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INTERNATIONAL GLACIOLOGICAL SOCIETY

CONFERENCE PROCEEDINGS VOLUMES

The following volumes of proceedings may be obtained from the Secretary General of the International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England, U.K.

JOURNAL OF GLACIOLOGY

Symposium on Remote Sensing in Glaciology (Cambridge 1974)					
Volume 15, Number 73, 1975 £10.00					
Symposium on Thermal Regime of Glaciers and Ice Sheets (Burnaby 1975)					
Volume 16, Number 74, 1976 £10.00					
Symposium on Applied Glaciology (Cambridge 1976)					
Volume 19, Number 81, 1977 £20.00					
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Volume 23, Number 89, 1979 £20.00					
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ANNALS OF GLACIOLOGY (replacing proceedings series in Journal of Glaciology)					
Symposium on Use of Icebergs: scientific and practical feasibility (Cambridge 1980)					
Volume 1, 1980 £15.00					
Symposium on Processes of Glacier Erosion and Sedimentation (Geilo, Norway 1980)					
Volume 2, 1981 £20.00					

ICE

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

NUMBER 65

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PHOTOGRAPHS. The Editor would like to replenish his stock of photographs used for the cover of ICE. Any member with good black-and-white photographs which they would like to see featured on the cover are asked to send them to him with appropriate credit and caption information.

COVER PICTURE. Icicles above a water surface from "Snow of Japan" by Kihei Takahashi.

CANADA

GLACIER STUDIES - GENERAL

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

GLACIER INVENTORY OF CANADA (C.S.L. Ommanney, M.M. Strome and J.W. Clarkson, Snow and Ice Division <S&ID>, NHRI/EC^{*}) Work has started on the inventory of the

Stikine and Iskut river basins and continues in Glacier National Park. Canadian glaciers contributing to the North Water have been inventoried in a cooperative study with GEOG/ETH (P. Kraus).

GLACIER STUDIES - ARCTIC

QUEEN ELIZABETH ISLANDS

(R.M. Koerner, D. Fisher and B. Alt <contract>, PCSP/EMR) Down borehole photography and deformation measurements were made in the Agassiz Ice Cap (Ellesmere Island) 1979 borehole. A TV camera and still camera were used for the photography and vertical strain rates were measured using a laser ranger in combination with a mirror mounted on a caliper. Borehole diameters and temperatures were taken. Studies to detect increasing acidity levels in the snow over the past 30 years were made at the top of this ice cap. The mass change along two profiles from the top of the Agassiz Ice Cap to sea level was measured as too was the mass balance of the north side of the Devon Island Ice Cap. Inclement weather prevented remeasuring Meighen and Melville Island ice cap balances.

The Agassiz 1977 core studies were continued and a time scale based on seasonal cycles of microparticle, ion and potassium concentrations completed. Volcanic layers as detected by high acid levels in the cores were studied for acid, ion, microparticle, K, Na, Ca and A1 concentrations.

A study of exceptionally warm and cold summers, their effects and causes was completed.

(A. Ohmura <for F. Muller[±]>, GEOG/ETH-McG) Mass balance measurements were made on the Laika Glacier and an ice cap on Coburg Island, on Leffert Glacier and an adjoining ice piedmont in central Ellesmere Island and on the White and Baby glaciers of Axel Heiberg Island. More deep holes were steamdrilled on White Glacier to continue the study of its thermal structure.

DEVON ISLAND

(P. Marsh and M.-K. Woo, GEOG/McM) Streamflow regimes of glacierized and nival basins have been compared and related to the runoff generating processes, including glacier melt, snowmelt and rainfall. The contribution of perennial snowbanks was also recognized.

GLACIER STUDIES - YUKON AND N.W.T.

ROCK GLACIERS, TUNGSTEN, N.W.T. (L.E. Jackson, Institute of Sedimentary and Petroleum Geology, Calgary, GSC/EMR) Survey markers were established on a 2.7 km long, ice-cored rock glacier near Tungsten, N.W.T., in 1963, to measure its movement. Four out of the six lines of these markers were surveyed and displacements calculated. Movements of individual marked rocks of up to 51 m were observed. Movements of the snout of up to 7.4 m were also measured.

The surficial geology of the Nahanni map area (1051) Yukon and N.W.T. was also mapped at a scale of 1:125,000.

GLACIER CORE/CLIMATIC VARIATIONS PROJECT MT. LOGAN

(G. Holdsworth, S&ID, NHRI/EC) A newly constructed "Rufli-Rand" electromechanical ice core drill was used at an elevation of 5340 m on Mt. Logan to retrieve 211 m of core. Three holes were drilled: 46, 62 and 103 m in depth. Core from the latter should yield climatic "proxy" data for about the last 500 years. A new borehole notch reamer was used to notch the deep borehole at 5 m intervals (total ice thickness at the site was measured by radar as 120 ± 5 m). Notches were sensed using a logger with a notch sensing device. A resurvey planned for 1981 will enable the time-depth relationship to be determined assuming steady-state conditions.

⁺ deceased

GLACIER SURGING, ST. ELIAS MOUNTAINS (G.K.C. Clarke, GPHYS/UBC <with D.E. Thompson, JPL/CIT and S.G. Collins>) The next surge of Trapridge Glacier is approaching rapidly and a large wave-like bulge is building up in the mid-glacier zone. Ice temperatures were measured in seven holes drilled to the glacier bed and it appears that the bulge is forming at the boundary between frozen and unfrozen basal ice. The 1969 flow network was resurveyed and extended. Field studies will continue until the surge is completed.

ICE DAMMED LAKES

(G.J. Young and M Perchanok <contract>, S&ID, NHRI/EC)

A reconstruction of the glacial chronology for the Donjek Glacier terminus has been completed. G.K.C. Clarke (GEOPHYS/UBC) and M. Perchanok completed assessments of the likely magnitude of floods from this lake. M. Perchanok has also completed an assessment of the flood hazards from the glacier-dammed lakes in the Stikine/Iskut river basins, B.C.

GRIZZLY CREEK, Y.T.

(P.G. Johnson, GEOG/OTT)

Glacier and alpine hydrology work continued in Grizzly Creek for three weeks until interrupted by a bear. The effect of spatial and temporal variation on contributions to streamflow from talus, rock glacier, alpine meadow and glacier sources was studied. Water chemistry was employed to distinguish source areas and flow conditions through ice and rock media. This technique was also employed in structural studies on rock glaciers.

GLACIER STUDIES - CORDILLERA

ISKUT RIVER GLACIERS, B.C.

(0. Mokievsky-Zubok, S&ID, NHRI/EC) Studies of 3 glaciers (106 km²) in two watersheds draining into Iskut River, representing an ice coverage of 67% and 23%, continued for determining their mass balance, their response to climatic change and their potential influence on the proposed constructions of river dams. "Andrei", "Yuri" and "Alexander" glaciers had negative balances of -0.18, -0.73 and -0.52 m H₂O respectively. Observations continued of glacier-dammed Flood and Natavas lakes in the Stikine and Iskut river watersheds. Both lakes were partially filled and discharged during the summer.

BRIDGE RIVER, B.C.

(0. Mokievsky-Zubok and S. Fogarasi, S&ID, NHRI/EC)

Studies continued in order to determine the effect of glaciers on basin runoff and to evaluate the seasonal and operational forecast models for a downstream reservoir (with J.R. Gordon, BC Hydro). Bridge, "Sykora" and "Zavisha" glaciers had balances of -0.41, -0.41 and -0.81 m H₂O respectively. MASS BALANCES, COAST MOUNTAINS, B.C. (0. Mokievsky-Zubok, S&ID, NHRI/EC) Measurements of winter and summer balances, meteorological variables and meltwater flow continued on Sentinel and Place glaciers. Mass balance only was determined for Helm Glacier. Specific net balances were -0.78, -0.89 and -1.07 H_20 respectively.

WEDGEMOUNT LAKE AND GLACIERS, B.C. (Karl E. Ricker Ltd., Vancouver, B.C.) A terrestrial photogrammetric survey of the area showed an average ice movement of 12 m/year. The 1980 glacier snout position revealed very little change from 1979, at best a retreat of 5 m in some portions.

SNOWCAP LAKE AND GLACIERS, B.C. Machine contouring of air photos showed significant glacier advances.

CLENDENNING CREEK, LAKE AND GLACIER, B.C.

Aerial photography revealed that 67% of all glaciers in this region advanced markedly since 1964. The surface contours of the glaciers will be studied using an aerial trigulation net.

SIMULATION OF ALPINE RUNOFF

(J.M. Power and G.J. Young, S&ID, NHRI/EC) The monitoring of the hydrology and climatology of glacierized and non-glacierized basins in Yoho National Park continues. Runoff simulation using the UBC forecasting model is being applied to various watersheds in British Columbia.

PEYTO GLACIER, ALBERTA

(G.J. Young and P.G. Johnson, S&ID, NHRI/EC) Basic monitoring of mass balance, meteorology and hydrology are continuing.

COLUMBIA ICEFIELD, B.C. AND ALBERTA (K.C. Arnold, S&ID, NHRI/EC and Parks Canada, Western Region)

A 1:50,000 scale map, with rock drawing and shaded relief, is scheduled to be printed in early 1981. The reverse side contains interpretive text and diagrams of glacier and other features of the landscape.

ATHABASCA GLACIER, ALBERTA

(K.C. Arnold, S&ID, NHRI/EC) Aerial survey flights were made at the beginning and end of the melt season to test the feasibility of using aerial photogrammetry to measure ice loss within a single ablation season. A flight with heat sensing scanner was made over an ice-cored lateral moraine, once in shadow and once in full sunlight.

GLACIER STUDIES - QUEBEC

CHIC CHOCS MOUNTAINS, GASPESIE, QUEBEC

(J.T. Gray and N. Ferron, GEOG/UofM) Rock glacier distribution and characteristics in the Chic Chocs Mountains, Gaspésie, were studied. Approximately 10 rock glaciers have been located so far, and ice exposures have been observed in two of them. These rock glaciers appear to have been quite active postglacially and some evidence indicates recent movement of small areas of their surfaces. A drilling program on one of these rock glaciers is planned for the summer of 1981.

CLACIAL GEOLOGY

DEMPSTER HIGHWAY, YUKON TERRITORY (R. Thomas, Terrain Analysis and Mapping Services Ltd., Carp, Ontario) The glacial geology along the Yukon part of the Dempster Highway was mapped during the summer, 1980, for the Department of Renewable Resources, Government of the Yukon. Maps at a scale of 1:100,000 are being prepared for publication by the Geological Survey.

NORTHWEST COAST, B.C.

(J.J. Clague and J.E. Armstrong, GSC/EMR, Vancouver and W.H. Mathews, GEOL/UBC) Geologic studies aimed at deciphering the late Pleistocene glacial and deglacial history of various parts of British Columbia were conducted. The pattern and timing of deglaciation and attendant sea-level change on the northwest coast of British Columbia and in the Fraser Lowland have been studied. Surficial geology maps for the latter area have been published. The timing of the growth of the Cordilleran Ice Sheet during the late (Fraser) glaciation has also been studied. The Quaternary history of British Columbia, emphasizing late Pleistocene glacial geology, has also been studied.

VANCOUVER ISLAND, B.C.

(J.M. Ryder, Terrestrial Studies Branch <formerly Resource Analysis Branch>, B.C. Ministry of Environment) The program of surficial geology mapping and related studies of Quaternary geology is being continued. Current projects include investigations of sea-level changes around, and Quaternary history of, Vancouver Island, and Holocene glacier fluctuations and glacial geomorphology in the southern Coast Mountains. Surficial geology maps (1:50,000) have recently been completed for northern Vancouver Island (parts of 92E, I and 102I) and the southwestern Coast Mountains (parts of 92F, G, J, K and N).

ROCKY MOUNTAINS, B.C. (Karl E. Ricker Ltd., Vancouver, B.C.) Quaternary stratigraphy and field mapping of all glacial features in the area east of Pine Pass, Rocky Mountains, B.C., were undertaken. Laboratory studies of the soil properties of glacial till and ice-contact gravel are being carried out. Results from the project will be used in planning a large coal mining development in the area.

