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ICE

INTERNATIONAL GLACIOLOGICAL SOCIETY

CONFERENCES IN 1980

1-3 APRIL, CAMBRIDGE, U.K.—Conference on the Use of icebergs: scientific and practical feasibility.

Organized by: International Glaciological Society.

Hosted by: Scott Polar Research Institute.

Sponsored by: Iceberg Transport International, Limited, King Faisal Foundation, and Abdul Aziz University.

25-30 AUGUST, GEILO, NORWAY—Symposium on Processes of glacier erosion and sedimentation.

Organized by: International Glaciological Society in co-operation with: Norsk Polarinstitutt and University of Oslo.

Proceedings of these conferences will be published by the Society in 1981, in the *Annals of Glaciology*. (See page 21 of this issue of ICE.)

ICE

NEWS BULLETIN OF THE

INTERNATIONAL GLACIOLOGICAL SOCIETY

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CONTENTS

NOTICES 1

RECENT WORK: Japan 2
Sweden 10
U.S.S.R. 11

PROFILE: Dr Bruno Salm 16

INTERNATIONAL GLACIOLOGICAL SOCIETY:
1979 Annual General Meeting — minutes 18
Conference Proceedings 21
Glaciological Literature 22
Journal of Glaciology 23
Branch News 24
1980 Symposium on Processes of Glacier Erosion and Sedimentation, Geilo, Norway ... 25

GLACIOLOGICAL DIARY 29

NEWS 29

NEW MEMBERS 32

COVER PICTURE. A stone monument to commemorate the birthplace of the first artificial snow crystals was unveiled on 4 July 1979 in the campus of Hokkaido University, Sapporo, Japan. The place of the monument is the historic site where a small low temperature laboratory was built in October 1935, probably the first one for the purpose of researches on snow and ice. The first artificial snow crystal was grown by the late Professor Ukichiro Nakaya in a cold room of this laboratory on 12 March 1936 and this success led to his extensive investigations on the artificial production of various snow crystals which finally bore fruit as the famous Nakaya diagram. For a few decades after its establishment, this small laboratory was the site of many pioneer works in the field of snow and ice: frost heaving, icing, thunderstorm electricity, formation of discoidal ice from water, etc. which achieved world-wide fame.

Although the Institute of Low Temperature Science, which was established in the University in 1941 as an expansion of the laboratory, equipped more cold rooms in its new building, the two small original cold rooms were used for more than 35 years until 1972. Last year this laboratory was torn down after it served for several years as a temporary office for the Chromosome Research Unit. Regretting the loss of this historic building, people in and out of the university, mainly scientists of Nakaya's school, decided to erect a monument and raised the money. The monument is in granite, shaped like a hexagonal plate type snow crystal. On the front surface is carved the words: "Birthplace of the first artificial snow crystal". The brushwork was done by Dr Yataro Sekido, who was a collaborator of Professor Nakaya when the first snow crystal was grown here. On the back of the monument a short history of the laboratory is written on an attached plate. Akira Higashi

RECENT WORK

JAPAN

ANTARCTICA

Glaciological studies in Mizuho Plateau area

Aiming to clarify the mass balance, ice flow, geomorphological features and climatic conditions of the ice sheet in the Mizuho Plateau-West Enderby Land area, a glaciological research programme was conducted by the Japanese Antarctic Research Expedition (JARE) from 1969 to 1975. It was composed of two major parts: (1) oversnow traverses for glaciological surveys and (2) deep-core drilling at Mizuho station (70°41′53″S, 44°19′54″E, 2230m a.s.l.). Earlier results have been published as JARE Data Reports Nos. 17, 27 and 28 by the National Institute of Polar Research (NIPR). The data obtained in 1974-1975 by JARE-15 was recently published in JARE Data Reports No. 36 (Glaciological research programme in Mizuho Plateau-West Enderby Land, East Antarctica). The analysed results obtained in this programme were also recently published by NIPR in the form of Memoirs of NIPR, Special issue, No. 7 (Glaciological studies in Mizuho Plateau, East Antarctica, 1969-1975, *Ed.* T. Ishida et al., 1978), which is mainly concerned with the geomorphology, climatic conditions of the ice sheet, studies on snow accumulation, ice flow, oxygen isotope composition and chemical constituents of surface snow in the Mizuho Plateau area. Another special issue, Memoirs of NIPR, Special issue No. 10 (Ice-coring project at Mizuho station, East Antarctica, 1970-75, *Ed.* K. Kusunoki and Y. Suzuki, 1978) was also published, which includes drilling operations, stratigraphies, structures, electrical, mechanical and optical characteristics of snow, firn and ice from the surface down to the depth of 147.5 m.

Polex-south

A three-year Polex-south programme from 1979 to 1982 was started to elucidate air-ice interactions in coastal and inland areas between Syowa and Mizuho stations. The latter is located in the katabatic wind zone characterized by the very strong katabatic wind constantly blowing over the ice sheet. A remarkably distinct temperature inversion was found by JARE 15 at an elevation of 300 m to 600 m above the surface of the ice sheet almost throughout the year. Factors related to the atmospheric structure including profiles of air temperature, humidity, wind direction and velocity, and cloud ceiling level are to be investigated by means of both conventional radiosondes and low-altitude radiosondes and sonic-radars in conjunction with water-vapour flux, general circulation of air above the ice sheet, atmospheric disturbance due to cyclones, solid precipitation, heat balance of the ice sheet and that of sea ice.

Aiming at shedding a light on micrometeorological conditions at or near the surface of the ice sheet, a 30 m-tower was constructed at Mizuho station in the beginning of January 1979, to observe vertical profiles of air temperature, wind velocity, incoming and outgoing amounts of radiation, horizontal and vertical visibility, flux of drifting snow, rate of falling snow, and so forth. S. Mae, M. Wada, both of NIPR, and T. Yamanouchi of Tohoku University have joined the Polex-south as wintering members of JARE-20 from 1978 to 1980.

Four unmanned stations are to be set up during the Polex-south in the Enderby Land area to obtain meteorological data over the ice sheet including air temperature, wind velocity and direction, atmospheric pressure and solar radiation.

NEPAL HIMALAYA

A Glaciological Expedition to Nepal (GEN) has been organized for glaciological and meteorological observations of glaciers in the Nepal Himalayas by K. Higuchi and his colleagues of the Water Research Institute (WRI) of Nagoya University with permission from and in co-operation with His Majesty's Government of Nepal. B. Upadhyay of Tribuban University of Nepal has joined the expedition. The activities conducted in 1978 were: (1) glaciological observations, including studies on the origins and physical properties of debris, and an energy exchange between air and debris-covered ice on the middle and the lower part of Khumbu Glacier; (2) studies on mass balance and accumulation-ablation processes during the monsoon season on AXOIO Glacier in Shorong Himal; (3) traverse observations and general surveys of glaciers in Hong Khola, Hinku Khola and Jugal Himalaya; (4) aerial observations of glaciers in the Khumbu-Api-Saipal Himal area.

The observational results obtained by GEN have been published in English as special issues of *Seppyo*, i.e. *Journal of the Japanese Society of Snow and Ice*, Vol. 38 (1976), Vol. 39 (1977) and Vol. 40 (1978). Anyone interested is encouraged to write to K. Higuchi.

KARAKORUM

H. Nishimura, S. Suizu and K. Nishimura of ILTS made an expedition to Biafo Glacier, 59 km long, one of the largest glaciers in the Karakorum region, in the summer of 1977, to study the mass balance, heat balance, flow, structure and meteorological conditions of the glacier. They have reported that the glacier is in a steady state, the annual values of areal net balance both in the accumulation and the ablation area and ice flux across the equilibrium line being

respectively 2.3, −2.2 and 2.6 x $10^8 m^3$ in water equivalent. They have also reported that short-wave radiation is a dominant factor in ablation. The results will be published soon in *Seppyo* in English.

PERENNIAL SNOW PATCH

K. Higuchi of WRI has organized a research group to study the distribution and mass balance of perennial snow patches in Japan in relation to the Permanent Service on the Fluctuation of Glaciers (PSFG) and International Hydrological Programme (IHP). Many investigators of universities representing Hokkaido, Hirosaki, Yamagata, Niigata, Toyama, Fukui, Shinshu, Nagoya, Kyoto and Yamaguchi have joined in the project. The results obtained will be published in *Seppyo* as "collected papers on perennial snow patches in Japan".

I. Tsuchiya of the National Institute for Environmental Studies has made a glacio-climatological study on the Kai-gata glacieret (perennial snow patch) in Mt. Chokai in Yamagata Prefecture.

S. Takahashi of ILTS has carried out field observations and wind tunnel experiments on the formation of polygonal hollows (or ablation hollows) which are often observed on the surface of a perennial snow patch. His findings are that ablation hollows are formed only when the wind speed exceeds the critical value around 4–5 $m \cdot s^{-1}$ in natural conditions and 7 $m \cdot s^{-1}$ in the wind tunnel irrespective of air temperature and vapour pressure, and that the diameter of an ablation hollow is inversely proportional to the wind speed. As a possible process in the formation of an ablation hollow he has proposed that it develops as a result of a difference in local heat transfer coefficients due to the separation of boundary layers.

SNOW HYDROLOGY

While a number of areas covered by perennial snow patches are found in high mountains in Hokkaido and Honshu, a joint research project of studying a mass balance of a snow patch as regards a climatic change has been organized, in connection with IHP, by K. Higuchi of Nagoya University and joined by many scientists and glaciologists of universities and institutions in Hokkaido and Honshu. The results obtained have been published recently in Vol. 41 of *Seppyo*.

Micrometeorological studies of snow deposited in the Moshiri basin in the northern part of Hokkaido, where the air temperature easily goes down to −40°C at night, have been made by K. Kojima and his colleagues of ILTS concerning snow hydrology and snow melting. What they have pursued include studies of a heat balance or an energy exchange between air and the snow surface, as well as a relation between discharge rates of meltwater from snow and water temperatures of a creek flowing underneath the snow cover.

D. Kobayashi and T. Uematsu of ILTS have measured water temperatures of streams in the Moshiri basin during the snow-melting season with respect to the run-off of meltwater in mountainous regions. In the snow-melting period, despite an untested belief that streams have a temperature close to 0°C because of the likeliness of a prevailing surface run-off, they have unexpectedly found that discharged water had temperatures as high as 3° to 5°C in the source areas of the snow-rich basin. They have reached a conclusion that a subsurface run-off prevails during this period in that most parts of meltwater infiltrate into the ground and reappear in springs and streams at some distant points.

A new branch laboratory of ILTS called the Snow Melting Observation Station was established in Moshiri in 1978 for a long-term observation and study of snow melting and heat balance of a snow cover.

T. Yamada, S. Suizu and H. Nishimura of ILTS have been studying regional characteristics and amounts of snow in mountainous areas in Hokkaido as a function of altitude and the lapse of time throughout the snow season. They have found in one of the mountains that the water equivalent of snow linearly increases with an increase in altitude from the foot up to the timberline regardless of the direction of the slope, while they have not found a definite relation in the alpine zone, where severe erosion is often caused by strong winds. They have also found that the melting rate of snow is practically the same regardless of altitudes, which is being examined in a different mountain, i.e., Mt. Teine near Sapporo, by carrying out meteorological observations at different altitudes.

A joint group of Nagoya University and Kyoto University has been studying variations in total amount of snow in the Lake Biwa area in regard to a climatic change and its contribution to the water resources of this largest lake in Japan, under the leadership of K. Higuchi. They have found that the total amount of snow in this area varies with the year from 3.5 to 5.0 million tons.

ENVIRONMENTAL STUDY OF SNOW IN URBAN AREAS

H. Aburakawa, R. Naruse and N. Ishikawa of ILTS have measured snow depths, water equivalents of snow, melting rates of snow, minimum air temperatures, and so forth, at 68 sites in urban and rural areas of Sapporo to account for influences of human activities in such a large city (releasing of excess heat, reducing of albedo of the snow surface due to pollution, reduction of wind speed because of obstructions like buildings and houses, etc.) on the accumulation and melting of snow and the air temperature. Their findings are: (1) multitudes of buildings and houses in the urban areas have such an effect on the wind speed and direction and snow drifting that snow accumulations show a remarkably uneven distribution; (2) the snow

melting rate in the rural areas on the leeward of the city is larger than that in the urban areas; (3) the minimum rate is in the rural areas on the windward of the city, which may be caused by the heat originated from the combustion of fuel in the urban areas and carried to the leeward rural areas by the wind; (4) in the night-time when radiative cooling takes place the urban areas have relatively high temperatures, the largest difference in temperature being 8°C between the urban and the rural areas, while, as for a heat balance of snow, the maximum amount of anthropogenic heat released in the urban areas amounts to about 30% of the amount of downward atmospheric radiation on such nights.

AVALANCHES

M. Nakagawa et al of Toyama University and H. Shimizu et al of ILTS have been jointly studying avalanches in the Kurobe Canyon, Toyama Prefecture, using an automatic recording system and automatic movie camera for measurements of impact pressure of an avalanche against a structure, its flow speed and simultaneously a variation in temperature in a powder snow avalanche, whereby in observations in the winter of 1977-1978 they obtained the impact pressure and the flow speed ranging from 29 to 140 ton·m^{-2} and from 20 to 40 m·s^{-1} respectively, as well as a sudden temperature rise of 1.0 to 2.5°C in powder snow avalanches as compared with the temperature at the circumference.

Y. Endo and E. Akitaya, who have studied both in the field and laboratory the gliding processes of a snow cover on a slope covered with bamboo grasses (Sasa paniculata), have confirmed that the snow cover on the slope is supported by a number of bamboo grasses, buried under and embedded in the snow cover, and that the snow cover does not slide down quickly, forming an avalanche, until the grasses have completely fallen down on the slope by the gradual sliding of the snow cover.

M. Saeki, S. Watanabe and Y. Ozeki, of Forestry and Forest Products Research Institute, Ministry of Agriculture, Forestry and Fisheries, have investigated a protective effect of young broadleaf trees on sloped forests against avalanche generation, whereby they have reported that the gliding of snow is greatly affected by the total number of trees; i.e., avalanches tend to occur in forests in which the number of trees is less than 3000 ha^{-1}, while in forests where it increases to more than 4500 ha^{-1} the gliding distance of a snow cover decreased down to 2–3 m in winter and the snow cover becomes stable.

