NUMBER 55 3rd ISSUE 1977

ICE

TRAVEL FROM LONDON TO OTTAWA, AUGUST 1978

If you wish to travel in our special group—leaving London on 12 August and visiting the Cold Regions Research and Engineering Laboratories in Hanover, New Hampshire, en route to Carleton University for the Symposia on Glacier beds and on Dynamics of large ice masses—

please remember that the last date for booking is 1 MAY 1978.

Details were given in the Second Circular of the Dynamics Symposium (sent to every member of the Society in July 1977 and reprinted in ICE 54).

If you have lost these, or wish to hear more about the special travel arrangements, please write to the Secretary General.

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ICE

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

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CONTENTS

COVER PICTURE. Ablation pinnacles near Fossil Bluff, Alexander Island, Antarctic Peninsula. Their occurrence is associated with differential melting due to the uneven covering of the ice by loose rock debris from the surrounding sedimentary mountains. They are often over 5 meters tall. Photograph by M. Landy, British Antarctic Survey.

RECENT WORK

ARGENTINA

The following activities were undertaken at the Instituto Argentino de Nivología y Glaciología during 1976: glacier inventory, snow and glacier hydrology, rock glaciers, paleoclimatology, avalanche studies, documentation.

GLACIER INVENTORY

For the purpose of the glacier inventory the snow and ice river fed basins of the first order were classified from Tierra del Fuego at 55° S (Río Olivia (A)) to San Juan at 28° S (Río Colorado (J)). For this inventory the following information was used: Unesco, IASH 1970, Müller et al 1976-1977, Post et al 1971.

In addition to these ten basins of the first order, one of the second order has been completed, the river Mendoza basin, with an area of 6 000 km^2. Five per cent of this basin is covered with glacier ice and the other 5% with debris covered glaciers, rock glaciers and ice cored moraines. In charge of this inventory are Lydia E. Espizua, Gladys Reynals de Leiva and Jorge Bengochea.

SNOW AND GLACIER HYDROLOGY

Based on the inventory, two small basins of the high Central Andes were chosen for this project: one in the eastern Andes and another in the Central Andes along the Chilean-Argentine border. This selection was made in order to find out if there are some differences in the response of glaciers located in apparently different zones.

One meteorological station and one stream gauging station were installed in the Eastern Andes basin and the same will be done in the Central Andes basin. Twenty and thirty years of stream run-off data are already available for the Eastern and Western basins respectively. The difficulty of carrying out glacier balance studies at 5 000 m is obvious, and a more expeditious method for these regions is being considered.

In charge of this programme is Juan Carlos Leiva (now in Grenoble), Roberto Bruce and Enrique Buk.

ROCK GLACIERS

A rock glacier is defined as a frozen core composed of various types of ice. The core is totally covered with debris. Rock glaciers are a dominant morphological feature of the high Central Andes between 28° and 38° S. Various types of rock glaciers were identified by means of aerophotographs and field inspection.

Run-off measurements from rock glaciers carried out at the end of the summer were compared with run-off from glacierized areas. It was also observed that for equal areas the rock glaciers are giving 56% of the total flow while the glaciers produce 44% of the total flow. Such measurements are done at the glacier snout. As a first approach, run-off measurements of different types of rock glaciers are being made and planned.

It is observed that the roughened surface of rock glaciers, the thermokarst deposits, the longitudinal bands and the tranversal arches are ideal places in which wind-drifted snow can be trapped.

For the study of the hydrological balance of rock glaciers no methodology is available; we are starting from nothing, and we are learning by trial and error. In this programme several members of the Institute are co-operating with the principal researcher, Arturo E. Corte.

PALEOCLIMATOLOGY

In this programme three projects which supply information on the subject are being developed: dendrochronology, palinology and glacial variations.

Dendrochronology. Under this project, work is being done with the University of Arizona Laboratory of Tree Ring Research. Trees from Patagonia and Chile were sampled, and a chronology of 1 000 years of paleoclimate based on Araucaria Araucana for Northern Patagonia is available.

Palynology. In this project the collection of pollen present is being made from well known Herbariums and field collections of plants.

Glacial variations. When carrying out the field survey for the glacier inventory based on moraine systems, data on glaciations were obtained. So far three Quaternary moraine systems were located. They are named according to their elevation as follows: the oldest and most extensive one is called the glaciation above the level of 2 500 m, the intermediate glaciation is of the level of 3 000 m, and the youngest glaciation is above 3 000 m. These three moraine systems are considered equivalent to the glaciation of the Chilean border in the River Aconcagua reported by Caviedes and Paskoff *(Journal of Glaciology, 1975, Vol. 14, No. 70)*. No radiometric dating is so far available for these moraine systems and for the sequences described below.

Five post-glacial climatic cycles are observed in the upper valleys of the high Andes. The five post-glacial climatic cycles are indicated by protalus ramparts, buried humus layers, and minor glacier advances. The five sequences of the rock glacier stages (i) fossil stage, ii) inactive stage, iii) structural debris stage, iv) thermokarst stage and v) the ice-cored moraines) are considered a consequence of the five cycles of decreasing glacier activity.

In charge of the programme is Arturo E. Corte, with José Boninsegna, Mónica Wingenroth and Liliana Andrada.

AVALANCHES

The international road and railway from Santiago, Chile to Mendoza, Argentina are affected by avalanches during certain winters. Because of the extreme variability in precipitation, in dry winters no avalanches are observed; however, in winters like the present one (1977) avalanches are closing the road continuously after heavy storms.

A map of avalanche active areas was prepared. A small village, Las Cuevas, located in a zone of rock falls and avalanches is being relocated to a safer zone. An expert in avalanche prevention is needed: **Please contact this Institute,** Casilla de Correo 330, Mendoza, Argentina.

Avalanche mapping is helping the location of a new tourist centre at the foot of the Aconcagua in the Horcones Valley.

In charge of the programme is Daniel R. Cobos.

DOCUMENTATION

The Instituto Argentino de Nivologia y Glaciología appreciates very much the donation by his family of the Library of the late Dr. J. J. Heinsheimer, consisting of 100 books and the following technical collections: Anales de la Academia Cientifica Argentina, Argentina Austral, Geotimes, Glaciological Notes, Journal of Glaciology, Polar Forschung, Transactions of American Geophysical Union and others, as well as reprints.

Likewise thanks go to Dr Henri Bader, who presented us with a valuable collection of 50 books and the Journal of Glaciology, SIPRE, CRREL, Institute of Polar Studies collections and reprints.

The British Council has been very kind in giving the Institute 100 scientific books, and shortly the Institute will receive another important donation. The French Embassy also presented the Institute with a valuable collection of books.

The Institute itself has bought a collection of books of recent editions in the field of glaciology and subscribes to various Journals.

In charge of Documentation is Ester C. Car.

A. E. Corte

AUSTRALIA

ANTARCTICA

CASEY IAGP TRILATERATION NET RESURVEYED

The trilateration survey net established for ice movement as part of the International Antarctic Glaciological Project (IAGP) in 1973 from the summit of Law Dome (100 km inland) to 250 km further south was resurveyed during 1975. In addition to astronomical control a U.S. participant, by the courtesy of the U.S. Geological Survey and the N.S.F. Office of Polar Programs, carried out repeat measurements with a geoceiver satellite doppler survey set. The geoceiver and tellurometer net reductions gave close agreement and the surface strains and velocities were accurately determined over the 2-year period.

The maximum surface velocity was obtained as $\sim 150 \text{ m a}^{-1}$ at lat. 68°S. Thereafter the velocity decreased gradually to 70 m a^{-1} by lat. 69°S. The ice velocity was found to fluctuate only slightly over the topographic undulations whereas the strain rates changed greatly.

2 000 m CONTOUR ICE FLOW MARKERS EXTENDED TO ENDERBY LAND

During the 1975-76 season a set of 8 ice movement markers was established using JMR doppler satellite survey equipment on an over-snow traverse from Mawson to Enderby Land. The markers covered a section of about 500 km near the 2 000 m ice sheet elevation contour from south of Mawson to near Sandercock Nunataks in Enderby Land. Along the route, ice thickness was measured with a radio echo sounder, and gravity and accumulation were also measured on route. Surface snow samples were collected for oxygen isotope studies. Strain grids were established around each of the ice movement markers. The resurvey of the markers is planned for the 1977-78 season.

TRAVERSES INLAND OF CASEY 1976

An autumn traverse was carried out along the previous IAGP route to near the 1500 m contour about 250 km inland. A fuel depot was made but a tractor breakdown prevented travel further inland. Marker poles were measured for accumulation, and some markers not previously relocated were repositioned for velocity and strain.

In summer a second traverse over this route was carried out and 4 new offset stations were established, using JMR doppler satellite receivers, about 25 km to the west of the previous markers. The three nearest the Vanderford Glacier were remeasured on the return journey. Elevation, ice thickness, gravity and accumulation were measured en route. The measurements to the offset stations are aimed at clarifying the transition from the high basal shear stress, slow velocity, ice cap flow, to the low stress, high velocity, outlet glacier flow.

AERIAL SOUNDING OF KEMP LAND AND ENDERBY LAND

The aerial sounding programme using a Pilatus Porter aircraft was primarily based at Mt. King in Enderby Land. The bulk of the region between Mawson and Enderby Land as far as about the 2 400 m contour inland has now been sounded to approximately 40 km spacing. The ice thickness is highly variable over the region, characteristic of the mountainous terrain. In future seasons it is planned to obtain more detail by filling in existing gaps and studying flowlines and cross sections of the fast outlet glaciers.

Simultaneous measurements from aerial magnetic sounding was also begun during the season. It is planned that the magnetics will be conducted routinely with the ice thickness sounding in future.

GEODETIC AND GEOPHYSICAL MEASUREMENTS WITH SOVIET TRAVERSE

At the invitation of the Soviet Antarctic Expedition N. W. Young of the Antarctic Division was transferred from the Nella Dan to Mirny to join the Soviet Traverse which went from Mirny to Pioneerskaya and on towards Dome C reaching longitude about 111°E. The equipment taken by him included a JMR doppler satellite receiver, a Lacoste Geodetic gravimeter, digital barometers and a magnetometer. Seven major geodetic locations were established with the JMR. In addition a number of intermediate stations were also established for shorter durations. If these stations can be remeasured during the 1977-78 season accurate inland ice velocities can be determined. On future traverses it is hoped that in addition to the previous equipment, a radio ice thickness sounder can also be operated.

CORE DRILLING ON LAW DOME

During 1977 the main programme based from Casey is core drilling on Law Dome, aimed at defining the flow properties and crystallography of the ice along a flowline from the summit to the coast. The cores also serve to show the variation of properties with depth in comparison with present values along the surface of the ice cap, such as isotopes, gas volumes, chemical content and particulates.

A resurvey of the 1974 350 m deep hole near Cape Folger in March 1977 for inclination revealed an increasing shear rate with depth to the zone where the ice has basal planes predominantly horizontal and thereafter a decrease to a relatively stagnant layer of ice with very large crystals and multiple maxima crystal orientation fabrics in the lowest 20% of the thickness. This result is in agreement with the conclusions derived from shear tests on the ice cores and also from the pattern of observed bubble elongation.

The crystal fabrics from other boreholes plus the results of recent echo sounding, showing internal layers, suggests that the phenomenon of a relatively stagnant basal layer of ice might be quite widespread.

A new hole was cored from April to June 1977 about 40 km upstream of the previous deep hole to a depth of 430 m where the ice thickness is about 800 m. This depth is a new record for our 500 m drilling rig. Core recovery was high and the hole was filled with fluid and logged for temperature, inclination and diameter.

During the spring-summer season it is planned to core a new hole at the summit of Law Dome where it is expected that annual layers can be traced back about 1000 years.

LABORATORY AND MODELLING STUDIES IN AUSTRALIA

The measurements of the flow properties of isotropic (randomly orientated) polycrystalline ice over the stress range .05 to 3 bars and temperatures 0 to −50°C are continuing. The main problem has been the long time required to reach a steady state or minimum creep rate. Tests have been generally carried on for several thousand hours and one test at −18°C with 1.3 bars octahedral shear stress for almost 2 years. A special set of tests including higher stresses has been started to clarify the time taken to reach minimum creep rates.

A third set of tests on the flow of anistropic ice has been completed. The ice from the Cape Folger ice core has been subjected to the range of shear stresses and temperatures encountered in situ in comparison with the laboratory-made isotropic ice. Excellent agreement has been found between the laboratory results and the shear rates measured in the borehole.

A fourth set of tests is aimed at examining the flow properties appropriate for temperate ice by measuring strain rates as a function of temperature approaching −0.02°C.

The ice sliding studies have been extended up to normal loads of 40 bars and shear stresses up to 2 bars.

Numerical modelling studies have been carried out to investigate the implications of the laboratory determined ice flow properties for the ice flow along the IAGP line inland of Casey in comparison with the measured surface velocities.

The laboratory sliding results are being used to model the transition to fast sliding of the outlet glaciers.

W. F. Budd

BELGIUM

SWITZERLAND

LEAD ISOTOPES IN ICE

The lead isotopic composition of recent snow and glacier ice older than 80 years was determined in a Swiss glacier (Tsanfleuron). This programme was carried out to investigate possible variations in isotopic composition of atmospheric lead during the last century, due to industrial development and automobile traffic increase. Preliminary results indicate an increase in the course of time of lead concentration and a variation in the isotopic composition of this element. The isotopic composition of recent snow is similar to that of aerosols collected on atmospheric filters in Switzerland; the isotopic composition of glacier ice older than 80 years is similar to that of present-day mean crystal lead. The team is composed of E. Picciotto and D. Petit at the Université Libre de Bruxelles.