POLLEN STUDIES

(M.-A. Guerts, GEOG/OTT) Studies of the pollen rain on Peyto Glacier and the relations between pollen rain and the direction of the wind, were carried out.

MANITOBA

(H. Groom, G. Matile, E. Nielsen and G. Conley, Manitoba Department of Energy and Mines) Mapping of the surficial geology of the South Riding Mountain district, west of the Manitoba escarpment at the second Prairie level, has been done.

An ice shelf model is proposed to explain the Late Wisconsin glaciolacustrine deposition in southeastern Manitoba. The model explains the variability in the glacial deposits discovered in the region.

Surficial geological mapping of the Gillam area in northeastern Manitoba was carried out, with emphasis on the glacial stratigraphy along the Nelson River downstream from Gillam.

Field mapping of the region of Brokenhead in southeastern Manitoba was also undertaken.

GLACIAL MARINE DEPOSITS

(C.P. Gravenor, GEOL/Windsor) Study of ancient glaciogenic deposits is being carried out in order to interpret modern glacial deposits, particularly those in the marine environments, and to understand the mechanism of deposition. A reinterpretation of paleopole positions derived from paleomagnetic studies of Wisconsin glacial deposits is being made.

ONTARIO GEOLOGICAL SURVEY

Properties, distribution and stratigraphy of Ouaternary unconsolidated sediments are determined in selected areas of Ontario each year. The origin, mode of deposition and depositional environment for the materials observed are often proposed. The history of deglaciation in Ontario and the Great Lakes is an ongoing project.

CHAMPLAIN SEA

(B.R. Rust, R.J. Cheel, GEOL/OTT, and V.A. Gostin <Univ. of Adelaide, Australia>) Studies of the facies variation in subaqueous outwash deposited on coalescing fans where glacial conduits emerged from the Wisconsin ice front beneath the Champlain Sea have been completed. The variations were attributed largely to variable confinement between ice walls of an inlet at the glacier front.

Rust and Gostin also studied glaciomarine features in extensive exposures near Twin Elm, southwest of Ottawa. Here the subaqueous outwash deposits are notable for till layers and lenses which show upward and downward gradation into stratified material. They are interpreted as flow tills, which originated by melt-out on the ice surface and subsequently slid to the sea floor, where subaqueous fans were accumulating.

STRATIGRAPHIC STUDIES

(P.F. Karrow, ES/Waterloo)

Stratigraphic drilling has been undertaken at several sites in Waterloo, Wellington, and York counties to investigate buried valleys and buried organic deposits of interstadial and interglacial age. This is supported by various geophysical, paleontological, and sedimentological analyses to aid interpretation of the sequences.

New or modified interpretations of till stratigraphy and the history of glacial lakes Algonquin, Nipissing, and Iroquois, and of the Champlain Sea, have been obtained.

Surveying of raised shorelines and study of associated sediments of glacial Lake Algonquin east and north of Lake Huron are being conducted.

UNGAVA BAY, QUEBEC (J.T. Gray and B. Lauriol, GEOG/UofM) Data have been obtained on the probable extent and retreat pattern of the Québec-Labrador ice sheet in Ungava, on the pattern of isostatic uplift and coastal emergency of the west coast of Ungava Bay, and on the marine and terrestrial environments of the region throughout the postglacial period.

GASPESIE, QUEBEC

(J.T. Gray, B. Hétu, L.B. Lafrenière and P. Richard, GEOG/UofM)

Attempts are being made to reconstruct and map the landforms and events associated with the Late Wisconsin glaciation and with postglacial climatic and vegetation changes in Gaspésie. The dominant role of one or several local Gaspésian ice caps is gradually being asserted. The Laurentide ice sheet does not appear to have overridden the highest summits, at least not in the classical Wisconsin phase. Evidence from deeply weathered soils in the summit zones is presently being examined in relation to an hypothesis concerning glacial limits and nunataks or glacial refugia.

SNOW AND AVALANCHES

SNOW METAMORPHISM AND MELT, N.W.T. (M.-K. Woo, P. Marsh and R. Heron, GEOG/McM) Snow metamorphism and snow melt processes were studied on Cornwallis Island, N.W.T. The effects of snow jams upon streamflow were examined. A basin-wide snow survey was repeated and the results were used to rectify the weather station snowfall data for water balance purposes.

SNOW HYDROLOGY, MILLER CREEK, B.C. (0. Slaymaker, R.P. Jordan and M. Church, GEOG/UBC)

Field work continues at Miller Creek on snow hydrology and variable runoff and sediment source hydrology. A thesis on the scale dependence of factors controlling snowmelt has been done. A computer model of meltwater percolation through a snowpack has been completed.

SNOW ACCUMULATION IN FORESTS, ALBERTA

(D.L. Golding, HYDR/UBC)

Research continued on the relationship of snow accumulation and melt to size of forest openings at the James River site in Alberta. The effect of forest harvesting treatment on Marmot Creek basin, to prolong snowmelt recession flow and delay the time of peak runoff, is also being studied.

PRAIRIE SNOWMELT

(B.F. Findlay, AES)

Staff of the Canadian Climate Centre are studying the physical basis of drought in the Prairies. Part of the work involves the application of a climatic water balance to a 300 grid point network for the period 1925-80 in order to identify prolonged periods of low soil moisture. Snowmelt models are being developed for principal vegetation regions and estimates will be made for each point of the vegetative interception loss and the infiltration amounts in frozen and unfrozen soils.

SNOW MANAGEMENT, PRAIRIES

(W. Nicholaichuk, Agriculture Canada, Sask.) Studies on snow management with grass barriers and by strips of tall standing stubble, to reduce the rate of salinity and to provide enough soil moisture for continuous cropping, are being conducted.

SNOW AND ICE COVERS, ONTARIO AND LABRADOR

(W.P. Adams, D.C. Lasenby and N.T. Roulet, GEOG/Trent and D.R. Barr, GEOG/McG) Work is continuing on the study of the snow and ice covers on lakes with reference to their biological roles and emphasizing the transmittivity of the lake cover for light and the lake oxygen regime.

The studies of the spatial aspects of snow and ice on Elizabeth Lake and those on the operational effectiveness of Soviet and Canadian snow gauges, with Tret'yakov and Nipher gauges in a variety of settings are continuing. The investigation of the snow cover in the Elizabeth Lake basin, Labrador, has been completed.

THERMAL REGIME IN SNOWPACKS

(J. Poitevin and J.T. Gray, GEOG/UofM) The thermal regime within a snowpack in permafrost areas in the Schefferville area of northern Québec, and on Mont Jacques Cartier, in Gaspésie, was studied.

GEOTECHNICAL ASPECTS OF SNOW MECHANICS

(D.M.McClung, DBR/NRC) A theoretical model for creep pressure calculations for the two-dimensional plane strain case was completed and submitted for publication.

Slow shear failure data were collected from the maritime climate at Whistler, B.C., for comparison with data from the Rockies for snow recrystallization in the presence of strong temperature gradients. The Whistler data indicate initially higher peak strength and shorter strain to failure than snow from the Rockies.

AVALANCHE AND SNOW PROPERTIES (R. Perla, S&ID, NHRI/EC)

Techniques for rapid preparations of plane sections in snow specimens were developed preliminary to a study of snow metamorphism, now in progress.

Numerical models for computing avalanche speed and runout distance were tested in cooperation with the Norwegian Geotechnical Institute, Oslo, and Water Survey of Canada.

AVALANCHE ENGINEERING

(P.A. Schaerer, DBR/NRC)

Impact pressure and seismic signals were recorded for several avalanches for the 1979-80 winter. These records included complete observations of signals for an avalanche of wet snow for the first time. Comparison with the other data from dry snow avalanches showed that wet snow has more uniform flow characteristics without the wave-like turbulence bursts apparent in dry snow flow.

A large plate with a loading surface of 196,000 mm² was set up near the load cells of smaller size. The load cells behind the plate were destroyed by avalanches early in the winter by tensile loading. Observations showed, however, that following impact by dry snow avalanches the plate had a dense symmetrical cone of very hard snow on it. These observations indicate intense shearing during the impact and underscore the importance of compressibility effects in treating impact problems on surfaces of large area.

AVALANCHE HAZARD EVALUATION (P.A.Schaerer, DBR/NRC)

The development of numerical forecasting models was discontinued. These studies, as well as those of others, have shown that the input data was usually not accurate enough for the prediction of avalanche hazards and that there is a need to define better the required output information.

Canadian guidelines for observations of the weather, snow cover and avalanche occurrences were revised.

ROLE OF SNOW IN SLOPE EVOLUTION (J.T. Gray, B. Hétu and M Cardinal, GEOG/UofM)

Postglacial slope evolution in northern Gaspésie is being studied. Amongst the various processes operating on these slopes are snow and slush avalanches. The latter are being studied in the context of an overall appraisal of the magnitude and variability of erosional processes both in wooded and nonwooded situations.

SNOW SAMPLER TESTING

(B.E. Goodison, AES)

A field program in cooperation with other Canadian and Unites States' agencies on the development of accurate small and large diameter snow samplers continued. Final designs are expected to be tested during the winter of 1980-81.

SNOW GAUGE TESTING

(B.E. Goodison and V.R. Turner, AES) Nipher-type shields developed for Fischer & Porter and Universal recording gauges are still undergoing performance testing. Gauges are now located at 8 stations across Canada. Initial measurements produce totals near but less than the standard MSC Nipher gauge and more comparative testing is warranted.

COMPUTER ANALYSIS OF SATELLITE DATA FOR SNOWMELT MAPPING

(W.D. Hogg, AES) The Hydrometeorology Division will continue to provide snow cover areal extent analyses for the Saint John River Flood Forecast Centre. Digital data from all four channels of TIROS-N generation, polar orbiting satellites, are used in a supervised clustering or classification technique to identify whether individual 1 km x 1 km areas are snow covered. The clustering technique uses a minicomputer and colour graphics display to specify regions of the feature space corresponding to various targets, e.g. snow in coniferous forest, snow in deciduous forest, and snow in open fields. Recorded satellite data are analyzed to produce maps of the areal extent of snow cover in the Saint John basin within a day of clear weather overflight. Improved map registration of the satellite data will permit automated subbasin snow cover determination during the 1981 snowmelt season.

SAR SNOW EXPERIMENTS

(B.E. Goodison, AES; A. Wankiewicz, NHRI) Inter-agency (AES, IWD, CCRS) experimentation to assess the use of active radar for determining snow cover conditions continues during 1980-81. This is a follow-on of the SURSAT SAR project.

LAKE AND RIVER ICE

CORNWALLIS ISLAND, N.W.T. (R. Heron and M.-K. Woo, GEOG/McM) A survey of lake ice and snow cover was carried out to determine the effect of snow depth on ice thickness. A small lake was studied intensively to examine the factors controlling ice melt and a model is being developed to predict lake ice conditions.

MACKENZIE DELTA, N.W.T.

(A.C.D. Terroux and D.A. Sherstone, S&ID, NHRI/EC)

April with the determination of maximum ice thickness at over 30 sites in the Delta. Studies continued through May and early June with repetitive air photo flights (PCSP) over 3 transects. Ground studies included water temperatures at and upstream of the melt front (on the Mackenzie River above the Delta and on the Peel River). The progress of freeze-up throughout the Mackenzie Delta was monitored using 35 mm cameras and small aircraft. Break-up events between Fort Norman (km 826) and Fort Good Hope (km 1100) were monitored on the ground and from the air from 14-24 May, 1980. Low water levels persisted throughout the break-up period. No major ice jams occurred, and much of the ice melt was in situ.

FREEZE-UP, BREAK-UP AND ICE JAMS (D.A. Sherstone, S&ID, NHRI/EC)

The third and final year observations of river ice break-up and ice jamming on the Fort Nelson and lower Liard rivers were carried out in 1980. Progress of break-up was recorded by aerial photography, using a PCSP aircraft. Ground based observations included river ice thickness measurements prior to break-up and channel geometry surveys at selected ice jam sites following ice clearance.