FROZEN GROUND AND FROST HEAVE

Joint studies on physical and biological environments in the permafrost were conducted by S. Kinosita of ILTS and his colleagues in and around Barrow, Alaska, and Tuktoyaktuk, MacKenzie Delta, Canada, from July to August 1977. The physical subgroup observed the thermal regime, acidity and water permeability of the uppermost layer in tundra areas together with the oxygen isotopic concentration of ground ice, while the biological subgroups surveyed, in connection with the structure and thickness of an active layer, diversities in Collembola and topographic features of the tundra, zooplankton in arctic temporary ponds, and plant communities in the permafrost. The results obtained and analysed were published in English by ILTS in December 1978 (Joint studies on physical and biological environments in the permafrost, Alaska and north Canada, *Ed.* S. Kinosita, pp. 149).

S. Kinosita and his colleagues have carried out both laboratory and field studies on frost heaving and associated phenomena. K. Takeda and Y. Suzuki of ILTS have observed water migration during the freezing of soil to look into the dependence of water tension just below the freezing front on two external conditions: the cooling temperature and the distance between the front and the ground water level, whereby they have found that the water tension decreases gradually with a decrease in cooling temperature and abruptly when the above distance is less than 50 cm. Meanwhile, S. Kinosita et al have made observations at the Tomakomai field site on frost heaving of soils put in four waterproof basins of different size and depth, making continuous measurements of heave amount of soils at the four basins, in relation to groundwater level, stratigraphic profiles and particle sizes of soils filled in the basins. K. Horiguchi of ILTS has investigated the behaviour of unfrozen water in frozen soil by measuring linear expansion coefficients of wet bentonite, illite and kaoline of various water contents in a temperature range from a few degrees above 0°C down to -110°C, with a conclusion that there are three kinds of unfrozen water in a frozen soil from the following experimental results concerning ways in which the coefficient varies with the water content: (1) bentonite, which has a relatively large internal surface, shows a characteristic way; (2) illite, which has a relatively small internal surface, shows another characteristic way, these two ways indicating the presence of two kinds of interlamellar water as unfrozen water, as confirmed by both differential scanning calorimetry and X-ray diffraction technique; and (3) kaoline, which has no internal surface, shows a discontinuity around 0°C irrespective of the water content.

M. Fukuda of ILTS studied the movement of water in soil by use of a γ-ray transmission method during his stay in California from 1977 to 1978 under the supervision of Prof. A. Luthin of the University of California at Davis, who made a two-week visit to ILTS in the summer of 1978 to discuss questions related to frost heaving with S. Kinosita and his group.

H. Yahagi, of Hokkaido Education University at Kushiro, has succeeded in using a time-lapse motion picture technique for direct observation of growing processes of ice lenses at the freezing front in a soil, which was sandwiched between transparent acrylic plates.

T. Takashi and his colleagues, of Seiken Reiki Co., Ltd., have made theoretical studies of the mechanism of frost heaving, experimental studies of frost heave force as a function of void water pressure and of the prevention of frost heaving by an increase in viscosity of void water pressure by adding $CaCl_2$ to the soil. They have also studied and developed an artificial method of freezing soil and ground for excavating tunnels and subways in ground as wet and soft as that which lies underneath a river.

SNOW AND ICE ACCRETION

Experimental studies on snow and ice accretions on power lines have been conducted by research groups from universities and electric power companies for developing prevention techniques or methods against snow and ice accretion. Adhesion of snow and ice has also been studied by them for the same purpose.

K. Fujino et al of ILTS have made experimental studies of snow accretion on a power line using a wind tunnel in a cold room to clarify the initial stage in growth processes of accretion, obtain the coefficient of collection, and measure wind speed and turbulence around a snow accretion on the line. Y. Mizuno and G. Wakahama of ILTS have measured the adhesive tensile strength of both wet and dry snow to different kinds of metals and plastics in conjunction with the prevention of snow accretion on power lines, running trains and automobiles, and structures on the mountain top like parabolic antennas and astronomical observatories.

K. Yano, of Yamagata University and D. Kuroiwa of ILTS have made wind tunnel experiments on ice accretion on wires under a polarizing microscope to observe growing processes of ice accretion in detail. They have also measured the adhesive strength of an accreted ice body as a function of temperature when supercooled water droplets, which contained 0.05-0.7% of KCl, were sprayed on to metal plates, using a centrifugal technique, whereby they have found that the adhesive strength markedly reduces down to 1 $Kg \cdot m^{-2}$ when the ice temperature is higher than the ice-KCl eutectic temperature ($-12°C$). S. Abe and K. Yano of Yamagata University, who have studied ice accretion on structures and trees in mountainous regions, have succeeded in taking time-lapse motion pictures of growing ice accretions on wooden boards and trees.

The snow accretion research group of Hokkaido Electric Power Co., Ltd., have developed several techniques for preventing snow and ice from accreting on power lines; i.e., anti-snow accretion line which has a plastic ring attached around it at an interval of 0.6 m; an anti-torsion technique of fixing parallel lines mutually against torsion by mounting a "spacer" on them, etc. Having made *in situ* experiments, they have reported that these techniques are very effective in preventing both snow and ice from accreting.

T. Hasemi, of the Institute for Natural Environmental Sciences Co., Ltd., has studied meteorological conditions, in which wet snow flakes are formed resulting in snow accretion on power lines.

D. Kobayashi of ILTS has studied snow accumulation on a narrow board, whereby he has found that falling snow flakes rebound sometimes even on the surface of freshly deposited snow in a calm condition and that they rebound more actively on a sloped surface of snow, the collection coefficient of snow on the board depending on both the width of the board and air temperature.

SEA AND LAKE ICE

T. Tabata and his colleagues of ILTS and SIRL (the Sea Ice Research Laboratory) have conducted observations of the motion of drifting sea ice off the Okhotsk Sea coast of Hokkaido by use of a sea ice radar system. T. Tabata and M. Aota made sea ice observations of northern Sakhalin Island in March 1978, in connection with the construction of an oil drilling platform in the sea under the Japan-Soviet co-operative project for oil drilling in the area. They carried out measurements of the thickness, the drift velocity, and the uniaxial compressive strength of sea ice in co operation with Russian scientists.

M. Aota el al measured sea currents beneath the pack ice with respect to ice movement by anchoring four AANDERA current meters, one each at points 4 and 15 nautical miles and two in different depths at a point 8 nautical miles off NE Monbetsu, from late December 1977, to early April 1978, whereby they obtained the harmonic constituents of the tidal current by a 32-day analysis together with the current ellipses. It was found that the residual current runs southwestwards along the coastline in winter as in warmer seasons, that the current speed is weakened at the beginning of the sea ice season, and that it becomes strong, however, soon after the middle of this season. Based on their observations and analyses, they concluded that the Soya warm current runs intermittently even in winter as an undercurrent.

Y. Nouguchi and T. Tabata have carried out uniaxial compression tests on sea ice taken from Lake Saroma, which is connected to the Sea of Okhotsk, in two different ways: one is a normal compression test by which the compressive strength is obtained as a function of temperature, strain rate, load direction and salinity; the other is a cyclic load test in which generation of compression and stress is alternately repeated between two levels of fixed stress

until a specimen breaks so that the number of repetitions and the time required until a failure takes place are obtained. Y. Nouguchi et al also made similar experiments at Barrow, Alaska, in April 1978.

T. Takizawa of ILTS has made a series of experiments on the deflection of a floating ice sheet subjected to a moving load at Lake Saroma, using a snowmobile as a moving load with a speed up to 50 km·h^{-1}, whereby he has observed the profiles of ice deflection and the associated waves both in the front and the rear of the moving load as a function of moving speed and water depth, in particular, in a special reference to the critical speed.

K. Shirasawa and T. Tabata have measured the Reynolds wind stress over the snow-covered frozen surface of this lake. They have carried out measurements by three different methods: (1) direct measurements of wind force on an ice disc floating in a circular pool by use of three tensiometers fixed at three points outside the pool; (2) the eddy correlation method using a three-component anemometer; (3) the wind velocity profile method. They have reported that the values of Reynolds stress by the first method agree fairly well with those by the second one, while the third one gives a little higher values. They have also measured the Reynolds wind stress over rough pack ice by the third method.

M. Wakatsuchi of ILTS has conducted laboratory experiments on saline convection occurring under a growing sea ice using a Schlieren optical system, whereby he has observed the brine rejected from the growing ice forming a large number of filamentous streamers, which fell in bunches into the underlying seawater, as well as detecting the associated convective motion of the seawater. He has also found that the volume fluxes of the brine are 3.2-3.8 x 10^{-5} cm^3 s^{-1} cm^{-2} and the average salinity of the streamers is higher by about 2.5% than that of the surrounding seawater.

K. Tusima and T. Tabata of ILTS made *in situ* measurements of the kinetic friction of sea ice against metals and plastics at Barrow, Alaska. The obtained data and the analysed results will be presented to the Port and Ocean Engineering under Arctic Conditions (POAC) to be held at the University of Trondheim, Norway, in August 1979.

N. Ono of ILTS has observed the drift of a pack-ice field by use of four radar buoys tracked by a radar system of SIRL at Monbetsu, in the Okhotsk Sea coast of Hokkaido, the drift movements being analysed in reference to the wind direction and speed and the sea current. He has also made observations of drift and deformation of sea ice off the same coast using this radar system, with the finding that, even when radar images show such a complicated ice motion as packing, loosing, eddying and rotating, the trajectory of each ice target selected in the image of an ice field indicates a simple curve resembling a trochoid, and that the period of the trochoidal trajectory of sea ice is closely equal to the inertial period in this region.

T. Kawamura of SIRL has investigated the divergence and rotation of an ice field off the same coast by analysing sea ice radar images taken every several hours by this radar system, whereby he has reported that, although divergence and rotation change remarkably not only with time but also with space, there are some spatial domains where several quadrilaterals show a similar tendency in deformation.

A. Tokairin, of Hokkaido Education University at Kushiro has studied curious shaped melting features often observed at the frozen surface of a snow-covered lake in the early stage of the melting season, in connection with the melting process of lake ice. Having also made experimental studies of the formation mechanism of the melting features, he has found that the melting features are initiated with the formation of thin water veins produced along triple grain boundaries among ice crystals composing the lake ice.

PHYSICS OF SNOW AND ICE

Since K. Kikuchi, of Department of Geophysics of Hokkaido University first found snow crystals in peculiar shapes in Antarctica, extensive studies have been made of such snow crystals in the field and laboratory for the past several years. With this in the background the cloud physics group of Hokkaido University organized an expedition to observe snow crystals in mid winter at Inuvik, N.W.T., in Arctic Canada and at North Battleford, Saskatchewan, Canada, under the leadership of C. Magono. The results were published in English in "Snow crystals in Arctic Canada" as an interim report (*Ed.* by C. Magono, 1978).

Y. Furukawa and T. Kobayashi of ILTS have studied the growth mechanism of polycrystalline snow crystals such as crossed-plate crystals, with the finding that this type of crystal is an assemblage of two to four thin basal plates, each plate extending along a CSL grain boundary with a relation of 70.3°/[11$\bar{2}$0], whereby they have proposed a possible growth mechanism to account for the characteristic growth in the direction of the axis [11$\bar{2}$0].

Physical, chemical and crystallographic analyses of snow and ice cores from Antarctica have been carried out by many researchers of ILTS, Faculty of Engineering of Hokkaido University, WRI, Muroran Institute of Technology, National Research Center for Disaster Prevention (NRCDP), and NIPR.

To measure both c-axis and a-axes orientations of individual crystals in polycrystalline ice, M. Matsuda of ILTS has devised a new method, by which he has measured the spatial lattice

orientations of each of crystals of several types of polycrystalline ice with different origins such as deep-ice cores taken at Amery Ice Shelf, Law Dome and Cape Folger by ANARE. He has shown that a great majority of adjoining crystals may be in a twinning relation, and that the multi-maximum c-axis preferred-orientation fabric (so-called "diamond pattern") is of the polycrystalline structure closest to the structure of a single crystal of ice among all the fabrics found in large ice masses. His suggestion is that plastic deformation of ice with this fabric may be attributed to mechanical twinning due to a strong shear stress.

N. Maeno of ILTS has studied the electrical properties of Antarctic firn and ice drilled at Mizuho station to the depth of 145 m in a wide range of frequency (0.1 Hz to 1 MHz) and temperature (0 to −50°C), with the results of measurements showing that the alteration of densification mechanisms occurs at a depth around 30 m corresponding to the density of 730 $Kg \cdot m^{-3}$, where the bonding and compaction of composing ice particles are regarded as reaching their optimum mode, which has also been confirmed by petrofabric analyses of cores. He has also found remarkable differences in electrical properties between the cores taken from depths shallower than 55 m and those from deeper parts. As for the former cores, which correspond to cores permeable to air flow and with densities less than 840 $Kg \cdot m^{-3}$, he has been able to explain dielectric properties of them as those of heterogeneous mixture, i.e. dielectrics of ice and air. Meanwhile, the latter cores, which correspond to impermeable cores with densities larger than 840 $Kg \cdot m^{-3}$, has showed extremely large dielectric constants and conductivities.

T. Nakamura and O. Abe, of Shinjo Branch of NRCDP, have measured the internal friction and shear modulus of Antarctic ice cores drilled at Mizuho station by an inverted torsion pendulum in a frequency range from 4 to 9 Hz and a temperature range from 96 to 272°K, whereby they have found two peaks of internal friction: one around 265°K, which was considered due to a grain boundary, and the other around 150°K considered due to mechanical relaxation, the height of the former peak decreasing with an increase in density of the core and the shear modulus decreasing very slowly with an increase in temperature up to around 253°K, where internal friction begins to increase sharply, and decreasing more rapidly above that temperature.

The following have been carried out in A. Higashi's laboratory of Faculty of Engineering, Hokkaido University: (1) T. Hondoh has studied the grain boundary sliding of a bicrystal of ice, in which the boundary was the $(10\bar{1}0)/34°$ tilt type, whereupon difference in the mode of sliding for two cases, when the sliding direction is parallel or perpendicular to its rotation axis, can be interpreted by existence and characters of grain boundary dislocations associated with the CSL structure of the boundary; (2) H. Shoji has carried out experiments on stress-strain relations of Antarctic deep-core ice under hydrostatic pressure, finding that the hydrostatic pressure causes a hardening effect on the mechanical property of the core ice, whereby this result has been applied to the flow profile of the ice sheet at Byrd station; (3) A. Fukuda has investigated the dynamical behaviour of dislocations in a single crystal of ice by X-ray diffraction topography and is now proposing a new mechanism for the faster motion of dislocations than anticipated by the D-L defects barrier mechanism; (4) M. Oguro (moved to Hokkaido Education University at Asahikawa) has studied mechanical relaxation in single crystals of ice, finding anisotropy in tan δ.