CHEMICAL COMPOSITION OF BASAL ICE FROM ALPINE GLACIERS

Several Swiss glaciers have been investigated to provide information on the origin of the basal ice layer. A paper on this subject will soon appear in the *Journal of Glaciology*. In cooperation with B. Hallet from Stanford University, the composition in major elements of the basal layer from an alpine glacier sliding over limestones (Tsanfleuron) was determined. Results are in agreement with the theoretical developments Hallet carried out. A joint paper has been accepted in the *Bulletin of the Geological Society of America*. The Belgian team is composed of R. Souchez, R. Lorrain and J. L. Tison.

ARCTIC CANADA

CHEMICAL COMPOSITION OF ICE AT THE BORDER OF ELLESMERE GLACIERS (ARCTIC CANADA)

In connexion with a Geological Survey of Canada field party at Mackinson Inlet in South-Eastern Ellesmere Island, R. Souchez and R. Lorrain spent part of the 1977 summer taking samples of ice at the border of several glaciers in order to determine the role played by deformed superimposed ice which can be chemically differentiated.

R. Souchez

DENMARK

ICELAND

A Danish Glacial Geomorphological-Sedimentological Expedition worked in Iceland during the 1977 summer. It was organized by the Geomorphological Department of the Geographical Institute of the University of Copenhagen, with 5 members under leadership of Ole Humlum and Johannes Krüger. The Expedition wishes to acknowledge financial assistance from the Danish Natural Science Research Council, and Dr. Sigurdur Thorarinsson, Reykjavik, for assistance with preparation of the expedition.

The investigations were concentrated on the margin and foreground of Höfdabrekkujökull and along the northeastern margin of the Myrdalsjökull ice cap. In spite of bad weather conditions, a lot of geomorphological and sedimentological data comparable with features studied in the Danish glacial landscape were collected.

The programme included the following investigations: (1) Höfdabrekkujökull: inglacial transportation, dead ice topography in old as well as active stages, ice-cored push moraines, and genesis of lodgement till and flow till. (2) Northeastern margin of Myrdalsjökull: detailed geomorphological mapping (1:10 000) of the glacier foreland between Maelifell and Öldufell, topographical survey of the present day ice margin and levelling of the longitudinal profile of the nearly 20 km broad glacier lobe, extensive areas of ground moraine with flutings and drumlins, systems of pushed ice marginal features, rate of frontal deglaciation based on field studies and air photo interpretations (1937 and 1960), and genesis of lodgement till.

It is planned to continue the investigations in the years to come.

J. Krüger

FRANCE

LABORATOIRE DE GLACIOLOGIE DU CNRS

The name of this public institution was "Laboratoire de l'Aiguille du Midi" from 1959 to 1964 and "Laboratoire de Glaciologie Alpine" from 1964 to 1969. It is one among the about 150 "Laboratoires propres" of the French National Center for Scientific Research (CNRS). Its staff is to-day, including undergraduate students, about 60 people.

Its director, Professor L. Lliboutry, is assisted by a scientific council of 6 members of the staff. A directorate examines the results and needs once a year: it includes the scientific director of the CNRS for the branch "Earth and Marine Sciences" (presently Professor J. Delhaye), Professor P. Morel (former head of the laboratory of dynamic meteorology of Paris), Professor P. F. Gobin (head of the laboratory of metallurgy of INSA, Lyon), Dr. J. Labeyrie (head of Centre des Faibles Radioactivités, Gif-sur-Yvette), Dr. J. -P. Bloch (Scientific director of the French Austral and Antarctic territories), and three delegates from the National Council for Scientific Research representing the sections 4 (mechanics), 14 (internal geophysics and structural geology) and 16 (atmosphere and oceans) respectively.

One half of the laboratory is located in an old building of the University in the town and the other half is on the new campus. The laboratory, together with a seismological laboratory under the leadership of G. Perrier, contributes to a teaching in geophysics at the level of mastership (4th year at the University) and DEA (5th year), and allows the preparation of "thèses de 3e cycle" (Ph.D.) (2 years more) and "thèses d'Etat" (at least 5 years more). Two options exist: internal geophysics and environmental geophysics, the latter including meteorology and glaciology. Starting in 1978, a two-year training in glaciology alone (DESS de glaciologie) will also be possible. This last one is specially created for foreign students, since French avenues for glaciologists are of course quite narrow.

PROJECTS IN ICE PHYSICS

Lattice defects in monocrystalline ice (J. Klinger, G. Rochas, in collaboration with Dr. Perez and others from INSA, Lyon.) Ice monocrystals of high quality are obtained with a Bridgeman crystallizer and by zone melting. With facilities given by the Centre of nuclear studies of Grenoble, equipment to measure thermal conductivities down to 0.4°K has been built. The first results were presented at the International Glaciological Society's Symposium on physics and chemistry of ice, Cambridge 1977. Thermal conductivity appears to be the most sensible tool to check the quality of the crystal lattice.

Absorption of CO_2 by snow (J. Klinger, J. Ocampo.) It is well known that the CO_2 content in polar ice cores is abnormally high. Work is in progress to examine the process which is involved.

Creep law of polycrystalline ice (P. Duval, A. Chaillou.) The laws of transient, secondary and tertiary creep have been studied for effective stresses in the range 0.5-3.7 bars up to melting point. Ice fabrics were determined before and after deformation and, when the creep was made at melting point, the liquid water content measured.

When the deformation is not simple shear, the peculiar pattern of the optic axes observed in most glaciers forms during tertiary creep, and is then not destroyed by simple shear, although it is less favourable for deformation than the pattern formed from isotropic polycrystalline ice by simple shear. Oscillations in the rate of tertiary creep are often observed. The mean rates of deformation during permanent creep obey Glen's law with n = 3. The apparent viscosity at melting point is dependent on the liquid water content.

Transient creep is observed when $\tau_2 \tau'_{ij}$ increases, and not merely when τ'_{ij} increases. Superimposed to Andrade's creep, there is a reversible creep, logarithmic at first but coming to a stop, which is proportional to the stress and rather independent from temperature. We call it "pseudo-elasticity". It affords reversible deformations which are one order of magnitude larger than classical elasticity (the one involved in sound transmission). According to Duval it comes from reversible motion of the low angle boundaries within individual crystals.

These results were presented during the IUGG Assembly in Grenoble, at the European Geophysical Society Symposium on temperate glaciers in Munchen, at the IGS Symposium on physics and chemistry of ice at Cambridge and at a Gordon Conference on plasticity at high temperatures. Two other publications were made for *Annales de Géophysique* and *Journal of Glaciology*. More work is in progress, with a research grant from CNRS.

P. Duval is a member of the team at Dome C (see below) in order to study the ice fabrics of the cores of very cold ice before any recrystallization during storage.

PROJECTS IN GLACIER STUDIES

Laboratory simulation of glacier sliding (R. Brepson, J. Meyssonnier, G. Marec, A. Manouvrier.) The old machine "Pénélope" has been put in our new cold room at 0°C and considerably improved. R. Brepson is drawing up all the results obtained. He has elaborated a highly sophisticated numerical computation (by finite difference method with curvilinear coordinates) of the stresses and strain rates to be compared with measured data.

A grant from CNRS has allowed the construction of a new machine, "Télémaque", which will be operative in 1978. Its device was made by J. Meyssonnier, which tackles also the numerical computation of the strain rates, using this time the finite elements method.

Sliding theory and glacier dynamics (L. Lliboutry, J. -P. Benoist, C. Ritz.) Consistent advances have been made on a glacier sliding theory by L. Lliboutry, with a bedrock model similar to Weertman's one (hemispheres of any size at random on a plane). The autonomous regime of leeward cavities is shown to be unimportant. The law which is found with this model predicts, for instance, the measured seasonal fluctuations of velocity at Glacier d'Argentière.

When the hemispherical knobs are no longer on a plane, but on an undulating surface, instabilities and surges may occur. The main parameter of the bedrock microrelief is not the spectral power density as in Nye and Kamb's theory, but the shadowing function. By numerical simulation of random profiles Benoist has shown that Smith's shadowing function is independent of the self-correlation (i.e. of the spectral power density). He has collected field data on glacial bedrocks.

These results are given in 3 papers submitted to *Annales de Géophysique* and will be presented at the NRC Symposium on glacier beds in Ottawa 1978.

Annual balances, glacier fluctuations and velocities on Alpine glaciers (L. Reynaud, C. Carle, Y. Morin.) Annual balances were measured for the 20th consecutive year on Glacier de Saint-Sorlin. Other French Alpine glaciers under study by Laboratoire de Glaciologie are Mer de Glace, Glacier d'Argentière (under contract EDF), Glacier des Bossons and Glacier du Tour in the Mont Blanc area.

S. Martin (now in the climatology team of Professor C. P. Péguy, dealing with solar energy potentialities) has found a better correlation between annual balances and meteorological data than the one already published in the *Z. für Gletscherkunde und Glazialgeologie*. It allows a reconstitution of all past annual balances in the French Alps since 1882. On this basis, the variations of transverse profiles recorded on Mer de Glace since 1890, Glacier des Bossons and d'Argentière since 1904 can be explained. Correlations of the observed profiles with the annual balances of previous years show that kinematic waves are formed in the areas where the glacier is thin and swift, in a similar way as wave ogives form yearly in a glacier fall (as explained by Nye). The front of Glacier des Bossons reacts sooner than the one of Mer de Glace not because it is swifter, but because the area where waves are formed is much nearer the snout.

Kinematic waves on Mer de Glace have been studied in detail by L. Reynaud. All these results were presented at the EGS Symposium on temperate glaciers in Munich.

Seismic and gravimetric exploration of glaciers (M. Vallon.) A map of the bedrock under Glacier Ampère (Cook Ice Cap, Kerguelen Islands) has been presented at the Symposium of Munchen. All the know-how gathered during 9 seismic surveys done since 1960 is given in the article to be published in *Z.G.G.* (in French). The last seismic survey was made on Glacier d'Argentière, upstream of the area already explored in relation to the Emosson hydroelectric project, under contract of this agency.

STUDIES OF PALAEO-ENVIRONMENTS FROM ICE-CORES

Boring, coring and bore-hole measurements (F. Gillet, D. Donnou, C. Girard, H. Ménétrier, C. Rado, G. Ricou.) The different equipment for shallow boring (to insert ablation stakes), deep boring (to measure glacier thicknesses), shallow and deep coring which were developed at the laboratory have been described by F. Gillet in *Journal of Glaciology* and *Ice-Core drilling* (Splettstoesser ed., Univ. of Nebraska Press, 1976). A caliper and a small and very accurate inclinometer for borehole surveys have been developed by C. Rado.

D. Donnou, J.-F. Pinglot, C. Rado and G. Ricou will try to core down to 1 000 m at Dome C, eastern Antarctica, this austral summer. The French glaciological team of this IAGP project includes as senior scientists C. Lorius (leader), P. Duval and Martine Briat (the first French woman on the Antarctic Ice cap). This project should have been done during the 1976-77 Austral summer, reaching Dome C by land, but late pack-ice prevented the ship from reaching Dumont D'Urville before January, and then to reach the coast by boat. This year the NSF will transport the team by air in November, starting from McMurdo airport.

Shallow coring will be done also during the 1977-78 summer at South Pole Station (J.-R. Petit, M. Pourchet) with NSF support and on Ross Ice Cap, near Marambio, Antarctic Peninsula (R. Delmas, A. Aristarain), with support from Instituto Antarctico Argentino (a contribution to IAP).

Accumulation and temperatures in recent times (C. Lorius, R. Delmas, J.-F. Pinglot, M. Pourchet.) Current studies on shallow cores at the laboratory include visual stratigraphy and beta-radioactivity profiles. Deuterium and tritium profiles, as well as Pb 210 dating are made at the Centre d'études nucléaires de Saclay and at centre des Faibles Radioactivités de Gif-sur-Yvette. This is a co-operative project (RCP 176) under the leadership of C. Lorius. Four papers on the results were presented at the IASH Symposium on Snow and Impurities in ice (Grenoble, 1975).

Accumulation along two profiles, one in Terre Adélie from Dumont D'Urville to Dome C, another in Greenland from "Carrefour" to "Crête" is by now well known. The variations of accumulation during the last 60 to 20 years are known in many places.

Palaeo-altitudes from air content of ice-cores (D. Raynaud, B. Lebel, M. Paillet.) First results of this important achievement were presented in 1975 at the IASH Symposium (2 papers) and at the Cambridge workshop. A good correlation between the air content of polar ice and the altitude and temperature of the site where the close-off happened has been established.

Raynaud's equipment allows a measure of the air content in samples of 20 cm^3 of ice. Ice cores from Camp Century, Byrd, Vostok, Devon Island and Law Dome are analysed.

Trace elements (C. Boutron, M. Briat, R. Delmas, A. Aristarain, M. Legrand, C. Cornish.) The laboratory is now able to give significant figures for concentrations of the order of 0.01 p.p.b. (10^{-11}). Fantastic precautions are needed, of course: for instance, the washing of a flask needs seven successive operations and lasts a whole week. The ultimate analysis is done by atomic absorption spectrometry (C. Boutron), neutronic activation (M. Briat) or ionometry (R. Delmas).

