, BC)
A series of small-scale under-ice spills of seawater/crude oil emulsions were conducted for Dome on the Beaufort Sea coast to determine the fate of emulsions during spring ice melt compared with straight oil.

All available data on ice information in the Beaufort Sea for October to January has been summarized to provide an operational document for the Conical Drilling Unit now under construction (for Gulf Canada).

Summer ice conditions along a minimum 30 m draught route from the Bering Sea to the Canadian Beaufort Sea were studied to evaluate caisson-tow-in probability (for Dome).

14 floes were surveyed at the polar pack edge in April 1982. A comprehensive set of statistics on multi-year ice thickness distribution in the Beaufort Sea was obtained through drillhole measurements and sonar profiling. It will be used by Gulf Canada to update design loads for offshore structures.

FULL SCALE SHIP TESTING
(H. Cheung, R.A. Dick, B. Dixit, E.W. Thompson and J. Wainwright, Melville Shipping Ltd, Calgary)
Several test programs involving the icebreaking bulk carrier M.V. Arctic were executed. Performance of the vessel was evaluated at various power levels, on different ice thickness and with the bubbler system on and off. Level ice and ridge ramming together with turning manoeuvres were performed in Admiralty Inlet in July 1981 and in Lancaster Sound in November 1981 to obtain full scale hull bending data with ship operating in ramming mode in multi-year ice, with a view to formulate a finite element model of the hull. Detailed measurements of ice thickness, strength, temperature and salinity, together with crystallography measurements were also taken. In the case of the Lake Melville trials SLAR and impulse radar (from C-CORE) were also utilized.

SEA ICE MOTION/ICEBERG DRIFT
(V.R. Neralla and S. Venkatesh, Forecast Research Division, AES/EC)
A model for forecasting sea ice motion has been developed. Validation and testing of this model using observed data collected over the Beaufort Sea have been completed. A model to predict iceberg drift has been designed and an operational iceberg deterioration forecast model for the Labrador Sea is being studied. Much useful data were gathered, and valuable knowledge of operating conditions was obtained after the arrival of M.V. Arctic at Nanisivik. Satellite imagery was received from Søndre Strømfjord, Greenland, but accessing it by telephone frequently resulted in less than satisfactory results. The level of aerial and shipboard ice reconnaissance data was up slightly from previous years mainly due to participation in special studies such as the Mould Bay project and in the Beaufort Sea area.

STUDY OF ICEBERGS AND SEA ICE COVER
(Offshore Res. Group, Petro Canada, Calgary)
Projects aimed at better understanding sea ice and iceberg characteristics include: the documentation of the size and distribution of icebergs in the Labrador Sea, estimation of the iceberg flux recurrence intervals in the Labrador Sea and Grand Banks, documentation of processes and characteristics of the sea ice cover and implications of icebergs for the design and operation of offshore structures.

IMPACTS IN ICE-INFESTED WATERS
(M. Arockiasamy, D.V. Reddy, A.S.J. Swamidas and H. El-Tahan, ENG/MUN)
The investigation includes a) dynamic response of a moored semi-submersible to bergy bit impact, irregular wave wind and current, and b) static response of a gravity platform to iceberg impact. The bergy bit impact forces were obtained using the impulse-momentum and energy concepts and the response to the impact forces determined in the time domain. motion response coefficients are obtained by contour integration around the strip and numerical intergration along the length of the submerged members. The numerical results are checked with experimental results on a 1:75 hydroelastic model of a SEDCO-709 type semi-submersible. Global impact forces were determined using two simplified models of energy concept. Results were obtained for various ratios of semi-submersible-mass and bergy bit-mass, structural and hydrodynamic damping cable stiffness, fluid inertial and drag forces, structural configuration and stiffening, etc.

ICEBERG IMPACT PROBABILITIES
(D.V.Reddy,M.Arockiasamy,P.S.Cheema,ENG/MUN)
Impact probabilities of icebergs with offshore structures are being investigated using the Monte Carlo method. Iceberg shapes are simulated from observed data.

ICEBERG DYNAMICS
(D.B. Muggeridge, W.E. Russell, N.P. Riggs and K. Shirasawa, ENG/MUN)
Theoretical and laboratory studies have been initiated on the stability and hydrodynamic drag characteristics of icebergs of different shapes.

MELTING STUDIES ON ICEBERGS
(A.Sharan, C.Dutton, R.Will and J.Lewington, ENG/MUN)
Both finite element and finite difference techniques are used to study theoretical models of melting of icebergs due to radiative and convective heat transfer process.

STABILITY OF ICEBERGS
(G.R.Peters, A.Sharan and D.Bass, ENG/MUN)
Icebergs of various geometries were analyzed for their stability under various wind forces, currents, etc. Computer graphics will be used in the stability analysis.

ICEBERG DRIFT
(R.T. Dempster and C.C. Hsiung, ENG/MUN)
Field data on iceberg drift has been analyzed and further work on the short-term drift of icebergs is in progress. A study of the effect of wind and waves and a detailed parametric analysis are in progress to determine the relative importance of the various environmental parameters.

PROJECT ICEBERG STATISTICS
(D. Mudry, P.W. Coté, R. Chagnon and F.E. Geddes, ICAD/AES/EC)
A report was prepared under contract by Martec Ltd, Ocean Science and Engineering Consultants, Halifax, N.S. East coast iceberg data taken from drill ships off the Labrador coast up to 1979 was analyzed with a view to extrapolation to the Hibernia site. Iceberg motions were calculated from hourly observations and correlated with measurements of

size, mass and ocean currents. In waters of 80 m, such as at Hibernia, a typical maximum iceberg mass should be about one-half million tonnes, except for large tabular icebergs which may be much greater. Another finding was the apparent concentration of observed icebergs and maximum towed icebergs between latitude 55°N and 56°N near longitude 58°W. The final report containing iceberg locations and drill ship data is available through the ICAD.

ICEBERG SCOURING
(T.R. Chari, A.S. Reddy, G.R. Peters and H.P. Green, ENG/MUN)
Laboratory tests were conducted with pipeline models embedded at different depths to interpret the effect of scouring on buried installations. Pressures on the different faces of the pipeline and the pressure decay were delineated. Work with iceberg models of different shapes is in progress.

V.R. Parameswaran

CANADA - U.S.A.