Y. Mizuno of ILTS has studied crystal imperfections including basal and non-basal dislocations, small-angle grain boundaries, stacking faults, and dislocation networks in ice using X-ray diffraction topography in order to clarify the growth process or origin of ice, i.e., ice from glaciers, ice grown from the melt, or ice formed by sublimation, with the results showing that the dislocation density of a hoar crystal is very large at the point at which it started to grow, but away from this region the density becomes so small that no dislocation can be seen, and that long screw dislocations with the Burgers vector c [0001] are observed in a tabular ice which was formed artificially at a very slight degree of supercooling. She has also studied the behaviour of dislocations in ice subjected to a tensile stress by use of the divergent X-ray technique, which gives both enlarged Laue spots and a transmission pattern in the same photograph.

K. Tsusima of ILTS has measured the friction anisotropy on planes of an ice crystal, basal (0001), prism $(01\bar{1}0)$ and $(11\bar{2}0)$ and pyramidal, as a function of track width, as well as measuring the amount of plastic deformation caused by frictional sliding, and so on. His findings are that at temperatures below −19°C for the prism planes, the maximum is in the sliding direction $[11\bar{2}0]$ on the planes $(01\bar{1}0)$ and in the direction $[10\bar{1}0]$ on the planes $(11\bar{2}0)$, the minimum being in the direction [0001] for both planes, and that a remarkable friction anisotropy exists on pyramidal planes, although track-width anisotropy is very small. The results of this work are in the process of being published.

K. Tusima has also studied the kinetic friction between crystallographically different ice surfaces and different kinds of plastic balls (nylon, polyethelene, derlin, teflon, etc.) of various diameters varying loads, temperatures, and

frictional velocities, with the results showing that soft materials such as teflon have such a fairly large kinetic friction as 0.1.

S. Tozuka and K. Tusima of ILTS have conducted a series of experiments on regelation. Measuring regelation speeds of thin wires of different materials (copper, piano wire, Almel, Constantan, Chromel) of various diameters, d, under different pressure, P, they have found that (1) the regelation speed, V, is proportional to the 1/5th power of the thermal conductivity of the material; (2) V is proportional to P exerted on the wire regardless of the material; (3) V/P is proportional to $(1/d)^n$, where n is larger than 1 for copper and less than 1 for nylon. Also measuring the temperature of the ice close to the wire, they have estimated the heat transported from the ice to the wire. They have further made direct observations of a moving wire and its vicinity under a microscope, whereby they have succeeded in taking a time-lapse motion picture, which shows that the meltwater produced at the front of the wire is flowing to the backside of the wire, and that internal melting takes place in the vicinity of the wire.

Meanwhile, K. Tusima has studied the grain-coarsening of ice particles immersed in pure water kept at 0°C by measuring the diameter of the ice particles statistically with a lapse of time, obtaining the relationship, $\phi = 0.20t + 0.005$, between averaged diameter ϕ (in mm) and time t (in hour), and estimating the grain boundary energy of ice from microscopic observations of contact areas between ice particles immersed in water. He has also made similar experiments on grain-coarsening of ice particles immersed in impure water in co-operation with C. Raymond of University of Washington, who stayed in ILTS from 1977 to 1978.

K. Araoka and N. Maeno ILTS have studied the restitution coefficient of spherical ice particles on a flat ice surface at −12°C in the range of impact velocity from 40 $cm \cdot s^{-1}$ to 500 $cm \cdot s^{-1}$, obtaining impact and rebound velocities by a stroboscopic technique and using spheres made of teflon, glass and ice containing some amount of NaCl. They have discussed a kinetic energy loss at the collision on the basis of the microscopic observation of the collided ice surface, forming a conclusion that most effective in causing an energy loss is the plastic deformation of the ice resulting in the creation of indentation marks in the ice surface.

H. Nishimura and N. Maeno have measured the surface electric conductivity of pure monocrystalline ice as a function of temperature, crystallographic face and sublimation rate, used in the measurement of electric surface currents. From the results showing that the dependence of surface conductivity on temperature varies around −6°C and that at temperatures above −6°C the surface conductivity increases markedly as the temperature approaches the melting point of ice, they have concluded that a rapid increase in surface conductivity near the melting point is caused by the appearance of a quasi-liquid layer on the ice surface. They have also found that, when the ice surface is forced to sublime with evacuation of air, the surface conduction increases, while they have concluded from a rapid increase in surface current at temperatures higher than −9°C that it is also attributable to the presence of a quasi-liquid layer on the ice surface.

In the light of an interesting and important problem presented by fluidization of snow in connection with avalanche dynamics and snow drifting, M. Maeno and K. Nishimura of ILTS have tried an experimental approach to this phenomenon by creating a fluidized state of snow in a cylindrical tube, into which air is sent through a compressor, and measuring the minimum fluidization speed of snow particles different in size and temperature. Their finding is that the minimum fluidization speed is almost independent of temperature, but increases with increasing diameters of snow particles. They have obtained the space density, viscosity and thermal conductivity of a body of fluidized snow, after having succeeded in evidently showing complex movements of snow particles in this state which are similar to those of molecules in a liquid and the overall behaviour of this body which is liquidlike.

SNOW CLEARANCE FROM THE ROOF

Snow on the roof has presented a serious problem in safety from hazard and damage during the winter. For instance, more than fifty persons were killed or injured in this winter by snow masses and ice blocks falling from the roofs of houses, while some of vinyl greenhouses and barracks were crashed down by a heavy weight of snow on the roof. Many investigators from NRCDP, universities and the Ministry of Agriculture, Forestry and Fisheries have recently been involved in studies concerned with the clearance of snow from the roof. T. Kimura of ISIS, Nagaoka, has been developing a method of removing the snow from the roof by use of solar radiation, heated pipes, etc. According to his report, the test result of the solar radiation device was that the additional amount of snow melted throughout the winter reached 300 $Kg \cdot m^{-2}$, the efficiency of his device being approximately 45%.

INSTRUMENTS AND METHODS

M. Matsuda of ILTS has devised a new method of measuring crystallographic lattice orientations of individual crystals in polycrystalline ice. This device is based on combination of a technique of optical measurement of a thin section and an etch-pit technique. When used on a polycrystalline glacier ice, it provides data of three orientations as well as the c-axis orientation of each crystal, with an accuracy of 5°.

Hideomi Nakamura of Shijo Branch, NRCDP, has devised a "snow making box", in which fernlike snow crystals can be produced, the maximum daily production of snow (density: 0.03 Kg·m^{-3}) being 12.3 kg.

T. Kimura of ISIS, Nagaoka, has developed a "snow distribution, forecasting and displaying system" in co-operation with the Ministry of Construction, aiming at monitoring snowfalls and snow distribution and properly maintaining traffic on roads and highways. Data of depths of snow measured by 32 automatic snow-depth meters (mostly reflection-type snow-depth meters developed by ISIS) and collected through a microwave telemetering network were processed and displayed at the snow monitoring centre in Nagaoka.

T. Abe and O. Sasaki, of the Faculty of Engineering, Niigata University, have developed a newly devised "laser Doppler velocimeter" for measuring falling speeds of snow flakes, snow crystals, sleet and rain. Real-time measurements of the falling speeds of individual particles and crystals can be obtained by this method, because the dimension of cross-section of a sampling volume is smaller than the dimension of a particle.

H. Aburakawa and S. Takahashi of ILTS have developed a "fibre-scope type snow-depth recorder", while a research group of Matsushita Tsushin Co., Ltd., have developed a snow-depth recording system by use of ultrasonic waves. After *in situ* measurements of snow depths throughout two winter seasons, both of them have been proved reliable and capable of recording snow depths for a long period of time.

K. Kodama, of Rikagaku Kenkyusho (Institute of Physical and Chemical Research), Tokyo, has devised a "cosmic-ray absorption snow gauge", whereby the water equivalent of snow can be automatically recorded by use of the absorption of a cosmic ray by snow. Having conducted *in situ* measurements at several sites in mountainous regions, his group has reported that this gauge is capable of recording the water equivalent of snow with an accuracy of 5 cm.

E. Akitaya of ILTS has designed a new type of calorimeter capable of determining the free water content of wet snow. This is the same in principle as Yosida's calorimeter, but reduces inconveniences in handling and the price. The standard deviation of error of the new calorimeter is found to be 1.0%.

H. Aburakawa of ILTS has developed a calorimeter by which the total heat flux of snowmelt can be measured directly on the snow surface. The main part consists of a sensor with a heat-absorbing thermoelement which uses an electric current provided to the sensor and a controller of this current. He has reported, after wind tunnel experiments and *in situ* measurements, that this calorimeter is useful in real-time estimation of the total heat flux of snowmelt.

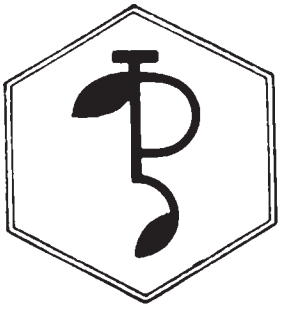
H. Yahagi, of Hokkaido Education University at Kushiro has developed a new type of device for the measurement of the maximum depth of frozen ground by reading a decrease in the amount of water in a transparent plastic pipe. Having used it in field measurements, he has reported that it is capable of measuring the depth of frost penetration with a good accuracy.

K. Yamamoto et al of WRI have developed a new core sampler for the measurement of the water equivalent of snow and for the observation of the stratigraphy of a snow cover. Its pipe is made of transparent acrylic resin convenient for examining the stratification of a core. Fur of a seal is pasted inside its cutter to prevent the loss of a core while it is being pulled up.

40TH ANNIVERSARY OF THE JAPANESE SOCIETY OF SNOW AND ICE

The 40th Anniversary of the foundation of the Japanese Society of Snow and Ice was celebrated on 23 October 1978, at the time of the autumn meeting of the Society held in Fukui. Z. Yoshida, President of the Society, T. Nakato and S. Watabe of Fukui University gave commemorative lectures on snow researches and how much contribution snow researches make to human life. Commemorative publication: Researches on Snow and Ice, No. 6 featuring a review of studies on snow and ice in Japan during recent years (1969-1978) will be published in 1979.

The "symbol mark" of the Society was decided, as illustrated in the attached figure, in commemoration of this anniversary. The hexagon means the symmetry of snow and ice crystals, the inner pattern is the Chinese character Yuki (snow), in a cursive style, while two budlike portions express new buds. The mark was designed by Akira Ushimura, member of the Society.



A "Symposium on Techniques in the Study of Snow Hydrology" was held in Tokyo on 26 May 1977, organized by D. Kuroiwa as the Chairman of the Japanese Commission of Snow and Ice, Japan Science Council. The symposium was alive with reviews on recent developments of techniques in the study of snow and ice, applications of remote sensing techniques to the study of snow and ice, and topics of instrumentation and methods for measuring elements related to snow and ice. More than 120 persons who participated in the symposium joined in active discussions of these topics, providing interesting and stimulating suggestions.

A "Symposium on Physics and Chemistry of Ice" was held for three days, 19-21 October, 1977, at the University Seminar House in Hachioji near Tokyo, with Akira Higashi as symposium convener. It was financed by the Ministry of Education of Japanese Government. About 50 participants, including graduate students, from all over Japan discussed such various subjects as phase transitions, neutron diffraction, electronic states, dislocations, grain boundaries, electrical properties, surface structures, etc.

G. Wakahama

SWEDEN

VARIATION IN THE POSITION OF GLACIER FRONTS

GLACIER	POSITION		VARIATION IN m SINCE THE PREVIOUS SURVEYING YEAR		TOTAL VARIATION	
	N	E	1977[1]	1978	metres	period
Salajekna	67°08′	16°23′	x	x	−119	65–76
Hyllglaciären	67°35′	17°29′	x	x	− 44	65–74
Årjep Ruotesjekna	67°26′	17°30′	−41	−11	−180	65–78
Suottasjekna	67°27′	17°36′	−19[2]	− 5	−153	65–78
Vartasjekna	67°27′	17°41′	0 [2]	x	− 51	65–77
Mikkajekna	67°24′	17°42′	−27	x	−181	65–77
Pårtejekna	67°10′	17°40′	−27	−10	−172	65–78
Ruopsokjekna	67°21′	17°59′	x	−34[3]	−120	65–78
Riukojietna	68°05′	18°05′	−28[3]	x	−104	63–77
Kårsajökeln	68°22′	18°21′	− 7	− 8	−124	65–78
Stuor-Räitaglac.	67°58′	18°23′	−17[3]	x	−116	63–77
Västra Påssusj.	68°04′	18°24′	−11	− 7	−109	68–78
Östra Påssusj.	68°04′	18°25′	− 2	− 4	−102	68–78
Rabots glac.	67°55′	18°29′	−14	− 6	−138	65–78
Unna Räitaglac.	67°59′	18°27′	−20[3]	x	− 62	63–77
Kuototjåkkaglac.	68°09′	18°34′	− 4	x	− 51	65–77
Isfallsglaciären	67°55′	18°35′	0 [4]	−10	−106	65–78
Storglaciären	67°54′	18°36′	0 [4]	−10	− 66	65–78

[1] Retreat since 1975 if no remark
[2] Retreat since 1974
[3] Retreat since 1972
[4] Retreat since 1976
x Not surveyed

MASS BALANCE STUDIES ON STORGLACIÄREN

	1977	1978
End of accumulation season	6 June	12 May[1]
Beginning of ablation season	11 June	23 May[2]
End of ablation season	7 Sept.	12 Sept.[3]
Total winter balance in m^3 of water x 10^6	3,82	4,53
Total winter balance in g/cm^2	123	146
Total summer balance in m^3 of water x 10^6	3,20	4,78
Total summer balance in g/cm^2	103	154
Net balance in m^3 of water x 10^6	+0,62	−0,25
Net balance in g/cm^2	+20	−8
Height of equilibrium line ma.s.l.	1420	1470

The following dates are valid for the area above 1450 m (47% of the total glacier area. 3,1 km^2).

[1] 29 May [2] 11 June [3] 1 Sept.

V. Schytt

In 1978 Soviet glaciological expeditions worked on the glaciers of the Caucasus, Central Asia, Altay and Polar Urals; in the mountains of South, Central and East Siberia, Kamchatka, in the Arctic and Antarctica.

CAUCASUS

The Institute of Geography, the USSR Academy of Sciences has accomplished its studies of accumulation, precipitation and run-off in the glacier systems of the Caucasus. Special attention was paid to paleoglaciological studies. Sampling of till was undertaken on the glaciers and in glacier valleys of Svanetiya along with lichenometric surveys and the drilling of alpine peat bogs. On the southern slope of the Main Caucasus samples were taken for lithological, palynological, diatomite and radio-carbon analyses in search of Pleistocene glaciation traces. They were obtained from key sections in the Ingury, Mulkhra and Sakeny river-basins.