Progress has been made since the IASH Symposium. In his "thèse d'Etat", C. Boutron has studied the concentration of twelve trace elements in Antarctic cores. The titration of sulphates is now operative. Their variations with time do not rule out a purely volcanic, not industrial, origin.

For the third season snow cores have been taken at the top of Mont Blanc to monitor the atmospheric pollution during the last 20 years. At this altitude in the Alps there is never melting, and pollution from local industries becomes insignificant.

Microparticles (J. -R. Petit.) Seasonal fluctuations of microparticles have been found in snow samples from the South Pole. Work to identify more distant events is in progress.

PROJECTS IN ATMOSPHERIC SCIENCES

Heat transfer and heat balances (A. Poggi, J. -C. Leiva, G. Zerva.) The data from the higher micrometeorological automatic station on Glacier Ampère (Kerguelen Islands) have been analysed. Similar studies will begin on Glacier du Mont de Lans (French Alps), a relatively large ice cap which previous corings have shown to lie almost entirely in the regelation zone.

Heat and vapour transfer on grass-covered soil is also studied together with hydrologist G. Vachaud.

Katabatic wind in Terre Adélie (A. Poggi, P. -L. Blaix, D. Delaunay.) The study of the effects of katabatic winds on the coastal heat budget in Adélie Coast will start during austral summer 1977-78. A network of five meteorological automatic stations with satellite telemetry and 20 m towers will be settled on the continent and in the sea in the vicinity of Dumont d'Urville in 1979 and 1980. This project is carried out in collaboration with the University of Alaska and NSF. The American network of 3 automatic stations will be from "Dome C" (1 000 km inland) to 100 km inside the continent.

Study of hail (P. Admirat, J. -C. Grenier, F. Mezeix, S. Zaïr, M. Renouf, G. Desroziers.) R. Montmory, who studies the process of ice nucleation on silver iodide, has left the laboratory. His former group works now on hail showers, with funds from the Department of Agriculture. It participates in an international (Swiss-Austrian-French-Italian) check of the Soviet method for hail prevention known as project *Grossversuch IV*. The Grenoble group studies the statistical parameters of hailstones sampled at the ground, to see if there are significant changes, in a double-blind experiment.

L. Lliboutry

ICELAND

In June 1976 and 1977, the Iceland Glaciological Society sent expeditions to Vatnajökull to carry out geodetic surveying and measure the height of the water level in the Grímsvötn caldera in order to predict when jökulhlaup on Skeidarársandur is likely to occur. This is now of importance for the Road Authority because of the road across the sandur. A jökulhlaup from Grímsvötn began in late September 1976. While this jökulhlaup was going on Helgi Björnsson and Magnús Hallgrímsson went to Grímsvötn and measured the successive lowering of the lake level and studied changes of the glacier surface. The discharge of the jökulhlaup on Skeidarársandur was measured by Sigurjón Rist. The bridges that were finished in 1974 withstood the jökulhlaup and were only slightly damaged.

In June 1976 a group from the Science Institute, University of Iceland, carried out radio echo sounding work on Vatnajökull, surveying the outlet area of the Grímsvötn caldera and a profile from Grímsfjall to the W edge of Vatnajökull.

In August 1977 Björnsson and his assistants also surveyed the central part of Myrdalsjökull, which is an ice-filled caldera. The work on Myrdalsjökull is very important for a better understanding of the subglacial volcano Katla which has shown signs of being likely to erupt in the near future. The Loran-c system was used for navigation on the glacier, using signals from Snaefellsnes, Jan Mayen and the Faroe Islands, and a satellite navigation equipment designed and constructed at the Science Institute proved successful. The equipment is an improved make of a Cambridge University equipment that was tested on Vatnajökull in a joint British-Icelandic expedition in June-July 1976. The transmitter consists of a thyristor which discharges a capacitor of approximately 300 ns, a peak power of 7 kW and the repitation rate is 1 KHz. The antennae are broad banded dipoles and the full length is 30 m. The receiving antenna is loaded with resistors, but the transmitting antenna is loaded with a specially designed combination of resistors, inductors, and diodes. This type of transmitting antenna is ten times as effective as a purely resistively loaded antenna.

The receiver consists of a phase linear band pass filter, 2-5 MHz, and a video amplifier which drives a delay line. The output of the delay line modulates the intensity of the beam of the oscilloscope. The x-sweep of the oscilloscope is controlled by a trigger circuit and a digital analog converter sweeps the Y-direction. A 35 mm reflex camera was mounted on the oscilloscope. Preparations are now made for recording the data on magnetic tapes.

Records on jökulhlaups and glacier variations have been kept by S. Rist. Longitudinal glacier variations were measured at about 40 localities. Most of the glacier margins are still retreating. In 1976 a northern outlet of Langjökull and outlets on the W side of Hofsjökull surged. In early July 1977 the first signs of a surging of Dyngjujökull (crevassing of its accumulation area) were observed and in late August its front began to advance.

Several foreign expeditions carried out glaciological work in Iceland:- from Cambridge University (radio echo sounding on Vatnajökull), University of East Anglia (glacial geomorphology on Breidamerkursandur), British Schools Exploring Society (surveying on Gljúfurárjökull), Young Explorer's Trust (North Iceland Glacier Inventory), Brathay Exploration Group (glacial geomorphology in SE Iceland).

The number of members of Iceland Glaciological Society is now ca. 500. Two new huts have been built by the Society and put up on Vatnajökull, one in the nunatak area Esjufjöll, and the other in western Kverkfjöll. Each hut has sleeping berths for 12 persons.

The journal *Jökull,* which the Icelandic Glaciological Society has published since 1951, will from 1978 on be published by the Society and the Geoscience Society of Iceland.

The next meeting of the Nordic Branch of the International Glaciological Society will be held at Kirkjubaejarklaustur in South Iceland, 17-25 June, 1978.

Sigurdur Thorarinsson
Helgi Björnsson

ITALY

The disastrous Italian economic situation has been heavily felt in the research work and in the glaciological studies that have been severely cut down. Lesca began new measurements on the Miage Glacier (Mont Blanc Group) and studies by Landsat satellite shots. Zanon went on with his studies on the mass balance of the Careser Glacier.

The yearly surveys of the glaciers are carried on by the Operators, but the bad weather conditions that are getting worse and worse from year to year make them very difficult. From 1977 part of the surveying is carried on by photogrammetrical surveys.

In July 1977 the *"Bollettino del Comitato Glaciologico Italiano—Rivista di Glaciologia"* no. 24 and no. 25 have been published.

C. Lesca

ANTARCTIC

Glaciological Research made by the 17th Japanese Antarctic Research Expedition Party, (JARE): Masaaki Wakatsuchi (Institute of Low Temperature Science, Hokkaido University, ILTS) who joined the 17th JARE, observed the mode of brine convection occurring underneath growing sea ice near Showa Station, at 69°.0 S and 39°.6 E, from March 1976 to January 1977. Since the sea surface near the station was already covered with ice as thick as 2 m, by removing sea ice of 5 m x 5 m in area, he made a square pool in which the free seawater surface was exposed to the atmosphere. After the surface began to freeze in the pool, he measured the vertical distribution of brine concentration in seawater from underneath the growing sea ice to the bottom 50 m in depth. He found that a concentrated brine which was rejected at an interface between a growing ice body and seawater was transported downward to the bottom by gravity, while part of the rejected brine diffused laterally at the depth of about 20 m. He also observed that seawater was supercooled to the temperature of −0.2°C when the growth velocity of sea ice was reduced.

Fumihiko Nishio of the National Institute of Polar Research, NIPR, Tokyo, measured the annual accumulation of snow at Mizuho Camp at 70°.42 S and 44°.17 E in combination with the observation of meteorological elements, whereby he reported that the accumulation of snow around the camp is primarily produced by cyclones which come up from the sea. His measurements disclosed the relative humidity around the camp to be 50 to 60% under the influence of the katabatic wind, which increased to 60 to 75% when a cyclone arose. Nishio also observed icequakes around the camp, as they occurred in snow layers 5 to 6 m under the surface only when the air temperature lowered rapidly.

The finding of many meteorites in a limited area near the Yamato Mountains has led to the conclusion that they were buried in the ice sheet long ago and emerged again at the ice surface near the mountains after a long journey through a glacier flow. According to the calculation made by Takeshi Nagata of NIPR, it took roughly 10^5 years for the meteorites to travel the glacier from the burial site to the emergence site. Shinji Mae (NIPR) calculated the sliding velocity of the ice sheet at the bed around Mizuho Plateau to be approximately 10 m/year.

Glaciological Research conducted by the 18th JARE led by Kou Kusunoki of NIPR: Concentration of microparticles in the air and snow were measured in connexion with climatological implications at Mizuho Camp. In order to compare microparticles contained in snow and ice with those suspended in the atmosphere, approximately 1 m^3 of air was sucked through a membrane filter 0.45 μm in pore size to collect aerosols suspended in the air while samples were taken extensively from newly deposited snow dunes and aged glazed ice surfaces. Sampling work was made every three days.

Yoshiyuki Fujii of NIPR conducted mass and heat balance studies under Kusunoki's supervision. Daily changes of sublimation and condensation of water vapor on the surface of snow were measured by 9 stakes grids installed in a glazed ice surface. The analysis indicated that until 25 April sublimation predominated over condensation, which was reversed thereafter. The stake measurement suggested that the condensation would amount to about 10% of the total annual accumulation. Ice-filled pans, 10 cm in diameter, were buried at the glazed ice surface and weighed every day for measurement of the rate of evaporation or condensation from the surface. The result indicated the predominance of condensation over evaporation during the winter season. To measure the net annual accumulation of snow, 201 snow stakes were installed at an interval of 1 m in the direction of prevailing wind. Besides, approximately 100 m^2 of the snow surface were photographed every 10 days to observe the surface morphology. The photographs are subjected to an analysis as to the processes of wind erosion and deposition on the snow surface. At the end of the austral summer, the surface of the snow was flat and stable, though it was disturbed in March by many storms which occurred at that time. The temperature profile of snow near Mizuho Camp was measured in a vertical bore 150 m in depth drilled in 1972.

NEPAL HIMALAYA

Glaciological and meteorological observations of glaciers in the Nepal Himalayas have been made by Keiji Higuchi and his colleagues of Nagoya University with the permission of and in co-operation with His Majesty's Government of Nepal. Chotaro Nakajima of Kyoto University joined this research expedition. The observations conducted in 1976 were: 1) Glaciological observations on Khumbu, Kongma, Kongma Tikpe, E9, and Gyajo glaciers in Khumbu Himal as well as on No. 1, No. 2A and No. 2B glaciers in Shorong Himal. 2) Meteorological measurements at Lhajung Station 4420 m above sea level in Khumbu Himal until 5 October 1976; meteorological data were obtained for 3.5 years starting April 1973; meteorological observations were conducted at Base Camp 4 900 m above sea level near Dudh Kund Glacier in Shorong Himal from 15 June to 20 September 1976. 3) Traverse observations carried out in the basin of the Dudh Kosi River and the Dudh Kund area. 4) Areal observations in Khumbu and Shorong regions. The results obtained by this expedition have been compiled and published in English in 1976 as a special issue of *Seppyo*, Journal of Japanese Society of Snow and Ice, Vol. 38, 1976. This issue is entitled "Glaciers and Climates of Nepal Himalayas". Glaciologists who are interested in it should write to Keiji Higuchi.

SNOW HYDROLOGY

Since typhoons and warm air streams from the Pacific Ocean release much rain on Japan throughout summer, little attention has been paid to the contribution of snow in winter as one of the water sources. Recent industrial developments of this country have called for investigation of the precise amount of snow deposited in the mountainous regions in Japan, for which a co-operative research project has been organized in relation to IHP, International Hydrological Programme. Keiji Higuchi of Nagoya University and many scientists and glaciologists from universities and institutions from Hokkaido to Honshu are taking part in the project. The names and altitudes of mountains subjected to snow surveys under this project and the individual universities concerned are: Mt. Daisetsu, 2 230 m, ILTS, Hokkaido University; Mt. Iwaki, 1 625 m, Hirosaki University; Mt. Gassan, 1 980 m, Yamagata University; Mt. Tanigawa, 1 967 m, Niigata University; Mt. Hakusan, 2 702 m, Fukui University; Mt. Tateyama, 3 015 m, Nagoya University; Mt. Hotaka, 3 190 m, Shinshu University; Mt. Hira, 1 100 m, Kyoto University; Mt. Daisen, 1 713 m, Yamaguchi University and so forth.

Heat and mass balance studies of snow deposited in Moshiri Basin in the northern part of Hokkaido have been made by Kenji Kojima et al of ILTS in relation to snow hydrology. Takahiko Uematsu and Daiji Kobayashi (ILTS) studied a relation between the rate of discharge of meltwater from snow and the temperature of water in a creek flowing underneath the snow cover. According to their observation, the temperature of water in the creek was $+5°C \sim +6°C$ despite the fact that the whole area of the basin was still covered with thick wet snow. In the melting season, the meltwater partly flows on the ground surface and discharges itself directly in the creek, and partly penetrates into the ground where, by raising the level of underground water, it accelerates the discharge into the creek. They reported that the rate of discharge of warm underground water into the creek exceeded the rate of discharge of cold meltwater which flowed down on the ground surface.

