NUMBER 30

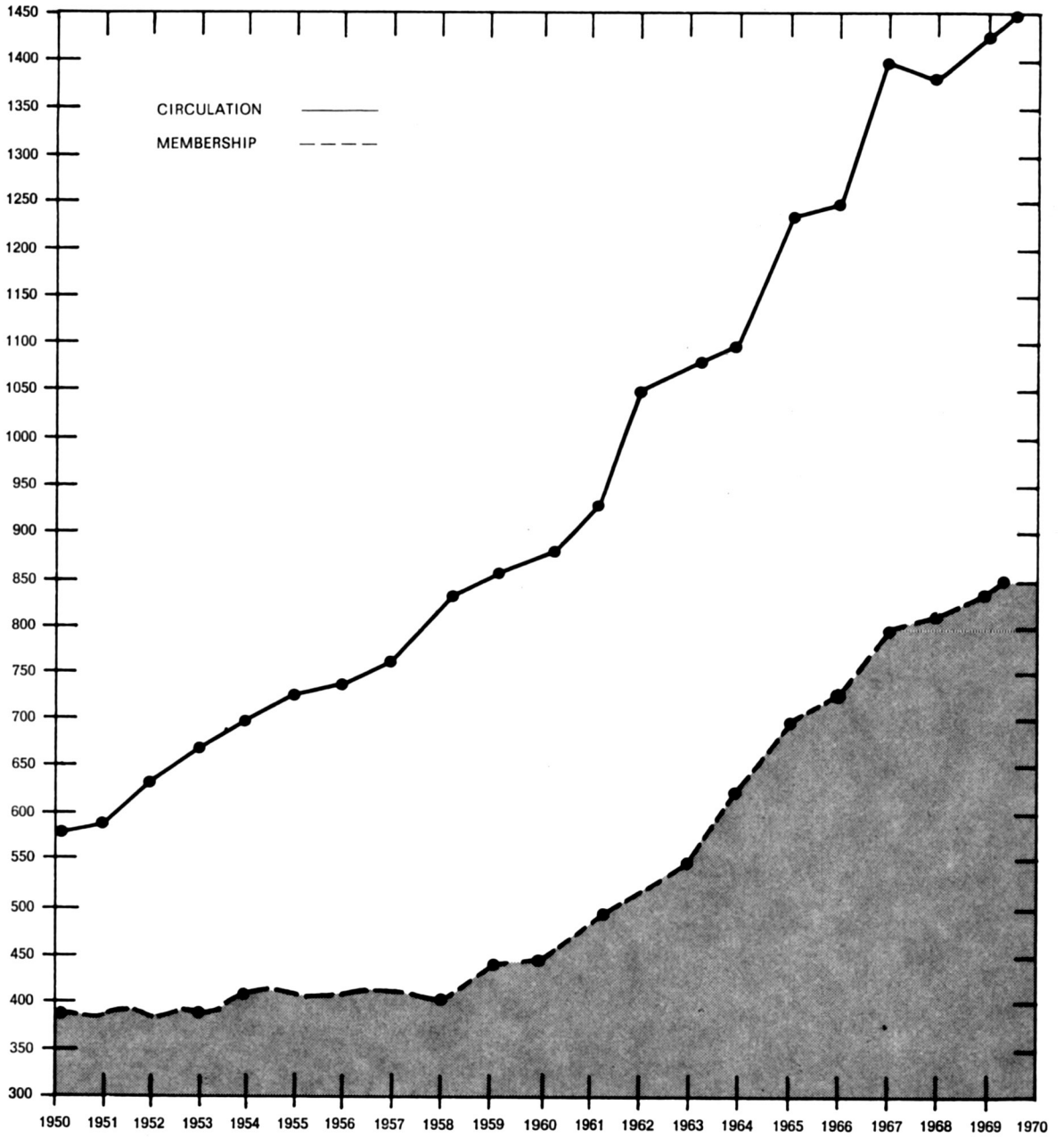
AUGUST 1969

ICE

CIRCULATION OF THE JOURNAL OF GLACIOLOGY

(excluding free and exchange copies)