LAKE ST-JOSEPH, QUEBEC

(B. Michel, IML, CIVIL/LAVAL) The heat budget is being measured on a small river at the outlet of Lake St-Joseph. Because of warmer water at the inlet coming from lower layers of lake water and high stream turbulence, this river does not freeze until it dissipates in a pond. Border ice studies are being made. The growth and decay of lake ice and its microclimatic influences are studied at the lake with a network of ice stations and a meteorological station.

AUFEIS, N.W.T.

(J. Anderson, S&ID, NHRI/EC)

From studies conducted in 1979, a report was prepared on the structure and growth mechanisms of an annually recurring icing on lower Hans Creek, N.W.T., near 68° 52'N, 133° 33'W, in the Parsons Lake region. Monitoring of aufeis accumulation thickness in culverts along the Dempster Highway, south of Inuvik, continued in 1980, and a progress report was prepared on this as part of a regional hydrologic study.

SEA ICE - REMOTE SENSING

REGIONAL ICE SURVEYS

(H. Hengeveld, AES) Operational support of the marine activities in ice-covered waters continued throughout the year, concentrating on southern and eastern waters during the winter season and in the Arctic during the summer. A light ice

season in the Gulf of St. Lawrence resulted in a slightly lower total level of airborne data collection, with approximately 2500 hours of chartered reconnaissance time. Of these, approximately 1350 hours were flown with the SLAR-equipped aircraft. Satellite data continued to provide an important supplementary information source, with coverage from TIROS and LANDSAT systems being available in near real-time over all the marine areas except in the Eastern Arctic. A cooperative Canadian-Danish effort to establish a TIROS receiving station at Søndre Strømfjord, Greenland, to fill this gap is now nearing completion and is expected to be operational by January 1981.

All collected data, both airborne and satellite, are archived by the Ice Climatology and Applications Division in Ottawa and are available to the general public. Publication of data in ice chart format is proceeding at a slightly accelerated rate, with current emphasis on updating the Summary and Analysis series for the Eastern Seabord. Publication of ice atlases for the Arctic and the Eastern Seabord, providing means and extremes of various digitized ice parameters over an 11-16 year period, is expected to be finalized in January 1981.

FIELD EXPERIMENTS - SURSAT AND WIEBS (H. Hengeveld, AES)

Remote sensing activities, in addition to operational data collection, concentrated on analysis of existing data sets and participation in SURSAT and radar satellite project activities. The Ice Branch participated in the 1979 Winter Ice Experiment Beaufort Sea (WIEBS) experiment through SLAR data analysis and project management committees. Summer students were employed to undertake ice dynamics studies using SLAR imagery and analysis of laser profilometer traces for topographic information. Several studies on applications of SLAR imagery in measuring various ice parameters, including icebergs, are also in progress. SURSAT activities included participation in an ice workshop held at AES Headquarters in June, and completion of several SURSAT study reports. Active involvement in the radar satellite study project commenced in the Fall of 1980, with Dr Ramseier taking a lead role in ice user requirement studies.

ICE MOVEMENT FROM LANDSAT, UNGAVA BAY

(J.T. Gray and J. Dupont, GEOG/UofM) Initial results clearly show the utility of overlapping LANDSAT imagery in determining daily rates of ice movement, which follow the counter-clockwise current around the shores of Ungava Bay.

SEA ICE DYNAMICS

(D.R. Inkster, Intera Environmental Consultants Ltd. and Intertech Remote Sensing Ltd.) Application of remote sensing and modelling techniques to floating ice is being studied by the use of high-resolution SAR LANDSAT. MSS, laserflurosensors, laser profilers, infrared scanners, SLARs, marine radars and cameras, to collect information on ice ridges and floes, bergs and oil slicks, in ice infested waters. The Intera modelling group has worked on both iceberg drift and sea ice dynamics problems.

RADAR APPLICATIONS

(K. Butt, C-CORE)

C-CORE's Impulse Radar System for airborne ice thickness measurement is now operational and a program of application studies is being planned. The technique of using positional radar to monitor ice and iceberg movement was successfully proven. A program in HF overthe-horizon skywave radar was begun with CRC Ottawa for the remote measurement of sea state and the detection of pack ice. A similar groundwave technology exists and is proposed for Canada for coastal and offshore applications, including ice and iceberg detection.

RADAR SEA ICE SENSOR

(F.R. Hunt, Electromagnetic Engineering/NRC) In order to fulfil the requirement for a helicopter-borne sea ice sensor with increased depth penetration, NRC has been investigating the use of a radar operating in the 10 MHz region. Construction of the test model has now been completed. Arrangements have been made with the National Aeronautical Establishment to carry out flight trials early in the new year. Flights will be made with parallel and perpendicular polarizations of the transmitter and receiver antennas. Although these early measurements will involve fresh water ice only, they should indicate whether the more costly trials over salt water ice are desirable.

PULSE RADAR

(S.Y.K. Tam, MPB Technologies Inc., Ste-Anne de Bellevue, Québec)

Under the sponsorship of the Transportation Development Centre, a sea ice thickness sensor (consisting of a synthetic pulse radar <SPR> and an impulse radar <IMR> sharing the same antenna) capable of measuring sea ice thickness from 0.5 metres to a few metres, was developed. Field trials of this sensor were carried out in the Beaufort Sea (300 km off Tuktoyaktuk) in collaboration with Can Mar of Dome Petroleum, C-CORE and PCSP.

SEA ICE

SEA ICE DRIFT MODEL

(V.R. Neralla, AES) The ice drift model developed earlier at AES is providing good numerical guidance to the forecasters at Ice Forecasting Central, Ottawa. Further modifications to this model are being planned.

Work is progressing well in a joint Government/Industry program to develop a short range prediction model for forecasting sea ice motion over the Beaufort Sea area.

FIELD MEASUREMENT OF ICE PROPERTIES (R. Frederking, DBR/NRC)

A finite-element analysis and preliminary field tests were carried out on the bending of in situ cantilever beams. The assumed boundary conditions at the root of the beam were found to be very important in determining the bending strength and elastic modulus of the ice.

NRC participated with Dome Petroleum Ltd. in a program of ice property measurements carried out during ice breaking trials of the "Kigoriak". Detailed ice crystallography and strength measurements were made on board ship at the time of the trials.

ICE BEHAVIOUR ON STRUCTURES

(R. Frederking, DBR/NRC) Investigations of ice behaviour around the dock at Nanisivik, NWT, have been continued. These have included periodic on-site measurements. Based on the observations, a revised model of ice behaviour is being formulated.

In conjunction with Gulf Oil Canada, DBR joined a field project to study the characteristics of an ice rubble field around the Issungnak artificial island. Particular emphasis was placed on characterizing the mechanical properties of the ice in the rubble field.

GROWTH PROCESSES IN SALINE ICE, ECLIPSE SOUND

(N.K. Sinha, DBR/NRC)

The theory developed to relate the growth of sea ice to weather and snow cover conditions has been successfully applied to two winters' data from Eclipse Sound near Pond Inlet, N.W.T. A dependence has been shown between the predicted growth rate and the measured salinity. The vertical salinity profile and the texture of first year sea ice, towards the end of the season, depicted a record of previous climatic conditions. Dependence of grain structure on the direction of water current has also been observed.

Heat budget observations during the construction of an ice platform in the High Arctic have been made and analyzed. Desalination process in built-up ice was also examined during the construction of the platform.

INTERTIDAL ICE EFFECTS, UNGAVA

BAY, QUEBEC (J.T. Gray, B. Lauriol, J. Dupont and P. Vincent, GEOG/UofM)

A study was conducted on the origin and rates of displacement of giant boulders in the intertidal mudflats of Leaf Basin, Ungava. Early results from photogrammetry and field survey show that from 0% to 15% of boulders in individual study zones migrate measurable distances across the intertidal mudflats over a one year interval. The mechanisms are as

yet unclear but the repetitive grounding and refloating of the Basin ice pack, as a result of the extremely large diurnal tidal variations, is believed to be responsible for the pattern of boulder movement.

ICE ENGINEERING

(Ocean Engineering Group, MUN/NFLD <for details see "Work in Progress - 1980", Ocean Engineering Group>) Studies on heat, mass and momentum transfer during iceberg melting are underway (N.W. Wilson). Numerical modelling of iceberg drift has been done (D.S. Sodhi and M. El-Tahan). Experimental modelling and determination of wind forces on pack ice is being done in the Ice Engineering Facility of U.S. Army, CRREL (D.S. Sodhi). A theoretical model to predict scour by icebergs in cohesive surficial sediments has been proposed (T.R. Chari, K. Muthukrishnaiah and G.R. Peters). Theoretical and experimental programs to investigate the creep and fracture behaviour of fresh water ice cover have been initiated (D.R. Muggeridge and H. Hamza). Laboratory experimental study of frictional forces between ice and various surfaces is underway (J. Molgaard and P.M. Smith).

OIL-IN-ICE

(E.M. Reimer, C-CORE)

The mechanisms and rates of oil dispersion in pack ice were the subject of study during 1980 and a variety of models of ice movement were evaluated. Some development in countermeasures technology for oil in ice are being developed, and a study of the seasonal ice dynamics of the Labrador Sea is being planned.

ICEBERG SCOURING

(J.V. Barrie, C-CORE)

Disturbance of the seabed by grounding icebergs in two areas of Canada's east coast is being investigated. Repetitive mapping techniques are being employed to determine scour rates on two areas of the Labrador Banks, as part of a continuing study in collaboration with the Atlantic Geoscience Centre. A.G.S. and Mobil Oil Canada Ltd. are also joint participants with C-CORE in a major regional geological survey of the Grand Banks, including a detailed study of the Hibernia — Ben Nevis area, where the initial objective in establishing scour rates is the development of a sediment dynamics model.

SEA ICE FLORA AND FAUNA

(E.H. Grainger, Arctic Biological Station/FOC, Ste-Anne de Bellevue, Québec) A study of the flora and fauna that accumulate in the growing sea ice was carried out. Nearly 200 plant species were identified in sea ice in the Canadian Arctic. A study of the ice fauna at Frobisher Bay, Baffin Island, showed that most of the species found were small copepods, some amphipods and other small forms of animals.

PERMAFROST AND GROUND ICE

PERMAFROST DISTRIBUTION AND ENVIRONMENTAL STUDIES

(R.J.E. Brown+, DBR/NRC) Regular ground temperature observations are being taken in northern Manitoba and District of Keewatin to obtain information on permafrost conditions across the boundary between the discontinuous and continuous zones. Similar observations have been initiated in cooperation with Polar Gas to monitor permafrost ground temperatures along the proposed "Wye" pipeline route from the Mackenzie Delta to northern Manitoba, which coincides roughly with the boundary between the permafrost zones. Ground temperatures are also being taken at the site of a uranium ore body in the District of Keewatin, west of Baker Lake. Ground temperature observations in alpine permafrost are continuing in the western Cordillera, Gaspé and Newfoundland, and also in the High Arctic at Alert, N.W.T. Work continues on a new permafrost map of Canada to be published jointly with the GSC.

CORNWALLIS ISLAND, N.W.T.

(P. Steer and M.-K. Woo, GEOG/McM) Several slopes were instrumented to study the hydrological processes operating upon the active layer in an area of continuous permafrost on Cornwallis Island.

PERMAFROST THICKNESS, NORTHWEST TERRITORIES

(A. Judge, A. Taylor, M.Burgess and V. Allen, EPB/EMR)

Temperature logs were carried out in 30 wells of depths ranging from 150 to 1000 m. New sites added were in the region south of Great Slave Lake and east of Dubawnt Lake in Keewatin. Data will be published as the 7th volume of the Geothermal Data Series. In the last 10 years permafrost thickness at 113 sites has been determined.

Freeze-back of the drained Illisarvik Lake on Richards Island was found to have proceeded to a depth of 4 m.

Offshore permafrost research on the Beaufort Shelf is continuing; 40 cores were taken and 35 thermal gradiometer penetrations done.