Lichenometric surveys enabled us to reconstruct the general picture of glacier variability on the northern slope of the Main Caucasus for the last 700-800 years, to estimate their areas and volumes for this period. The cyclic recurrence of variation of the Caucasus glaciers was established. Facts were ascertained pointing to the undisturbed existence of vast glaciation here, exceeding the present glaciers even during the Holocene climatic optimum, related to the excessive role of winter accumulation. Analysis of some debris sections confirmed the assumption of considerable income of till from the glacier bed and intense erosion of glacier beds.

The North-Caucasian Hydrometeorological Service performed meteorological and hydrological observations, measurements of snow and ice melting, snow surveys and recording of data on the Marukh Glacier. Some observations were undertaken on the Kachu Glacier (Eastern Caucasus). The studies of atmospheric precipitation distribution about the glacerized zone were continued together with fluctuation surveys of 28 glacier tongues situated on the northern slope of the Main Caucasus. Accumulation-ablation conditions of 1977/78 balance year were found to be nearly normal; 22 glaciers retreated and six were advancing.

The Laboratory of Aerospace Observations, Moscow University continued large-scale (1:5.000 and 1:10.000) photogrammetric surveys of the El'brus glaciers: Bol'shoy Azau, Terskol and Irik and also the Dzhankuat Glacier.

Snow-avalanche studies of the El'brus area were continued by the **Alpine Geophysical Institute.** Observations undertaken directly at the points of avalanche origin showed great difference between the physico-mechanical properties and the structure of unconsolidated horizons of snow cover. A nomogram was plotted to determine the unconsolidated horizon. It was concluded that the mechanism of avalanche occurrence is caused by the two qualitatively different phenomena: the initial violation of stable equilibrium of a snow stratum is caused by the effect of the normal component of gravity while the further development of avalanching depends on the relationship between the tangential component of gravity and forces of dynamic friction occurring at the bed of a stratum. This all permitted identification of the zones of most efficient influence upon the snow cover in the El'brus area, with the objective of preventive avalanche triggering.

An equation of snow sequence stability on the slope has been proposed, and it is the first to consider the bending stress of a snow stratum. Types of snow-falls in the El'brus area causing avalanches of fresh snow have been determined. Interconnections between the properties of these snow-falls have been studied in order to forecast the period of avalanche danger engendered by snow-falls. Data on the duration of the avalanche-hazard period in altitudinal zones of different exposure have been systematized and generalized, as well as data on the frequency of different types of avalanching and dimensions of avalanche sites in the El'brus area for 1967-1977. The data of observations in 1953-1976 revealed the significance of seasonal snow cover for the nature of the surface albedo.

Kharkov University continued studies of the former and present dynamics of the Bashkara Glacier. The lake lying on the glacier surface was found to be a potential source of glacial mud-flows. In the period of its low level water discharges from the lake under small hydraulic head, intraglacier run-off channels are jammed by crashed ice and rocks. When the level rises, the jams in these channels may be burst, thus bringing about mud-flows.

The Institute of Geography, Georgian Academy of Sciences continued the studies of Tbiliso Glacier, where ice melting was evaluated. Meteorological, actinometric and gradient observations were undertaken together with precipitation measurements and surveys of the glacier tongue motion. It was established that in 1967-1970 the glacier retreated by 10 m; in 1971-1976 by 28 m, and in 1977-1978 it degraded by 13 m, i.e. on average for the last 12 years it retreated at a rate of 4.2 m per year.

Glaciological investigations of the Transcaucasian Hydrometeorological Institute and Hydrometeorological Service of Azerbaidzhan embraced the Devdoraky, Yuzhnyy, Yugo-Vostochnyy, Tikhitzar and Murkar glaciers. Ice velocity, ablation and glacier tongue variations were measured, along with meteorological and hydrological observations.

CENTRAL ASIA

The Section of Physical Geography of the Academy of Sciences, Kazakhskaya SSR, continued glaciological studies of glaciers in the Zailiyskiy, Dzhungarskiy, Kungey and Terskey Alatau. Accumulation-ablation processes in snow and ice, glacier mass balance, changes of ice thickness and glacier fronts, as well as ice velocity were observed. Multidisciplinary studies of dynamics of glacier variation were performed, following the 1st class programme of observations for Tsentral'niy Tukuksu Glacier in Zailiyskiy Alatau and the 2nd class programme for Ígly Tuyuksu, Shokal'skiy and Zmeevidniy glaciers in the Zailiyskiy Alatau, Shumskiy Glacier in the Dzhungarskiy Alatau. Scale and vector values as well as some dynamic properties of the Tsentral'niy Tuyuksu and Shemiskiy glaciers were mapped for different years.

Conditions of avalanche occurrence and regularities of spreading of avalanche sites of different types were studied in areas of avalanche danger in south-eastern Kazakhstan. Numerical properties of avalanches, avalanche sites and indexes of avalanche hazard were measured. Snowiness of the south-eastern Kazakhstan mountains and the annual totals of atmospheric precipitation at the equilibrium line of glaciers were evaluated. It became possible to reveal regularities of zonal distribution of precipitation in the mountains, to calculate their annual and seasonal totals; to determine the modular coefficients of melt-water run-off and estimate the glacial component in the discharge of mountain-rivers, to consider the melt-water regime in debris and water-regulating capacity of till. The curves of water-discharge recession permitted calculation of the greatest volume, which can be accumulated in glacier till in the period of its greatest saturation with moisture. Conclusions on the regularities of occurrence, development, regime, outburst and degradation of morainic lakes of the Zailiyskiy Alatau were made.

The Kazakh Hydrometeorological Service continued snow-avalanche and glaciological investigations of the Zailiyskiy and Dzhungarskiy Alatau, and also of the Talasskiy and Ugamskiy ranges. The winter of 1977/78 was poor in snow, with insignificant avalanche activity. Only in the Talasskiy and Ugamskiy ranges were heavy snowfalls and frequent avalanching registered. The maximum volume of an avalanche reached 300,000 m^3.

The Central Asia Hydrometeorological Institute studied the distribution of glaciers in the Bartang and Muksu river-basins; their numerical properties were obtained as a result. The Institute studied the changes of the annual balance of a perennial snow-patch. The self-regulation mechanism of its dimensions, established earlier, was confirmed. Block-diagrams and numerical models of climatically induced variations of these snow-patches and small glaciers have been obtained. A more profitable technique has been worked out for exerting an artificial influence upon glacier melting by way of prolonging the melting period of glacier tongues.

The Institute of Geography, the USSR Academy of Sciences continued surveys of the Medvezhiy, RGO, Abdukagor and Dustiroz glacier variations in the Pamirs. Geodetic and photo-theodolite surveys, meteorological, actinometric and balance observations were carried out together with ice drilling and measurements of ice temperatures of the Medvezhiy Glacier. Comparison of the Medvezhiy velocities for annual intervals indicated insignificant growth of its velocity during the three years after its last surge in 1973 and slower motion of the glacier front, as compared to the similar period after the surge of 1963. Thus it may be assumed that the next surge of the Medvezhiy Glacier will take place not in ten years, as it was last time, but later.

Maps of accumulation, ablation and discharge fields have been compiled for Central Asia. Their interpretation allowed us to determine the norms of glacier run-off and possibilities for regulation. These possibilities do not exceed 5 km^3. Areas of excessive and reduced accumulation have been distinguished. The maps indicated the domination of S-W moisture transfer in the Pamir-Alay, prevailing western moisture transfer in the Tien-Shan and significant role of northern transfer in the accumulation of the Central Tien-Shan glaciers.

The Tien-Shan station of the Kirgiz Academy of Sciences continued stationary studies of the Karabatkak Glacier. In 1978 mass-balance of this glacier was negative. A dry and hot summer promoted the rise of the seasonal snow line on the northern slope of Terskey Alatau Range to the height of 3950-4050 m. As a result considerable parts of glaciers appeared in the ablation area, thus increasing the glacial run-off in rivers. The subsidence of the terminal moraine surface, often causing outbursts of morainic-dammed lakes, was estimated. The greatest values (up to 70 mm per year) coincide with the central parts of the moraine.

Semistationary studies were performed on the four glaciers of the Arabel river basin (one of the tributaries of the Bol'shoy Naryn river). Preliminary conclusions about the decreasing effect of exposure on glacier processes linked to elevation were made. It was established that in conditions of slight cloudiness in summer 1978 and under considerable insolation during the ablation period, melting at altitudes differing by 500-700 m was practically the same. Plans of some glaciers in the Terskey Alatau Range, Akshiyrak Massif, have shown that these glaciers are permanently shrinking, however sometimes only a thickening of the surface occurs, not accompanied by pronounced linear shrinkage.

The Kirgiz Hydrometeorological Service fulfilled multidisciplinary glaciological studies of the Golubin Glacier in the Alaarcha River-basin

(northern slope of the Kirgiz Alatau Range) comprising meteorological observations, measurements of snow and ice accumulation and ablation, ice surface motion and changes of its level and also surveys of the variations of the glacier lower boundary. Observations of the glacier tongue position and changes in the surface level were undertaken on five other glaciers of the Kungey Alatau Range, Talasskiy and Chatkalskiy Ranges.

Mass-balance of the Golubin Glacier was negative in 1977/78, and by the middle of August the seasonal snow line was 200 m higher than the mean perennial position of the firn line. Of the six glaciers under consideration only the Dolonata Glacier continues to retreat; the surge of Aksu Zapadniy Glacier is coming to its end. The Aksu Vostochniy, Kengtur and Chongtur Glaciers advance, while the Golubin Glacier is in a stationary position.

Glaciological Laboratory of the Institute of Geology and Geophysics, the Uzbek Academy of Sciences studied the Shulty Glacier, in the Koksu river basin (Alayskiy Range). The laboratory observed the changes of heat-balance components, comprising micro-gradient measurements at certain points of the profile typical of the heat regime on bare rocky or turf-covered walls of the valley, the debris and different types of glacier surface. Initial data on the impact of geological conditions of the mountain-glacier area on the heat regime and melting of glaciers have been obtained.

The Institute of Mechanics, Moscow State University analysed dynamics of the Shumskiy, Tsentral'niy Tuyuksu and Medvezhiy glaciers.

ALTAY

Tomsk University continued investigations of the Aktru mountain-glacier basin. As the data of repeated aerial photography indicated a certain retardation of glacier retreat during the last decade, the Aktru basin was resurveyed by photogrammetric methods in order to obtain more detailed characteristics of glacier variations and glacier complexes. Surveys of 22 icings of different genesis were undertaken along the Aktru valley.

Snowiness of the winter 1977/78 can be considered average. 93 avalanches were registered; fresh snow avalanches prevailed. Hydrometeorological observations of three gauge stations on the Aktru river showed that 30% of the channel flow is filtered through fluvio-glacial deposits, covering the bottom of the valley. In 1978 radio echo sounding of the Altay glaciers was first carried out. The maximum thickness of the Maliy Aktru Glacier in its ablation area was 140 m, while the ice thickness of the Leviy Aktru Glacier in the medial part of the ice flow (1.5 m below the firn line) reached 140 m. Fluctuations of the density and spatial distribution of the intermediate layer of a presumably internal moraine have been revealed.

Section of Geography of the Kazakh Academy of Sciences undertook multidisciplinary observations on the Maliy Berelskiy Glacier under the 2nd class programme.

MOUNTAINS OF CENTRAL AND EAST SIBERIA

The Institute of Geography of Siberia and the Far East has accomplished glaciological studies of the Yuzhno-Minusinsk Basin and the northern slope of Western Sayan. Regularities of snow thickness distribution and its dependence on biometrical indexes of plant communities, successional changes of vegetation and stage-like development of trees have been revealed by icings in the Chara Basin, in the N of the Chitinsky region. Data on snow cover and avalanche warning observations were generalized. A scheme of glaciological zonation in the south of East Siberia has been plotted.

Tomsk University continued investigations of ice bodies in caves, in Kuznetskiy Alatau. The Malosyiskiy Glacier was found to have a positive mass-balance (15 g/cm^2) in 1977/78. Detailed studies of snow distribution as a function of landscape conditions were carried out in this area.

The Novosibirsk Institute of Railway Transport studied the dependence of snow cover metamorphism on mass- and heat-exchange, as well as on the wind. Multidisciplinary studies of avalanching were continued. They comprised evaluation of snow stability on the slopes, studies of avalanche dynamics and avalanche impact on engineering constructions and estimation of avalanche hazard. The mechanism of strong snowdrifts and mountain snowdrifts was studied for the first time. New classification of snowdrifts based on the wind force was put forward.

POLAR URALS

The Institute of Geography, the USSR Academy of Sciences continued investigations in the mountain-glacier basin of the Bol'shaya Khadata. Surveys of the variations of the Obruchev, MGU and IGAN glaciers were carried out. The Institute fulfilled geodetic measurements and phototheodolite surveys, meteorological, actinometric and balance observations, drilling of the ice and measurements of its temperature. Analysis of the data has shown that the MGU Glacier reached its maximum dimensions in 1920's; in 1950's-1970's it receded catastrophically and in 30-50 years must disappear. 4-year observations of the Obruchev Glacier showed that ablation fields, corresponding to the main weather types, are mainly similar. In general, the ablation field of small glaciers is more complex than it was believed earlier, and this is connected to the dominating effect of surrounding topography on the processes of external mass- and energy-exchange.

The data of terrestrial radio echo sounding made it possible to compile maps of ice thickness and subglacial topography of the Obruchev Glacier for 1974 and 1976. Dynamics of the Obruchev Glacier was analysed by **the Institute of Mechanics, Moscow University.**

KAMCHATKA

The Institute of Volcanology, the USSR Academy of Science continued to investigate the dynamics of present-day glaciers in the areas of active volcanism. Basic studies were fulfilled on the Kozelskiy Glacier (Avachinskaya group of volcanoes). Snow surveys and pits dug in the reference points of profiles permitted evaluation of snow storage, varying from 0 in the areas of snow blow-out to 7 m and more in the areas of deposition of drifting snow, and areas of avalanching. In general, meteorological conditions of 1977/78 appeared to be unfavourable for the glacier.

Small values of accumulation, slight wind regime and rather a warm summer predetermined a negative balance for the Kozel'skiy Glacier, which was 100-120 g/cm^2, according to the preliminary estimation. In 1978 the seasonal snow limit rose to the height of 1290-1320 m; about 4.5 m of snow and firn melted in the accumulation area, and up to 8 m on the tongue.