ROCK GLACIERS - TETON AND WIND RIVER RANGES, WYOMING
(W.C. Mahaney, GEOG/York University)
Tongue-shaped and lobate-shaped rock glaciers in the Teton Range were studied from 1974 to 1981: (a) below the Jaw Glacier (N of Mt.St.John), (b) in Paintbrush Canyon (S of Holly Lake) and in Garnet Canyon (N of Nez Perce Peak). In the Wind River Range, rock glaciers in Indian Basin (N of Harrower Peak), in Stroud Basin (SW of Split Mountain and Gannett Peak) and Mammoth Basin (W of Gannett Glacier) were mapped at scales of 1:4000 and 1:5000. Rock glacier lobes were differentiated and assigned relative ages on the basis of topographic position, weathering characteristics,lichen diameters, vegetation cover, and soil development. The rock glaciers lacked ice cores and appear to have formed during the Neoglacial (<5000 yrs BP).

BREITENBUSH VALLEY, WESTERN CASCADES, OREGON
(Karl E. Ricker Ltd and Columbia Geoscience, Portland, Oregon)
Multiple Pleistocene glaciation of this valley and intermontane basin is indicated by varying degrees of geomorphic and pedologic modifications of glacially produced landforms such as Sumas Stade, of Fraser (Late Wisconsinan), Glaciation on a few cirque basins and alpine valley extensions thereof (eg. Elk Lake Basin), an earlier Evans Creek Stade of Fraser Glaciation (valley glaciers reaching the mouths of South and North Fork as well as Humbug Creek in the Breitenbush Valley), a Salmon Springs Glaciation transection glacier with upper limits around 900 m on the mid reaches of the valley and extending well out into the North Santiam Valley to the west, and upland erratics and deeply weathered drifts.

RADIO ECHO SOUNDING, MOUNT WRANGELL, ALASKA
(G.K.C. Clarke and B.T. Prager, GPHYS/UBC; C.S.Benson, Geophysical Inst., Univ. Alaska)
In April 1982 Clarke and Benson carried out an airborne radio echo sounding survey of the ice-filled caldera of Mt. Wrangell. The soundings will be used to guide the selection of ice-core drilling sites. The sounding data are now being computer processed and plotted by Prager. The most remarkable feature of the results is the discovery of several continuous reflecting horizons, presumed to be caused by impurities from past eruptions of the volcano.

V.R. Parameswaran

NEW ZEALAND

ANNUAL PHOTOGRAPHIC SURVEY
The end-of-summer glacier snowline elevation survey is continuing and this year (April 1983), another successful one-day flight of the glaciers of the Southern Alps was made. These photographs give much information in addition to annual climatic variations depicted as snowlines. Currently most of the information has been used in the New Zealand glacier inventory.

DART GLACIER
(G. Bishop, NZ Geological Survey, Dunedin)
Ablation, flow and meteorological measurements are continuing on this glacier, normally on a schedule of three summer visits each year. The glacier is currently suffering a pronounced collapse and retreat of the snout.

ANTARCTICA
(Min. of Works and Development,Christchurch)
The glaciology-hydrology programme is continuing in the Dry Valleys region, Antarctica. Mass balance measurements are continued on one glacier, with ablation measurements on the snouts of an additional 3 glaciers.

Interest is currently concentrating on the structure of these glaciers where folding and unconformities reflect pulses of climate change. Attempts are being made to develop relationships between climate and meltwater discharge.

T.J. Chinn

THE SILESIAN UNIVERSITY EXPEDITIONS TO SPITSBERGEN

The involvement of the Silesian University in glaciological investigations dates back to 1977. Since that date, the Spitsbergen expeditions of the Silesian University have been carrying out geomorphological and glaciological observations in South Spitsbergen, mainly in the region of Hornsund (77°N).

The interest of the expeditions is focussed on three major problems:
1) identification of the elements of the mass balance for selected glaciers, and the relationship between these glaciers, climate and morphological conditions;
2) cryochemical processes, their role as a contributing factor to water circulation in subpolar glaciers and their influence on the chemistry of meltwater. Consideration is also given to the problem of chemical denudation in glaciated and unglaciated catchment areas;
3) Short- and long-term fluctuations of glaciers which empty into the sea, and geomorphological consequences of the fluctuations.

The main object of investigations, especially those included in (1) and (2), is Werenskiold. Werenskiold is an alpine-type glacier, which covers an area of 27 km^2 and terminates on land. Observations carried out in the hydrological year 1979/1980 helped in the determination of the annual net mass balance for this glacier (M. Pulina et al.) which was found to be negative -0.65 m H_2O.

The ablation and fluctuations of the Werenskiold Glacier were also investigated by photogrammetric methods (J. Jania). The front of this glacier was plotted on topographic maps at 1:5,000 in 1957, 1973 and 1978. Terrestrial photogrammetric surveys of the ablation zone were recommenced in August 1982 (J. Jania and L. Kolondra). At the same time measurements were performed for the velocity of the glacier surface.

Meteorological stations working in this region are owned by the University of Wrocław. They are situated in the firn area, near the equibilibrium line, at the front of the glaciers, and on the terminal moraine. The stations usually operate during summer, but they have also completed a couple of full year's observational cycles in 1979/80 (J. Pereyma and M. Pulina) and in 1981/82 (M. Sobik and K. Migała).

In the winter season of 1979/80, the observations revealed a discharge of glacier waters. Such a discharge accounts for the formation of wide and thick icings (aufeis). A field laboratory installed in the investigated region enabled analyses to be made of the chemical composition of the water (M. Pulina). The high degree of mineralization (exceeding 1 g/l) determined in the water samples should be attributed to cryochemical processes. The calculated mass of rock material dissolved in the basin of the Werenskiold Glacier in the hydrological year 1979/80 was 33.8 m^3/km^2. The enormous effect of denudation has been caused by the large quantities (1800 mm) of water circulating in this catchment area. It is interesting to note that the ablation of the glacier accounts for some 30% of this total water volume (M. Pulina et al.).

Drillings in the accumulation zone of Amundsenisen in the spring of 1980 made it possible to conduct comparative studies, in cooperation with the Institute of Geography of the Soviet Academy of Sciences, which revealed the existence of water levels in the firn. Water was present in numerous 0.5-1.0 cm diameter pores occurring at various depths, one of them even at a depth of ca. 150 m. Water samples taken from these pores exhibited increased levels of mineralization, similar to those measured in the discharge from the Torell Glacier in the winter season.

Further observations,as well as some cryochemical experiments, carried out under field conditions, have substantiated the importance of mineralization of precipitation as a contributing factor to the migration of waters deep into the firn zone of the Spitsbergen glaciers. The investigations have also confirmed the relationship between cryochemical processes, chemistry of the waters discharged by a glacier and chemical denudation.

When investigating the chemistry of glacial waters and the drainage system of the Werenskiold Glacier, a speleological exploration of the glacial mills and caves was also attempted.

The results obtained so far have revealed the distribution of some interglacial channels and encouraged further research, which is now being planned on a wider scale for September 1983.