ENVIRONMENTAL STUDY OF SNOW IN URBAN AREAS

The distributions of both snow accumulation and snow melting in Sapporo City, with a population of 1 200 000, and its environs have been measured by Hideaki Aburakawa et al of ILTS. It is most likely that the accumulation mode and snow melting rate in urban areas are significantly modified by human activities. Many snow stakes were installed in the open places in this city and its environs intact by vehicles. They found that the average values of snow accumulation and snow melting rate measured in the central part of the city were lower than those measured in the environs. In the environs, the melting snow rate was always higher in the leeward area than in the windward area, suggesting that the excess heat released from the city is transported by winds and accelerates the melting of snow in the leeward area.

AVALANCHES

Masayuki Ishikawa et al of Forest Experimental Station, Tokyo has studied a relation between a snow glide and vegetation on a slope. A steel fence, 2.5 m in height and 9.1 m in length, was installed perpendicularly to the fall line to arrest the glide of snow on the slope covered with thick Miscanthus Sinesis, susuki in Japanese, which is a common grass having long blades 1 m in length. In order to study the resistance of this grass against the snow glide, the slope was divided into two sections; namely before the snow fall susuki stands were cut and their stubbles were left on the one section, whereas stands on the other section were left intact. Many pressure gauges were attached to the fence to measure the pressure created by a snow glide. The value of pressure induced on the fence installed on the latter was 3 times higher than that on the former. This experiment suggested that the short susuki stubbles resisted the snow glide but the long susuki blades which fell down on the ground provided a snow cover with an easy glide bed.

Yasoichi Endo and Eiji Akitaya of ILTS have studied the mechanism of the glide of snow lying on the slope covered with thick bamboo grasses (Sasa Paniculata) which have strong stems 1 m in length and hard evergreen leaves. They observed how bamboo grasses resisted the snow glide from the beginning to the middle of winter. When buried in snow with the stems partly fallen, the bamboo grasses brought about a very low glide velocity. As the glide velocity of snow increased, more numbers of stems fell down, resulting in an increase in the glide velocity. They observed the occurrence of a slab avalanche at places where they had pulled out from and laid on the slope the entire stems and leaves of the bamboo grasses.

Okitsugu Watanabe et al of ISIS, Nagaoka have investigated the distribution of percentage of thickness of coarse-grained snow against the total depth of a snow cover in Niigata Prefecture with special reference to an avalanche occurrence. In this prefecture, the grain coarsening of snow primarily takes place as the result of repeated series of melting and freezing in snow because of the comparatively warm climate in winter. They reported that the occurrence of a ground avalanche is closely correlated to the increase in the percentage of thickness of coarse-grained snow. Extensive studies have been made in ISIS, Nagaoka to find economical protection devices against avalanches.

Hiromu Shimizu et al of ILTS and Masayuki Nakagawa et al of Toyama University have studied the impact pressure of an avalanche against structures in Kuroba Canyon, Toyama Prefecture, using an automatic recording system and movie cameras. A typical result obtained in 1975~1976 was that the maximum values of impact pressure and flow velocity of avalanches were 28 tons/m^2 and 25 m/sec respectively. They measured simultaneously the change of barometric pressure caused by powder avalanches and reported that the depression of barometric pressure from the normal value was 12~15 mb.

Fluidization of snow associated with avalanches is an interesting problem in avalanche dynamics. When a powder avalanche occurs, fragments of snow burst forth in the air like a smoke or cumulus cloud. A theoretical approach to fluidization of snow was made by Zyungo Yosida, former ILTS member. He calculated the critical air velocity required to lift up snow flakes from the snow surface into the sky, assuming that no adhesive force acts between flakes and that the air flow which lifts up flakes is created by a sudden drop of barometric pressure. The value of critical air velocity obtained for new snow with the porosity of 90% was 50 cm/sec.

SEA AND LAKE ICE

While the surface temperature of sea ice or lake ice follows rapidly the change of the ambient air temperature, the temperature in lower subsurface layers does not. Therefore the thermal expansion or contraction in the surface layer must be constrained by the lower layers. If a constraint due to the lower layers is removed, one can measure the thermal stresses acting on the ice surface. Nobuo Ono of ILTS measured the thermal stresses created in sea ice and lake ice by cutting an ice slab from the surface, allowing it to expand or contract as the result of the sudden release of the constraint, and measuring change of distances between the pins, which were carefully driven in the ice surface, before and after the removal of the ice slab from the surface. The value of constrained stress he obtained was approximately 0.7 kg/cm^2 for sea ice and 14 kg/cm^2 for fresh lake ice. Isao Yamaoka of the Faculty of Engineering of Hokkaido University measured the vertical distribution of thermal stresses created in ice at Lake Daisetsu, an artificial lake in Hokkaido for electric power generation. In winter the surface of the lake freezes completely and ice developed to 60~80 cm in thickness exerts a large force on the dam walls and water gates. Three pressure gauges and three thermocouples were embedded within the ice layer at the depth of 3.5, 8.5 and 13.5 cm from the surface. The maximum value of thermal stress, 5.4 kg/cm^2, was observed at the depth of 8.5 cm.

Isao Takashi et al of Seiken Reiki Company carried out laboratory work on the brine distribution in sea ice to clarify differences of the values of distribution coefficient of solute entrapped in ice among different methods applied as to the presence and absence of convection and among different freezing rates. They reported that the value of the distribution coefficient of solute in ice grown from an NaCl solution, 3% in concentration, increased with the increasing freezing rate and that the value was always lower when solute molecules rejected at the interface between the liquid and solid were diffused into the solution by the aid of convection, in comparison with that obtained when the solute molecules were diffused into the solution without causing any convection near the interface. For 1.2 mm/h in the rate of freezing, the value of distribution coefficient of solute entrapped without and with convection was respectively C.626 and 0.196.

SNOW ENGINEERING AND MECHANICS

Trafficability of vehicles on snow presents practical problem in areas abounding in snow. Hiroshi Kuriyama et al of ISIS, Nagaoka measured the coefficient of kinetic friction between the ice surface and a rubber tire of a wheel as a function of temperature and vehicle speed. He obtained the following empirical formula: $\mu = 0.053 \times (0.998)^v - 0.0085 \times (0.976)^v \times t$, where μ is the coefficient of kinetic friction of a rubber tire, v the velocity in km/h, t the temperature of ice in the centigrade. This formula may be applicable for $v = 3\sim60$ km/h, and $t = 0\sim-11$°C.

Japanese National Railways (JNR) has intended to construct superspeed railways, 200 km/h, in snowy regions, posing serious problems which may arise on accretion of snow on to trains, snow removal on railways, compression of snow by such trains and so forth. Hiroshi Sugiyama of Technical Research Institute of JNR, Tokyo measured the resistive force of snow against the high-speed compression using a piston having the conicoid surface, which he found roughly proportional to the square root of the speed of impaction.

Atsushi Sato and Gorow Wakahama of ILTS measured the velocity of propagation of plastic waves in a snow mass created by impaction. A cylindrical metal block having a flat surface was penetrated into the snow confined in a plastic cylinder at the velocity of 4~6 m/sec. The velocity of propagation of a plastic wave created in the snow mass measured by pressure sensors buried previously therein, while the mode of propogation was photographed by a high-speed movie camera. They found that the velocity of propagation of the plastic waves increased with the increasing density of snow in the range of 0.17~0.46 g/cm^3 and estimated that the value of pressure created by the plastic waves was 0.05~0.1 bar.

Zenpachi Watanabe of Fukushima University proposed the following empirical formulae of the strain of snow creeping under tension. $e = 3 \times 10^{-4} \times \rho^{-3}(F^2t/T)^{2/3}$ and $e = 1.5 \times 10^4 H^{-1.3}(F^2t/T)^{2/3}$, where F is the applied tension in kgw, ρ the density of snow in g/cm^3, T the temperature in the centigrade, H the Kinosita's Hardness of snow in g/cm^2 and t the time for creep in minute.

BLOWING SNOW

Hideki Narita of ILTS has studied the temperature dependences of the transportation and saltation of snow particles due to blowing snow, whereby he has proposed the following empirical formulae: $L = 1.16\ T + 6.1$ for the mean distance of saltation in cm and $\mathrm{Log}\ Q = 0.036\ T + 2$ for the amount of transportation of snow in g/m sec, where T is the air temperature in the centigrade. It should be noted that the data used to arrive at these empirical formulae were obtained under the condition that the average wind speed measured at 1 m above the snow surface was 7.0~7.8 m/sec and the range of air temperature was −3~−48°C.

Masayuki Inoue of ILTS measured the amount of transportation of snow particles, Q, in Antarctica as a function of height above the snow surface, using a specially designed apparatus to collect snow articles conveyed by a wind. Plotting Q-values measured against the height and the frictional velocity of a wind, he found that Q-values in the air flow less than 25 cm above the snow surface were proportional to the 3rd power of the frictional velocity. This suggests that the transportation of snow particles in the air flow near the surface may be primarily made by saltation. In the air flow higher than 25 cm above the snow surface, however, the transportation of snow particles may be chiefly made by turbulent diffusion. He estimated that the total amount of the snow transported around Mizuho Camp, Antarctica, was approximately 0.64×10^6 tons $year^{-1}$ km^{-1}.

Tokio Kikuchi of ILTS has attempted to measure the velocity of snow particles being transported in the air flow, which must be lower than that of the air flow because of their inertia. A laser-Doppler anemometer and a hot-wire anemometer were used to measure the velocity of snow particles and the wind speed, respectively. A preliminary experiment made in a wind tunnel installed in the cold room indicated that the average speed of snow particles measured at 8 cm above the floor of the wind tunnel was approximately lower by 15% than the average wind speed measured at the same height, and that the average velocity of snow particles measured at 4 cm above the floor was lower by 25% than the average wind speed measured at the same height. These differences in velocities between snow particles and air flows may be brought about by a drag force of wind acting on the snow particles.

SNOW AND ICE ACCRETION

It has been accepted that wet snow containing much free water does not accrete on electric wires unless the wind speed is less than 3 m/sec, because wet snow deposited is easily blown away by a wind from the electric wires. However, many cases of severe damage such as breaking of wires and crushing down of suspension iron towers for power transmission have often been caused by the wet snow accretion in Hokkaido Island. Gorow Wakahama et al of ILTS have conducted extensively many experiments of wet snow accretion on wires, using a wind tunnel installed with a device to produce artificial wet snow. They showed that the wet snow which adhered on a wire began to rotate around it and entirely enveloped it without being blown away even when the air temperature was +1~+2°C and the wind speed exceeded 20 m/sec. Photographs taken by a high-speed movie camera indicated that a large number of ice particles were rebounded on the surface of wet snow deposited on the wire. Part of the results was presented at the International Glaciological Society's Symposium on Applied Glaciology, Cambridge, 1976.

Kazuo Goto et al of Technical Research Institute of Hokkaido Electric Power Company studied how to remove wet snow deposits from electric wires and the galloping phenomena of wires associated with snow accretion, using a specially designed wind tunnel. This tunnel had a horizontal orifice, 0.7 m x 15 m, in which a uniform air flow was produced by 11 electric fans. Flakes of artificially made wet snow were continuously provided into the air flow. They found that, when a span of a suspended wire was long enough, the formation of cylindrical deposition of snow on the wire could be made by the twisting motion of the wire itself. They also found an effective way to prevent the iced electric wire from galloping, a kind of self-excited oscillation caused by an aerodynamic lift.

Apart from the wet snow accretion on the electric wire, wet snow deposition on a radome is also becoming a serious problem in areas with much snow. TV broadcasting by radio waves at frequencies of 12 or 22 GHz through an artificial satellite resting in the sky is being planned. Since a paraboric antenna must be set upward to receive the waves from it, a radome is absolutely needed to protect the antenna from snow deposition in such areas. Michiya Suzuki et al of Yamagata University have made experiments on how to protect the radome surface from snow deposition. A spherical radome 1 m in diameter made of a fibre-reinforced plastic was rotated by an electric motor to remove accreted snow on the radome surface by centrifugal force. In this case the result was fairly successful, except for a small amount of snow deposition on the vertex of the radome. Several techniques were also tested to wipe or brush off snow from the radome surface.

It seems difficult to understand why dry snow flakes or ice particles accrete on structures at a low temperature range without any coexistence of liquid phases or supercooled water droplets. However after a snow storm or blizzard it can be seen that dry snow flakes or ice particles adhere on the windward surface of structures such as electric poles, traffic sign boards, fences and tree trunks even when the air temperature is well below the melting point of ice. Maso Takeuchi et al of Experimental Station of Civil Engineering, Hokkaido Prefectural Government, have studied the accretion of dry snow on metallic traffic sign boards as a function of wind speed and angle of the inclination of the boards against the air flow. When a board was placed vertically against an air flow, snow particles deposited conically at the central part of the board where the air flow was stagnated. When the board was inclined against the air flow, the conical shaped snow deposition was displaced toward the edge of the board with the relative shift of the stagnant point of the air flow.

FROZEN GROUND AND FROST HEAVE

Many studies have been made of the thermal and mechanical properties of frozen soil and water migration in the ground in the branch laboratory of ILTS in Tomakomai, where Masami Fukuda and Masanori Inoue measured the dynamic properties of frozen soils using the flexure vibration method. The water contents and bulk densities of the frozen samples used were respectively 20.2% and 1.84 g/cm^3 for sand, 66.8% and 1.32 g/cm^3 for silt, and 62.2% and 1.4 g/cm^3 for clay. The value of mechanical damping of these samples were 0.035~0.01 for sand, 0.029~0.013 for silt, and 0.064~0.026 for clay, in each of which the larger value was obtained at -5°C and the smaller value at -30°C. The values of Young's modulus were 10^{11} dyn/cm^2 for frozen sand and 10^{10} dyn/cm^2 for frozen clay.