PERMAFROST ENGINEERING

(G.H. Johnston, DBR/NRC)

Ground temperature observations were made by DND site personnel at Alert, N.W.T., in a cooperative study of a duct-ventilated building foundation. Observations were continued to assess the performance of the bridge over the Eagle River on the Dempster Highway, Y.T. Observations just to the north, at Mile 237, of a highway test section insulated with foamed-in-place polyurethane were continued.

Instrumentation was installed in September 1979 at a pavement-covered test site at

+ deceased

Thompson, Manitoba, and observations were begun at this site and were continued at an adjacent gravel surface site in a study to evaluate "n-factors".

WESTERN ARCTIC

(J.R. Mackay, GEOG/UBC) Field work has been carried out along the western arctic coast, Canada, on the growth of permafrost, ground ice, and pingos. Measurements and observations have included: permafrost growth with two-sided freezing; movement of water in frozen ground; the initiation of ice-wedge cracks in newly freezing ground; and a study of Pleistocene syn-

(H.M. French, GEOG/OTT)

genetic ice wedges.

The following studies are underway: geomorphic process studies on Banks Island, terrain disturbance studies in the Canadian Arctic, permafrost conditions, Quaternary geology and geomorphology of the Dawson City area and Dempster Highway in the N.W.T. and Yukon, and compilation of a ground ice map of Canada (with J.R. Mackay, GEOG/UBC).

MACKENZIE HIGHWAY EMBANKMENT STUDY, N.W.T

(L.E. Goodrich, DBR/NRC) Routine site visits were made in 1980. During this period the equipment performed satisfactorily although some data loss resulted from damage to the cables caused by animals. The data collected since 1975 indicated that a steady degradation of permafrost is occurring under the roadbed.

NORTHERN BRITISH COLUMBIA

(K.E. Ricker Ltd., Vancouver, B.C.) East of the Pine Pass area of northern B.C. periglacial features ranging from one active rock glacier to various sizes and types of patterned ground were seen on the ridge tops above 1850 m. There is a continuous variation from the upslope patterned ground features of periglacial origin and lobed deposits of soliflucted origin downslope.

SEASONALLY FROZEN GROUND - ONTARIO (B.D. Kay, LRS/GUELPH)

Coastal studies have been carried out in the Hudson/James Bay area and along the northern shore of Lake Ontario, in collaboration with Environment Canada, in order to establish a baseline data bank and reach a basic understanding of the evolution of the landscape, the processes and biology of a remote, virgin, emerging coast of a brackish inland, cold, arctic to subarctic sea.

Seasonally frozen soils from Elora and Milton, Ontario, were studied to measure dry and bulk densities, total water content and ice lenses, to understand frost penetration into the ground.

QUEBEC AND LABRADOR

(J.T. Gray, J. Poitevin, J. Pilon and B. Singh, GEOG/UofM)

In Gaspésie, discontinuous permafrost has been delineated for the highest summits of the Chic Chocs Mts. In the Great Whale River basin, in northern Québec, the thermal regime of discontinuous permafrost has been evaluated at potential dam sites. In the Leaf Bay area, Ungava, the depth and thickness of permafrost, and evolution of the active layer, have been studied in proximity to the arctic tree lines. In the LG-2 area, James Bay, the seasonal frost and thaw development for various sediment covers has been studied over a complete annual cycle.

GROUND THERMAL REGIME

(L.E. Goodrich, DBR/NRC)

A finite-element heat flow program is being set up which will be suitable for nonlinear problems in one and two dimensions. A field study of in situ thermal conductivity measurements is essentially complete. Development of a portable conductivity instrument for field use is continuing.

FROST HEAVE STUDIES IN NORTHERN REGIONS

(0.J. Sevec, DBR/NRC)

A frost heave parametric study, including suction potentials induced by soil freezing, is continuing. The influence and importance of various parameters is being evaluated and compared to published experimental results by other authors.

The experimental study of the heat flow around a model chilled gas pipeline including the effect of insulation width together with heating cables has been partly completed and reported.

A new frost heave cell for larger samples to facilitate experiments at lower temperature gradients has been designed and is under construction.

FROST ACTION IN SOILS

(E. Penner, DBR/NRC)

A new technique was worked out that makes it possible to determine the temperature of ice lens growth in situ. The technique involves locating the ice lens by X-ray, measuring the I gradient in the freezing sample and by superposition obtaining the temperature of growth at the soil/ice lens interface. Effects of overburden pressure, rate of growth, influence of soil type, fall off temperatures with time and other conditions surrounding ice lens growth on the ice lens temperature were measured.

PHYSICO MECHANICAL PROCESSES IN FROZEN SOILS

(V.R. Parameswaran, DBR/NRC) Experimental work on the creep of small-scale model piles in frozen sand and silt is being continued at -2° and -6° C. Preliminary studies on the effect of an alternating load on the rate of displacement of piles in frozen soils showed that the rate is noticeably increased by an alternating load of magnitude as small as 2-5% of the static load. Field measurements of the vibrations on piles under a powerhouse in Inuvik were carried out in September 1980.

Triaxial tests on frozen saturated sand containing 20% by weight of moisture have been completed, and tests of sand-ice specimens containing different concentrations of sand such as 10%, 25% and 50% by weight, are now being carried out, in collaboration with S.J. Jones (S&ID, NHRI/EC).

The electrical potential generated during freezing of water and moist soils onto a pile kept cold by circulating methanol or liquid nitrogen is being studied in the laboratory. Freezing potentials (dc) of up to 12 V in water and 500 mV in soils were measured. Field measurements of such freezing potentials at a site in Inuvik during freezing of the active layer, and at the drained Illisarvik Lake on Richards Island, where permafrost is aggrading downwards, will be done in collaboration with J.R. Mackay (GEOG/UBC) in the summer/fall 1981.

DEFORMATION AND STRENGTH OF FROZEN AND THAWING SOILS

(T.H.W. Baker, DBR/NRC)

Time-domain reflectometry (TDR) has been used to locate the frozen/unfrozen interfaces in experiments involving the freezing of distilled water and saturated sand. The correlation between the TDR measurements and other standard techniques was excellent. The precision of locating the freezing boundary was within 0.7 cm in water and within 0.5 cm in saturated sand. This precision is thought to exist in transmission lines up to 1 m in length.

Compliant platens were manufactured and sent to FENCO in Calgary and Exxon in Houston for their ice testing programs. Interest in the use of compliant platens is continuing for strength testing in the field as well as in closed-loop testing machines in the laboratory.

FROST IN ROADWAYS

(P.M. Gifford and J.E. Gillott, CIVIL/CALG) The use of sulphur in roadway frost applications was studied.

ICE PHYSICS - ICE ENGINEERING

PHYSICS OF ICE

(S.J. Jones and H.A.M. Chew, S&ID, NHRI/EC) High pressure triaxial testing of a frozen sand/ice mixture containing about 20% moisture by weight, has been completed (in collaboration with V.R. Parameswaran, DBR/NRC). Further work, varying the amount of sand, is in progress. Triaxial strength of polycrystalline ice has also been studied. The effect of grain size on the strength of polycrystalline ice is being investigated. Some preliminary results have been obtained. At -10°C, at the strain rate of 5 x 10^{-4} s⁻¹, grain size, in the range 0.7 - 1.8 mm, has little effect on the uniaxial compressive strength.

(N.K. Sinha, DBR/NRC)

Effects of the test system on the measured strength properties of ice were studied by comparing the results from a conventional screw type machine and closed-loop servohydraulic test machine. It was found that the use of an average strain rate, rather than the conventional nominal strain rate as an independent variable, gave closer agreement of strength values with the usual strain rate sensitivity of stress under true constant strain rates. Preliminary tests on acoustic emission in ice during strength testing have been carried out. Micromechanics of deformation and failure of S-2 ice is being studied.

(V.R. Parameswaran, DBR/NRC)

The propensity for crack formation on basal and prismatic planes and twin nucleation on two pyramidal planes in hexagonal ice was examined on the basis of fracture theories and anisotropic elasticity theories of dislocations. Calculations showed that the ease of crack formation is almost the same in the basal and prism planes, whereas it is almost impossible to produce mechanical twinning in ice by stress alone.

OPTICAL, DIELECTRIC AND THERMO-DYNAMIC PROPERTIES OF ICE

(G.P. Johari, S&ID, NHRI/EC) A report on the Raman spectrum of the main frequencies of intramolecular vibrations was presented at the Chemical Institute of Canada 1980 Conference. Theoretical calculations of the dielectric properties of ice and ice clathrates have been done. An analysis of the heat capacity of ice and other disordered solids has been reported.

NEW MODELLING TEST BASIN

(B.D. Pratte and G.W. Timco, MECH/NRC) The Hydraulics Laboratory of NRC has constructed a facility for model testing the dynamic interaction between a structure and an ice cover. The facility consists of a refrigerated chamber which houses a tank 21.4 m long, 7.0 m wide and 1.2 m deep in which carbamide (urea) model ice is grown. The facility will be used for studying the properties of model ice and in basic research on ice-structure interactions.

MECHANICAL PROPERTIES (B. Michel, IML, CIVIL/LAVAL) A laboratory tank 5 m x 4 m is being used with a 2 m stroke piston to push indentors of variable geometry into a floating ice sheet made of different types of ice, including sea ice. The first series of tests will be to study the limiting condition of buckling by vertical face indentors for various conditions of loading.

The long range program to study the mechanical properties of ice by uniaxial testing of ice samples in the brittle and ductile range is now being extended to simulated arctic ice. The development of a micropressure transducer to measure internal stresses in Lake St-Joseph, produced by wind and thermal expansion, is progressing.

WINTER ROADS AND BRIDGES

(K.M. Adam, Interdisciplinary Systems Ltd., Winnipeg, Manitoba)

Studies on winter roads, ice bridges, and their design requirements, construction and their environmental effects, are being continued. Studies in progress include updating the bibliography and preparing specifications for building winter roads, conducting test trials and evaluating the effectiveness of the specifications.

ATMOSPHERIC ICE AND CLIMATE

ALBEDO MEASUREMENTS ON

"ANDREI" GLACIER, B.C. (S. Fogarasi, S&ID, NHRI/EC) Spectrally integrated (0.3-2.5 mµ) glacier surface albedos were measured along two traverses. Four albedo classes were established as a function of dirt deposited by snowdrifting. The influence of rain on albedo variation was assessed and albedo mapping attempted.

SENTINEL GLACIER, BRITISH COLUMBIA (S. Fogarasi and O. Mokievsky-Zubok, S&ID, NHRI/EC)

Daily total direct and diffuse radiation was calculated on a 250 m grid and the sum compared with measured global radiation values. Initial surface albedo was estimated, its daily variation calculated by Petzold's method, and inferences made with respect to the magnitude of attenuation coefficients. Net radiation values were calculated, plotted, and their impact on hydrologic processes examined.

AIR TEMPERATURES, MT. RHONDDA, B.C. (S. Fogarasi and A.C.D. Terroux, S&ID, NHRI/EC)

Air temperature data from an automatic weather station were compared to free atmospheric temperatures estimated from the 700 mbar weather charts. The unbiased estimation and the observed values were close in the region of the mean 700 mbar values. Annual mean temperatures at Mt. Rhondda had to be similar to the annual mean temperatures of the free atmosphere. This realization offers an important tool for paleoclimatic interpretation of radiocarbon-dated ice cores from the vicinity.

CLIMATIC CHANGE, CHURCHILL MANITOBA

(P.G. Murray, AES/Winnipeg) Climatic change in the Churchill area (1700 to 1860) was studied by analyzing Catchpole's data on freeze-up and break-up of river ice, from old Hudson Bay Company journals. Preliminary observations indicate that little long term change has taken place and that the overall averages are very similar to those of recent years.

CLOUD PHYSICS

(Cloud Physics Research Division, AES) The Cloud Physics Research Division has been making aircraft observations of the occurrence of ice in summer convective clouds since 1975. An extensive array of probes is used to both electronically image ice particles and to collect particles for later analysis. In March 1981 an aircraft study will be undertaken to examine plume-cloud interactions and the scavenging of particulates and gases by snow. The Division also has a major program concerned with the radar measurement of snowfall. A colour radar display has been developed which provides both qualitative and quantitative snowfall rates for a variety of users. To provide surface time histories of snow crystal types during snowstorms, the Division maintains a Particle Measuring System 2-D Grey Scale Optical Array Imaging Probe. This probe can record images (4 levels of light transmission) of snow crystals and snowflakes for extended periods of time on magnetic tape.