Observations of the fluctuations of a glacier emptying into Hornsund have been carried out since 1978. In this study use has been made of detailed topographical maps and photogrammetric surveys (J. Jania, C. Lipert et al.). As far as the fluctuations problem is concerned, the most thoroughly investigated object is Hans Glacieris, an outlet glacier with a surface area of about 67 km^2. The observations show that average annual mass loss due to calving approaches 16 x $10^6 m^3$ of ice. This accounts for some 20% of the total mass loss (J. Jania).

In 1982, a project was initiated, which aims at constructing a model to quantify the ablation by calving. Periodic plotting both of the extent of the glacier terminus and of the surface velocity of the glacier tongue was carried out by terrestrial photogrammetry. At the same time seismic microshocks

of the tongue, associated with movement and calving, were recorded. These data, along with those obtained from the observations of the weather conditions, constitute the information base required for the construction of the model.

In August 1982, photogrammetric pictures were taken of the front of the Torell Glacier. Comparison with data reported earlier shows a gradual recession of the Torell Glacier, which has been noted since 1936. In the period from 1960 to 1982 the retreat of the glacier varied from 500 to 750 m. The recession occurs in the form of small fluctuations, which consist of transgressions and retreat of the ice cliff (but retreats seem to be preferred). This is likewise true of Hans and any other glacier emptying into the sea, and has some important consequences in the lithology and stratigraphy of glacial submarine sediments.

Investigations were also carried out on the origin and age of terminal ice-cored moraines. Their origin is attributed to the regression of the glacier front from the sea onto the land as a result of ablation by calving (J. Jania).

The results which have been obtained up to now during observations in Spitsbergen and from laboratory investigations, made it possible to start the preparation of a synthetic hydro-glaciological map of the Hornsund region at 1:50,000 (J. Jania and M. Pulina). Further research is planned to be carried out in August and September 1983 during the fifth Spitsbergen expedition of the Silesian University.

Jacek Jania and Marian Pulina

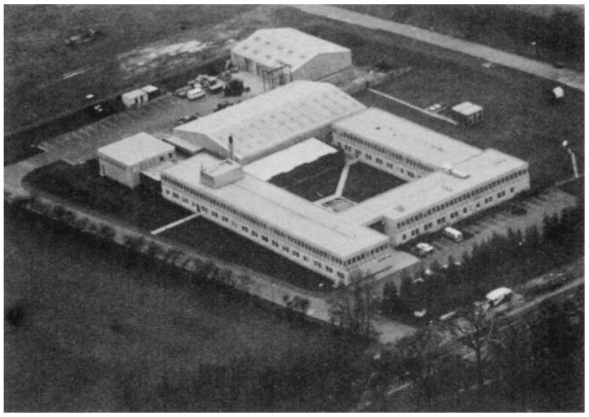
U.S.A. — CANADA

COMPRESSION TESTS ON ICE FROM THE BARNES ICE CAP, BAFFIN ISLAND, N.W.T.

(R.W.Baker, PLANT/ES, Wisconsin-River Falls)

Seven samples of isotropic glacier ice collected from Barnes Ice Cap, Baffin Island, N.W.T., were deformed under conditions of simultaneous simple shear and uniaxial compression, in a cold laboratory at the University of Wisconsin-River Falls. Both compressive and shear strain rates were measured and tests were continued until samples had strained well beyond the minimum values. These minimum values were then used to calculate the second and third invariants of the deviatoric stress tensor. Combined stresses reduce values of the second invariant of the deviatoric strain-rate tensor, E_2, below those from simple shear experiments, due to the fact that an increase in compressive stress decreased the shear strain rate. The third invariant J increased steadily with decreasing E_2 for these tests.

Viscosity, $\eta = \frac{3_1}{2B(J_2, J_3)}$, increased as J_2 increased. A flow law based on the second and third invariants may be more appropriate to describe ice deformation.



BRITISH ANTARCTIC SURVEY

Cambridge, U.K.

The British Antarctic Survey (BAS), a component body of the United Kingdom Natural Environment Research Council (NERC), is responsible for British scientific research in British Antarctic Territory and Falkland Island Dependencies. The Survey began in 1943 under naval auspices but from 1946 onwards was controlled by the Colonial Office (later the Commonwealth Office). It was transferred to NERC, under the Department of Education and Science, in April 1967. Two Antarctic stations were established at the beginning of 1944 and 18 more in the ensuing years, five of them being occupied today by a wintering total of about 70 men. There are also minor stations and field huts which are used by summer field parties.

BAS activities, which have continued without interruption since 1944, now cover a wide range of disciplines and environments. Two of the permanent stations are geophysical observatories and two are biological stations. Rothera (67°34'S, 68°08'W) on Adelaide Island off the west coast of the Antarctic Peninsula is the aircraft operating base to support work in geology, glaciology and field geophysics throughout the Antarctic Peninsula area. The aircraft take field parties with their equipment and lightweight oversnow vehicles into work areas within a radius of 1800 km. They also carry out radio echo sounding of ice depths and magnetometer surveys.

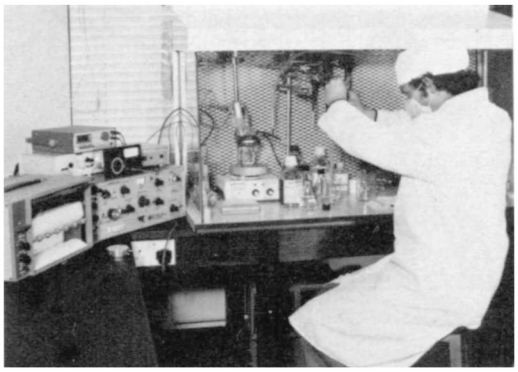
Men and supplies are taken to the Antarctic each southern summer in 2 purpose-built and ice-strengthened vessels, the Royal Research Ships John Biscoe and Bransfield, and then transported into the field by two de Havilland Twin Otter aircraft. In addition to the annual relief of the bases, the ships undertake biological, geophysical and hydrographical surveys,and transport summer field parties to otherwise inaccessible places. John Biscoe has recently been converted into a marine biological research ship.

The Director of BAS is Dr R.M. Laws, CBE, FRS. All aspects of the work, both scientific and logistic, are organized by the BAS headquarters in Cambridge. Besides a radio teleprinter link to the Antarctic stations and ships there is now a direct satellite communication link to two Antarctic stations. The headquarters organization consists of three scientific divisions and an Administration division. Each scientific division is subdivided into sections, including a section head, other research scientists and a few contract scientists. In the Atmospheric Sciences and Life Sciences

British Antarctic Survey stations

divisions, an initial training period in the United Kingdom is generally followed by 2 years in the Antarctic and a further period of up to 2 1/2 years in the United Kingdom completing the research for publication. In the Earth Sciences Division, summer field work in the Antarctic alternates with laboratory work in the United Kingdom and preparation for the next season.