A simple method to record successively the depth of freezing water in soil has been developed by Yutaka Yahagi of Hokkaido University of Education, Kushiro. A plastic pipe 1 m in length filled with water was vertically buried in the ground in such a way that the top of the pipe emerged at the surface of the ground. When the water in the pipe began to freeze from the top of the pipe downward, unfrozen water in the pipe was gradually squeezed out in the form of droplets through a small hole of the pipe, enabling a count to be made of the number of droplets squeezed. The rate of freezing of water in soil could be obtained by the measurement of the rate of water droplets squeezed per unit time.

It has been accepted that the pressure in soil produced by frost heaving is inversely proportional to the average diameter of soil particles and effective radius of the capillary in soil. Isao Takashi of Seiken Reiki Company showed that the pressure created by frost heaving was also governed by the rate of freezing of soil and that the value of maximum pressure could be obtained by measuring the pore pressure in soil.

Many huge insulated tanks to store LNG, liquid natural gas, have been constructed in the Tokyo area. Since the temperature of LNG is about -160°C, it is necessary to prevent tanks from frost heaving. Kinosita et al of ILTS have made many studies to solve this problem.

PHYSICS OF SNOW AND ICE

Akira Yamashita of Tokyo University has studied growth modes of ice crystals formed in the free air containing supercooled water droplets; he found that a nuleated spherical ice crystal changed successively its shape from the sphere to the polyhedron, octahedron and thick hexagonal plate. As the hexagonal plate crystal grows, a lacuna develops individually on 6 prismatic faces and then these lacunas join together in such a way that two basal planes develop to form double hexagonal plates. However, in general, only one of the double hexagonal plates thus formed is allowed to grow into a large dendritic or hexagonal plate, whereas another plate remains as a small hexagon.

Yoshizumi Furukawa and Teisaku Kobayashi of ILTS have studied twin structures in ice crystals grown in the free atmosphere. Employing the coincidence site lattice theory, they showed that bullet-type crystals or three dimensionally developed dendritic snow crystals may have twin structures. Masayoshi Matsuda et al of ILTS have made an extensive petrofabric analysis of crystalline structures of deep core ice samples obtained in Antarctica; they found that ice crystal grains in the deep core ice sample which show the so-called diamond pattern in the Schmidt Net have twinning relations. This finding would provide fruitful results in the future study of glacier ice.

The following laboratory work was carried out in Higashi's laboratory of Faculty of Engineering, Hokkaido University: 1) X-ray diffraction topographic studies on the structures and behaviors of grain boundaries in ice—characteristic line images appear on the boundary when a specimen is stressed and disappear when it is aged; it was suggested that the boundary deviated a little from the CSL boundary and is composed of flat facets and steps; the facets impede the migration of the boundary. 2) Mechanical properties of Antarctic deep core ice were studied—stress-strain relations were re-examined under the hydrostatic pressure up to 5 000 kb. 3) Mechanisms were studied as to growth of a recrystallized grain in a deformed single crystal of ice applying bendings in different ways; the mobility of the grain boundary was measured.

Shigenao Suzuki of ILTS and Kozaburo Sato Hirosaki University have studied the surface structure of single crystals of ice using scanning electron microscopy. They found that tiny hexagonal pits deevloped on the basal surface of ice when the ice was subjected to evaporation near $-100°C$ in a scanning electron microscope. They have proposed that these etch pits may be produced by evaporation of water molecules through a thin film formed on the surface of ice as the result of condensation of a residual vacuum oil vapour existing in the microscope.

Katsutoshi Tsushima of ILTS has studied extensively the anisotropy of the coefficient of kinetic friction between a steel ball and the surface of single crystalline ice as a function of the ice temperature and sliding velocity of the ball. He found the anisotropy in the value of kinetic friction on the different crystalline facets of ice. Part of results of this work was presented at the IGS Symposium on Applied Glaciology, Cambridge, 1976.

Tsutomu Nakamura of National Research Center for Disaster Prevention, Shinjo has studied the internal friction of single crystals of ice in the low frequency range less than 10 HZ using a torsional vibration method. The value of internal friction of single crystals of ice significantly changed before and after deformation, suggesting that dislocations created in ice by deformation may play an important role in the mechanical damping of ice. Electrical, mechanical and optical properties of deep core ice samples offered by Dr. C. Langway are being studied by Daisuke Kuroiwa and others of ILTS.

D. Kuroiwa

POLAND

Special investigations on snow cover and hoar frost in mountains were continued in 1976, mainly in the Karkonosze Range (the highest, most snowy ridge in Sudetes Mountain system) and in the Tatra Massif (the highest, most snowy in Carpathian Mountain system).

In **Karkonosze Ridge** systematic investigations were carried out on Szrenica Mt., by the Mountain Branch Observatory of Meteorology and Climatology of Wrocław University (for the programme, see former numbers of Ice), and on Sniezka Mt., by the Mountain Observatory of Institute of Meteorology and Water Economy. Outside Karkonosze, special investigations in the Sudetes Mountains were carried on Snieznik Mt., by the Department of Meteorology and Climatology of Wrocław University, and in other parts by the Institute of Meteorology and Water Economy. The results of measurements are published in yearbooks and special reports.

In the **Tatra Massif** investigations on snow, hoar frost and avalanches were carried out systematically by the Mountain Observatory on Kasprowy Wierch, of the Institute of Meteorology and Water Economy. Of course standard nival measurements were undertaken by all meteorological stations in Poland. The results are published in yearbooks and special reports.

POLAR ZONE

1. Geophysicists from the Geophysical Institute of the Polish Academy of Sciences under the leadership of Prof. Roman Teisseyre, and with the participation of geophysicists from the USA, continued the investigations from previous years (1971-1975) in SW Spitsbergen, Hornsund region: seismic registrations on glaciers, strand-flat gravitation measurements and paleomagnetic designations of rocks; and also took seismic profiles of the bottom adjacent to the West sea.

2. Geological investigations by a group from the Paleontological Institute of the Polish Academy of Sciences, under the leadership of Prof. Gertruda Biernat, were carried out in two regions of Spitsbergen: in Belsund Fiord and in Ice Fiord.

3. Meteorological and glaciological observations were carried out in Petunia Bay (NW branch of Billefjord) by the Polar Section of the High Marine School in Szczecin; this Section traversed in 1975 the Vatnajökull ice cap in Iceland from Kerlingar via Grimsvötn to Kverkjökull; and also in NE Spitsbergen, along the profile from the Nordenskiold Glacier front via New Frisia to 80° and back, by Arctic Club from Szczecin, on skis.

4. The Oceanographic Expedition to the Iceland-Greenland sea region worked from the hydrological ship "Turlejski" on behalf of the Sea Research Committee of the Polish Academy of Sciences, to get observations on sea ice and to co-ordinate the Polish sea ice nomenclature within the framework of the international one. As members of this expedition were, among others, Prof. S. Szymborski of the Oceanographic Institute of the Polish Academy of Sciences in Sopot, Dr J. Cegła and Dr S. Baranowski of the Geographical Institute of Wrocław University.

5. Investigations of surface-water pollution and sea ice in the Arctic in Baffin Bay and in the Sub Antarctic region between S. America and Graham Land were carried out during 1976-1977 from the yacht "Gedania".

6. Prof. K. Birkenmajer, from the Geological Institute of the Polish Academy of Sciences in Kraków, participated in geological investigations in NE Greenland within the framework of the Danish Grønland Geologiske Undersøgelse. It was a continuation of his geological investigations during the summer of 1971. He also collected glaciological observations.

7. The Institute of Biology of the Polish Academy of Sciences established in the Sub Antarctic (on S. Shetland Islands) a research station where also meteorological glaciological observations will be made.

8. In 1976 a Polar Symposium at the University in Torun was organized with 22 papers concerning the results of Polish investigations on Spitsbergen.

A. Kosiba

SWEDEN

No results have been published in ICE about Storglaciären since 1st issue 1975, No. 47, and for glacier front variation the last results were published in 3rd issue 1973, No. 43. The following table shows the main results of the routine studies since then.

VARIATION IN THE POSITION OF GLACIER FRONTS

In 1976 there were nearly no measurements because of thick newly-fallen snow during the normal surveying period.

Glacier	Position		Variation in m since the previous surveying				Total variation	
			Surveying year:					
	N	E	1974[1]	1975	1976	1977	metres	period
Salajekna	67°08′	16°27′	−22	x	−20	x	−119	65—70
Hyllglaciären	67°41′	17°21′	− 2	x	x	x	− 44	65—74
Årjep Ruotesjekna	67°26′	17°30′	− 1	−11	x	−41	−169	65—77
Suottasjekna	67°27′	17°39′	− 6	x	x	−19	−148	65—77
Vartasjekna	67°21′	17°41′	0	x	x	0	− 51	65—77
Mikkajekna	67°24′	17°42′	−15	−12	x	−27	−181	65—77
Pårtejekna	67°10′	17°43′	− 7[2]	−12	x	−27	−162	65—77
Riukojietna	68°05′	18°05′	x	x	x	−28[2]	−104	63—77
Kårsajökeln	68°22′	18°21′	−28[2]	s	x	− 7	−116	65—77
Stuor-Räitaglac.	67°58′	18°23′	x	x	x	−17[2]	−116	63—77
Västra Påssusj.	68°04′	18°24′	−29[2]	s	x	−11	−102	68—77
Östra Påssusj.	68°04′	18°25′	−14[2]	s	x	− 2	− 98	68—77
Rabots glaciär	67°55′	18°27′	−23[2]	s	x	−14	−132	65—77
Unna-Räitaglac.	67°59′	18°27′	x	s	x	−20[2]	− 62	63—77
Kuototjåkkaglac.	68°09′	18°34′	− 8	s	x	− 4	− 51	65—77
Isfallsglaciären	67°55′	18°35′	− 8	s	0	0	− 96	65—77
Storglaciären	67°54′	18°36′	− 2	s	s	0	− 56	65—77

1) Retreat since 1973 if no remark.
2) Retreat since 1972.
x Not surveyed.
s Snow-covered front, no retreat.

MASS BALANCE STUDIES ON STORCLACIÄREN

	1975	1976	1977
End of accumulation season	2 June[1)]	9 May	6 June[3)]
Beginning of ablation season	2 June[2)]	17 May	11 June[4)]
End of ablation season	15 Sept.	30 Aug.	7 Sept.[5)]
Total winter balance in m^3 of water $x10^6$	6.15	5.98	3.82
Total winter balance in g/cm^2	198	197	123
Total summer balance in m^3 of water $x10^6$	2.51	5.13	3.20
Total summer balance in g/cm^2	81	173	103
Net balance in m^3 of water $x10^6$	+3.64	+0.85	+0.62
Net balance in g/cm^2	+117	+26	+20
Height of equilibrium line m a.s.l.	1380	1440	1420

At about 1450 m a.s.l. the glacier is rather steep and quite narrow. The ablation period is often shorter above this level.

The following dates are valid for the area **above** 1450 m (47% of the total glacier area, 3.1 km^2):
1) 8 July 2) 16 July 3) 13 June 4) 25 June 5) 18 August

UNITED KINGDOM

ICELAND

The Cambridge University Vatnajökull Expedition 1977 was concerned with ice depth soundings of the largest ice cap in Europe and involved both the development of impulse radar systems and the use of satellite survey equipment for locating experimental stations and ice depth traverses.

Vatnajökull, which translated means 'water-ice', is a temperate ice sheet and measures approximately 140 km east to west and 100 km north to south, thereby occupying more space than all other glaciers in Europe combined. Ice depth studies had previously been limited to seismic experiments conducted during the French-Icelandic expedition of 1951, when some 33 individual soundings were recorded. A few gravitational studies have also been made. It was not until 1976, however, that a first glacier base profile was obtained by a joint British-Icelandic expedition using electronic equipment developed at the University of Cambridge. From that expedition some understanding of the electrical properties of ice was deduced and it became possible to design equipment that, theoretically, could measure the deepest parts of the ice cap.

The Expedition left the U.K. in mid-May and spent one week in Reykjavík surmounting an unusual number of difficulties, culminating with the discovery that the expedition's weasel caterpillar-tracked vehicle had a broken starter motor. The perseverance of members plus the unstinting assistance of the staff of the Science Institute and the Command of the United States Naval Base at Keflavik finally saw the weasel and almost 3 tonnes of equipment despatched to the ice cap at the end of May.

After three days of preparation at Base Camp, the expedition moved on to the ice cap on 31 May, successfully negotiating crevasses and several slush pools. However, blizzards and problems with transport meant that it was not until 12 June that the expedition moved on to the Grimsvötn hut, skirting crevasses and dangerous caldera holes, the latter emitting sulphurous steam. By now the continuous recording on Polaroid film of ice depths was becoming routine.