and MEMBERSHIP OF THE GLACIOLOGICAL SOCIETY



ICE

NEWS BULLETIN OF THE GLACIOLOGICAL SOCIETY

AUGUST 1969 NUMBER 30

CONTENTS

ICELAND 1970 — On page 18 of this issue of ICE you will find preliminary details of our plans to hold a joint meeting with the Icelandic Glaciological Society. We aim to keep the cost as low as possible, using sleeping bags in schools rather than beds in luxury hotels. Group travel from either side of the Atlantic will also help to keep costs down, but for this we need to know how many people might be interested in such a glaciological meeting, which can also be a "glaciological holiday". The meeting will take place in the middle of June, to take advantage of the driest month of the year in Iceland and the cheap excursion season air fares. When you have read the details, please complete the form and return it to the Secretary, Glaciological Society, Cambridge CB2 1ER, England. The organization of transport will be handled by the British Branch of the Society for the European side of the Atlantic and by the Northeast North American Branch of the Society for the American side of the Atlantic. Dr Sigurdur Thorarinsson is very kindly making the arrangements in Iceland.

ANNUAL GENERAL MEETING 1969. As previously announced, this will take place on Thursday 11 September at the University Centre, Granta Place, Cambridge, at 7.15 p.m. and will be followed at 8.15 p.m. by the Society's Annual Banquet. Tickets for the Banquet may be obtained from the Secretary, price £2 5s. wines included. ***Last day for booking is Monday, 8 September.***

AIRMAILING THE JOURNAL TO NORTH AMERICAN MEMBERS. Unfortunately we cannot help those members who are keen to receive their Journals quickly, as the minimum requirement of 150 was not reached. The overwhelming majority of those who did reply favoured the scheme.

COVER PICTURE. Etch pattern produced when a snow crystal is placed on the surface of a viscous etchant (5% Formvar solution in ethylene dichloride). Photograph taken by Dr D. Kuroiwa, Institute of Low Temperature Science, Hokkaido University, Japan.

ERRATUM ICE No. 29. We apologise for the error in the date of death of Prof. H. Oura: the correct date was 11 March 1969.

FIELD WORK

AUSTRALIA

WILKES

During 1968 the SPRI designed radio echo-sounder used by D. Carter in 1967 for ice thickness profiling around the triangular sector of the Wilkes ice cap was operated on several traverses in autumn and spring by C. Champion and V. Morgan. The earlier continuous recording along traverse lines was supplemented by measurements on a grid ultimately covering the entire ice cap to yield a 3-dimensional bedrock and ice thickness picture. It is aimed to complete this programme in 1970.

The optical levelling programme was continued with a complete re-survey around the 210 km triangle back to bedrock at Wilkes. Further gravimetry traverses were conducted around the triangle for continued monitoring of the rate of surface elevation change.

The 1967 radar sounding profiles have been analysed by D. Carter to confirm theoretical relations between surface and bedrock shapes, and the relation between the average attenuation and the dielectric absorption calculated from temperature depth profiles.

AMERY ICE SHELF

The 4-man Amery Ice Shelf party led by M. Corry had a successful year on the shelf. They core-drilled to a depth of 310 m near the bottom of the ice shelf at G1, 64 km from the ice front, and measured the temperature profile and borehole closure rate. About 40% of the total core was returned to Australia in good condition for analysis. At the 280 m level a transition was found between what is believed to be the ice of the shelf and that of the Lambert Glacier 150 km inland. A semi-automatic micrometeorological and heat budget station was maintained throughout the year by A. Nickols and operated continuously even while the base was abandoned for the survey work.

In spring and summer tellurometer and optical levelling traverses were carried out down the centre-line of the ice shelf from the sea edge to the Prince Charles Mountains. Cross profiles were established at either end, and where possible tied to rock. A remeasurement of the tellurometer work is planned for the 1969-70 summer. About one hundred 9 m steel markers have been established at the measurement stations for future reference. It is planned to remeasure the optical levelling profiles several years hence.

W. Budd

CANADA

SNOW AND ICE

SNOW SURVEYS

In 1967-68, standard programmes were carried out by various Federal and Provincial government agencies. The results were again published by the Meteorological Branch of the Department of Transport, by the Meteorological Service of the Department of Natural Resources of Quebec and by the Water Resources Service of the Water Investigations Branch of British Columbia.

SNOW STUDIES

(1) Current snow-hydrological studies at the **Hydrology Branch, B.C. Hydro and Power Authority,** are concerned with precipitation and snowmelt run-off relations, both short term and seasonal, as applicable to hydro-power operations in British Columbia. The following drainage basins are involved: Lower Mainland—Alouette Lake, Stave Lake, Coquitlam Lake, Downton and Carpenter Lake (Bridge River), Cheakamus River, Clowhom River; Vancouver Island—Upper Campbell River; Interior—Peace River, Duncan Lake, Columbia River above Mica Creek, Columbia River below Mica Creek to Arrow Dam.