The four divisions were formerly scattered around the country: administration was in London and the scientific divisions were housed in various universities. It was not until 1976 that they were able to come together in a new headquarters building which was officially opened by HRH the Duke of Edinburgh. The building is equipped with laboratories, workshops, library, archives,



Snow analysis in chemical laboratory

a conference room, and computer facilities.

In common with all UK government funded research institutes,BAS has to operate within strict financial and staffing limits. Its 1982-83 expenditure was £6.8 million. Since the South Atlantic conflict, the budget of BAS has been increased, and an expansion in activity and staffing has begun.

Earth Sciences Division

Dr C.W.M. Swithinbank is head of the Earth Sciences Division. The geological sections contain eleven scientists: two sedimentologists, two igneous petrologists, two metamorphic petrologists, two structural geologists, an isotope geologist/geochronologist and a geological map compiler. The land geophysics section under R.G.B. Renner has three geophysicists and two electronic technicians. They have completed a reconnaissance geophysical survey of the Antarctic Peninsula and are now studying the tectonic relationship between East and West Antarctica by means of field work at the head of the Weddell Sea.

Glaciology is formally administered in three sections: Glacier Chemistry, Glacier Geophysics and Glacier Physics, headed by Drs D.A. Peel, C.S.M. Doake, and J.G. Paren. R.D. Crabtree, a geomorphologist is also permanent staff. The remaining seven glaciologists are on contract, generally on their first job since graduating from university. First degrees of the contract glaciologists are Chemistry (2), Physics (2), Electrical Engineering (1) and Geophysics (2). Four glaciologists are registered for higher degrees and have academic supervisors outside BAS.

BAS Antarctic field parties are sometimes scattered widely in the summer. The constraints on the choice of sites for glaciological field work are the scientific value of the site and whether the operation can be supported by air or by sea. Intense activity continues on ice shelves. Earlier glacio-

Sampling seawater under the ice shelf

logical surveys of the Brunt Ice Shelf and George VI Ice Shelf were undertaken by glaciologists wintering at Halley and at Fossil Bluff. Present day research on the dynamics of grounding lines, the electrical structure of ice shelves, and oceanography beneath ice shelves is now undertaken only in summer. Glaciologists are also to be found on the plateau of the Antarctic Peninsula, on ice rises and ice domes where shallow and deep drilling is carried out for climate and pollution studies. The most remote glaciological field site was occupied for two summers at the grounding line of the Rutford Ice Stream where 2000 m thick ice goes afloat beside the Ellsworth Mountains. Those who worked there were keen to remind glaciologists working further north in the Antarctic Peninsula of the easier working conditions in higher latitudes. BAS glaciologists are a tough breed, adapted to working in inhospitable weather and patient enough to lie out a storm.

J.G. Paren

PRESENTATION OF THE SELIGMAN CRYSTAL TO DR MARCEL DE QUERVAIN

24 August 1982, West Lebanon, New Hampshire, U.S.A.

The Council of the IGS decided at a meeting in September 1981 to award its highest distinction, the Seligman Crystal, to Dr Marcel de Quervain, past President of the Society and former Director of the Swiss Federal Institute for Snow and Avalanche Research. The Seligman Crystal, created by the IGS in memory of its founder Gerald Seligman, is awarded "from time to time to one who has contributed to glaciology in a unique way so that the subject is now significantly enriched as a result of that contribution".

The decision was based on three principal areas in which Marcel has contributed to glaciology: his early work in snow metamorphism, creep and evaporation including the development of the International Snow Classification system; the tremendous contribution he made as Director of the Swiss Federal Institute for Snow and Avalanche Research, including his own work on snow cover and on the development of methods of avalanche hazard evaluation and avalanche defence systems; and the very significant contribution he has made to international glaciological activities.

Marcel retired from the Directorship at Davos-Weissfluhjoch in May 1980 after holding the post for 30 years. But he can look back on a career in snow and ice of almost twice that length. His first experience came early: he earned pocket money as a 7-year old boy by helping his father, the glaciologist Alfred de Quervain, with measurements on the lower Grindelwald Glacier. He studied at the Swiss Federal Institute of Technology, graduated in 1940 and got his doctorate in 1944. He started work at this stage as a crystallographer at the Institute for Snow and Avalanche Research.

His early work on snow metamorphism, creep, and evaporation led to the preparation of a widely-used snow classification. He spent time at the National Research Council of Canada in Ottawa and at the U.S. Army Snow, Ice and Permafrost Research Establishment in Wilmette, Illinois. Contacts established there led to the distinctly international flavour of the Weissfluhjoch institute after he returned as Director in 1950. At that time the Institute had about a dozen employees whereas today it has over 30. Together with his collaborators, Marcel developed new avenues of fundamental research of theoretical interest and of direct relevance to practical snow problems. More than 150 publications under his name made the achievement of the Weissfluhjoch research station widely known both at home and abroad. At the same time the Institute assumed new responsibilities which included the weekly Avalanche Bulletin for skiers, advice on avalanche zoning, methods of construction in avalanche areas, and courses in avalanche protection.

It has always been a special interest of Marcel to develop international scientific relations. He has played a leading part in the classification of avalanches and in developing internationally accepted ways of measuring the physical properties of snow. He organized symposia on the scientific aspects of snow and ice avalanches (Davos 1965) and on snow mechanics (Grindelwald 1974). In 1959 he led the Swiss group on EGIG (Expédition Glaciologique Internationale au Groenland), following in the footsteps of his father, who crossed Greenland 32 years earlier. IGS recognized his achievements 29 years ago by making him one of our very few Honorary Members. He has worked tirelessly on behalf of the Society and served as President from 1975-1978.

Many Swiss groups have benefitted from his cooperation and advice. He has also been active in education, lecturing on atmospheric physics, snow, and avalanche protection at ETH Zürich, where he was given the title of Professor in 1969. Marcel has always been ably supported by his wife, Madame Rita de Quervain, who has contributed a great deal to the human aspects of glaciology by being at his side at national and international conferences and by entertaining many visitors at their home. We welcome them both on this happy occasion and congratulate Marcel on reaching what we believe is the highest peak in glaciology.

SYMPOSIUM ON GLACIER MAPPING AND SURVEYING

FIRST CIRCULAR

26-29 August 1985, Reykjavik, Iceland

The Society will hold a symposium on Glacier Mapping and Surveying, in Reykjavik, Iceland in 1985. Co-sponsors of the event include the Iceland Glaciological Society, the Icelandic Coast Guard, the Icelandic Marine Research Institute, the Institute of Meteorology, the National Energy Authority, the Nuclear Power Company of Iceland, the Public Roads Administration and the Science Institute of the University of Iceland. Registration will take place on Sunday 25 August and sessions will be from Monday 26 to Thursday 29 August in the University of Iceland. There will be a post-symposium 3-day study tour on 30, 31 August and 1 September to southern Iceland.