SCHEINER'S HALO

(E. Whalley, CHEM/NRC)

Scheiner's halo, a rare halo that occurs at 28° from the sun and that cannot be explained by crystals of hexagonal ice, is probably formed by octahedral crystals of cubic ice. This is the first evidence that ice I_C occurs naturally.

ENERGY BALANCE AND ICE AGES

(A. Shabbar, AES/Winnipeg) The mean annual energy balance model of Gal-Chen and Schneider has been extended to allow seasonal simulations, including both ice-feedback and bio-feedback. Without bio-feedback, the annual model and the seasonal model respond similarly to changes in solar constant. With the inclusion of bio-feedback, the seasonal model is more sensitive than the annual model. The implication of this on the astronomical theory of ice ages is considered.

Reports collected by V.R. Parameswaran



The Institute grew out of the Research Team on the Utilization of Ice and Snow in High Mountains (directed by the Chinese Academy of Sciences - Academia Sinica). It was formally constituted in 1958, initially with a view to glacier inventory and glaciological research in the mountains of northwest China but research into permafrost was added in 1960, and in 1962 it became the Division of Glaciology and Cryopedology within the Institute of Geography of Academia Sinica, Beijing (Peking). A programme to study the special problems associated with catastrophic debris flow arising from earthquake shock and glacier bursts (and called "mudrock flow" in China) was added in 1964. With the addition of a study team on the hydrology of the arid regions of northwest China to those on mountain glaciation and frozen ground on the Qinghai-Xizang (Tibet) Plateau, the Division was amalgamated with the Division of Desert Research in 1965. The amalgamation lasted until 1978 when desert research became concentrated in a separate institute, although housed in the same building as the Institute of Glaciology and Cryopedology.



THE LANZHOU INSTITUTE OF GLACIOLOGY AND CRYOPEDOLOGY

Several areas in western China, in the Quinghai-Xizang (Tibet) and Xinjiang regions, have been selected for work in glaciology and glacier inventory. These include Qomolangma (Everest) and Xixabangma in the Himalayas, the Karakoram (notably the Batura Glacier in connection with maintence of the Karakoram Highway), the Tian Shan and, perhaps the most





continental of all, the Qilian Shan on the northeast margins of Tibet and relatively close to Lanzhou. Here glaciology has been applied to the problem of water supply for the semi-arid farming and grazing lands of the Gansu Corridor. Avalanches and means to prevent them have been studied in the Tian Shan and some work has been done on the mechanics of ice jams on the upper Hwang He (Yellow River). In recent years, several glaciological expeditions have been mounted to the Altai Shan, the eastern Kunlun and several other ranges within the Tibetan Plateau. Geomorphological work will be concentrated in the current (1980-1983) period on the Hengduan Shan (Sichuan Province), the Qilian Shan and the Tian Shan. The Institute maintains a permanently manned glaciological research station in the latter mountain range, directed by Zhang Jinhua, an engineer and glaciologist. There is a manned meteorological station, with telex link to Urumqi, and a regular programme of mass balance observations currently concentrated on "No.1" glacier. Heated tent accommodation can raise the summer numbers to about 50 scientists. Bedrock mapping and till provenance maps have been produced and a tentative glacial chronology (into the main last Pleistocene glaciation, Late Glacial, Neoglacial and Little Ice Age) established on the basis of study of the moraines.



Glaciological Research Station, Tian Shan

Glacier inventory in the 1960's established a total glacierized area for China of 57,069 km² of which 11,639 km² (20.4%) is in the Kunlun, 11,055 km² (19.4%) is in the Himalaya, and 9,548 km² (16.7%) is in the Tian Shan. It is now recognised that glacial cover, both current and Pleistocene, has been greatly overestimated and the results of the inventory have resulted in re-evaluation of a variety of glacio-climatic and stratigraphical problems.

Cryopedology is being studied from both empirical and theoretical points of view. The question of the present and past extent of permafrost in western China is still hotly debated. It is generally agreed that permafrost is continuous in the northern half of Qinghai-Xizang but not all accept that it is discontinuous southward of this region. The majority view is that the area of permafrost exceeds 2 million km². Equally, there is no agreed view on the age of the permafrost: some regard it as having re-formed in post-glacial times with continuing uplift of the Plateau.

The Institute in Lanzhou is well equipped with cold rooms, and geotechnical testing of frozen materials from Tibet continues, using oedometer, triaxial frame and direct shear apparatus. Some field testing has also been done but the need for theoretical refinement is recognised. A major stimulus to this work has been the need to understand thermal and dynamic properties of permafrost along the Xinjiang railway and the Qinghai-Xizang Highway, as well as in some coal mining districts such as those of the Qilian Shan.

The surveying and mapping section of the Institute has achieved impressive results using terrestrial stereophotography. Products include a superb map of the Qomolangma region at a scale of 1:50,000, the 1:60,000 scale map of the Batura Glacier and the very beautiful map of the glaciers and glacial geology of the Mount Tomol region of the Tian Shan. The Institute is equipped with Wild and Leitz stereoplotters and is increasingly using LANDSAT remote data for snow and ice inventory.



Cirque glacier, Karawucheng Shan, central Tian Shan (Professor Cui Beijing, foreground) The Institute of Glaciology and Cryopedology is directed by Professor Shih Yafeng, a glaciologist and glacial geologist and veteran of the Chinese Qomolangma and Xixabangma expeditions. His intellectual astuteness is matched by his kindliness and both are thrown into relief by his irrepressible sense of humour. Wang Wenying is Vice-Director and an engineer by training. He has special responsibility for the surveying and mapping programme. Chief of the Glacier Division is Hsieh Tsu-chu whose wide experience of glaciers and glaciation includes both China and the U.S.S.R.



(1. to r.interpreter, Wang Wenying, staff, E. Derbyshire, Shih Yafeng, interpreter, Hsieh Tsu-chu, staff)

The Institute is accommodated on three floors of a new building on Tung-kan-si-lu, directly opposite Lanzhou University and adjacent to the Meteorological Institute of Academia Sinica. Work in association with selected University departments is a notable characteristic of the Institute, as yet by no means typical of the Academy. The proximity of the Glaciology Section of the Department of Geology and Geography, headed by Dr Li Jijun (a man of wide experience in glacial geology), has encouraged fruitful co-operation between the two institutions. Joint work in recent years has been done in the Tian Shan, the Qilian Shan, the Kunlun Shan, the Hengduan Shan and on the curious problem of the Lushan, south of the Chang Jiang

(Yangtze). The Lushan has become the critical site in the contentious discussion of Pleistocene glaciation of the massifs of south-east China since glaciation was first proposed there by J.S. Lee in 1933. With the application of modern concepts and techniques, opinion is now swinging against such an interpretation. Drastic revision of ideas on Pleistocene ice extents and snowlines in China is bound to result. The co-operation between the Lanzhou Institute and Lanzhou University extends to work on local Tertiary sandstones, the Lanzhou loess (probably the thickest in the world) and the nival and cryergic forms of the local massifs (Goa Lan Shan, La Ji Shan). There is a strong paleoenvironmental and stratigraphical emphasis in much of the work in glacial geology and the potential of glacial sedimentology is fast being recognised. A ¹⁴C dating laboratory was set up in 1980 and a geomagnetic dating laboratory is currently being established in the Glaciology Section of the University.

Co-operation with other universities generally takes on the form of honorary associates. One such is Cui Zhi-jiu, Associate Professor at Beijing and another Himalayan veteran.

The Institute has almost 400 scientific staff, technicians and ancillary workers and a good library with an impressive array of earth science journals in all languages. Its own publication "Journal of Glaciology and Cryopedology" is distributed throughout the world and includes translations of reports from ICE.

Shih Yafeng's leadership ensures a good balance between theoretical, empirical and applied approaches to glaciology in the very broadest sense. Resources are by no means unlimited but the ingenuity of the staff is not dampened thereby! Witness their recently developed quartz crystal thermometer (accurate to 1.5° C) and the building of radio echosounding equipment for ice surface use. An impressive amount of laboratory equipment is made in China and much has been adapted by the Institute's staff. The enthusiasm of the staff is patent and infectious and augurs well for Chinese glaciology.

Edward Derbyshire University of Keele

ANNUAL GENERAL MEETING 1980

MINUTES OF THE ANNUAL GENERAL MEETING OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

28 AUGUST AT GEILO HOTEL, GEILO, NORWAY

The President, Dr L.W. Gold, was in the Chair

1. <u>The Minutes</u> of the 1979 Annual General <u>Meeting</u>, published in ICE No.60, 2nd Issue 1979, p. 18-21, were approved and signed by the Chairman.

2. The President gave his report for 1980-81: This is the first Annual General Meeting of the Society to be held in Norway. It is a particularly fitting location for our Symposium on Processes of Glacier Erosion and Sedimentation. On your behalf I would like to express to the Norsk Polarinstitutt and the University of Oslo our great appreciation for their cooperation in the organization of the Symposium and for providing such appropriate and enjoyable surroundings. And to the local Organizing Committee - Olav Orheim, Olav Liestøl and Johannes Sollid, and all those individuals that are assisting them, I wish to express our thanks for the excellent arrangements they have made for us and for the opportunity to observe at the natural laboratory at Finse many of the processes we are discussing in the sessions.

Last year I had to present a gloomy report because of the difficult financial situation in which the Society found itself. This year I am very pleased to report that the situation is much improved. From a net deficit of £11,665 for 1978, we have moved to a net surplus of £2,931 for 1979. This is not a cash surplus, however, as it has been expended on the purchase of additional stocks of the Journal to be sold in future years. As you can see, we have stopped the heavy drain on our finances that occurred in 1978, but much care and a constant watch on publication costs is still needed. At the meeting of the Council held in Cambridge in April, it was agreed that the fees of the Society be increased in 1981 to £20 for members (£10 for Juniors) and library subscriptions to £40. This should maintain our surplus position in 1981 and allow us to begin to rebuild the contingency fund.

Membership in the Society has remained relatively constant: the number as of June 1980 is 1036, distributed amongst 33 countries. There are 676 subscriptions from libraries and 26 journal volumes are provided free or on exchange.

The editors of the Journal of Glaciology continue to do a tremendous job for us, under very difficult conditions. One of the decisions that had to be made last year was to limit the Journal to 500 pages in 1980. This has resulted in an unfortunate delay in the publication of papers. I know that this situation is frustrating and disappointing for authors, but it was the only way open to us to bring the financial affairs of the Society under control. I do want to emphasize here that the decision was taken by the Council and the editors have had no choice but to accept the delays that resulted and to apply more stringent refereeing. They have also been much more critical of long papers and are offering the opportunity to publish such papers in extended summary form. On vour behalf I want to thank our Editor-in-Chief, John Glen and his Co-Editors David Homer, Ray Adie and Doris Johnson for their help and cooperation during this difficult period and for the excellent job they are doing in maintaining the high technical and editorial standards of the journal.

During the year arrangements were made to remove Glaciological Literature from the Journal and to incorporate it with "Recent Polar Literature" published by the Scott Polar Research Institute. The new publication is entitled Recent Polar Literature and Glaciological Literature and can be ordered at the time you pay your annual Society fee. Removal of this material has freed about 60 additional pages for papers.

A major development during the past year was the initiation of the Annals of Glaciology. You will recall that in 1978 the Council formed a Working Party of Past Presidents to review the publication policies and activities of the Society. One of its recommendations was to establish a new publication series for the proceedings of symposia and other occasional publications. It was in response to that recommendation that the Annals was initiated by the Council at its meeting in Fort Collins last August. Since that meeting, the terms of reference and modus operandi have been established. The first volume is to be the Proceedings of the Conference on the Use of Icebergs organized by the Society and held in Cambridge last April; the second volume will be the Proceedings of the Symposium we are attending here in Geilo. We expect the Proceedings of the Conference on Snow in Motion held in Fort Collins last year will be the last to be published in the Journal. Using the Annals for these special Society publications will greatly reduce the load on the Journal editors as well as reduce our overall expenditure on publications.