Morphology, regime and dynamics of the other 7 glaciers of Kamchatka were studied. Short-term meteorological observations of the Klyuchevskoy Glacier were carried out at different heights and in the crater of the volcano. Temperature gradient, calculated according to the data of Klyuchy weather station (abs. height 25 m) and the reference points at 1800, 2700 and 4750 m a.s.l. turned out to be 0.6° per 100 m of elevation. However, at the interval of 4000-4750 m a.s.l. the gradient is a bit lower (0.4° per 100 m), which is evidently caused by the warming effect of the active volcano crater. At the altitudes of 4400 m and over, brooks flow at an air temperature of −8 and −10°, while at 4650-4750 m a.s.l. the slope is bare, snow and ice are lacking.

THE ARCTIC

The Institute of Geography, the USSR Academy of Sciences carried out field studies of Svalbard glaciers. Radio echo sounding of 35 glaciers of different types was carried out from a helicopter. Stable returns from the glacier bed were obtained on the majority of them. A great thickness of ice (up to 400-500 m) inundating very deep valleys has been discovered. Studies of water/ice balance of five glaciers, situated in different areas of Spitsbergen, were continued. In 1977/78 their balance appeared to be negative. New data on the structure of marine terraces on the Ny Friesland peninsula and their relationship with former glacial deposits were obtained. The motion of some ice streams of the ice sheet from the periphery of Spitsbergen to the estuaries of some valleys and fjords may have occurred in the way it now happens in the "dry" valleys of Antarctica. New data on the occurrence of riegels in troughs, on the depth and intensity of glacial erosion, the effect of glaciation on the development of river valleys and post glacial history were obtained.

The Arctic and Antarctic Institute continued to study the regime of Severnaya Zemlya glaciers, based on the investigations of the Vavilov Dome station. Radio echo sounding of ice along the route of 350 km was carried out. Mass balance of the Severnaya Zemlya glaciers was negative in 1977/78, which is accounted for by intensive advection of warm air masses in summer. Oxygen-isotope investigations of the core from the 459 m-deep borehole showed a certain growth of glacier accumulation in 1970's (41 g/cm^2 per year) as compared to the period of 1950-1960 (30g/cm^2 per year). According to data from structural studies, firn sequence in the accumulation area of the Vavilov Dome equals 3-3.5 m. Summer heating of the sequence usually reaches a depth of 40-50 cm, while in 1978 it expanded to a depth of 100-120 cm, due to a big income of turbulent heat brought about by advection of warm air masses. This caused intensive ablation of snow and ice and deeper infiltration of melt waters. The surface run-off reached 80-90 mm within the firn zone. Conditions of infiltration ice-formation, common in the firn-ice zone, dominate in the accumulation area of Severnaya Zemlya glaciers. Thermometry of a deep borehole revealed a continental type of temperature regime. The thickness of the active layer equals 18 m, the temperature at its bottom is −11.8°. The complex of glaciological radiophysical and cryostructural studies showed minor dynamic activity in the Vavilov Dome. **Institute of Mechanics, Moscow University** calculated the age of ice on this dome.

ANTARCTICA

Studies were continued under the IAGP Programme. **The Institute of Geography, the USSR Academy of Sciences together with the Arctic and Antarctic Institute** undertook field investigations of accumulation and regime of the Antarctic Ice Sheet along the route Mirny-Vostok and Pionerskaya-Dome C. Within the scope of the Ross Ice Shelf Project (RISP) the thermal regime of sea water under the ice shelf was studied at a long distance from its margin together with melting/congelation at the lower surface of the shelf.

Existence of a stratum of relatively warm water 50 m thick was discovered near the bottom of the Ross Sea at a distance of about 300 km from the edge of the ice shelf. Discovery of this fact, made on the basis of exact temperature measurements in water sequence at intervals of about 1 m and accuracy of nearly 0.001°C,

throws new light on the theory of interaction between ice shelf and subglacial sea waters.

Ice temperature was measured in a 800 m borehole at the Novolazarevskaya station. The core for further studies was selected along the whole depth of the borehole.

About 2500 mass-spectrometric analyses of snow, firn and ice from the Mirny, Pionerskaya, Komsomolskaya, Vostok and Novolazarevskaya stations and the routes Mirny-Vostok and Pionerskaya-Dome C have been performed. Additional corrections were introduced into the previous results of oxygen-isotope analyses of samples from the Vostok borehole. It is established that culmination of the last glaciation stage (Wisconsin) coincides here with the period of 15-29 thousand years B.P., with a small warming interval (around 2°) about 17 thousand years B.P. The period from 29 to 50 thousand years B.P. was characterized by a relatively stable temperature (4-5° lower than at present), well pronounced against the general cold background. In the next period, from 52 to 63 thousand years B.P. temperature was still lower by about 1°.

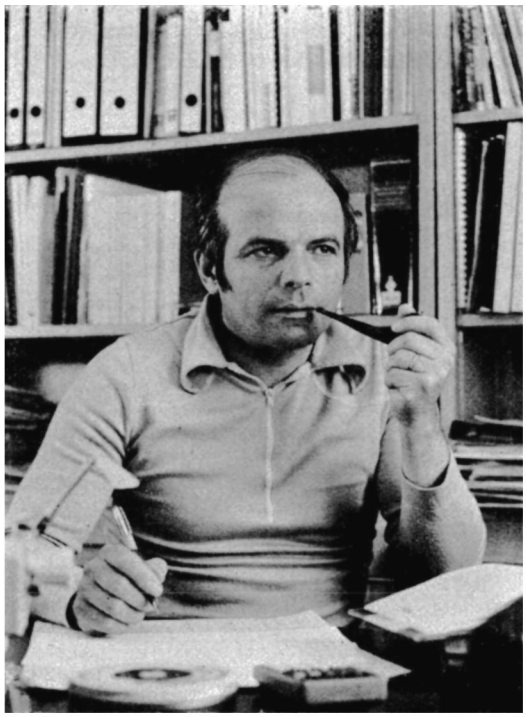
Processing of field data on the paleoglaciology of Antarctica, obtained in the vicinity of the Ross Sea in 1974-1975 and in reference areas of Queen Maud Land, MacRobertson Land and Shackleton Mts. in 1976-1977, was continued. The main stages of MacRobertson Land glaciation history were established.

The concept of an "Antarctic model of glaciation" has been formulated. It is characterized by the combination of terrestrial, marine and floating glaciers, constituting a unique dynamic system and also the special way of degradation, connected to the retreat of the grounding line, surges of ice sheets and wide spreading of calving bays. It has been shown that this very model reflects most exactly the type of former glaciation of the northern hemisphere and the main events of its history. The mechanism of the "marine" ice sheet surges was considered together with their relationship to external disturbances such as variations of the sea level, of ice thickness and glacio-isostatic movement of the earth's crust. This mechanism is designed to forecast the coming changes of the West Antarctic Ice Sheet in view of the climatic warming, expected for the next decade.

An algorithm has been worked out to solve the problems of motion and thermal state of large ice sheets, permitting account to be taken of different horizontal velocities of ice in ice sheets. This is quite new to mathematical theories describing glacier dynamics. Movement and heat exchange within the sequence of the ice sheet along the flow line from Vostok Station to Byrd Glacier has been calculated on the basis of this algorithm. This calculation revealed new regularities in the behaviour of thick ice sheets, in particular the presence of stagnant (dead) ice areas near the bed.

Institute of Mechanics, Moscow University advanced a new method of ice temperature and accumulation rate calculation, based on data about the form and dimensions of horizontal projection of a stationary glacier tongue. Studies of the former moraines of the Meserve Glacier permitted determination of the course of air temperature changes and the amount of atmospheric precipitation in the McMurdo Oasis for the last million years.

V. M. Kotlyakov



BRUNO SALM

Bruno Salm was born in Berne, Switzerland, on New Year's Day 1932 — a day that is believed by the Japanese to be very lucky. He attended school in Berne, enjoying particularly his secondary (high) school days 1948-52. A happy balance between arts and science subjects appealed to him and this is illustrated by his love of the music of both J. S. Bach, with its mathematical complexities, and the romantic composers. Although he will disclaim any expertise, he is a competent pianist.

Such was his preference for a many-sided life that he found difficulty in choosing a speciality for further education and training. He finally decided to study at the Department of Civil Engineering, Federal Institute of Technology, Zürich. The person who influenced him most here in the years 1952-57 was the head of the Mechanical Institute, Professor H. Ziegler, a clear thinking man who considered it essential to make ideas and definitions as precise as possible. His guiding principle was that strict definitions are the framework of all sciences: they are the invisible guests at each unbiased discussion.

Bruno achieved his Diploma in 1957 with a treatise on hydraulic engineering and shortly afterwards, in early 1960, went to work at the Federal Institute of Snow and Avalanche Research, Weissfluhjoch/Davos. Here he was encouraged by the scientific imagination of Dr Robert Haefeli, the founder, through publications and discussions, of snow mechanics as a subject. He was also encouraged by the broad knowledge of Dr Marcel de Quervain, Director of the Institute.

In 1971, Bruno Salm was appointed Head of the Section on Snow Mechanics and Avalanche Control and Head of Documentation. This latter post he finds stimulating, for he has to work with film producers — a very different world from his scientific one.

During the past ten years he has been working on a thesis on snow mechanics with H. Ziegler and M. de Quervain. In contemplating the length of time this work has taken, he says he ruefully recalls Professor Ziegler's guiding principle, to which he is trying to adhere.

Bruno has served as a Captain in the Avalanche Service of the Swiss Army, an experience which gave him much practical experience in snow and avalanches. Since 1975 he has helped the International Commission on Snow and Ice in the division for Seasonal Snow Cover and Avalanches, while in 1974 he was a leading light (in more ways than one) in the Commission's Symposium on Snow mechanics, in Grindelwald. He has taught snow studies on UNESCO courses in developing countries.

Another facet of his life evolved when he spent 1970 in Japan, at the Institute of Low Temperature Science, Hokkaido University, in Sapporo. It was a year of new impulses and thoughts, scientific and personal, and one in which he could enjoy work and discussions unencumbered by commonplace problems. He took a great interest in Japanese culture and shared with his colleagues in Sapporo a fondness for sake. During the celebration at the Institute of a Japanese national holiday, with everyone very happy and much sake flowing, he asked the then Director, Professor Zyungo Yosida, if he was not disturbed by such high spirits. The answer came: "Not at all. Hard-working people can afford to relax like this, but not the others."

Bruno appreciates also good wine and food. He likes warm-hearted and broad-minded people — and dislikes the opposites. This will hardly surprise his friends in many parts of the world, for he is well known for these characteristics. They would have indeed been sad if his warm attitude to others had led to his demise in India, when, in typical informal fashion, he walked alone from the airport in Agra to the Taj Mahal. On his way, more and more friendly — or so he thought — children gathered around him. But soon their attitude towards a person they regarded as an unnecessary, rich foreigner was made clear with a barrage of stones. A face full of blood and an asymmetric nose, broken by a stone, were hardly an appropriate welcome for Bruno, who normally creates a very different atmosphere wherever he appears.

INTERNATIONAL GLACIOLOGICAL SOCIETY

ANNUAL GENERAL MEETING 1979

MINUTES OF THE ANNUAL GENERAL MEETING
OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY
13 AUGUST AT COLORADO STATE UNIVERSITY,
FORT COLLINS, COLORADO, U.S.A.

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

1. **The Minutes of the 1978 Annual General Meeting,** published in ICE No. 58, 3rd issue 1978, were approved and signed by the Chairman.

2. **The President** gave his report for 1978-79:
Five years have passed since we have had the opportunity for a major review of research related to avalanches. The last, I believe, was the Grindelwald snow mechanics conference sponsored by the International Commission on Snow and Ice. The excellent papers that have been submitted to this symposium indicate that much has been done since that meeting. On your behalf I would like to express to the Rocky Mountain Forest and Range Experiment Station our appreciation for the opportunity to co-sponsor this meeting and to publish the proceedings as a special issue of the Journal of Glaciology.

I have just read the draft manuscript of the history of the first 25 years of the Society, written by Peter Wood. It is a fascinating story and I know you will find it very interesting. The active role that the Society is now playing in organizing its own international symposia, assisting others in this task and in disseminating in its publications the information brought together by these meetings, was clearly one of the desired goals of the founder of the IGS, Gerald Seligman.

Sponsoring conferences and publishing proceedings, however, is not without its problems and financial difficulties. One can see evidence of the problems to be faced in the history that Peter Wood has written, particularly during the 10-year period 1952-1962. Even after a further 17 years, we are still in the process of evolving and problem-solving, which is probably a healthy situation for a society such as ours.

Most of us are in the business of research and, for me, one of the final and most important steps of that activity is publication. Publication cannot be separated from the act of research. This is the way that the results of our investigations get added to the store of knowledge and, at a more personal level, this is the principal way we establish our scientific reputation. But how many individuals and organizations include the cost of publication as part of the cost of a research project? Scientific societies and others that have carried the full cost of production of journals have allowed us to forget that the researcher and the research sponsoring organization probably have a greater interest in seeing results published than that unknown quantity, the reader.

This situation is changing due to the rapidly escalating cost of printing. In 1959, the cost of printing a page in the Journal of Glaciology was about £7. The cost of a page in the 1978 volume was close to £40. The end is not in sight. Keeping the cost of the Journal within the financial means of the Society has been a major preoccupation of your Council since the Journal was established.

The first indication in the Society's history that the cost of publication should be shared was in 1958 when Gordon Manley suggested that articles submitted from institutes or similar bodies be partly financed by the contributor. Today we specify a page charge which is paid on a volunteer basis. Revenue from page charges provided about 50% of the cost of the Journal in 1977. The proportion received from this source appears to be dropping.

The problems raised by the increasing cost of the Journal to the individual Society member, and the effects on this cost of publishing the proceedings of symposia as special Journal issues, were carefully considered by your Council at its meeting in Ottawa, Canada, last year. The Council decided that it needed the advice of wiser heads, and so set up a Working Party composed of the Past Presidents of the Society. The Working Party was asked to consider questions such as how the Journal might be published at less cost without sacrifice of quality, the number of pages in symposium volumes that should be devoted to discussion, whether changes should be made in the editorial set-up and how the Society should deal with occasional publications, for example, symposia proceedings and the history of the Society prepared by Peter Wood.

The report of the Working Party has now been received and reviewed by Council. In this review, the Council also took into consideration the sobering information contained in the auditor's report. Because of an overrun in the number of pages in the Journal in 1978 and the drop in revenue from page charges in that year, the Society had a deficit that wiped out our contingencies and most of our accumulated funds.