TOPICS

The Symposium will be concerned with the mapping and surveying of snow and ice masses for glacier inventories and for the study of ice dynamics, mass balance, subglacial and surface topography, characteristics and snow hydrology. We invite submission of papers relating to such work under the following topics:

1. Data collection and validation methods (for example, ground surveys, photogrammetry, strain measurements, velocity measurements with automatic cameras).
2. Data processing, and modelling.
3. Presentation,analysis and interpretation.

Please note that in 1986 the International Glaciological Society will hold the 2nd Symposium on Remote Sensing in Glaciology,which will pay particular attention to those developments that have occurred since the 1st Symposium in 1974, including mapping from satellites.

PAPERS

The Papers Committee will be happy to consider any paper on topics 1, 2 and 3. Details about the summaries and final papers will be given in the Second Circular, to be published in the summer of 1984. Dates for submission are firm ones and must be adhered to. The Committee may decide to invite review papers on some of the topics if submitted contributions do not give sufficient coverage.

PUBLICATION

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

ORGANIZATION

The main organization is undertaken at the Society's Headquarters office in Cambridge, England, while local arrangements will be made by members in Iceland. The Society's Annual Dinner will be held during the week. Arrangements for special travel to Iceland from Europe and U.S.A. and for optional tours there will be given in the Second Circular.

FURTHER INFORMATION

You are invited to attend the symposium and to return the attached form as soon as possible. The Second Circular will give information about registration fees,accommodation, general programme, preparation of summaries and final papers. Requests for copies of the Second Circular should be addressed to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

Note: Members of the International Glaciological Society will automatically receive a copy.

LOCAL ARRANGEMENTS COMMITTEE

Helgi Björnsson (Chairman) (Science Institute, University of Iceland)
Elias B. Eliasson, (National Power Company of Iceland)
Thor Jakobsson, (Institute of Meteorology)
Haukur Tómasson,(National Energy Authority)

SYMPOSIUM ORGANIZATION

Hilda Richardson (Secretary General, International Glaciological Society)

INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON GLACIER MAPPING, 1985

Family Name.....

First Name.....

Address.....

.....

* I hope to participate in the symposium in 1985 [ ]
* I expect to submit a summary of a proposed paper on Topic No... [ ]
* I am interested in the travel arrangements from Europe/USA [ ]

* without obligation

TO BE SENT AS SOON AS POSSIBLE TO:
Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

SYMPOSIUM ON SNOW AND ICE PROCESSES AT THE EARTH'S SURFACE

SECOND CIRCULAR

2-7 September 1984, Sapporo, Japan

The Society will hold a symposium on Snow and Ice Processes at the Earth's Surface, in Sapporo, Japan in 1984. The Japanese Society for Snow and Ice (JSSI) are co-sponsors of the event, which will be hosted by the Institute of Low Temperature Science and the Hokkaido Branch of JSSI. The main organization is undertaken at the IGS headquarters office in Cambridge, England. Registration will take place on Sunday 2 September and sessions will be from Monday 3 to Friday 7 September. There will be a separate meeting with the Japanese Society for Snow and Ice in Tokyo on Saturday 1 September. A field study tour of NW China, open to participants in the Symposium, will take place from 10-21 September, with the approval of the Chinese Academy of Sciences.

1. PARTICIPATION

This circular includes a booking form for registration and accommodation. The form and registration fee should be sent to the address given below before 1 May 1984 as indicated. (The registration fee covers organization costs, distribution of preprints of summaries to participants, the Banquet and a copy of the proceedings volume which will be published in 1985.) Payments should be made in £ sterling

- by sterling cheque payable to: International Glaciological Society and sent to the Secretary General at the Society's address;
- by sterling Bank transfer to: International Glaciological Society, Account No.08102112 and sent to the National Westminster Bank Ltd., 56 St. Andrew's Street, Cambridge CB2 1ER, England;

For people resident in Japan, fees may be paid in Yen equivalent to: International Glaciological Society and sent to Dr N. Maeno, Institute of Low Temperature Science, University of Hokkaido, Sapporo 060, Japan.

Registration fees:

Participants	£84
Junior members of IGS and JSSI (under 26 years of age)	£50
Accompanying persons aged 18 or over	£20

LAST DATE FOR REGISTRATION BOOKINGS
1 MAY 1984

2. TOPICS

The symposium will be concerned with the following topics:

1. Mass and heat exchange at the snow/ice surface.
2. Physical and chemical processes associated with snow and ice (snow metamorphism, snow/ice accretion, drifting snow, ground freezing, etc.)
3. Behaviour of airborne snow (blowing snow, avalanching, fluidization).
4. Sea ice drift and its effects.

3. PROGRAMME

A detailed programme will be given in the Third Circular. Social events will include a reception and a banquet. Various local tours will be available for those interested and may be booked when registering on Sunday 2 September.

4. ACCOMMODATION

Accommodation has been booked at a conference centre/hotel, recently built by a Hokkaido Pension Fund. The sessions will also be held here. The price of accommodation is very reasonable, and all rooms have private bath, radio and television. The rate will be approximately £14 per person per night. For participants taking the package tour from London or Los Angeles, this cost is included in the total sum for the tour. Meals, not included in the package tour price, may be obtained at three different eating places in the hotel, at various prices.

5. PAPERS

(i) Submission of Papers.

Those participants who would like to contribute to the symposium should first submit a summary of their proposed paper in English; this summary should contain sufficient detail to enable the Papers Committee to form a judgement on the likely merit of the proposed paper, but should not exceed three pages of typescript. Summaries must be submitted on paper of international size A4 (210 x 297 mm) with wide margins and double spaced lines. Summaries should be sent to: Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

LAST DATE FOR SUBMISSION OF SUMMARIES
1 JANUARY 1984

(ii) Selection of Papers

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account technical quality, relevance to the theme of the symposium and interdisciplinary appeal. The Papers Committee will then invite a limited number of papers for presentation, allowing time for discussion. The Committee will not necessarily confine the invitations to authors who have submitted summaries. It is hoped to notify authors of papers during April 1984.

(iii) Distribution of Summaries

The summaries of the accepted papers will be sent before the symposium by surface mail to all participants who have registered in good time.