During the approach to the Grimsfjall ridge it was noted that the central summit had disappeared in what must have been a massive landslide. This was probably caused by the jökulhlaup in 1976 producing a rapid lowering of the Grimsvötn basin. Only a few yards from the hut the weasel broke down again due to water in the fuel, presumably from drift snow. Whilst repairs to the skidoos and the weasel were performed, satellite fixes of the Grimsfjall East Station were taken, as previously requested by the Icelanders, and a route down the crevassed hillside and on towards Kverkfjöll surveyed. On 14 June, another leg of the ice depth survey traverse was completed to Kverkfjöll on the northern edges of Vatnajökull, the second area of extensive geothermal activity. Taking advantage of tracks made the previous day, the expedition moved in poor visibility on 15 June to a position suitable for beginning a southern traverse towards Esjufjöll.

The next day was given to electrical experiments, since visibility was mostly limited to 20-50 m. Optimal use of time was achieved by using such days of limited visibility, when traverses would be dangerous and theodolite survey impossible, to carry out lengthy tests, e.g. to measure antenna impedance and compare various antenna configurations. However, on 17 June, a long traverse was made south towards Esjufjöll followed by a line towards Snaefell and a traverse east to Camp 8, just beneath the summit of Breidabunga. The first part of the traverse crossed probably the expedition's deepest recorded ice of 930 m and included the discovery of an old sub-glacial volcanic zone, further evidence of which was provided by the surface topography. The final section of the first leg and the whole of the second and third legs of this remarkable day were over hard, uneven ground which limited the speed of the weasel to less than 3 km per hour. During this day, satellite fixes were made every 5 km and were complemented by theodolite surveys.

The weather of 18 June permitted another long traverse, which began with a visit to the summit of Breidabunga followed by a short northerly traverse towards Kverkfjöll and a very long and slow traverse towards Grimsvötn.

At the request of the National Research Council of Iceland no attempt was made to locate the sub-glacial precipice close to the outlet of the Grimsvötn jökulhlaup nor to visit the Grimsvötn basin to extend the 1976 studies.

In very poor visibility on 20 June, the expedition followed old tracks past the dangerous section of Grimsfjall and eventually set up camp on Tuugnáarjökull. Poor visibility was again utilised the next day to start another series of electrical experiments. Meanwhile, two members found and flagged out a route down to lower altitudes and better visibility. On 22 June everyone successfully moved through crevassed areas and around slush pools. Because there were large areas of bare ice a southern traverse was made before heading directly down over very hard, uneven ice towards Base Camp on the edge of the ice cap, arriving there that evening.

Throughout the duration of the expedition the weasel, even allowing for the breakdowns mentioned, proved to be a very reliable and highly efficient means of transporting the expedition members, equipment and antenna array over some 295 km of the ice cap.

A few days after arriving in Reykjavík, a reception was given by the British Embassy to thank some 60 Icelanders and local Britons who had helped the expedition in various ways. Detailed information concerning the projects will be published shortly in various scientific and technical publications.

Expedition Members

Bishop, J. F.	St. John's College, Cambridge, and British Antarctic Survey
Chandler, S.	University of Cambridge, Engineering Department
Cumming, A. D. G.	Emmanuel College, Cambridge and University Engineering Department
Ferrari, R. L.	Trinity College, Cambridge and University Engineering Department
Johnscher, C. M. J.	Trinity College, Cambridge
Miller, K. J.	Trinity College, Cambridge and University Engineering Department

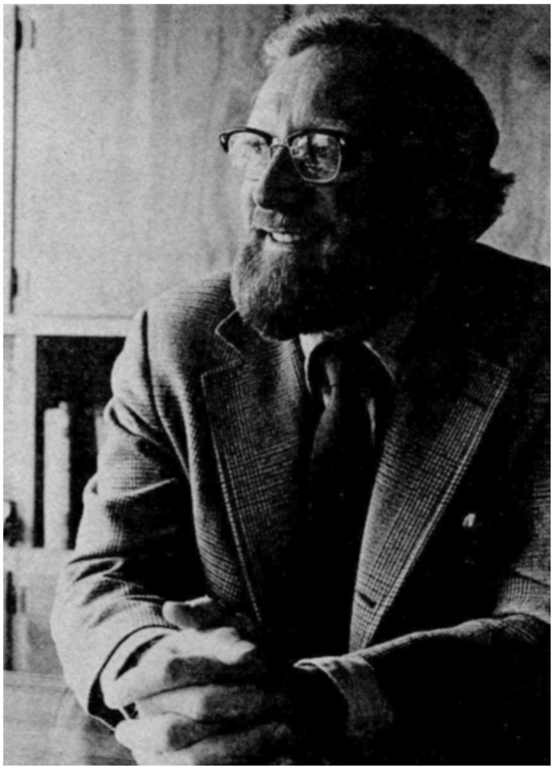
. . . . JACK IVES

Jack Ives was brought up in Grimsby, a fishing port on the east coast of the northern half of England, an area famous for its hard work, friendliness and sense of humour. As a schoolboy he went on trips on fishing trawlers, spending three summer holidays in the Barents Sea—White Sea areas and visiting en route the mountains and fjords of Norway and Spitzbergen. These trips fired his enthusiasm for arctic and alpine regions, and he specialised in these studies during his undergraduate days at Nottingham University.

After exploring Iceland with a friend in the summer of 1952, he returned to the Geography Department with an ardent enthusiasm to continue his exploration of Iceland, a country for which he has maintained a great affection ever since. His infectious enthusiasm soon spread to others in the University and he called upon his fishing trawler friends to provide logistical support for a series of student expeditions to Arctic Norway and Iceland. These matured into the first University of Nottingham scientific expeditions to Oraefi, Vatnajökull, Southwest Iceland, that he led in the summers of 1953 and 1954.

The expeditions were a major influence on Jack's glaciological enthusiasms, and included the benefits of Cuchlaine King's tuition and expertise in the field (see profile in ICE No. 52, p. 8, 1956) and the spiritual charges delivered by Gordon Manley and W. Vaughan Lewis, who was responsible for firing enthusiasm for glaciology in generations of students from Cambridge University and from other groups associated with his expeditions.

It was in Iceland that he met his wife, Pauline, who was a member of a Bedford College party



working in north Iceland under the general tuition of Gordon Manley.

The expeditions to Iceland demonstrated his ability in organization and in leadership. He graduated with first class honours in Geography in 1953, and continued his interest in Icelandic geomorphology in his postgraduate work which eventually earned him the degree of Ph.D. after his emigration to Canada in 1954. The Iceland field-work provided a useful introduction to glaciology and glacial geomorphology, and whetted his appetite for further work in this field.

It was a McGill-Carnegie-Arctic Scholarship that took Jack to Montreal in 1954, and facilitated his formal training in arctic research, together with a series of expeditions into northern and central Labrador-Ungava. He was soon put in charge of the Knob Lake (Schefferville) research station of McGill University, where he stayed from 1956-59. During this time he broadened his investigations of the glacial and climatic history of Labrador-Ungava by organizing field research and other studies in permafrost, lake ice and micro-climatology. Pauline helped the expeditions in Labrador-Ungava as assistant, cook, back-packer and general enthusiast and cheer-leader.

In 1960 he transferred to Ottawa, where he served first as assistant director and then as director of the Geographical Branch of the Canadian Federal Department of Energy, Mines and Resources. His glacial interests turned further north to Baffin Island, organizing and leading, in spite of a heavy administrative load, a series of interdisciplinary expeditions. These allowed many research students and others to benefit from the experience of field-work in the Arctic. He showed his broad-mindedness (for those days) in including women in the expeditions. It was during this period as a federal civil servant that he gained experience in handling a sizeable staff (120 plus 40 to 50 student summer associates) and in the politics of research management.

In 1967 he moved to Colorado, where his great administrative ability was turned to the development of the Institute of Arctic and Alpine Research of the University of Colorado in Boulder. The beautiful front range of the Rocky Mountains provides a wonderful setting for the high level research station that Jack has made an important centre of high altitude research in many aspects of science. The quarterly journal *Arctic and Alpine Research* was founded by him in 1969, and now has a circulation of over 900 copies. The growth of the Institute, in size, work-load and international reputation, has been probably the greatest achievement so far of Jack Ives' career.

More recently, he became involved in the UNESCO Man and the Biosphere Programme (MAB), serving as chairman since 1973 of its Project 6—study of the impact of human activities on mountain and tundra ecosystems. This has induced the development of a research design that will at first be applied to the Andes and to the Himalaya and associated mountain systems. His sabbatical leave (on a Guggenheim Fellowship) in Switzerland 1976-77 was partly devoted to the development of this study.

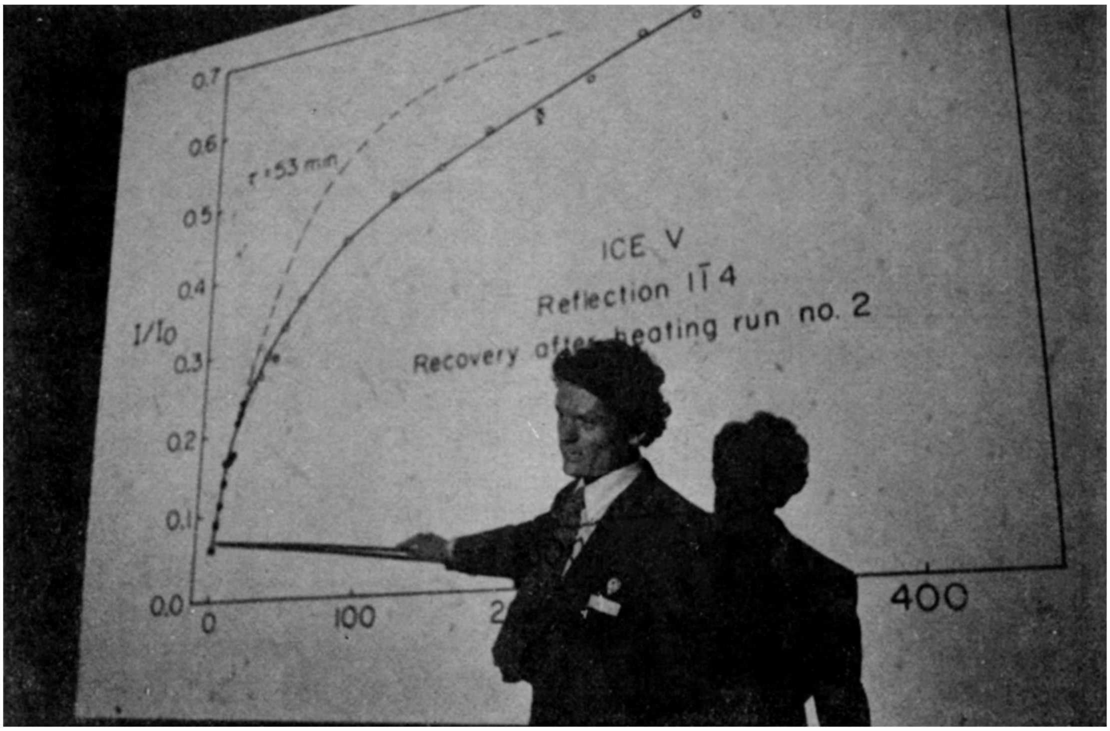
The Institute has now the responsibility for directing World Data Center A—Glaciology, directed by Robert Barry. He, and John Andrews, also a senior member of the Institute staff, have worked with Jack since the McGill Subarctic Research Laboratory days.

His main continuing academic interest, in spite of all the other work he undertakes, still lies in the links between glaciology, glacial geomorphology, climatic change, permafrost and natural hazards (especially avalanches). As much as by his own work, he has made an important contribution to glaciology by the cheerful encouragement and opportunities that he has provided for many people, including students and other workers.

PRESENTATION OF SELIGMAN CRYSTAL 1977

The President, Dr. Marcel de Quervain, presenting the Crystal to Dr. Barclay Kamb (on left),

who then gave a special lecture . . . .



SPECIAL MEETING, 13 SEPTEMBER 1977

CAMBRIDGE, ENGLAND

The President, Dr Marcel de Quervain, welcomed members and visitors and presented the Crystal. Afterwards Dr Kamb gave a lively and interesting lecture on some aspects of his work.

"The Council of the IGS decided at a meeting in September 1976 to award its highest distinction, the Seligman Crystal, to Dr Barclay Kamb, Professor at the California Institute of Technology.

The Seligman Crystal, created by the IGS in memory of its founder and longtime leader, Gerald Seligman, is offered "from time to time to one who has contributed to glaciology in a unique way so that the subject is now significantly enriched as a result of that contribution."

Dr Kamb entered glaciology about 20 years ago starting out from a geological crystallographical base. Soon he is found in the leading group of scientists in three different fields. The broad spectrum of successful activity is accounted for by the rare coincidence of gifts, namely that of natural observation, of experimental skill and of mathematical abstraction. Another particular quality has led B. Kamb to important contributions to science. It is certain lack of respect against established authorities. Generally accepted ideas and procedures are critically screened and suddenly a mistake is detected and a new solution is offered.

The three fields of glaciology which have been significantly enriched by B. Kamb are

1. The structures of the high pressure—and low temperature—modifications of ice.
2. The petrofabrics of polycrystalline ice.
3. The flow mechanism of glaciers, in particular the glide conditions on the bedrock.

The structure of a great number of ice modifications have been cleared up by Kamb and his collaborators by means of x-ray and neutron-diffraction. Included in these investigations was the degree of proton order in the respective structures. These important contributions have elucidated our knowledge on the water molecule, on its deformability and its tendency to lattice formation.