This will be referred to in detail in the Treasurer's report. The experience has driven home the fact that for the Society to remain in a healthy state, it is absolutely necessary that the size of the Journal be limited each year to that which can be justifiably supported by the available financial resources. These include membership fees, library subscriptions, estimated revenue from page charges, confirmed grants and committed support from symposia organizers.

In response to the recommendations of the Working Party and our serious financial situation, the Council has taken the following action with respect to the Journal. The budgeted number of pages for 1980 has been set at 500. We know that this decision will create problems for the editors and be an inconvenience to authors. Because of the normal time between submission and publication, we already have committed over 300 of the allotted 500 pages. Authors will have to accept delays and there will be strong encouragement for papers to be shorter. The Council feels that it has to take this drastic step, however, to bring our budget into balance and to begin to rebuild our contingencies and accumulated funds.

We have also decided to remove Glaciological Literature from the Journal and to produce it in a less expensive way, perhaps in collaboration with the Scott Polar Research Institute. This will free about 60 pages for additional papers and should result in a significant net saving to the Society. Glaciological Literature will be offered for sale in the new format and will be a separate item on the 1980 subscription renewal form. It will be sent only to those who elect to buy it. We are now investigating the most appropriate way in which to publish this material.

The editors are keeping under continual review developments in printing techniques and will change to less expensive methods as they become available—if those methods are capable of producing the standard of journal desired by the Society. They have also suggested that the Journal offer to print only a synopsis of some of the long papers that are considered suitable for publication, with a note indicating how the full paper can be obtained. This is a service that is now being offered by some journals. The Council agreed to it in principle and the editors will now consider the practical aspects of implementing it.

One of the recommendations of the Working Party was the establishment of a new publication series for conference proceedings and other special publications. These publications would normally be from camera-ready copy and would be printed using a less expensive method of reproduction than is used for the Journal. The idea for this series arose from the request to the Society to organize the Iceberg Conference that will be held in Cambridge next spring, and to produce the proceedings of that conference in a relatively inexpensive manner. Establishing the new series does not mean that proceedings of conferences cannot, on occasion, be published in the Journal. But, as a general policy, the Council will require, for both the new series and for the Journal, adequate guarantees that the cost of publication can be covered either by the Society or other sponsoring bodies.

The new publication will be called **Annals of Glaciology.** Normally, for proceedings of conferences, the papers committee will be responsible for technical editing and for ensuring a standard of paper and style consistent with guidelines to be established by the Society. Copy editing and administration is to be handled from the Society's office in Cambridge on a contract basis for each volume.

Members will not receive copies of this series automatically as they do for the Journal. Instead, a member will have the option to purchase the volume at a preferred rate at the time it is offered on the subscription renewal form.

We feel that this new publication will provide to the Society a flexibility to respond on an ad-hoc basis to opportunities as they arise. The first publication in the series will be the Proceedings of the Iceberg Conference; the second will be the Proceedings of the Society's Symposium on Glacier Erosion to be held next year in Norway.

I would like to emphasize here that the new series has the support of the editors of the Journal. We have a high quality Journal, and it was the unanimous opinion of the Working Party and the Council that this standard be maintained. The quality and success of the Journal has been due in every large measure to the devoted efforts of its editor-in-chief, John Glen, and co-editors, David Homer, Ray Adie and Doris Johnson. They deserve our warmest thanks for the very considerable work they do on our behalf.

During the past year our Branches have continued to be very active. The Western Alpine Branch held a meeting last September in Bonneval-sur-Arc, in France. The British Branch held its 1979 meeting in March in Newcastle-upon-Tyne. The North East North American Branch meets every second year, and held its meeting in March near Orono, Maine. A new activity has been started in Ottawa, Canada, where a local chapter has been established. It seems very appropriate that its inaugural meeting was held at the end of a major snow storm. The fact that it still had a turn-out of over 30 is an indication of the stuff of which glaciologists are made. This local chapter held 5 meetings during the first 4 months of 1979.

Branches (and local chapters) are a very important part of the life of the Society. Through their activities, members become more closely identified with our aims and activities. They have the opportunity to experience the Society as more than an issuer of publications and sponsor of symposia as they become involved with

regional and local exchange of glaciological information and in that way become better acquainted with colleagues in glaciology and their work. We would hope that through such meetings the aims and work of the Society will become better known and new members attracted to it.

These regional and local activities should not be allowed to go by unrecorded. I know Hilda would welcome even a short report for Ice, including photographs.

As I mentioned earlier, conferences and conference proceedings are now a major part of our Society's activities. The Proceedings of the Symposia on Dynamics of Large Ice Masses and on Glacier Beds are now nearing completion and will appear as regular issues of the Journal for 1979. The Proceedings of this Symposium on Snow in Motion will be a regular issue of the Journal in 1980. Arrangements have now been completed for the Society to organize the Second Conference on the Use of Icebergs and to publish the Proceedings as one of its special publications. The request to organize this conference came to us direct from the sponsors and reflects their confidence in our ability to carry out this task. The Scott Polar Institute will host the conference. Arrangements are also well in hand for the Society's next Symposium, which will be held in Geilo, Norway, in August 1980 and will deal with Processes of Glacier Erosion and Sedimentation.

The Society will be a co-sponsor of the SCAR Symposium on Antarctic Glaciology and has been asked to publish the Proceedings. That Conference will be held in Columbus, Ohio, August, 1981. We have also accepted an invitation to be a co-sponsor of the biennial symposium on ice problems organized by the International Association for Hydraulic Research and to be held in Quebec City, Canada, in 1981. Arrangements are now being made for the Society's second symposium on Applied Glaciology. An invitation has been accepted to hold it at CRREL in Hanover, N.H., in August of 1982. As you can see, we are maintaining good activity in our stimulation and encouragement of glaciological research. Much of this has been as a result of the excellent reputation that the Society and the Journal have developed over the years.

During the past year Hilda has been investigating the possibility of having Gerald Seligman's book republished. This edition will become available early in 1980. There will be a special pre-publication price to members of the Society and others interested in this classic book. Orders will be taken from October onwards, when the selling price will be announced and order forms sent out. Order promptly to be sure of a copy!

The passing years cannot be without their sad events. I very much regret to have to inform you of the passing of Brian Roberts. He was associated with the Society right from its early days and was turned to regularly by Gerald Seligman for advice and guidance. He always had a strong interest in the Journal and he, perhaps more than anyone else, ensured from the beginning that it would be a publication of quality. He was keenly interested in the Society's library, and so it is only fitting that the Council has decided to use the bequest of £500 that he left to the Society to undertake some necessary work to put the library in good order.

As usual, we have some changes in the Council. On your behalf I want to express our appreciation to retiring members Sam Colbeck, Erkki Palosuo, Julian Paren and Hans Clausen. They have been active members and their presence will be missed. On the other hand, we welcome Heinz Kohnen, Charles Raymond, Hans Röthlisberger and Ian Whillans to the Council and Charles Bentley as a Vice-President. We look forward to their contributions.

I cannot end my report without paying tribute to the individuals that truly keep our Society moving: Hilda Richardson and her two assistants, Beverley Baker and Pat Lander. During the past year, Hilda Richardson has carried a double load —the International President of the Soroptimist International as well as the Society's Secretary General. These duties have taken her to many parts of the world during the past two years— Australasia, Japan, Philippines, Turkey, Italy, South Africa, eastern and western United States, Canada and Hawaii. This activity has absorbed all her spare time and holiday periods.

Beverley Baker took some time off when her daughter was born. We were very fortunate that Beverley's mother, Pat Lander, joined the staff at that time, so we now have two part-time assistants in the headquarters office.

I wish also to express our thanks to Gordon Robin, Director of the Scott Polar Research Institute, for providing space to the Society for the office of our Secretary General and for our library. We greatly appreciate this support and the opportunity to be associated in this way with the Institute.

3. **The Treasurer**, Dr J. A. Jacobs, gave his report:

No one likes to have to present a gloomy report, but I must stress the seriousness of our financial situation. In 1977 we ended the year with a surplus of just over £2,000, which was reduced to £553 upon the transfer of £1,500 to the Contingencies Fund. The previous year the surplus was just over £5,000 before transferring £1,000 to the Contingencies Fund. For 1978 we are faced with a deficit of £11,635. This is almost entirely due to the cost of publishing the Journal (£35,012 in 1978 as against a budgeted £26,000). This was mainly due to the increase in the number of pages, although there was of course some increase in production costs. It was for this reason that your President and I instructed the Editors this June to keep the

total number of pages in the Journal for 1979 below 600. In my report last year, I pointed out that consideration must be given to the size of the Journal since increased growth could cause serious financial problems. In this I was unfortunately correct.

It is imperative that the Council discuss in detail the report of the Working Party on Publication Policy, together with the comments from the Editors. I would like to make two points. I strongly support the proposal that Council approve the establishment of a new publication series to handle proceedings of symposia. If this was adopted we would see the first results in 1981 in the publication of the two 1980 symposia. If we used camera-ready copy for symposia volumes, it is estimated that we would save approximately £10,000. Admittedly a new publication series involves some uncertainties as to its financial success, but I believe that it is well worth any risk involved. Secondly I strongly support the suggestion that Glaciological Literature be published separately on a subscription basis. This could prove a significant saving and release pages in the Journal.

With inflation running at about 15% per annum, subscription rates have to be increased. It is proposed that for Libraries, the 1980 subscription rates should be £35 + £35, members' subscriptions remaining the same. It is inevitable, however, that members' subscriptions will have to be increased in 1981. It is interesting to note that had the Council in 1978 adopted my recommendation that the subscription rate for Libraries be £25 + £25 and not cut it to £20 + £25, income would have been increased by approximately £3,500, which would just about have covered the estimated deficit for 1979.

Finally perhaps Council might consider different grades of membership with different subscription rates: e.g. some older or retired members might be happy to receive Ice only, others Ice and the Journal, whilst a third catagory could receive Ice, the Journal and Symposia volumes.

4. **Election of auditors for the 1979 accounts:** S. C. Colbeck proposed and J. W. Glen seconded, that Messrs. Peters, Elworthy and Moore, of Cambridge, be elected auditors for the 1979 accounts. This was carried unanimously.

5. **Elections to the Council 1979-82:** After circulation to all members of the Society of the Council's suggested list of nominees, no further nominations had been received. The following people were therefore elected unanimously:-

Vice-President	C. R. Bentley
Treasurer	J. A. Jacobs
Elective Members	H. Kohnen
	C. Raymond
	H. Röthlisberger
	I. M. Whillans

The President thanked the retiring Council members for their years of service: S. C. Colbeck, E. Palosuo, J. G. Paren and H. B. Clausen.

PROCEEDINGS OF CONFERENCES AND SYMPOSIA

Beginning in 1975, with the proceedings of the Society's 1974 Symposium on Remote sensing in glaciology, proceedings volumes have been published each year in the Journal of Glaciology series. Sometimes the volumes have been the outcome of meetings organized by the Society, sometimes of those organized by other groups. The cost of producing these volumes in a high-quality format has become so high that the Society's Council decided in August 1979 to transfer the proceedings volumes to a new series, which will be produced by more economical and faster methods. The new series is called—

ANNALS OF GLACIOLOGY.

The first number will comprise the proceedings of the 1980 Conference on the "Use of icebergs" and will be published early in 1981. The second number will comprise the proceedings of the 1980 Symposium on "Processes of glacier erosion and sedimentation" and will be published in the spring of 1981.

The cost per volume will be appreciably less in the Annals than in the Journal and we are sure that these financial savings will be appreciated by the libraries who buy our publications. Members will be able to purchase the volumes at a reduced rate. Orders may be made on the annual dues reminder forms, circulated in early November: thus the two proceedings volumes to be published in 1981 may be ordered on the form to be circulated in November **1980**.

Further details about the Annals of Glaciology are given in the President's Report to the 1979 Annual General Meeting, on pages 18-19 of this issue of ICE.

GLACIOLOGICAL LITERATURE

This bibliography will be published separately from the Journal of Glaciology, beginning in 1980. It will be combined with "Recent Polar Literature", which was at one time published as part of Polar Record, the journal of the Scott Polar Research Institute.

The combined publication will be prepared by the joint efforts of both organizations: Scott Polar Research Institute and International Glaciological Society. It will be available on **subscription direct from the Scott Polar Research Institute, Lensfield Road, Cambridge CB2 1ER, U.K.**

Members of the Society have received a circular direct from the Institute, inviting them to subscribe.

JOURNAL OF GLACIOLOGY

The following papers have been accepted for publication in the *Journal:*

SYMPOSIUM ON GLACIER BEDS: THE ICE-ROCK INTERFACE (Vol. 23, No. 89)

G. S. Boulton:
Processes of glacier erosion on different substrata.

Bernard Hallet:
A theoretical model of glacial abrasion.

W. H. Mathews:
Simulated glacial abrasion.

J.-P. Benoist:
The spectral power density and shadowing function of a glacial micro-relief at the decimetre scale.

L. Lliboutry:
Local friction laws for glaciers: a critical review and new openings.

J. Weertman:
The unsolved general glacier sliding problem.

E. M. Morris:
The flow of ice, treated as a Newtonian viscous liquid, around a cylindrical obstacle near the bed of a glacier.

A. C. Fowler:
A mathematical approach to the theory of glacier sliding.

R. Brepson:
Simulating glacier sliding over an obstacle.

W. F. Budd, P. L. Keage and N. A. Blundy:
Empirical studies of ice sliding.

Craig S. Weaver and Stephen D. Malone:
Seismic evidence for discrete glacier motion at the rock-ice interface.

A. J. Gow, S. Epstein, and W. Sheehy:
On the origin of stratified debris in ice cores from the bottom of the Antarctic ice sheet.

Susan Herron, formerly Hoar, and Chester C. Langway, Jr:
The debris-laden ice at the bottom of the Greenland ice sheet.

R. M. Koerner and D. A. Fisher:
Discontinuous flow, ice texture, and dirt content in the basal layers of the Devon Island ice cap.

A. H. W. Woodruff and C. S. M. Doake:
Depolarization of radio waves can distinguish between floating and grounded ice sheets.

Richard C. Metcalf:
Energy dissipation during subglacial abrasion at Nisqually Glacier, Washington, U.S.A.

David N. Collins:
Sediment concentration in melt waters as an indicator of erosion processes beneath an Alpine glacier.

D. J. Goodman, G. C. P. King, D. H. M. Millar and G. de Q. Robin:
Pressure-melting effects in basal ice of temperate glaciers: laboratory studies and field observations under Glacier d'Argentière.

Wilfred H. Theakstone:
Observations within cavities at the bed of the glacier Østerdalsisen, Norway.