The operation of the Annals is to be completely separate from the Journal and is to be managed from the Society's office in Cambridge. An Editorial Board Composed of a Chairman, Vice-Chairman, Chief Scientific Editors, the House Editor and the Society's Treasurer and Secretary General, has been set up to provide policy guidance. Each volume will have a Chief Scientific Editor who will serve on the Board during the preparation of that particular volume. In the case of a proceedings of a conference or symposium, the Chief Scientific Editor will normally be the Chairman of the Papers Committee. Members of the Papers Committe, who are chosen for their knowledge of the topic of the Symposium and assess the submitted summaries become, at the proceedings stage, the scientific editors. Thus the editing is carried out on a world-wide basis. I feel this is a very important feature and each volume of the Annals should truly reflect the international character of our Society. The Chief Scien-tific Editor for Volume 1 is Charles Swithinbank; for Volume 2, that is the proceedings of this Symposium, Garry Clarke.

The copy editing will be done by the House Editor in Cambridge. For the first two volumes we are very fortunate to have Ailsa Macqueen carry out this task for us. Ailsa has had considerable experience in assisting with some of the editing work for the Journal and with the preparation of Glaciological Literature. I do want to thank her on behalf of the Society for her keen interest and support in this work.

Financing for each volume of the Annals is to be established before the Society undertakes the job of producing it. They are to be produced on a free-lance basis from camera ready copy. Experience with the first volume has shown that by going to this less expensive form of printing, the Society is able to publish the proceedings of symposia at about one-third the cost of placing them in the Journal. Each volume will be sold separately to members at a reduced rate and to non-members and libraries at an economic rate. Following this policy, the Annals will not be a drain on the general finances of the Society but should, in time, help build up our reserves.

Other changes are in the offing. Hilda has compiled and edited ICE since it evolved in 1958 from our previous news bulletin "Reports to Members". She considers it is now time for a change. At present, text submitted from various authors and sources is reviewed and edited by Hilda, typed to a uniform style and processed by photographic printing techniques. Again, following what seems to us a natural development for an international organization, we felt it was not necessary for ICE to be produced completely at the Cambridge Office. Simon Ommanney from Ottawa, Canada, has kindly agreed to take over the job of Editor and we are now investigating the logistics of production.

This Symposium is the second scientific meeting with which we have been associated this year. We had the honour of organizing the Conference on the Use of Icebergs held in Cambridge in April. That Conference was sponsored by Iceberg Transport International Limited, the King Faisal Foundation and the Abdul-Aziz University and hosted by the Scott Polar Research Institute. The meeting, which was relatively small with 56 participants plus visitors, was held in the Institute. It was opened by Prince Mohammed al Faisal al Saud of Saudi Arabia and participants were welcomed by His Worship Donald Mackay, Mayor of Cambridge. Individuals attending the Conference had the opportunity to tell the Mayor and some of the town councillors all about ice and icebergs at a civic reception given in their honour by the City of Cambridge at the end of the meetings.

Looking ahead, next year we will be associated with the SCAR Symposium on Antarctic Glaciology to be held in Columbus, Ohio, USA, in September 1981. The Society will be publishing the proceedings of that meeting as Volume 3 of the Annals of Glaciology.

Good progress is being made on our next Symposium, which will be on applied glaciology and held in Hanover, New Hampshire, USA, 23-27 August 1982. This symposium is being organized with the help of our members at CRREL. The first circular will be issued in October and will include the list of topics. The proceedings of that symposium will be published as Volume 4 of the Annals.

During the past two years we have had interest expressed from both Japan and China for the Society to hold a symposium in those countries. It is an exciting prospect as the Society has not yet held a meeting in Asia. Possibilities to hold it in Japan are now being considered by the Council and we hope to arrange something for 1984. This interest on the part of our Japanese and Chinese col-

SYMPOSIUM ON PROCESSES OF GLACIER EROSION AND SEDIMENTATION



The referees worked hard . . . Dick Goldthwait and Jan Frederick



GEILO NORWAY 25-30 AUGUST 1980

Olav Orheim, Chairman, Organizing Committe



Discussions were both informal . . .



. . . and intense, Almut Iken, Uli Spring and Bernard Hallet



Roger Hooke, Bernard Hallet and Roland Souchez



Beverley Baker assisting at one of her last IGS functions



Olav Orheim and Annemor Brekke ensured that the Symposium ran smoothly



Norwegian night was a time for relaxation



Johannes Sollid at Midtdalsbreen



Matti Seppälä regaled us with Finnish jokes

FIELD TRIPS

Gunnar Østrem's ice cream party at Omnsbreen

The Omnsbreen Hymn

I'm dreaming of a white Omnsbre Just like the one I used to know With reindeer flighting And shear planes sliding Forming flutings as they go.

I'm dreaming of a white Omnsbre Just like the one I used to know With the snout a sunning And melt streams running And eskers forming down below.

I'm dreaming of a white Omnsbre Just like the one I used to know With dirt cones standing And basal banding And Omnsbreen praying for more snow.

Words: Roger Till Tune: Ice Hammerstein



visit to a stave church



J. Ehlers

Nigardsbreen

leagues indicates the growing international character of our Society. It is important to hold our meetings in different parts of the world if the Society is to be effective in increasing and strengthening the bonds between glaciologists in all countries.

In July of this year, we were saddened to learn of the sudden death of one of our colleagues, Fritz Müller. Fritz was a friend of many of us and a highly respected and dedicated glaciologist. He was a Professor of Geography at the Swiss Federal Institute of Technology in Zürich as well as Professor of Glaciology at McGill University in Montreal. Fritz was Director of the Permanent Service on the Fluctuations of Glaciers of the Federation of Astronomical and Geophysical Services of the International Council of Scientific Unions (see ICE, Nos 62/63, p.20-22, for a Profile of the Permanent Service) and an enthusiastic participant in the activities of glaciological and alpine societies and organizations. He will be greatly missed by his students, friends and fellow glaciologists.

Some changes have taken place in the Council this year. I would like to express our thanks to the retiring members Louis de Crécy, Pete Martinelli, Joachim Schwarz and Gorow Wakahama for their dedicated service during the past three years. We welcome in their place Tony Gow from CRREL, David Drewry from the Scott Polar Research Institute, Seiti Kinosita, the new Director of the Institute of Low Temperature Science in Sapporo, and Simon Ommanney from the Federal Department of the Environment in Canada, and look forward to their advice and contributions to our discussions. I also want to thank Valter Schytt and Olav Liestøl for their assistance during the past year as coopted members.

In April our Treasurer, Professor Jack Jacobs of Cambridge University, found it necessary to resign because of pressure of other duties. The Society is fortunate indeed that John Heap, one of our past Treasurers, was able to take his place.

There have also been some changes at our headquarters in Cambridge. In addition to Hilda Richardson and her assistants Beverley Baker and Pat Lander, we have the House Editor for the Annals, Ailsa Macqueen, working part-time, and a part-time secretary, Doreen Cleary, who helps with the Annals as well as with general Society work. Beverley Baker and Pat Lander share a full-time, job: Beverley two days a week and Pat three days. Hilda still occupies an office in the Scott Polar Research Institute, which has provided us with space since 1952, and the others are in our "satellite" office across the road. We have a strong, dedicated team at Cambridge and they deserve our thanks for looking after our affairs so ably. I might add that

Hilda's talents and capabilities have been recognized by others and we are trying to reduce her work load to that of Secretary General only, so that she will have an opportunity to accept some of the interesting requests for her help.

I cannot close this report without paying special tribute to the Scott Polar Research Institute and its Director, Gordon Robin. We greatly appreciate the help that has been given to us over the years and, in particular, the space that has been provided for our Secretary General and library. It was a real pleasure to work with the Institute in the organization and holding of the Iceberg Conference and we look forward to future joint activities.

I am pleased to announce at this time that Mark Meier has been elected an Honorary Member of the Society. Mark's many contributions to the objectives of the Society are well known.

The Treasurer, Dr J.A. Heap, submitted the following report which was summarised by the President:

On returning to the Treasurership after a three-year "holiday" I hope you will excuse me if I reflect a little on "then and now". What follows, I emphasize, is not intended to be in the least bit critical. Our problems stem from having been outstandingly successful in an economic climate which had hardly been favourable to us.

Some five or six years ago Council took the decision to publish symposium proceedings in the Journal. Our objectives were to help symposium organizers to overcome the problems of giving their proceedings an adequate distribution. We also believed it would benefit the Society's membership to have these symposium proceedings, which they would receive at no extra cost to themselves, because under our Constitution members are entitled to receive the Journal free. Over the years members have been receiving about 500 + 500 pages of superbly edited and presented scientific literature in their subject for £10 rising to £15 in 1979.

Then came the annus horribilis of 1978, with suddenly rocketing contributions of high quality which led to the executive decision that in future the Editors must keep down the size of the Journal to the budgeted length. This length was restricted in 1979 and 1980, and many articles were, and are, badly delayed. We should raise the page limit as soon as we are financially able. We are, as I have already hinted, suffering a penalty of our own success. The decision to double the publication rate has indubitably contributed to fulfilling the first and second of the Society's constitutional objectives. In August 1979, the Council decided to use cheaper printing methods for proceedings volumes, and to publish them in the Annals of Glaciology.

Hilda's figurings show fairly clearly that, allowing for a 500 page Journal in 1981, we shall run at a small loss of about £1,300. If we project 20% inflation into 1982 this would mean a loss for that year of about £10,000. With practically no Contingencies Fund or other cash reserves, and with sale-able assets (back numbers of the Journal) which, although valued at £19,000, are almost useless for purposes of paying off a deficit, we cannot knowingly plan to run at such a loss. It follows, I'm afraid, that if we go on publishing the Journal as we are I should have to advise Council to raise the subscription in 1982. Furthermore, for every £5 increase in members' dues we can raise only \$5,000 - barely sufficient to cover increases in printing bills, which are not the only increases in our expenditure. The only way I can see open to us is to go to significantly cheaper forms of printing. I do not think that we should accept at this stage that cheaper methods means, of necessity, lower aesthetic standards.

The statement of accounts for the year ended 31 December 1979 shows that we finished with a small surplus of $\pounds2,931$ compared to our deficit of $\pounds11,665$ in 1978. We received $\pounds19,718$ income from pages charges, up from the $\pounds17,027$ received in 1978. Income from voluntary donations also increased slightly.

- Election of auditors for the 1980 accounts: J.W. Glen proposed and R. Hooke seconded that Messrs. Peters, Elworthy and Moore, of Cambridge, be elected auditors for the 1980 accounts. This was carried unanimously.
- 5. Elections to the Council 1980-83: After circulation to all members of the Society of the Council's suggested list of nominees, no further nominations had been received. The following people were therefore elected unanimously:

Treasure	<u>^</u>
Elective	Members

J.A. Heap D.J. Drewry A. Gow S. Kinosita C.S.L. Ommanney

The President thanked the retiring Council members for their years of service: L. de Crécy, P. Martinelli, J. Schwarz and G. Wakahama.

BRANCH NEWS

The annual meeting of the British Branch will take place from Wednesday 23 to Friday 25 of September 1981 at the University of East Anglia, Norwich. The meeting will be longer than usual to include symposia on three currently active areas of glaciological research. These are:-

- Floating Ice comprising ice shelves, icebergs, sea ice and lake ice in all their aspects (e.g. distribution, climatic implications, mass balance, mechanics, etc.)
- Large Ice Sheets the dynamics of ice sheets, their mass balance, geomorphological effects, climatic relations, etc.
- Water in Glaciers flow in channels, water chemistry, water at the glacier bed, jökulhlaups, etc.

The lecture programme will begin after lunch on the 23rd and end at lunchtime on the 25th. The afternoon of September 25 there will be a workshop on prediction techniques for run-off from glaciers, to which all are invited.