While treating the problem of the orientation of crystal axes, Kamb has first noticed that measured angles have been corrected with a wrong method following old authorities, and he has provided us with the theory for correct corrections. Then he has theoretically and experimentally linked the fabrics of polycrystalline ice with the parameters of stress, strain and recrystallization. The number of measured crystal axes quoted in one paper was more than 4 000. This is just one way of saying that genius had to be linked with perseverance. Another clever contribution to this field of activity was an investigation on the preferred glide direction in the c-plane of an ice monocrystal. The known lack of such a preferred direction which could not be understood before was explained in a surprising manner.

The work on the living glacier, accomplished together with a number of colleagues in the heights of the Olympic Mountains, has composed on the example of the Blue Glacier a magnificent picture on the dynamics of a glacier. As a single aspect the glide mechanism on the glacier bed has been treated by Kamb in a profound theoretical analysis. Starting out from ideas given by Weertman, Lliboutry and others and pulling all the stops of ice mechanics and thermodynamics he gets to new conclusions which apparently have been confirmed.

I would not be surprised if someone would complete this spectrum of outstanding contributions with other work which escaped my attention.

This justification for awarding the Seligman Crystal to Dr Kamb would not be complete without mentioning his personality. We are not going to distinguish a brain or a machine, but a man.

The often-found authorship of Barclay Kamb in combination with other names points to his ability of making contacts and working together with colleagues. It seems to me that this attitude has contributed to his success. Nevertheless his personal fingerprint is always found in the joint work.

Let me illustrate the kind of personality Barclay proved to be when he was working on the Weissfluhjoch—it was in winter 1960/61. Unfortunately he was run over one day by a ski rowdy and had to spend one full month in the Hospital of Davos with a broken upper thigh. To our astonishment he did not want to be in a single room but preferred the company with other patients in a general room, applying and refining his knowledge of the German language, and the co-patients were pleased to have the company of this cheerful and encouraging foreigner.

Now let me ask Dr Kamb to come to the floor and receive the Seligman Crystal."

JOURNAL OF GLACIOLOGY

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

C. U. Hammer, H. B. Clausen, W. Dansgaard, N. Gundestrup, S. J. Johnsen and N. Reeh:
Dating of Greenland ice cores by flow models, isotopes, volcanic debris, and continental dust.

N. Reeh, H. B. Clausen, W. Dansgaard, N. Gundestrup, C. U. Hammer and S. J. Johnsen:
Secular trands of accumulation-rates at three Greenland stations.

A. S. Jones:
The dependence of temperature profiles in ice sheets on longitudinal variations in velocity and surface temperature.

M. J. Hambrey and F. Müller:
Structures and ice deformation in the White Glacier, Axel Heiberg Island, N.W.T., Canada.

P. W. Anderton and T. J. Chinn:
Ivory Glacier, New Zealand, and I.H.D. representative basin study.

S. Hastenrath:
Heat-budget measurements on the Quelccaya Ice Cap, Peruvian Andes.

N. Eyles and R. J. Rogerson:
A framework for the investigation of medial moraine formation; Austerdalsbreen, Norway, and Berendon Glacier, British Columbia, Canada.

J. S. Oliver, E. F. O'Connor and D. J. Watson:
Observations on submerged glacial ice in McMurdo Sound, Antarctica.

A. D. Kerr:
On the determination of horizontal forces a floating ice plate exerts on a structure.

J. R. Weber:
Ice floes in collision.

J. D. Bergen:
Some measurements of settlement in a Rocky Mountain snow cover.

J. A. Warburton and G. O. Linkletter:
Atmospheric processes and the chemistry of snow on the Ross Ice Shelf, Antarctica.

N. J. Griffey:
Lichen growth on supraglacial debris and its implications for lichenometric studies.

D. D. Gilbertson and A. B. Hawkins:
The col-gulley and glacial deposits at Court Hill, Clevedon, near Bristol, England.

Instruments and methods:

S. C. Colbeck:
The difficulties of measuring the water saturation and porosity of snow.

A. Coumes, V. Liva and F. Zadworny:
Testing of radiometric detection of avalanche victims.

A. Herrmann:
A recording snow lysimeter.

K. Evans, D. J. Goodman and G. Holdsworth:
Recording wire strainmeters on the Barnes Ice Cap.

V. A. Squire:
An investigation into the use of strain rosettes for the measurement of propagating cyclic strains.

H. Gubler:
Determination of the mean number of bonds per snow grain and of the dependence of the tensile strength of snow on stereological parameters.

H. Gubler:
An alternate statistical interpretation of strength of snow.

J. England and R. S. Bradley:
Former ice shelves in the Canadian High Arctic.

R. LeB. Hooke and P. J. Hudleston:
Origin of foliation in glaciers.

C. Lafargue, S. Bourgeois and G. Evrard:
Dielectric behaviour of disperse ice mono-crystals in the frequency range 10^5—10^{-2} Hz.

D. E. Sugden:
Glacial erosion by the Laurentide ice sheet.

P. J. Martin and D. A. Peel:
The spatial distribution of 10 m temperatures in the Antarctic Peninsula.

T. J. O. Sanderson:
Thermal stresses near the surface of a glacier.

I. J. Smalley:
EARLY DISCOVERERS XXXII P. A. Tutkovskiy and the glacial theory of loess formation.

Short notes:

O. Mokievsky-Zubok:
A slide of glacier ice and rocks in Western Canada.

H. W. Posamentier:
Thoughts on ogive formation.

R. Perla:
Short note on slab avalanche measurement.

P. Hoare:
The glacial record in southern County Dublin, Eire.

BRANCH NEWS

See Glaciological Diary for dates of 1978 meetings—BRITISH BRANCH and NORDIC BRANCH.

RECENT MEETING (of other organizations)

SYMPOSIUM ON SEA ICE PROCESSES AND MODELS

The Symposium, sponsored by the International Commission on Snow and Ice and the Arctic Ice Dynamics Joint Experiment, was held at the University of Washington, Seattle on 6-9 September 1977. Four invited papers were presented and 44 other papers, over half of them in poster sessions.

Invited Paper: N. Untersteiner—AIDJEX review.

P. Gloersen, W. J. Campbell, R. Ramseier & H. J. Zwally—Interpretation of aircraft and spacecraft microwave images during the main AIDJEX.

R. T. Hall—A test of a sea ice model using Landsat imagery—AIDJEX sea ice studies involving the use of remote sensing data.

R. O. Ramseier, L. Gray, W. J. Campbell, W. D. Stromberg—Scatterometer and imaging radar results obtained over Big Bear, AIDJEX 1975.

M. A. Bilello—Ice decay patterns of land-fast sea ice in Canada and Alaska.

R. D. Ketchum & A. W. Lohanick—Airborne passive microwave scanning of Arctic sea ice.

W. B. Tucker, W. F. Weeks, A. Kovacs & A. J. Gow—Near shore ice motion at Prudhoe Bay, Alaska.

W. F. Weeks, W. B. Tucker, M. Frank & N. Fungcharoen—Characterization of the surface roughness and floe geometry of the sea ice over the continental shelves of the Beaufort and Chukchi Seas.

T. Tabata, T. Kawamura & M. Aota—Divergence and rotation of ice field off Okhotsk sea coast of Hokkaido.

P. Wadhams—A comparison of sonar and laser profiles along corresponding tracks in the Arctic Ocean.

G. Wendler—The ice conditions of the Bering Sea for the winter of 1976/77.

Invited Paper: M. D. Coon—Modelling review.

R. Colony & D. Rothrock—A perspective of the time-dependent response of the AIDJEX model.

G. Maykut—Estimates of the regional heat and mass balance of the ice cover in the central Arctic.

R. S. Pritchard—A simulation of near shore winter ice dynamics in the Beaufort Sea.

R. S. Pritchard & J. F. Nye—Characteristic curves of the AIDJEX model equations and their interpretation.

R. S. Pritchard & D. R. Thomas—The range of influence of boundary parameters in the AIDJEX model.

D. A. Rothrock, R. Colony & A. S. Thorndike—Stress divergence in pack ice.

R. T. Schwaegler & R. S. Pritchard—AIDJEX model response to axisymmetric loadings.

A. S. Thorndike—Tests of the ice thickness distribution theory—Where has all the ice gone?

W. D. Hibler—Modelling pack ice as a viscous continuum.

C. H. Ling, W. J. Campbell, P. Gloersen, L. A. Rasmussen & H. J. Zwally—A mesoscale continuum sea ice model.

S. I. Pai, H. Li & M. M. Das—Compactness and thickness effects on drift of Arctic pack ice based on two-phase flow model.

D. Sodhi & W. D. Hibler—A finite element formulation of a sea ice drift model.

D. Barnett—A long range ice forecasting method for the north coast of Alaska.

V. R. Neralla, M. B. Danard, W. S. Liu & S. Venkatesh—Techniques for predicting sea ice.

J. E. Walsh—A determination of Beaufort Sea ice predictability based on empirical orthogonal functions.

Invited Paper: C. Paulson—Atmospheric program review.

M. Albright—Geostrophic wind calculations for AIDJEX.

E. Banke—Wind stress at AIDJEX.

R. A. Brown—Semi-empirical modeling of the planetary boundary layer: theory and results from AIDJEX.

F. Carsey—The boundary layer height in air stress measurement.

D. I. Katz—Air stress measurements from an aircraft.

E. Leavitt—Surface-based air stress measurements made during AIDJEX and their relationship to the geostrophic wind.

P. Martin, M. Albright, M. Clarke & D. Short—One year of barometry on the frozen ocean.

W. Denner & L. Ashim—The operational determination of wind stress on the Arctic pack ice.

G. F. Herman—The effect of ice extent on the climatology of the GISS general circulation model.

C. Parkinson & W. Washington—Progress on a large-scale sea ice model.

I. Allison—Sea ice and ocean energy balance studies at Mawson, Antarctica.

T. D. Ralston—Yield and plastic deformation in ice crushing failure.

V. A. Squire—Propagation of flexural-gravity waves in sea ice.

N. W. Wilson—Prediction of heat, mass and momentum transfer during laminar forced convective melting of ice in saline water.

Invited Paper: K. Hunkins—Oceanic program review.

E. Bauer, A. Amos & K. Hunkins—Salinity and temperature measurements from the AIDJEX manned array.

K. Hunkins, B. Allen & T. Manley—Ocean current profiles from the AIDJEX manned array.

M. P. Langleben—Water drag coefficient at AIDJEX, Station Caribou.

M. G. McPhee—An analysis of pack ice drift in summer.

E. R. Pounder & A. LeBlanc—Ice-water stress at Station Snowbird, AIDJEX.

ICEBERG UTILIZATION CONFERENCE

An international conference on iceberg utilization was held on the campus of Iowa State University, Ames, Iowa, U.S.A. 2-6 October 1977, under the sponsorship of the U.S. National Science Foundation, King Abdul-Aziz University, King Faisal Foundation, Iceberg Transport International, U.S. Coast Guard, the International Working Group on Iceberg Utilization, and Iowa State University. Other organizations gave support to specific events.

The Conference was very well organized by a committee chaired by Daniel J. Zaffarano, with Abdo A. Husseiny as Technical Chairman. From about 20 countries came 200 participants, most of them at the special invitation of the organizers. There was an amalgam of talents far more varied than normally occurs at conferences, and this feature made the conference stimulating, valuable and educational to all. The Secretary General IGS appreciated the opportunity to attend the conference, as representative of the Society, at the invitation of the committee.

Papers ranged from basic science to flights of imagination, through theory and practice, experience and inventiveness. The media were much in evidence, lapping up every new idea and extracting comments with ease from many willing interviewees. The presence of a small, 2000 kg iceberg, picked up from the lake in front of the Portage Glacier near Anchorage, Alaska, and transported specially to the conference in Ames, attracted much local attention and its brief life was reported fully. Chemical analyses showed that the water it produced on melting was only slightly less pure than distilled water. This was a dramatic comparison with water being drunk in most parts of the world, including big cities, some of which recycle their water 8, 10 and even 17 times. The conference, also, emphasized how great is the need for increasing the world's supply of fresh water: indeed the meeting would never have taken place if the shortages in arid and semi-arid countries were not so great that every means of overcoming them has to be explored.

Although the uses of icebergs for energy production, as well as for water supply, was considered, papers presented on the practical problems of transporting them emphasized the need to concentrate on the basic problems that will be encountered: how to grab hold of a berg and then how to tow it.

The opening paper by Dr Henri Bader (awarded the Seligman Crystal by IGS in 1967) summarized these problems, while excellent illustrations in several other talks, notably those by R. L. Cameron and C. Swithinbank, and personal experiences in the Antarctic seas, vividly recounted by tugboat captains, served to underline them.

Plenary sessions, concurrent sessions and workshops provided opportunities for presentation of the many aspects of iceberg utilization, including tracking and selection, towing, protection, international law, regional needs, weather and environment modifications, energy and water production, economics and management.

The consensus of informed opinion at the end of the week was that much more basic research and an experimental tow of 2000 miles or less (to southern Australia, for example) were needed before the possibility of providing fresh water from icebergs to arid countries in low latitudes can be assessed with any accuracy.

The Proceedings of the Conference will be published in 1978.

FUTURE MEETINGS (of other organizations)

INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH

SYMPOSIUM ON ICE PROBLEMS

7-12 August 1978—Luleå, Sweden

The Organizing Committee for the Fourth International IAHR Symposium on Ice Problems takes pleasure in inviting colleagues to participate in this symposium, which will be held in Luleå, Sweden, 7-12 August 1978.