B. E. Broster, A. Dreimanis and J. C. White:
A sequence of glacial deformation, erosion, and deposition at the ice-rock interface during the last glaciation: Cranbrook, British Columbia, Canada.

R. P. Goldthwait:
Giant grooves made by contrated basal ice streams.

Steven M. Hodge:
Direct measurement of basal water pressures: progress and problems.

Bernard Hallet:
Subglacial regelation water film.

Joseph Walder and Bernard Hallet:
Geometry of former subglacial water channels and cavities.

B. Wold and G. Østrem:
Subglacial constructions and investigations at Bondhusbreen, Norway.

SYMPOSIUM ON DYNAMICS OF LARGE ICE MASSES (Vol. 24, No. 90)

I. M. Whillans:
Ice flow along the Byrd Station strain network, Antarctica.

G. S. Boulton and A. S. Jones:
Stability of temperate ice caps resting on beds of deformable sediment.

Shinji Mae:
The basal sliding of a thinning ice sheet, Mizuho Plateau, east Antarctica.

Renji Naruse:
Thinning of the ice sheet in Mizuho Plateau, east Antarctica.

K. E. Rose:
Characteristics of ice flow in Marie Byrd Land, Antarctica.

N. W. Young:
Measured velocity of interior east Antarctica and the state of mass balance within the IAGP area.

W. F. Budd and N. W. Young:
Results from the IAGP flowline study inland of Casey.

D. Raynaud, C. Lorius, W. F. Budd and N. W. Young:
Ice flow along an IAGP flowline and interpretation of data from an ice core in Terre Adélie.

D. S. Russell Head and W. F. Budd:
Ice sheet flow properties derived from borehole shear measurement combined with ice-core studies.

Roger LeB. Hooke, Charles F. Raymond, Richard L. Hotchkiss and Robert J. Gustafson:
Calculations of velocity and temperature in a polar glacier using the finite-element method.

A. J. Gow and H. Kohnen:
The relationship of ultrasonic velocities to *c*-axis fabrics and relaxation characteristics of ice cores from Byrd Station, Antarctica.

S. C. Colbeck and A. J. Gow:
The margin of the Greenland ice sheet at Isua.

S. F. Ackley:
Mass balance aspects of Weddell Sea pack ice.

R. H. Thomas:
The dynamics of marine ice sheets.

Robert W. Baker and William W. Gerberich:
The effect of crystal size and dispersed-solid inclusion on the activation energy for creep.

C. S. Lingle and J. A. Clark:
Antarctic ice sheet volume at 18,000 years B.P., and Holocene sea-level changes at the west Antarctic margin.

David J. Drewry:
Late Wisconsin reconstruction for the Ross Sea region, Antarctica.

Douglas Reed Macayeal:
A catastrophe model of the paleoclimate.

G. de Q. Robin:
Formation, flow and disintegration of ice shelves.

R. H. Thomas:
Ice shelves: a review.

C. S. Neal:
The dynamics of the Ross Ice Shelf revealed by radio echo-sounding.

S. Shabtaie and Charles R. Bentley:
Investigation of bottom mass balance rates by electrical resistivity soundings on the Ross Ice Shelf, Antarctica.

Kenneth C. Jezek, Charles R. Bentley and John W. Clough:
Electromagnetic sounding of bottom crevasses on the Ross Ice Shelf.

Joseph F. Kirchner and Charles R. Bentley:
Seismic short refraction studies on the Ross Ice Shelf.

Joseph F. Kirchner, Charles R. Bentley and James D. Robertson:
Lateral density differences at a site on the Ross Ice Shelf, Antarctica, from seismic measurements.

Charles R. Bentley, John W. Clough, Kenneth C. Jezek and S. Shabtaie:
Ice thickness patterns and the dynamics of the Ross Ice Shelf.

M. H. Herron and C. C. Langway, Jr:
Dating of Ross Ice Shelf cores by chemical analysis.

D. A. Rothrock:
Modeling sea-ice features and processes.

M. D. Coon and R. S. Pritchard:
Mechanical energy consideration in sea-ice dynamics.

V. R. Neralla and W. S. Liu:
A simple model to calculate the compactness of ice floes.

Donald R. Wiesnet:
Satellite studies of freshwater ice movement on Lake Erie.

D. E. Thompson:
Stability of glaciers and ice sheets against flow perturbations.

A. C. Fowler:
The use of a rational model in the mathematical analysis of a polythermal glacier.

M. Nakawo:
Deduction of glacier flow from the distribution of elongated bubbles.

David A. Yuen and Gerald Schubert:
The role of shear heating in the dynamics of large ice masses.

BRANCH NEWS

OTTAWA GLACIOLOGICAL GROUP

The Group was formed in January 1979 by glaciologists from the National Capital Region interested in promoting the exchange of ideas and information on all aspects of snow and ice and in providing an opportunity for some informal social contact between colleagues. Meetings generally take place on the third Thursday of every month. A small membership fee is collected to defray the cost of refreshments at the meetings and any out-of-pocket expenses of the speakers. Some meetings are held jointly with the Ottawa Geotechnical Group.

Executive:—

Chairman:	Dr Sivan Parameswaran, NRC
Vice-Chairman:	Dr Peter Johnson, Ottawa Univ.
Secretary-Treasurer:	Mr. Simon Ommanney, DOE

Meetings have been held as follows:

1979

20 September M. Dunne/ P. Noble:
Ship trials in ice covered waters.

12 October B. Michel:
Ice problems in Canada.
(Joint meeting with Geotechnical Group)

Future meetings include:

5 November Yoshimitsu Kubo:
Bearing capacities studies on river ice.

13/16 November V. M. Kotlyakov:
Modern studies on Soviet glaciers.

20 December René Ramseier:
Remote sensing of sea ice in the microwave spectrum.

1980

10 January E. Penner:
Frost heave and pipeline problems.
(Joint meeting with Geotechnical Group)

31 January L. W. Gold/E. F. Roots:
The International Glaciological Society and the International Commission on Snow and Ice.

28 February Ron Wade:
Air cushion vehicles—ice breaking capabilities.

27 March Peter Johnson:
Rock glaciers and glacier hydrology.

BRITISH BRANCH

The next meeting of the British Branch will be held on Thursday 17 April 1980 in Birmingham. This date has been chosen to coincide with the end of the UK Geophysical Assembly, which is taking place on 14-16 April in Birmingham. (The UKGA is an annual gathering of UK geophysicists; for details of the meeting write to Dr R. King, UKGA, Department of Geological Sciences, P.O. Box 363, Birmingham B15 2TT.)

The inclusive cost of the meeting will be £6.00. This will include lunch and refreshments. Accommodation for either Wednesday or Thursday night can be arranged.

Arrangements have been made to visit an interesting site in the Peak District on Friday 18 April.

Further information may be obtained from Dr M. Walford, Department of Physics, Tyndall Avenue, Bristol BS8 1TL, U.K.

SYMPOSIUM ON PROCESSES OF GLACIER EROSION AND SEDIMENTATION

25-30 August 1980, Geilo, Norway

(Extracts from Circular)

INTERNATIONAL GLACIOLOGICAL SOCIETY

President:	L. W. Gold
Vice-Presidents:	C. R. Bentley
	O. Orheim
	C. W. M. Swithinbank
Immediate Past President:	M. de Quervain
Treasurer:	J. A. Jacobs
Secretary General:	H. Richardson

ORGANIZING COMMITTEE:

O. Orheim (Chairman)
O. Liestøl
J. L. Sollid
L. W. Gold (President IGS)
J. A. Jacobs (Treasurer IGS)
H. Richardson (Secretary General IGS)

PAPERS COMMITTEE

G. K. C. Clarke
B. Hallet
H. Röthlisberger
J. L. Sollid
L. W. Gold (Chairman)
H. Richardson (Secretary General, IGS)

General information about the Symposium may be obtained from:

The Secretary General
International Glaciological Society
Lensfield Road, Cambridge CB2 1ER
England. Tel. Cambridge 355974

Detailed information about arrangements in Geilo may be obtained from:

Dr. O. Orheim
Norsk Polarinstitutt
P.O. Box 158
1330 OSLO LUFTHAVN
Norway. Tel. Oslo 12 36 50

A Symposium on Processes of glacier erosion and sedimentation will be held in Geilo, Norway, 24-30 August 1980 in co-operation with Norsk Polarinstitutt and the University of Oslo. Registration will take place on Sunday 24 August at Geilo Hotel, and sessions will be held from Monday 25 to Saturday 30 August. There will be a guided one-day excursion to nearby glaciers at Finse in the middle of the Symposium week.

1. PARTICIPATION

This circular includes a booking form for registration, accommodation and travel. The form should be sent to the address given below before 1 May 1980 with the appropriate deposits, as indicated. (Registration fees cover organization costs, distribution of preprints of summaries and cost of the one-day excursion to Finse.)

Payments should be made in £ sterling—

by cheque payable to: International Glaciological Society Symposium, and sent to the Secretary General; or

by Bank transfer to: International Glaciological Society Symposium, Account No. 54775302, and sent to the National Westminster Bank Ltd., 56 St. Andrew's Street, Cambridge CB2 3DA, England.

Registration Fees:

Participants	£35
Junior Members of the International Glaciological Society	£20
Accompanying persons aged 18 or over	£10

(There is no fee for those under the age of 18.)

For people resident in Norway, payment of registration fees and deposits may be made in N. Kr. to IGS-Symposium, c/o Norsk Polarinstitutt, account No. 6223.20.07635, Kreditkassen, Oslo.

2. TOPICS

The Symposium will primarily be concerned with the erosional and depositional processes by which glaciers shape the surface of the earth. The topics to be discussed will include: thermal conditions of the basal ice and the subglacial moraine; formation of fjords and other major glacial features; formation of detailed surface relief; erosional and depositional processes of partially floating glaciers, and of polar and surging glaciers; subglacial drainage system; stagnant ice topography; erosion quantities under recent and Pleistocene glaciers.

3. PROGRAMME

A detailed programme will be given in the Third Circular. On Sunday evening, 24 August there will be an informal party, on Tuesday 26 August there will be a folklore evening, and on Friday 29 August the Symposium Dinner will be held. Various local tours will be arranged for those interested, and may be booked when registering on Sunday 24 August.

4. ACCOMMODATION

Accommodation, meals and meetings will be at Geilo Hotel. All rooms are with two beds, toilet and shower. Prices per night per person will be as follows:

Shared accommodation with full board—
N.Kr. 200 (About £18)
Single accommodation with full board—
N.Kr. 245 (About £22)
(Children, 3-12, 50% reduction.)

These prices also include all taxes and the cost of the "Norwegian evening" and the Banquet.

A deposit of £10 (N.Kr. 100) (for people resident in Norway) must be paid when booking accommodation. This deposit is returnable if notice of cancellation is received before 1 July 1980.

5. TRANSPORTATION

Geilo is located near the highest point on the Oslo-Bergen railway, about 3½ hours by train from either city. Both Bergen and Oslo have international airports. *En bloc* reservations will be made on 24 August on a train leaving Oslo around 3.45 p.m. arriving Geilo in time for dinner. Fare on this train will be about £7, while the regular fare from Oslo or Bergen to Geilo will be about £10. One can also easily drive from Oslo to Geilo.

6. PAPERS

(i) SUBMISSION OF PAPERS

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

Last date for submission of summaries:
1 December 1979

(ii) SELECTION OF PAPERS

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account scientific quality and relevance to the theme of the Symposium. The Papers Committee will then invite a strictly limited number of papers for presentation and thorough discussion at the Symposium (not necessarily confining themselves to authors who have submitted summaries). It is hoped to notify authors of papers during March 1980.

(iii) DISTRIBUTION OF SUMMARIES

The summaries of the accepted papers will be distributed by surface mail to all participants before the Symposium.

(iv) SUBMISSION OF FINAL PAPERS AND PUBLICATION

The Proceedings will be published by the International Glaciological Society. Papers presented at the Symposium will be considered for publication in these Proceedings, provided they have not been submitted for publication elsewhere. Final typescripts of these papers should be submitted to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England, by 1 July 1980. They should be written in English and prepared in accordance with the instructions that will be sent to authors when they are notified about acceptance of papers for the Symposium. The maximum length for papers will be 5000 words or the equivalent length including any illustrations. The papers will be refereed according to the usual standards of the Society before being accepted for publication. Speedy publication of the proceedings will depend upon strict adherence to deadlines.

Last date for submission of final papers:
25 June 1980

7. SOCIAL EVENTS

(i) WELCOME PARTY

On the evening of Sunday 24 August there will be an icebreaker hosted by Norsk Polarinstitutt.

(ii) "NORWEGIAN EVENING"

On the evening of Tuesday 26 August there will be a meal of Norwegian specialities followed by local folklore.

(iii) DINNER

The Dinner will be held on Friday 27 August. In addition to being the main social event of the Symposium, it will also be the Annual Dinner of the International Glaciological Society.

(iv) LOCAL TOURS

Geilo is the largest winter resort in Scandinavia, and offers various local attractions including chair lifts to the higher parts of the mountains. The village is also known for its several factories producing speciality knives. There will be a programme for accompanying persons to such places, and also three half-day tours will be offered: 1) a visit to the spectacular waterfall Vøringsfoss and to the Hardangerfjord, 2) a tour of Gudbrandsskar, a 250 years old mountain farm which is still in active use, and to the Stave Church at Hol, and 3) a visit to Skinnfellgarden in Hemsedal, where leather garments and accessories are made to order.

8. DISPLAY SPACE

There will be a limited amount of space available for displays of photographs and maps related to the theme of the Symposium. Those participants who wish to use such space are asked to write to the Secretary General of the Society in Cambridge, giving details of the material they wish to display and the area required.

9. EXCURSIONS

i) MID-SYMPOSIUM TOUR

On Wednesday 27 or Thursday 28 there will be a one-day excursion to Finse and nearby glaciers. Participants may visit either Hardangerjøkulen (erosional and depositional features both fossilised and under formation) or Omnsbreen, a dying glacier (glacier dammed lake, stagnant ice features, flutings). Travel is by train (40 mins each way) and by foot (about 5 hours). You are advised to bring boots and clothes for potentially wet and cold conditions. The excursion will be guided by scientists from Norsk Polarinstitutt and the University of Oslo.

ii) POST-SYMPOSIUM TOUR

Immediately following the Symposium there will be a four-day excursion displaying most of the classic phenomena of glacier erosion and sedimentation.

Sun. 31 Aug.: Train Geilo-Myrdal and down the spectacular Flåm Valley, visiting selected localities. Boat across Sognefjord to Sogndal, overnight stay. (Fjords and other large scale erosional features, glacio-fluvial erosion, glacio-marine deposits.)