(iv) Submission of Final Papers and Publication

The Proceedings will be published in the **Annals of Glaciology** by the International Glaciological Society. Papers presented at the symposium will be considered for publication in these proceedings, provided they have not been submitted for publication elsewhere. Final typescripts of these papers should be submitted to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England, by 1 July 1984. They should be written in English and prepared in accordance with the instructions that will be sent to authors when they are notified about acceptance of papers for the symposium. The maximum length for papers will be 6000 words or the equivalent length including any illustrations. Papers longer than this and late papers will be excluded from the Proceedings Volume. The papers will be refereed and edited according to the usual standards of the Society before being accepted for publication. Speedy publication of the proceedings will depend upon strict adherence to deadlines by authors, referees and editors.

LAST DATE FOR SUBMISSION OF FINAL PAPERS
1 JULY 1984

6. SOCIAL EVENTS

Various events will be arranged and details given in the Third Circular.

The Banquet will be held on Wednesday 5 September, in the hotel. In addition to being the main social event of the Symposium, it will also be the Annual Banquet of the International Glaciological Society. The registration fees include the cost of the Banquet.

Local tours will be available and may be booked upon arrival at the hotel. Representatives of Japan Travel Bureau will be on duty to give assistance with these tours.

7. PACKAGE TOURS FROM LONDON AND LOS ANGELES AND CHINA TOUR

In order to reduce the costs of travel from Europe and North America, we authorized Traveller's World to negotiate with the airlines. Japan Air Lines made the best offer, and we have accepted their arrangements. The details are listed below.

There are two tours from London and two from Los Angeles. One from each place is for those participants who wish to attend the Symposium only. The other is for those who wish to attend the Symposium and then go on to China for the study tour 10-21 September. This tour is available only for people who register for the Symposium.

The price of the Japan-only tour includes flights and ground transportation to Tokyo, Sapporo, Tokyo, London/Los Angeles, hotels in Tokyo and Sapporo, service and local tax, and a half-day tour of Tokyo. No food is included.

The price of the Japan plus China tours includes the above plus flight Tokyo-Beijing-Tokyo, plus all transport, accommodation and food in China for 11 days, at the standard rate charged to visitors. Participants resident in Japan (and others who do not wish to take one of the package tours) may join the China tour. However, the cost of the flight Tokyo-Beijing-Tokyo will be the full price which is four times greater than the price included in the package tours. There are other big savings to be made by taking one of the package tours: we must travel together on the stated dates from London and Los Angeles, and during the Symposium and the China tour, but individual return travel may be arranged.

The following information is summarized from the brochure produced by Traveller's World, copies of which may be obtained from the International Glaciological Society.

TOUR PROGRAMME

SYMPOSIUM

Aug.29	Depart London/Los Angeles on JAL
Aug.30	Arrive Tokyo. Free day.
Aug.31	Half-day tour of Tokyo. Rest of day free.
Sept. 1	Meeting with JSSI.
Sept. 2	Fly to Sapporo for Symposium.
Sept. 7	Coach to Noboribetsu in evening.
Sept. 8	Visit to hot springs, etc.
Sept. 9	Coach to airport. Tokyo flight.
Sept.10	Return flight to London/Los Angeles or other arrangements as requested.

CHINA TOUR

Sept.10	Fly to Beijing.
Sept.10-13	In Beijing.
Sept.13	Fly to Ürümqui (capital of Xinjiang Uygur Autonomous Region, China's most western province, 3,270 km from Beijing. The city lies as a green-blanketed oasis amidst Xinjiang's

barren and uninhabited deserts, loess highlands, and the snow-capped peaks of the Tian Shan)

Sept.13-16 In Ürümqui (3 nights).

Sept.14 For 30 people (glacier specialists) visit to No.1 Glacier and overnight stay at Research Station. For others tour of glaciological features in Tian Shan, also on the 15th for all.

Sept.16 Fly to Lanzhou (capital of Gansu Province, situated on the upper reaches of the Yellow River, in a narrow desert corridor, along the old Silk Road, which extended across Central Asia and westward to the Roman Empire).

Sept.16-19 In Lanzhou (3 nights). Visit Institute for Glaciology and Cryopedology - lectures, discussions on the work of the Institute.

Sept.19 Fly to Beijing.

Sept.21 Return flight to Tokyo (or other arrangements in China).

Sept.22 Return flight to London/Los Angeles or other arrangements in Japan, as requested.

ITINERARIES

A. Depart London Heathrow Wednesday August 29th at 1430 hrs arriving Tokyo August 30th at 1720 hrs. Depart Tokyo September 10th at 2230 hrs returning London Heathrow September 11th at 0615 hrs.

B. Depart London Heathrow Wednesday August 29th at 1430 hrs arriving Tokyo August 30th at 1720 hrs. Depart Tokyo September 10th at 0915 hrs arriving Beijing 1400 hrs. Depart Beijing September 21st at 1400 hrs returning London Heathrow September 22nd at 0615 hrs.

C. Depart Los Angeles Airport Wednesday August 29th at 1100 hrs arriving Tokyo August 30th at 1615 hrs. Depart Tokyo September 10th at 2020 hrs returning Los Angeles Airport September 10th at 1405 hrs.

D. Depart Los Angeles Airport Wednesday August 29th at 1100 hrs arriving Tokyo August 30th at 1615 hrs. Depart Tokyo September 10th at 0915 hrs arriving Beijing 1400 hrs. Depart Beijing September 21st at 1400 hrs returning Los Angeles Airport September 22nd at 1105 hrs.

E. China tour only, Sept 10-21, inclusive of all transportation, accommodation and meals in China.

INCLUSIVE PRICE PER PERSON

	Twin	Single
A.	£1150	£1263
B.	£1957	£2060
C.	US $1936	US $2112
D.	US $3230	US $3398
E.	£ 692	£ 692

All prices valid for group travel only.

Registration. Package Tours. Accommodation.

SYMPOSIUM ON SNOW AND ICE PROCESSES AT THE EARTH'S SURFACE

2-7 September 1984, Sapporo, Japan

Mail to: Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England - **BEFORE** 1 May 1984. See above for method of making payment.

A. REGISTRATION (please type or print in black ink)

Name of participant:

.....
(family name) (initials)

Address.....

.....

.....

Accompanied by (indicate age if under 18)

Name.....

Name.....

I send registration fee/s as follows:
(i) Participants (£84 each) £....
(ii) Junior members (£50 each) £....
(iii) Accompanying persons (£20 each) £....

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

TOTAL REGISTRATION FEE/S = £....

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*B. PACKAGE TOURS
I wish to join the package tour from London* Los Angeles* and have sent the booking forms and deposits to Traveller's World (brochure available from the IGS)

OR:

*C. ACCOMMODATION
(This section is for those people who are not joining the package tour.) Please reserve accommodation at the hotel in Sapporo for the nights of Sunday through Thursday 6th September 1984. Payment will be made direct to the hotel by you upon registration

*Single *Twin *Sharing with.....

---

*D. CHINA TOUR
I wish to participate in this tour and have sent the booking forms and deposit to Traveller's World.