The Symposium is being organized by the town of Luleå and by the Division of Water Resources Engineering, University of Luleå and is also sponsored by the IAHR Committee on Ice Problems, the IAHS Commission on Snow and Ice and the International Glaciological Society.

The Symposium will take place at the University of Luleå.

Papers are invited on any of the four topics: a) ice in estuaries and harbours, b) thermal regime of ice covered waters, c) mechanics of broken ice masses, d) ice forces on structures.

Papers on fundamental mechanics of ice will be accepted for topic (d) and on thermal regime of ice-atmospheric heat exchange processes—meteorological conditions for topic (b).

MANUSCRIPTS

Authors are requested to submit very short typewritten abstracts of up to 400 words that should reach the Organizing Secretary by 1 February 1978.

The authors will be given instructions for the preparation of the manuscripts in February 1978 and required to send the full text of papers in English by 31 March 1978. It is intended to provide preprints to the participants in advance of the Symposium. The authors should notice that depending on the number of manuscripts some of the papers may be presented by General Reporters.

The final proceedings of the Symposium will be printed as soon as possible after the Symposium and mailed to the participants.

PROGRAMME

Registration will take place on Sunday 6 August and technical sessions and study tours on 7, 8 and 9 August. A Reception will be held on the evening of 7 August and a Banquet on 8 August.

REGISTRATION FEES

Full Participants: 500 Swedish kroner.

The registration fees will entitle participants to pre- and post-session proceedings, participation in technical sessions, study tour, exhibition and reception of August 7 and banquet (including accompanying persons).

ACCOMMODATION

The request for hotel accommodation may be forwarded via your local travel agency to: Mrs Inger Aström, Luleå kommun, Fack, 951 85 Luleå, Sweden.

An enquiry desk at the Kallax airport will serve the Symposium participants. Special transport will take the participants from the airport to the city during the whole of Sunday and on Monday morning. An information desk will be set up in the lobby of the Stadshotellet.

POST-SYMPOSIUM STUDY TOURS

Two study tours are planned. One 3-day tour to the Swedish mountain district can be combined with another 3 days to be spent in Lofoten, Norway.

FURTHER INFORMATION

Further information and registration forms may be obtained from the secretary of the Organizing Committee, **Mr Bertil Köhler, Fack, s-951 95 Luleå, Sweden.**

The third circular will only be distributed to those who have registered for the Symposium.

GLACIOLOGICAL DIARY

1978

14 April
Meeting of British Branch of IGS, Manchester. (David Collins, Geography Dept., University of Manchester, Manchester M13 3PL, England.)

16–18 May
Symposium on Snow removal and ice control research. Hanover, NH, USA. Transportation Research Board; CRREL; US Department of Transportation. (A. Clary, Transportation Research Board, 2101 Constitution Avenue NW, Washington, DC 20418, USA.)

17–25 June
IGS Nordic Branch meeting, Kirkjubaejarklaustur, South Iceland. (Dr S. Thorarinsson, Division of Geosciences, Atvinnudeild at Hringbraut, Reykjavík, Iceland.)

10–13 July
Third International Conference on Permafrost, Edmonton, Alberta, Canada. National Research Council of Canada. (M. K. Ward, c/o National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada.)

1–4 August
Symposium on Physics and mechanics of ice. Copenhagen, Denmark. (International Union of Theoretical and Applied Mechanics.)

7–12 August
IAHR Symposium on ice problems, Sweden. (Mr Bertil Köhler, Fack S951 95, Luleå, Sweden.)

15–19 August
Symposium on Glacier beds: the ice-rock interface, Ottawa, Canada. Sub-Committee on Glaciers of the Canadian National Research Council. (C.S.L. Ommanney, Glaciology Division, Environment Canada, Ottawa K1A 0E7, Canada.)

21–25 August
Symposium on Dynamics of large ice masses, Ottawa, Ontario, Canada. International Glaciological Society. (Mrs H. Richardson, Sec. Gen., Cambridge CB2 1ER, England.) (see p. 18-23 of this issue of ICE.)

26–29 September
Meeting on Snow and runoff modeling, Hanover, NH, USA. (S. C. Colbeck, CRREL, Hanover, NH 03755, USA.)

1979

24–28 April
Symposium on Electronics and avalanches Graz, Austria. (Dr W. Fritzsche, Institute of Electronics, Technical University of Graz, Inffeldgasse 12, A 8010 Graz, Austria.) **Note change of date.**

12–17 August
Symposium on Snow in motion — Avalanches and blowing snow. Fort Collins, Colorado, USA. Rocky Mountain Forest and Range Experiment Station. Co-sponsored by International Glaciological Society. (Dr M. Martinelli, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO 80302, USA.) (See p. 25 of this issue of ICE.)

2–12 December
International Union of Geodesy and Geophysics, Canberra, Australia.

1980

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

REVIEW

Glenn C. Forrester, Niagara Falls and the Glacier, Exposition Press, Hicksville, New York, 1976, 140 p.

This is a little book on the origin of Niagara Falls and Gorge and some related principles written by a local enthusiast with a long time interest in the geology of the Niagara. It is a condensed and only slightly updated version of the author's earlier well written and popular work—*The Falls of the Niagara,* D. Van Norstrand, 1928, 155 p. Like the 1928 book, this one is apparently intended to present the story of the Niagara in readable and informative fashion as extracted from the generally less accessible geologic literature. However, it is written at a somewhat less technical level and is perhaps less up-to-date for the present state of knowledge concerning the Niagara area than was its predecessor for 1928.

The first third of the book considers some general geology pertinent to understanding the Niagara story itself including a clever illustration of the "immensity" of geologic time but relative recency of gorge-cutting, explanations of radiocarbon dating, tectonics, erosion, and sedimentation, the stratigraphic importance of fossils, an early hypothesis for the local preglacial drainage, and the concepts of postglacial isostatic recovery. The gorge-cutting history itself, considered in the following sixtyfour pages, is organized around the rather speculative correlation of the glacial Great Lakes drainage history with Gorge configuration as defined by G. K. Gilbert and Frank Taylor, and presented in the U.S. Geological Survey Folio 190, 1913. Extra attention is paid in this section to lucid and illustrated accounts of formation of the Niagara Glen and of the Whirlpool. The Niagara story, and the book itself, is brought to a close with a short walking tour guide similar to those included in Forrester's earlier book and with a section titled "A Look Into the Future". The latter includes a proposal for dewatering and subsequent study of the Horseshoe Falls.

The concept of summarizing and simplifying geologic literature for amateur consumption is sound and this little book is a readable, generally concise and informative example as far as it considers the basic geologic processes forming the Gorge. It could have been a more accurate and useful reference for today's inquisitive and educated brand of amateur had it provided more informative figure captions, scales for its maps, and most important of all, had it included and made reference to some of the pertinent modern literature on Niagara with which this reviewer has became familiar over the past 15 years. No mention is made of the radiocarbon information that now helps date the filling of the St. Davids Gorge as pre late Wisconsin, the last Pleistocene glacial retreat as that from the Port Huron advance, or the opening and closing of the late

Wisconsin and Holocene Trent River and Ottawa River by-pass drainages. Furthermore, the author does not appear to be familiar with the post-1928 literature which demonstrates that the St. Davids Buried Gorge extended more than a mile upstream from the Whirlpool rather than just to the Whirlpool as Taylor stated in 1913. Accounts of the horizontal configuration of the Falls and its rate of recession and future have also been published as outgrowths of the recent detailed US Army Corps of Engineers studies on the American Falls and Upper Great Gorge. Nevertheless, the most important and basic geologic principles of Gorge formation have not changed over the years and they are made clear here for those with the $7.50 (U.S.) to purchase this thin primer.

Parker E. Calkin

NEWS

U.S.A.

The Administrative Board of the Institute of Polar Studies renamed the Institute library to honour Emeritus Professor Richard P. Goldthwait, upon his retirement from the Ohio State University Department of Geology and Mineralogy. The **Goldthwait Polar Library** commemorates Dr Goldthwait's role in founding the Institute of Polar Studies and his significant contributions to the collection during the past 18 years. Emeritus Professor Goldthwait plans to continue his research under the auspices of the Institute of Polar Studies during his retirement years.

CANADA

Association of Canadian Universities for Northern Studies

The Association of Canadian Universities for Northern Studies has opened an Ottawa headquarters at 130 Albert Street under the direction of Dr Trevor Lloyd, formerly Director, Centre for Northern Studies and Research, McGill University, Montreal. The recently founded Association is a federation of the twenty-five universities in all parts of Canada which have special interest and competence in studies, training, and research concerning the North. Officers of the Association are Dean J. K. Stager, University of British Columbia, President; Dean R. Bergeron, Université du Québec à Chicoutimi, Vice-President; and Professor V. F. Valentine, Carleton University, Secretary-Treasurer. The three additional members of its Board are Professor R. M. Bone, University of Saskatchewan, Professor W. N. Irving, University of Toronto, and Professor B. Ladanyi, Ecole Polytechnique. The other universities affiliated with the Association are Alberta, Calgary, Concordia, Lakehead, Laval, Manitoba, McGill, McMaster, Memorial, Montréal, New Brunswick, Ottawa, Québec à Montréal, Queen's, Trent, Waterloo, Western Ontario, Windsor, and York.

The main purpose of the Association is the advancement of northern studies and research. This is to be achieved by fostering relations with residents, organizations, and governments in northern Canada, with the Government of Canada and the Provinces, with non-governmental organizations and industry, and with universities, scientific institutions, and polar organizations at home and abroad.

The Science Council in its recent Report "Northward Looking—a Strategy and a Science Policy for Northern Development" draws attention to the Association as "an important development that could provide a vehicle for co-ordinating university involvement in government-sponsored research activities. With its several working committees it has major potential as an institutional device for achieving the coordination of research".

Five specific aspects of the Association's program now being dealt with by these committees are: Relations with Northern Peoples (Dr B. Robitaille, Laval, Chairman); Research (Dr H. M. French, Ottawa, Chairman); Northern Education (Dr R. W. Wein, New Brunswick, Chairman); Northern Research Stations (Dr F. Cooke, Queen's, Chairman); and International Scientific Relations (Dr R. E. Longton, Manitoba, Chairman).

The Association attaches particular importance to developing close relations with northern residents and to encouraging some trained scientists to remain in the North rather than to commute there for the summer field season as is customary, and urges the greater use of young Native residents as scientific assistants. Other priorities of the Association include: the exchange both within Canada and internationally of university professors and graduate students with northern research experience; increasing use by government, industry, and the interested public of university resources of information, skills, and understanding relating to the North; and strengthening of northern training and research facilities in the universities by more generous financial allocations to them by governments, industries, and private foundations. The Association is preparing a Directory of university specialists on the North, arranged by subject and region as an aid to governments and industries requiring research assistance and technical information.

In support of Canada's obligation to contribute data, research results, experience, and skills toward the world-wide study of the polar regions, the universities expect to increase their contribution to international programs, conferences, organizations and information exchanges.

The Association is supported financially by its member universities and by the Donner Canadian Foundation.

Research Institute

The Government has recently announced its intention to create a National Hydrology Research Institute (NHRI) in Saskatoon. A major component of the NHRI will be the Glaciology Division of Fisheries and Environment Canada. It will be located in a research park adjoining the University of Saskatchewan and the move is expected to take place in late 1980.

Field Course in Glacial Hydrology

Carleton University may attempt to organize another Field Course in glacial hydrology in the summer of 1978 if there is enough support. Anyone interested should contact Dr J. Peter Johnson, Jr., Department of Geography, Carleton University, Ottawa, Ontario K1A 5B6, Tel: (613) 231 2641, as soon as possible.

Temperate glacier radio echo depth sounder

A monopulse sounder has been built at University of British Columbia. The transmitted pulse is several cycles of a damped sinusoid of 1-5 MHz depending on antenna length and damping. This frequency range is suitable for sounding temperate ice. The equipment is portable and easy to operate with minimal basic instruction. The identification of bottom reflections is straightforward and each depth measurement can be obtained in a few minutes.

The system is capable of measuring a wide range of ice thickness. Soundings ranged from 700 m on the Kaskawulsh Glacier (Yukon Territory) to 40 m on Wedgemount Glacier (British Columbia).

Arrangements for loan of the equipment and further information can be obtained from E. Waddington or G. Clarke, Department of Geophysics and Astronomy, University of British Columbia, 2075 Wesbrook Place, Vancouver, British Columbia V6T 1W5.

NEW MEMBERS

Alamy, Fawaz, Chairman of Physics, King Abdul Aziz University, Jeddah, P.O. Box 1540, Saudi Arabia.

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INTERNATIONAL GLACIOLOGICAL SOCIETY

Lensfield Road, Cambridge CB2 1ER, England

DETAILS OF MEMBERSHIP

Membership is open to all individuals who have scientific, practical or general interest in any aspect of snow and ice study. Payment covers purchase of the Journal of Glaciology and Ice. Forms for enrolment can be obtained from the Secretary General. No proposer or seconder is required. Annual payments 1978:

Private members	Sterling:	£10.00
Junior members	Sterling:	£4.00 (under 25)
Institutions, libraries	Sterling:	£20.00 for Volume 20 (Nos. 82, 83, 84) £20.00 for Volume 21 (Number 85)

Note—Payments from countries other than Britain should be calculated at the exchange rate in force at the time of payment. If you pay by bank draft, rather than by personal cheque, please ensure that sufficient money is included to cover the bank charges of £0.50p per cheque. Thank you.

ICE

Editor: Hilda Richardson

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