A short field trip, to see impressive exposures of large chalk blocks in tills on the Norfolk coast near Cromer, has been arranged on Wednesday morning for anyone interested who arrives on Tuesday night or early Wednesday morning.

It should be stressed that papers on any topic in glaciology are welcome, and that the symposia topics can be changed if there is a strong response in any other field.

The cost for the fixed part of the meeting will be £26. This will include bed and breakfast for 2 nights, tea, coffee and biscuits during the meeting, and the annual dinner on Thursday evening. It does not include lunches or other dinners as these can be obtained self-service on the campus at a cheaper rate than can be offered by conference organisers. For those who do not wish to use the university accommodation, there is a limited amount of floor space available. Accommodation is available for those who arrive early or decide to stay on afterwards, provided they indicate their needs on registration.

Anyone requiring additional information or wishing to attend the meeting and needing registration forms should contact Dr G.D. Smith, School of Mathematics and Physics, University of East Anglia, Norwich NR4 7TJ (Norwich (0603) 56161, Ext. 2542) as soon as possible.

NORTHEASTERN NORTH AMERICAN BRANCH (NENA)

The biennial meeting of NENA was held at the Chateau Montebello, Québec, from February 27 to March 1, 1981. Some 35 glaciologists gathered in the magnificent three-story log structure that was built in the 1930's for the Seigneury Club. Unseasonably warm weather had melted all the snow so the Can-Am challenge ski race could not be run. The highlight of the meeting was the Saturday night banquet which included an apparently inexhaustible supply of wine, single roses for the ladies, bottles of Canadian Club for many deserving visitors and an excellent talk on the eruption of Mt. St. Helens by Sam Colbeck. Profits from the meeting have been donated to the Society. Gordon Young, Environment Canada, was elected President and Paul Mayewski, University of New Hampshire, Vice-President.

The following papers were presented:-

- R.O. Ramseier Radar satellite ice program.
- E. Whalley Scheiner's halo and its parhelion: evidence for ice Ic in the atmosphere.
- W. Blake, Jr. Lake sediment cores and ice cap symmetry, east central Ellesmere Is., N.W.T.
- D. Fisher High Arctic Wisconsin ice sheet, thick or thin?
- R.M. Koerner Acid precipitation in the High Arctic.
- G. Holdsworth Special lecture: Mount Logan ice core studies.
- R.L. Cameron and R. Morris Ice movement at South Pole Station, Antarctica.
- A. Kovacs The McMurdo Ice Shelf brine layer.
- W.D. Hibler, III Modelling pressure ridge build up on the geophysical scale.
- R. Frederking Strength testing of sea ice in the field.
- S.J. Jones and H.A.M. Chew The effect of grain size on the strength of ice.
- G.K.C. Clarke, D.E. Thompson and S.G. Collins The surge mechanism for Trapridge Glacier, Yukon Territory.
- D.E. Thompson Higher order corrections to kinematic wave response models for glaciers.
- D.S. Munro and G.J. Young A global radiation model for glacier basin investigations.
- P.G. Johnson Hydrological studies and the structure of rock glaciers.
- S. Colbeck and W. St. Lawrence Glaciology and the eruption of Mt. St. Helens 1980, personal observations (Banquet Lecture).
- N. Eyles, J.A. Sladen and S. Gilroy Facies of sub-ice sheet glacial and fluvial sedi-

mentation and their implications for glacial stratigraphy - examples from Northeast England.

T. Day - A till wedge from an active glacier.

WESTERN ALPINE BRANCH

The 9th meeting, with a theme of glacial and periglacial landforms, was held in Luchon, France from 5-7 February, 1980. On September 5, a long hike took participants to the Espingo shelter which was unfortunately shrouded in mist. The following day included an ascent of the Tusse de Montarque (2889 m) from where the more enterprising went on to climb the Seil de la Baque (3187 m). The banquet that night finished late after stories and songs.

Papers on the following topics were presented on the final day.

- G. Soutade The Luchon mountains and their glaciers.
- F. Valla Glaciological measurements in the Hautes-Pyrénées: Taillon and Ossoue.
- P. Barrère Recent observations on the glaciers of Balaïtous and Vignemale.
- G. Soutade The eastern part of the Pyrénéan mountains.
- F. Cazenave-Piarrot Glacial forms and vegetation on Ruwenzori (Africa).
- W. Good Snow techniques: a comparison by the study of forms.
- J.P. Tihay Lahars, rock glaciers: a problem of geomorphological interpretation.

At the general meeting François Valla was elected President and Treasurer, Walter Good Vice-President and Gérard Bocquet Secretary. Plans for the excursion to Iceland were discussed. It will take place during the second fortnight of July 1981, will last about 16 days and will include the weekend of July 14. The estimated price is 5 500 F per person. The excursion will include a tour of the island and trips into the interior. Further information will be available from the Section Hydrotechnique de France.

CHANGES IN I.G.S. H.Q. OFFICE

Beverley Baker, who has been Hilda Richardson's assistant since 9 February 1971, has resigned. She continued to work free-lance for the Society until the end of March 1981 at which time she took maternity leave pending the arrival of her second child.

Pat Lander has now been appointed Hilda's assistant — and maintains the family connexion, as she is Beverley's mother.

1981

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

28 June - 1 July

Third International Symposium on Arctic Geology, Canadian Society of Petroleum Geologists. Calgary, Alberta, Canada. (Canadian Society of Petroleum Geologists, Room 229, 640 Fifth Ave. S.W., Calgary, Alberta, T2P 3G4, Canada)

27-31 July

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

27-31 July

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

24-29 August 8th Annual Meeting of the European Geophysical Society. Uppsala, Sweden. Symposium on High Mountain Hydrology (Conveners: Drs J. Martinec and B.E. Ryden) and Symposium on Atmospheric and Oceanic Transport and Assimilation Processes in the Arctic (Conveners: Prof. D. Dyrssen and Dr B. Ottar). (Dr C.E. Lund, Box 556, S-75122 Uppsala, Sweden)

24-29 August

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

- 4-6 September Western Alpine Branch Meeting, International Glaciological Society. Luchon Pyrénées, France. (F. Valla, c/o Nivologie CT-GREF, B.P.114, 38402 St Martin d'Hères, France)
- 4-5 September Radio Glaciology Workshop, World Data Center-A for Glaciology (Snow and Ice), in conjunction with Third International Symposium on Antarctic Glaciology. The Ohio State University, Columbus, Ohio, USA. (P.K. MacKinnon, WDC-A for Glaciology, CIRES, P.O. Box 449, University of Colorado, Boulder, CO 80309, U.S.A.)
- 7-12 September Third International Symposium on Antarctic Glaciology. The Ohio State University, Columbus, Ohio, U.S.A. Scientific Committee on Antarctic Research of ICSU. Cosponsored by ICSI and the International Glaciological Society. (Dr C.B.B. Bull, Institute of Polar Studies, the Ohio State University, 125 South Oval Mall, Columbus, Ohio 43210)
- 7-16 September International Conference on Hydrology and Rational Water Resources Management convened by Unesco and WMO. Paris, France. (S. Dumistrescu, Director, Division of Water Science, Unesco, 7 Place de Fontenoy, 75700 Paris, France)
- 10-15 September Symposium on Variations in the Global Water Budget. Oxford, England. (Dr F. A. Street, School of Geography, Mansfield Road, Oxford OX1 3TB, U.K. or Prof. R.E. Newell, Department of Meteorology, 54-1520, MIT., Cambridge, Massachusetts 02139, U.S.A.)
- 23-25 September British Branch Meeting, International Glaciological Society. Norwich, U.K. (G.D. Smith, School of Mathematics and Physics, University of East Anglia, Norwich NR4 7IJ, England)

- 28 September 3 October International Symposium on Tracer Techniques in Hydrology. Berne, Switzerland. (Dr Ch. Leibundgut, 4. SUWT, Geographisches Institut, Universität Bern, Hallerstrasse 12, CH-3012 Bern, Switzerland)
- 4-5 November Perspectives on Natural Resources Series: Symposium IV. The Arctic -Resource Development. Sir Sandford Fleming College, Ontario, Canada. (Dr S.H. Watts, Sir Sandford Fleming College, Frost Campus, P.O. Box 8000, Lindsay, Ontario, K9V 5E6, Canada)

1982

March

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

20-23 April

Western Snow Conference first fifty years and a look at the future. Joint Meeting, 39th Annual Eastern Snow Conference and 50th Annual Western Snow Conference. Reno, Nevada, U.S.A. (Bob Brown, Southern California Edison, Box 800, Rosemead, California 91770, USA)

17-19 May

Lake Agassiz Symposium, Geological Association of Canada. (Prof. J.T. Teller, Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada)

19-30 July

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

August

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

21 August - 2 September

Ice Drilling Technology Workshop. University of Calgary, Calgary, Alberta, Canada. (Dr G. Holdsworth, National Hydrology Research Institute, 4616 Valiant Drive N.W., Rm.101, Calgary, Alberta, T3A 0X9, Canada) 11th International Congress on Sedimentology, International Association of Sedimentologists. McMaster University, Hamilton, Ontario, Canada. (IAS Congress, Department of Geology, McMaster University, Hamilton, Ontario, L8S 4M1, Canada)

23-27 August

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

1-9 September

INQUA Conference. Moscow, U.S.S.R. (Dr I.P. Kartashov, Secretary General of the XI INQUA Congress, Geological Institute, USSR Academy of Sciences, Pyzhevsky 7, Moscow 109017, U.S.S.R.)

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

21-23 September

International Symposium on Hydrological Research Basins and their Use in Water Resources Planning. Bern, Switzerland. (Dr M. Spreafico, Landeshydrologie, Postfach 2742, CH-3001 Bern, Switzerland)

1983

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

15-26 August
18th General Assembly of the IUGG.
Hamburg, Federal Republic of Germany.
(P. Melchior, Observatoire Royal de Belgique, Avenue Circulaire 3, B-1180, Bruxelles, Belgium) World Glacier Inventory. Proceedings of the Workshop at Riederalp, Switzerland, 17-27 September 1978, organized by the Temporary Technical Secretariat for the World Glacier Inventory. IAHS Publication No.126, 1980, 351 pp., \$39.00 (US).

The first attempt to organize a world-wide glacier inventory in 1955 was stimulated by the International Geophysical Year. New impetus was given by the International Hydrological Decade, 1965-74, with the publication by Unesco/IAHS of a guide for the compilation of a world inventory of perennial snow and ice masses. In order to coordinate the collection of data ICSI set up a Temporary Technical Secretariat (TTS) in Zürich, Switzerland, under the directorship of Fritz Müller with financial support coming mainly from UNEP and Unesco. In September 1978 a workshop on the World Glacier Inventory was organized by the TTS and held at Riederalp in Switzerland. The papers presented there have now been published in these proceedings.

Topics dealt with at the workshop included techniques of glacier inventory data compilation; difficulties with glacier identification and classification; glacier fluctuations; data storage and retrieval; and analysis of glacier inventories for practical purposes and monitoring climatic change. The progress made towards compiling national and regional glacier inventories and some of the difficulties encountered is explained in the first 30 papers. The remaining eleven papers cover a number of related subjects ranging from cross-sectional shapes of glacier valleys, parameterising equilibrium line altitudes, rock glaciers, effect of climate and topographic orientation on glacier fluctuations, to use of satellite data.