Mon. 1 Sept.: Bus to Nigardsbreen (glacier erosion, glacier lake sedimentation, glacio-fluvial phenomena, deglaciation history). Overnight near Skjolden.

Tues. 2 Sept.: Bus across Jotunheimen, and in smaller vehicles to Juvasshytta at the highest mountain in Norway. (Cirque glaciers, frost action and permafrost features.) By bus across another mountain range to overnight stay at Dombås (Deglaciation features of continental ice sheet.)

Wed. 3 Sept.: Bus to Alvdal, (further deglaciation features, drumlins), train to Oslo arriving in the evening.

The cost of the excursion including all accommodation, meals, and travel from Geilo to Oslo will be approximately £95 or N. Kr. 1050.

It may be necessary to limit the number of participants on the last two days of the excursion to around 45 persons.

It will be possible to participate in the first one or two days only of the excursion, and return individually by public transport from the Sogndal/Skjolden area. (There are various choices of public transport, including daily flights from Sogndal to Oslo-Bergen.) The cost of one or two-day participation will be about 300 and 550 N. Kr. respectively.

The excursion will be guided by scientists from Norsk Polarinstitutt, the Universities of Bergen and Oslo, and the Norwegian Water Resources and Electricity Board.

A deposit of £20 (or 200 N.Kr.) (for those resident in Norway) is required by **1 May 1980** to secure a place on the excursion. Because of possible limitations interested persons are urged to send their deposits early. (Deposits will be returned if written notice of cancellation is received before 1 July 1980.)

The balance of the amount due will be paid when registering in Geilo on Sunday 24 August.

Your copy

INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON PROCESSES OF GLACIER EROSION AND SEDIMENTATION

25-30 August 1980, Norway

The following reservations were made on the forms returned to the Secretary General on

..... / ..... /19...
(day) (month)

A. REGISTRATION FEES

(i) Participant £.....

(ii) Junior Member IGS £.....

(iii) Accompanying persons £.....

B. ACCOMMODATION DEPOSITS

£10 per person £.....

C. POST-SYMPOSIUM TOUR DEPOSITS

£20 per person £.....
One day/Two days/Four days

TOTAL
PAYMENT (sum of A,B,C).....= £.....
Sent by cheque/Bank transfer

D.
I wish/do not wish to travel on the 3.45 p.m. train on 24 August from Oslo to Geilo.

DATES TO REMEMBER

1 December 1979	Last date for submission of papers for consideration.
1 May 1980	Last date for reservations: registration, accommodation, post-symposium tour.
25 June 1980	Last date for submission of final versions of accepted papers, for consideration for publication in the Proceedings.

Registration, Accommodation

SYMPOSIUM ON PROCESSES OF GLACIER EROSION AND SEDIMENTATION

25-30 August 1980, Norway

Mail to:
Secretary General, International Glaciological Society, Cambridge CB2 1ER, England.

BEFORE 1 MAY 1980

A REGISTRATION FORM

(please type or print in black ink)

Name of participant .....
Title .....
Address .....
.....
Accompanied by (indicate age if under 18)
Name .....
Name .....
I send registration fee/s as follows:
(i) Participants.....£35 each.....
(ii) Junior members.....£20 each.....
(iii) Accompanying persons .....£10 each.....
(There is no registration fee for accompanying persons under the age of 18.)
TOTAL REGISTRATION FEE/S =£.....

B ACCOMMODATION FORM

Please reserve following accommodation for the nights of 24-30 August 1980, for which I enclose a deposit of £10 per person.
Hotel—Shared accommodation with full board £.....
Single accommodation with full board £.....
TOTAL DEPOSITS FOR ACCOMMODATION =£.....

C POST SYMPOSIUM TOUR

£20 per person deposit .....£.....
I wish to book for the first day only .....☐
I wish to book for the first 2 days .....☐
I wish to book for all four days .....☐
(Please tick as appropriate)

D
I wish/do not wish* to travel on the 3.45 p.m. train on 24 August from Oslo-Geilo.
(*delete as appropriate)

TOTAL PAYMENT (Sections A, B, C)
(sent by Cheque/Bank transfer) =£.....

GLACIOLOGICAL DIARY

1979

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

1980

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

7–17 April
International Geological Congress (International Union of Geological Sciences), Paris. (Sec. Gen. International Geological Congress, Maison de la Géologie, 77-79 rue Claude Bernard, 75005 Paris, France.

17 April
British Branch meeting, International Glaciological Society, Birmingham. (Dr M. Walford, Department of Physics, Tyndall Avenue, Bristol BS8 1TL, U.K.)

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

1981

27–31 July
International Association of Hydraulic Research—Ice Symposium, Quebec City. (B. Michel, Département Génie Civil, Université Laval Ste-Foy, Quebec G1K 7P4, Canada.)

27–31 July
Port and Ocean Engineering under Arctic Conditions (POAC-81), Quebec. (B. Michel, Département Génie Civil, Université Laval, Ste-Foy, Quebec G1K 7P4, Canada.)

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

1982

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

NEWS

APPOINTMENT

A scientist with an international reputation in glaciology has accepted appointment to the foundation Chair of Meteorology in the University of Melbourne.

He is Dr W. F. Budd, who is at present Senior Glaciologist in charge of the Glaciology Section of the Antarctic Division (Department of Science and the Environment) and a Senior Academic Associate in the Department of Meteorology in the University.

Dr Budd holds the degree of Bachelor of Science and the Diploma in Education from the University of Sydney. He undertook postgraduate studies in the University of Melbourne and graduated with the degree of Master of Science in 1965 and Doctor of Philosophy in 1968.

In 1960, he joined the Antarctic Division as a glaciologist and spent the winter of 1961 at Wilkes Station, Antarctica, and most of 1964 at Mawson Station. He has been a leading participant in research projects and scientific conferences in Australia, Japan, North America, the Soviet Union, France, the United Kingdom and Argentina.

Dr Budd's research interests are in glaciology with a central theme including the past history of climate and ice masses and the possibilities of future change, current climate monitoring, the role of carbon dioxide in climate change, interannual climate fluctuations, and the role of Antarctic sea ice and ocean temperatures in climate.

GRADUATE STUDIES

Cold Regions Science & Engineering

A joint program is offered by the Thayer School of Engineering at Dartmouth College and the U.S. Army Cold Regions Research and Engineering Laboratory. This program, leading to the master's degree in engineering or science, consists of Thayer School course work at the graduate level, as required of all candidates for ME and MS degrees at Dartmouth (*see Dartmouth College Bulletin: Thayer School of Engineering*), and projects or thesis work conducted in affiliation with CRREL.

Thayer School of Engineering is an associated professional school of Dartmouth College. A major concept in Thayer's graduate program is the recognition that there are over 50 branches of engineering, and that a need has developed for kinds of engineering not included among the traditional fields of specialization. The opportunity to select a study plan such as the graduate program in cold regions studies that crosses traditional divisions is one of the unique features of an engineering education at Dartmouth.

CRREL is a specialized research laboratory of the U.S. Army Corps of Engineers located near Dartmouth in Hanover, New Hampshire. The laboratory's investigations consist of basic research on the physical, chemical and mechanical properties of snow, floating ice, ice sheets, and perennially and seasonally frozen ground. The knowledge gained from these investigations is applied to engineering problems of the cold regions, including design of buildings, roads and airfields in cold environments, control of ice in waterways, environmental impact, and energy conservation. The CRREL staff numbers almost 300, including about 100 research scientists and engineers. Laboratory research takes place mainly in Hanover but field work is regularly conducted in Alaska, Greenland, Antarctica and other areas.

The joint program provides research and course work opportunities in the following areas:

- *Electronics and Instrumentation for Polar Environments:* When measurement equipment is being designed for use in cold regions, certain special factors must be taken into consideration. These include portability, low temperature instability, unusual power drains, and severe weather conditions (blowing snow, icing, etc.).
- *Mechanical Design for Polar Environments:* The need to drill, excavate and sample cold regions materials (snow, ice, permafrost) requires the development of specialized augers, drills and cutters for these applications. Equipment design must take into account material properties and extreme environmental operating conditions.
- *Environmental Engineering:* Modern engineering must consider the protection of local environments. For example, the design and construction of pipelines, roads, and wastewater treatment facilities in low temperature environments or in permafrost demand special treatment.
- *Materials Science:* Engineering solutions to cold regions problems require the characterization and quantification of the response of snow, ice and frozen soil to mechanical, thermal, electrical, and other forcings. Therefore the fundamental properties of these materials must be well understood.
- *Hydraulics and Hydrology in Cold Regions:* The presence of an ice cover on rivers and lakes and the formation and movement of ice in these bodies as a two-phase flow creates a set of problems not yet adequately addressed. Snow cover characteristics, the movement of water through snow, and snowmelt runoff prediction all require study.
- *Geophysics of Snow, Ice and Frozen Ground:* The large scale behavior of snow, ice and frozen soils in response to natural forcing fields must be understood. The movement of sea ice driven by winds and currents, the deformation of large ice sheets by gravity, and the freezing and thawing of lakes are some of the areas under investigation. Engineering mechanics, oceanography, physics, and fluid mechanics are applied in the study of these problems.
- *Polar Marine Engineering:* This area covers the influence of ice covers on structures, transportation systems, etc. in marine, river and lake environments. Icebreakers, ice forces on structures, and icing on the walls of canal locks are all currently being investigated.

Financial assistance is available for well-qualified students.

For admission requirements and more detailed information, reference this announcement and contact

The Dean of Thayer School of Engineering
Hanover, N.H. 03755

PUBLICATIONS

HYDROLOGICAL SCIENCES BULLETIN
Edited by John C. Rodda
Water Data Unit, Reading Bridge House, Reading, U.K.
The Bulletin which has been published since 1956 is the official journal of the International Association of Hydrological Sciences and is designed to provide a forum for original papers and for the exchange of information, news, and views on significant developments in hydrology. The scope of the Bulletin includes:

Hydrology as an aspect of the earth sciences and of water resources. This encompasses the hydrological cycle on the earth and waters of the continents, their physical, chemical and biological processes, their relations to climate and to other physical and grographical factors and the inter-relations between surface and ground waters.

Ice and snow in all their physical and geographical aspects.

Erosion and sedimentation.

Physical and mathematical modelling of water systems.

Hydrological aspects of the use and management of water resources and their change under the influence of man's activities.

Hydrological Sciences Bulletin is published quarterly and the subscription price for 1979 is £26 (outside North America), $47.50 (U.S.A. and Canada) per annum, post free. The Bulletin is delivered to North America by air freight and subscribers there can expect to receive their copies within two weeks of British publication.

Blackwell Scientific Publications Ltd, P.O. Box 88, Oxford, U.K. — to whom enquiries should be addressed.

Dr M. Abe, a member of the Society, and a professor at Yamagata University, has presented to the Society a copy of the book "Zao Juhyo no subete" (Rime on Mount Zao), partly written by him and recently published by Tohoku Shuppan Kikaku Co., Tsuruoka, Yamagata Prefecture.

Dr Gorow Wakahama writes:

Mount Zao, (highest point 1841 m a.s.l.) is located very close to Yamagata City in Tohoku (Northeast) District of Honshu Island, and is famous throughout Japan due to a number of beautiful rimed trees (so-called Monster) and many good ski courses on the mountain. Dr Abe has been studying for several years detailed growing processes of riming on trees by using time-lapse photography and thin section techniques in a "natural wind tunnel" built by himself on Mount Zao.

The book is written in Japanese, and has many beautiful colour pictures of rimed trees on the mountain.

Dr Brian John, a member of the Society, has edited a book entitled "The Winters of the World". It examines the effects of ice ages on the earth. The authors show us why ice ages occur, how they are structured, how the ice alters the face of the land, and how life has been forced to adapt, time and again, to a thick and extensive cover of glacial ice. Finally, the evidence of past ice ages is used to predict future climatic effects. The book has many vivid illustrations, and is published by David and Charles, Brunel House, Newton Abbot, U.K.

FILM
"LAWINE" — 16 mm sound colour film
Information may be obtained from:
Karl Herrmann,
400 W. Lake Samish Drive,
Bellingham, WA 98225,
U.S.A.

NEW MEMBERS

Boyne, Harold S., Department of Earth Resources, Colorado State University, Fort Collins, CO 80523, U.S.A.

Davidson, K. D., 900 Saturn Drive, No. 303, Colorado Springs, CO 80906, U.S.A.

Diether, Philip A., 959 Blair Court, Palo Alto, CA 94303, U.S.A.

Gansser, Fritz, Via Roncaccio 21, 6942 Savosa (Lugano), Switzerland.

Geisler, C. B., 227 Wildwood Drive S.W., Calgary, Alberta T3C 3E2, Canada.

Gerath, Robert F., Thurber Consultants Ltd., 1623 McKenzie Avenue, Victoria, B.C. V8N 1A5, Canada.

Jensen, Willy H., Miljøafd., Amtsgården, DK 6760 Ribe, Denmark.

Josberger, E. G., School of Oceanography, Oregon State University, Corvallis, OR 97331, U.S.A.

Lowell, Thomas V., 21 High Street, Lincoln, ME 04457, U.S.A.

Mackay, S. M., 13 Colenso Road, Blackburn, Lancs. BB1 8OR, England, U.K.

Major, Robert A., Arctec Inc., 9104 Red Branch Road, Columbia, MD 21045, U.S.A.

Qui, Jiaqi, Xinjiang Institute of Geography, Ürümqi, The People's Republic of China.

Riis, Jens J., Statholdervej 11, 4TV, 2400 Copenhagen NV, Denmark.

Tabler, Ronald D., U.S. Forest Service (Research), 222 S 22nd Street, Laramie, WY 82070, U.S.A.

Thomsen, Henrik H., Grønnevaenge 2, 2920 Charlottenlund, Denmark.

Vimont, John C., Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523, U.S.A.

Visser, J. N. J., Department of Geology, P.O. Box 339, 9300 Bloemfontein, South Africa.

Wang, Wenying, Lanchou Institute of Glaciology and Cryopedology, Academia Sinica, Lanchou, The People's Republic of China.

Woodall, Peter M., 139 Cornwall Road, Ruislip, Middlesex HA4 6AH, England, U.K.

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 1979

Private members	Sterling:	£15.00
Junior members	Sterling:	£ 6.00 (under 25)
Institutions, libraries	Sterling:	£20.00 for Volume 22 (Nos. 86, 87, 88) £25.00 for Volume 23 (Number 89) £20.00 for Volume 24 (Number 90)

ANNUAL PAYMENTS 1980

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ICE

Editor: Hilda Richardson

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