*delete as appropriate

NORTH-EAST NORTH AMERICA BRANCH (NENA) BIENNIAL MEETING

4-6 March 1983, Waterville Valley, New Hampshire, U.S.A.

The University of New Hampshire hosted the biennial NENA meeting at the Snowy Owl Inn and the Fourways Restaurant in Waterville Valley, New Hamsphire. A total of 43 people attended including 21 participants, 10 additional registrants and 12 children. A total of 14 presentations were made at the meeting as follows:

North Sound-Bering Sea shore ice features (A. Kovacs)
The role of Antarctic phytoplankton in ice nucleation (T. Forest)
SAR capabilities for sea ice monitoring (R.A. Shuchman and B.A. Burns)
Antarctic sea ice studies (S.F. Ackley)
An interpretation model for the glacier in Mt. Wrangell caldera (G.K.C. Clarke, C.S. Benson and B.T. Prager)
Structure of first-year pressure ridge sails in the Prudhoe Bay region (W.B.Tucker,III)
Theoretical models for the radar echo sounding of ice (K. Sivaprasad)
Studies on sea ice dynamics in the Baltic Sea (M. Lepparanta)
Ice-ocean modeling (W.D. Hibler, III)
Glaciochemical studies in the Himalayas: an overview (P.A. Mayewski and W.B. Lyons)
Nitrate geochemistry of an Himalayan ice core (W.B. Lyons and P.A. Mayewski)
Slides from the University of New Hampshire Nun Kun expedition (P.J. Axelson)
Slides from a glaciological tour of the Himalayas - Snow, ice and water in the Himalayas (G.J. Young)
Home movie from northern Victoria Land, Antarctica (B. Allen, III)

Mariellen C. Lee and Paul A. Mayewski

WESTERN ALPINE BRANCH ANNUAL MEETING

At the beginning of September 1982, the Western Alpine Branch of the International Glaciological Society held its 11th meeting in Switzerland around the Aletschgletscher. The 45 participants in this glaciological tour, organized in person by the President, Walter Good, arrived at Brig on the evening of September 2nd.

After a welcome from the Mayor and an ice-breaker, the participants soon tackled the problem of glaciology with an informal talk from Siegfried Escher on Ignaz Venetz, a pioneer of applied glaciology, about the origin of the theory of the glaciations.

The following day, while one group went to Lötschental to visit the lower part of Langgletscher, a second party, headed by Marcus Aellen, studied the problem of the release of water from the ice-dammed Märjelensee then climbed up the Aletschgletscher as far as Konkordiaplatz and the Swiss Alpine Club hut. This excursion on the largest glacier in the Alps permitted, apart from the observations of the magnificent scenery, a discussion of the various studies undertaken over many years by ETH on this majestic glacier.

The third day finished by elaborating on the different glaciological topics broached the previous day. (a visit to the observation sites and the permanent equipment established for glacier studies) The day ended with a stroll through the Aletsch forest reserve and the gathering of all the participants at Riederfurka where there was a warm welcome at Villa Cassel from staff of the Aletsch Ecological Centre (part of the Swiss League for Nature Protection).

It was here that the final day was completed in the traditional manner with the presentation of papers.

After a talk by M.Luder, the Director, who described the different activities of the Centre, the General Assembly of the Western Alpine Branch took place. Louis Reynaud was elected President, Guy de Marliave vice-President and Gérard Bocquet and François Valla were reconfirmed in their positions of Secretary and Treasurer respectively.

The following papers were presented:

Glacier surge phenomena and nourishment of supraglacial channels in relation to fluctuations of Gornersee in 1982 (A. Bezinge)
Brief report on the Variegated Glacier, a glacier in Alaska, just before its surge (A. Iken)
Photographs from an overflight of Greenland and Alaska on the occasion of a trip to Japan via the Pole (J.-Y. Bernard)
Glaciological observations on the Great Aletsch Glacier (M. Aellen)
Avalanche prediction using the nearest neighbour method (O. Buser)
Mapping of sunshine potential in the high mountains: method and results (G. Bocquet)
Isotopic analysis and origin of water samples obtained during a visit to Iceland (E. Roth)
Report on the 1983 tour in the Massif des Ecrins: le glacier Blanc (L. Reynaud)

Following a most useful scientific meeting, during which the participants benefitted from superb weather during their exploration of the mountains, a date was set for the next meeting in September 1983 in the Massif des Ecrins in France.

G. Bocquet

SYMPOSIUM ON SNOW AND ICE CHEMISTRY AND THE ATMOSPHERE

Peterborough, Ontario, Canada, 19-24 August 1984

A symposium "Snow and Ice Chemistry and the Atmosphere", sponsored by the Royal Society of Canada, Trent University and the Commission on Atmospheric Chemistry and Global Pollution,will be held at Champlain College, Trent University, Peterborough, Ontario, in 1984. Registration will be on Sunday, 19 August, and sessions will be held through Friday, 24 August. The Symposium is being organized by the Subcommittee on Glaciers of the National Research Council of Canada.

ACCOMMODATION

Accommodation will be available in Champlain College, Trent University, or, in hotels or motels within 5 km of the campus.

TOPICS

Although the Subcommittee on Glaciers is organizing the symposium, the scope of its theme is **NOT** limited to glacier ice.

Analyses of ice cores provide a baseline for monitoring atmospheric contamination and a record of past climates, volcanism, cosmic and anthropogenic effects. How changes in the earth's atmosphere are expressed as variations in ice and snow chemistry is the theme of this conference. Topics to be discussed include: ice core records of particulate and chemical constituents in ice masses; models of transport, air chemistry and climatic change; methods of atmospheric and ice core sampling and analysis; volcanic and cosmic contributions to atmospheric and ice chemistry; processes of incorporation of airborne constituents into ice sheets and snow.

PAPERS

Those who would like to contribute to the symposium should submit titles and extended abstracts (two to three double-spaced pages) by December 1, 1983, to:

Dr. W.P. Adams, Dean of Science,
Trent University,
Peterborough, Ontario,
K9J 7B8, Canada

Titles and extended abstracts should be in English or French. The abstracts will be mailed to participants before the symposium. The proceedings will be published in the **Annals of Glaciology**. Papers presented at the symposium will be considered for publication provided that they have not been submitted for publication elsewhere. Further details concerning the preparation of typescripts and publication of the Proceedings will appear in the Second Circular which will be distributed in December 1983. It will contain details regarding submission of final papers, registration fees, price and availability of accommodation, etc. To receive the 2nd Circular, please contact Dr W.P. Adams.

7TH IAHR INTERNATIONAL SYMPOSIUM ON ICE

27-31 August 1984, Hamburg, West Germany

The Symposium, sponsored by the International Association for Hydraulic Research and organized by the Hamburgische Schiffbau-Versuchsanstalt GmbH., will be held at the Congress Center Hamburg (CCH).