As might be expected from the wide variety of glacier environments there is almost as much variation in style and content of the regional presentations. They start geographically in South America, continue to Canada and Alaska, jump from Greenland to the Himalayas, back through China and the USSR to Europe, cross to Africa and New Zealand ending in Antarctica. Reading through these papers is a form of high level travelogue offering much material and inspiration for those wishing to visit practically any glacierized part of the world. Problems with following the instructions for the inventory are discussed in many of the papers. Some of the most common difficulties somewhat surprisingly seem to be in finding or even defining the equilibrium line altitude (ELA)

and distinguishing between this and the snow line. There is much discussion on the climatological significance of the ELA and its associated parameter, the accumulation area ratio (AAR) defined as the ratio of accumulation to the total area of the glacier. Empirical ways of assessing the two quantities from other inventory data are described by several authors and make one cautious about attaching too much importance to individual results, although statistical methods may help to illustrate trends over wider areas. The close relationship between the World Glacier Inventory and the Permanent Service on the Fluctuation of Glaciers (established by ICSI in 1967 in Zürich) becomes obvious in the papers dealing with climatic and glacier fluctuations. For example changes in mass balance profiles and therefore of the ELA can be used in computer models to show how glaciers would respond to changes in climate. Glacier inventory data are being used by the USSR to help compile a World Atlas of Snow and Ice Resources, while the US Geological Survey is well advanced in the production of a satellite Image Atlas of Glaciers. There is clearly a wealth of information which will soon be available.

In the closing remarks in the final session Professor Uwe Radok, President of ICSI, said that "...it is hardly a secret that some of us did not expect it to be very interesting. Now that it is over there can be no doubt that it was in fact intensely interesting, rewarding and memorable...." The truth of these sentiments is evident in the way in which these Proceedings can be used as a treasure trove - open them almost anywhere and a nugget of fascinating information can be found. This is largely due to the enthusiasm which most authors manage to bring to their presentations (perhaps sometimes helped by strong editing - several papers carry an editorial note that the author's original text was shortened by the editors) and to their dedication to their work, even in one case in the face of hostilities in Afghanistan. Uwe Radock also said in his closing remarks that "Our special thanks should go to Fritz Müller who kept the inventory idea alive through years of arid negotiations and his enthusiasm has now transformed it into a vibrant and dynamic enterprise". Professor Müller's tragic death must be a big setback for the World Glacier Inventory, but judging from this workshop he has managed to get it to a stage where it should now be self-supporting without his unique guidance and dedication.

C.S.M. Doake

Monique Fort. Etudes sur le Quaternaire de l'Himalaya, la Haute vallée de la Buri Gandaki, Népal. Editions du CNRS, Paris, 1980, 210 pp., 70 fr.

The Nepalese Himalayas, formerly one of the most remote mountain regions of the world, have in recent years become not only a popular climbing and trekking region, but an area of increased scientific activity. This monograph reports on an investigation of the Quaternary landforms and sediments in a high south-draining tributary of the Trisuli River, some 250 km west of Mount Everest, in an area dominated by Manaslu, one of Nepal's 8000 m peaks. The report focusses on the glaciers, glacial sediments, and periglacial phenomena of the Sama Basin, the Gya Valley, and the Samdo confluence near the crest of the range. Field studies involving geomorphic mapping were supplemented by laboratory analyses of sediments, including granulometry, petrography, and electron microscopy. Schematic maps and sketches show the disposition of glaciers, end moraines, terraces, and related surficial deposits.

The author identifies two classes of glaciers, those consisting largely of clean ice and those covered by debris; the contrast between the classes is thought to be related to differences in local lithology and exposure. Recent moraines fronting the glaciers were classified as of the "himalayan type" having large morainal walls >100 m high that are modified by proglacial meltwater and outburst floods, and a "transitional type" typical of debris-covered glaciers of the Tibetan flank of the range and characterized by low, irregular dump moraine that is cored by slowly ablating glacier ice.

The chronological results of the investigation are disappointing. Moraines, terraces, and erosional morphology were regarded as indicating an "ancient" stage of glaciation, considered possibly to be of late Pleistocene age, two intermediate events of uncertain but probable Holocene age, and a recent advance marked by moraines fronting the glaciers. No datable organic matter was found, and relative-age criteria presented in the report are inadequate to assess the ages of the deposits with any degree of confidence. However, maps, photographs, and descriptions in the monograph suggest to this reviewer that moraines within about 3-4 km of present glacier termini may be of Neoglacial age and that older deposits and landforms down-valley may be related to one or more recessional phases of the last glaciation. But in the absence of semi-quantitative weathering data, such age assignments are speculative. Soil-profile descriptions and lichenometric analyses no doubt would help shed light on this question.

Inactive rock glaciers occur within the study area and are believed by the author to date to a period when the climate was both wetter and colder and the supply of debris more abundant.

This study provides interesting and useful information about the physical geography and geomorphology of the seldom-visited highmountain country of central Nepal and is therefore an important contribution to the literature of the Himalayas, but it raises a number of questions about the late Quaternary glacial, climatic, and neotectonic history of the area, the answers to which will have to await the development of a well-controlled chronology of events.

Stephen C. Porter

Sea Ice Processes and Models. Proceedings of the Seattle Symposium, September 1977 (Editor R. Pritchard). Hardback edition published by University of Washington Press, 536 pp., \$30, paper back edition, IAHS Publication No.124, 474 pp., 1980, \$35.

This book contains the proceedings of a symposium of the same name sponsored by the Arctic Ice Dynamics Joint Experiment (AIDJEX) and the International Commission on Snow and Ice. Unfortunately for the potential audience, the book does not quite live up to the editor's remark that "they (the papers) represent the state-of-the-art of polar research being performed throughout the world." The main reason the book falls short is lack of timeliness; the papers are 1977 vintage (the year the symposium was held) while the book has a 1980 publication date. During the intervening years, while the editors have been editing and the printers printing, research has proceeded, and the state-of-the art has advanced from what it was in 1977. Several of the 40 papers have appeared in more complete form in various journals. Further belabouring the point, since it is an important one, editors and publishers do not do any field of research a good service by keeping the state-of-the-art buried in what is often dubbed "the gray literature" for three years.

It is a major irony to compare the timeliness and content of this volume with that of the AIDJEX Bulletin, 40 issues of the stateof-the-art in sea ice research. Available continuously from 1970 through 1978, it was always topical, and the editors of this book might have been better advised to use that well-established mechanism for the AIDJEX wrap-up than to have gone to the trouble of producing this book. Several papers are in fact available in more complete form in the last few issues of the AIDJEX Bulletin (Vols 35-40). The interested reader is referred to these issues as well as to the following few references for both more up-to-date versions of the papers given in this volume and papers I consider to be more representative of the current state-of-the-art.

Herman, G.F. and Johnson, W.T., 1978. The sensitivity of the general circulation to arctic sea ice boundaries: a numerical experiment. Monthly Weather Review, Vol.106, No.12, 1649-1664.

Hibler, W.D., III, 1979. A dynamic thermodynamic sea ice model. Journal of Physical Oceanography, Vol.9, No.4, 815-846

Maykut, G.A., 1978. Energy exchange over young sea ice in the central Arctic. Journal of Geophysical Research, Vol.83, No.C7, 3646-3658

Parkinson, C.L. and Washington, W.M., 1979. A large-scale numerical model of sea ice. Journal of Geophysical Research, Vol.84, No.C1, 311-337

Other aspects of the book also leave something to be desired. In the first section, several papers are given that test aspects of the "AIDJEX Model", such as the influence of boundaries, tests of the constitutive law, time-dependence and so forth. In each paper, however, the AIDJEX model appears in quite a different form: constant strengths are used here, one-dimensional forms there, a linear water stress as opposed to the more realistic quadratic water drag law somewhere else. After reading this section, one wants the "real" AIDJEX model to step forward and identify itself.

Some good things happen in Section III, Sea Ice Processes and Observations, where a decent mix of the more recent international work appears. Two papers by Tucker et al. describe some near-shore Alaska ice observations. Peter Wadhams compares two of the more useful tools for ice characterization laser profilometry and submarine sonar pro-

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files — over "corresponding" tracks (note the avoidance of the term "same tracks"). Papers by Squire and Allen, Don Barnett, John Walsh, T. Tabata et al., and Allison and Akerman round out this section and lend some credibility to the claim of an international cast for this symposium, with these participants representing the U.S., Canada, the U.K., Australia, and Japan, and with results from several sea ice regions.

The last section purports to represent the Atmosphere and Ocean but hardly seems representative enough of either medium, with only one oceanographic paper (in general, the oceanographers are conspicuous by their absence from this volume) and with all seven of the atmospheric papers concentrating exclusively on air stress measurements as an input to the sea ice model.

Both the AIDJEX model papers and the Atmosphere and Ocean section are revealing to me as a participant in the 1972 AIDJEX Pilot Field Experiment. Over 80 people were on the ice at that time, covering a wide range of disciplines and studies: ice strain measurements at several scales, deep-water oceanography, air and water boundary layer studies, ice topography and structure studies, heat flux measurements, ocean tilt, remote sensing. Between that time and the main AIDJEX experiment in 1975-76, much similar work was deferred in order to focus on those studies that were necessary for input to the model. This volume, by being deficient in papers on those other aspects, unfortunately accentu-ates what a zenith period the 1972 Pilot Experiment was for sea ice research compared to the main AIDJEX experiment in 1975-76.

S.F. Ackley

AWARDS

Sam C. Colbeck, of the Cold Regions Research and Engineering Laboratory, is the 1980 recipient of the Horton Award of the American Geophysical Union, Section of Hydrology. The citation refers to his well-known and respected research work on the physics of snowmelt and the movement of water in and through the snow cover, to his contributions to the field of snow hydrology through his activities inmany organizations and specifically to the way in which he has been able to help the hydrologic community become better acquainted with the problems and possible benefits from snow hydrology studies. The Award will be presented at the annual meeting in May 1981.

ARTS OF SNOW AND ICE

Mr Kihei Takahashi has presented a copy of his book "Arts of Snow and Ice" to the Society. An accomplished photographer and one of the pioneering avalanche researchers of Japan, he has used his camera to capture the beauty of snow and ice in its natural environment. The text and captions are in Japanese. More information can be obtained from the author at Morioka Bijutsu, 8-2 Saien, Itchyome, Morioka, Iwate-Ken, 020 Japan. Recent drilling experience by the Polar Continental Shelf Project has shown that at the top of the Canadian Arctic islands ice caps there is good accessibility (100 m depth) to ice of 10,000 years age and older. With an electro-mechanical drill a core into Ice Age ice would only take a few days to obtain. A core could therefore be dedicated to one line of research in contrast to the present where it is impossible to accommodate all requests for old (>10,000 years) ice. The hole itself could be used for bulk sampling for trace studies (e.g. ¹⁰Be, ¹⁴C, pollen, etc.) using existing techniques. More than one hole could be drilled at any one location to accommodate various studies. All holes would be at top-of-flowline locations. This note is to determine if there is sufficient interest in the glaciological (or any other scientific) community for PCSP to follow such a program and purchase an electro-mechanical drill. Anyone interested should write to:-R.M. Koerner and D. Fisher,

Polar Continental Shelf Project, 880 Wellington Street, 4th Floor, Ottawa, Ontario, K1A 0E4, Canada

WORLD DATA CENTRE A FOR GLACIOLOGY (Snow and Ice)

Effective January 1, 1981, the Center will be administered through the Cooperative Institute for Research in Environmental Sciences (CIRES), and the offices will be located in Research Laboratories Building 2, 30th Street, Boulder. The new address for the Center is:- WDC-A for Glaciology (Snow and Ice), CIRES,Campus Box 449, University of Colorado, Boulder, Colorado 80309, U. S. A. (tel: (303) 492-5171 or (303) 492-5488)

INTERNATIONAL MOUNTAIN SOCIETY

An International Mountain Society (IMS) has been formed with the objective of achieving a better balance between mountain environment, human welfare, and the development of natural resources by:

- publishing a new quarterly entitled "Mounttain Research and Development";

- holding meetings to focus on specific mountain issues;

- exchanging ideas and experience through the IMS;

- making the IMS's expertise available to various governmental and non-governmental organizations;

- contributing to the training and education

of the world community.

"Mountain" is used broadly to include upland areas with steep slopes at lower elevations.

Officers of IMS include Drs J.D. Ives, C. Jest, H. Löffler, R.G. Barry and M. Plam. There is a governing council of scientists, engineers, architects and administrators representing mountain countries and existing international centres.

Membership is open to all for an annual subscription of \$30, to students for \$18 and libraries for \$45. For further information contact IMS, P.O. Box 3148, Boulder, Colorado 80307, U.S.A.

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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.

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

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ICE

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