ACCOMMODATION

Several hotels of different price categories have been contacted to accommodate the guests. Reservation forms will be provided with the 2nd Circular. During the Symposium, several technical and sightseeing tours will be organized, e.g. the new model ice basin of HSVA and a boat trip to Helgoland.

TOPICS

The program includes the following topics which cover most of the fields of ice engineering. Two days of single sessions on basic topics in ice engineering will be followed by parallel sessions on river ice and sea ice engineering.

BASICS IN ICE TECHNOLOGY
1. Physics and mechanics of river, lake and sea ice.
2. Instrumentation and measuring techniques.
3. Statistical methods.
4. Physical modelling of ice problems.

ICE ENGINEERING FOR INLAND WATERS
1. Formation of river and lake ice.
2. Ice hydraulics.
3. Transportation systems.
4. Structures in rivers.
5. Ice management in rivers.

ARCTIC MARINE ENGINEERING
1. Ice conditions.
2. Application of geophysical research.
3. Marine transportation in Arctic regions.
4. Offshore structures and harbours.
5. Ice piling and ridging.

FURTHER INFORMATION

The official Symposium language is English. All correspondence, abstracts and papers are to be addressed to:

Dr Joachim Schwarz,
Ice Engineering Division
Hamburgische Schiffbau-Versuchsanstalt GmbH.
P.O.Box 600 929 - 200 Hamburg 60 - W-Germany

SYMPOSIUM ON CLIMATE AND PALEOCLIMATE OF LAKE, RIVERS AND GLACIERS

4-7 June 1984, Igls near Innsbruck, Austria

This Symposium is sponsored by the International Climate Commission of IAMAP, the Paleoclimate Commission of INQUA, the International Commission on Snow and Ice of IAHS and the International Glaciological Society. Papers are invited on the following topics.

1. Present climate, water and energy budgets of lakes, rivers and glaciers.
2. Recent changes: records with direct measurements up to 200 years.
3. Historical changes: documented periods, proxy data up to 2000 years.
4. Late glacial and postglacial development up to 20,000 years.
5. The physical basis and models for paleoclimatic reconstructions:
   - water and heat budget (the interface)
   - global circulation connection (forcing).

For further information contact:

Dr M. Kuhn,
Institut für Meteorologie und Geophysik,
Schöpfstrasse 41,
A-6020 Innsbruck, Austria

GLACIOLOGICAL DIARY

1983

5-9 September
XXth IAHR Congress. Moscow, U.S.S.R. (Organizing Committee, Institute "Hydroproject", Volokolamskoe Chaussée 2, Moscow A-80, 125812, U.S.S.R.)

12-16 September
International Symposium on Isotope Hydrology in Water Resources Development. Vienna, Austria. (International Atomic Energy Agency, P.O. Box 100, A-1400 Vienna, Austria)

18-23 September
European Mechanics Colloquium on Mechanics of Glaciers. Interlaken, Switzerland. (Dr K. Hutter, Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie, ETH - Zürich, CH-8092 Zürich, Switzerland)

28 September - 1 October
34th Alaska Science Conference. Whitehorse, Yukon, Canada. (Art Pearson, Box 4580, Whitehorse, Yukon, Y1A 2R8)

4-7 October
13th International Polar Meeting, German Society of Polar Research. Bamberg, Germany. (Dr Heinz Miller, Institut für Allgemeine und Angewandte Geophysik, Theresienstrasse 41, D-8000 München 2, Germany)

5-8 October
10th Annual meeting of the German Geomorphological Working Group. Berlin, Germany. (Prof. Dr G. Stäblein, Geomorphologisches Laboratorium, Altensteinstrasse 19, 1000 Berlin 33, Germany)

1984

12-16 February
3rd International Symposium on Offshore Mechanics and Arctic Engineering. New Orleans, Louisiana, U.S.A. (Dr D.S. Sodhi, CRREL, 72 Lyme Road, Hanover, New Hampshire 03755, U.S.A.)

4-7 June
Symposium on Climate and Paleoclimate of Lakes, Rivers and Glaciers. Igls, near Innsbruck, Austria. (Dr M. Kuhn, Institut für Meteorologie und Geophysik, Schöpfstrasse 41, A-6020 Innsbruck, Austria)

5-12 June
Interpraevent 1984 (prevention of avalanche and flood danger). Villach, Austria. (Forschungsgesellschaft für vorbeugende Hochwasserbekämpfung, Postfach 85, A-9021 Klagenfurt, Austria)

20-21 June
Third Workshop on Hydraulics of River Ice. University of New Brunswick, Fredericton, New Brunswick, Canada. (Dr K.S. Davar, Department of Civil Engineering, University of New Brunswick, P.O. Box 4400, Fredericton, New Brunswick, E3B 5A3, Canada)

19-24 August
Snow and Ice Chemistry and the Atmosphere. Trent University, Peterborough, Ontario, Canada. (Dr W.P. Adams, Dean of Science, Trent University, Peterborough, Ontario, K9J 7B8, Canada)

27-31 August
7th International Symposium on Ice, International Association for Hydraulic Research. Hamburg, West Germany. (Dr J. Schwarz, Ice Engineering Division, Hamburgische Schiffbau-Versuchsanstalt, P.O. Box 600 929, 2000 Hamburg 60, West Germany)

27-31 August
25th International Geographical Congress. Paris, France. (Comité d'organisation du 25e Congrès International de Géographie Paris-Alpes 1984, 19 rue Isidore Pierre, 14000 Caen, France)

2-7 September
Symposium on Snow and Ice Processes at the Earth's Surface. Tokyo and Sapporo, Japan. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, U.K.)

1985

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

1986

7-12 September
Symposium on Remote Sensing in Glaciology, 50th Anniversary of the International Glaciological Society. Cambridge, England. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK)

NEW MEMBERS

Anno, Yutaka, Construction Machinery Plant, Higashi 2-JYO, 8 Chome Tsukisamu, Toyohiraku, Sapporo 062, Japan
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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 1983

Private members	Sterling: £20.00
Junior members	Sterling: £10.00
Institutions, Libraries	Sterling: £50.00 for Volume 28 (Nos. 101, 102, 103)

Annals of Glaciology — prices vary according to size of volume. For further information, apply to the Secretary General.

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

This news bulletin is issued to members of the International Glaciological Society and is published three times a year. Contributions should be sent to Mr C. S. L. Ommanney, Snow and Ice Division, National Hydrology Research Institute, Environment Canada, Ottawa, Ontario, K1A OE7, Canada.

Annual cost for libraries, etc. and for individuals who are not members of the Society: Sterling £7.50.

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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