(2) At the **Department of Civil Engineering U.B.C.,** two investigations are being continued under the supervision of M. C. Quick: a) an experimental and theoretical study of the energy exchange processes during the ripening and melting of a snowpack and b) a mathematical modelling of the snowmelt flood processes.

(3) The **B.C. Water Investigations Branch** is expanding its snow course network, is developing computerized streamflow forecasting procedures and is supporting studies on the Berendon, Salmon, Ram and Peyto glaciers, where fluorometric measurement techniques are utilized.

(4) The **Forestry Branch of the Canada Department of Fisheries and Forestry** is carrying out two snow research projects:

a) Distribution of snow accumulation on Marmot Creek at maximum pack.

Research has been conducted on Marmot Creek since 1961 with the eventual purpose of cutting the timber cover to increase water yield, delay peak flows and retain high quality water. One parameter thought to be profoundly affected by any timber removal is the snow distribution-interception pattern on the watershed.

In 1968 a 5 x 10 chain grid of snow measurement points was established to evaluate snow distribution in the uncut state. These points will be measured at the time of maximum snow accumulation each spring—both before and after treatment. The results will indicate what changes, if any, occur in the snow accumulation pattern. Both depth and water content will be measured.

b) Ablation as a result of Chinook winds in Alberta.

Chinook winds have a reputation for evaporating snow in remarkably short time periods. Snow accumulation and soil moisture measurements together indicate that little if any snow melt water appears as soil moisture in areas below 6000′ msl in Marmot Creek. A study to determine the disposition of accumulated snow of various elevations was thus instituted in 1968 to begin in January 1969. The first phase of this study will be to measure the evaporation from snow surfaces during periods of strong westerly winds. This will be accomplished using small plastic pans as lysimeters. These lysimeters will be temporarily installed at various elevations from 5000 to 9000 ft during chinook periods.

(5) The **Faculty of Forestry of the University of British Columbia** has carried out snowpack measurements in lodgepole pine stands at low elevations in the Kananaskis River Valley, Alberta.

(6) The **Water Survey of Canada, Calgary,** continued its plaque line and toe survey of the Athabaska and Saskatchewan glaciers as part of a biennial survey conducted since 1945.

(7) The **Canada Department of Agriculture's Research Branch,** Swift Current, Saskatchewan, is measuring the run-off from rain and snowmelt from two small agricultural watersheds in southern Saskatchewan and is investigating the overwinter soil moisture changes.

(8) The **University of Guelph,** Ontario, is assessing photogrammetric measurements of the snow cover in a southern Ontario watershed. The snow cover on the Blue Springs Creek watershed was photographed from an altitude of 3000 ft just before the spring run-off of 1966 began. Accurate photogrammetry was combined with photointerpretive estimates to extend the results of local ground measurements over the whole watershed. The method appears to be valuable in giving improved accuracy of extrapolation of the snow course measurements of snow depth and density.

(9) The **Department of Civil Engineering, University of New Brunswick,** has three programmes: a) Method of snowmelt estimation from a 10.4 sq mi basin from a modification of the snowmelt theory originated by the U.S. Corps of Engineers. b) Method of estimating run-off based on a simple soil moisture storage model and on the physical characteristics and extent of the snowpack. A Muskingum type of storage routing equation was used to synthesize the hydrograph of run-off at the basin outlet. c) Synthesis of streamflow hydrographs from snowmelt and rain-on-snow events in the North Nashwaaksis Stream basin.

(10) On the **Axel Heiberg Expedition,** the field data for the methodological and statistical study of amount, distribution and decay of the snow cover in a high arctic catchment basin (Wolf River basin on Axel Heiberg Island, area: 20 sq km) was successfully collected and is being written up as an M.Sc. thesis (G. Young). The aim of the study is to explain the snow accumulation pattern within the basin in terms of various landscape parameters. Snow depth and density measurements were taken at each of 200 points, arranged on a regular grid, before melt began. After melt was completed the points were visited again and measures of slope angle and azimuth, altitude and exposure were taken. Multivariate techniques are being employed in the analysis of the data to determine associations between the variables and to allow a predictive model for snow accumulation to be formulated.

SNOW AND PERMAFROST SURVEY,

(McGill Sub-Arctic Research Laboratory, Schefferville, P.Q.: B.G. Thom—see also report of the Sub-Committee on Hydrology, N.R.C., Snow and Ice Section)

During 1967 and 1968 a major interest of the laboratory has been the problem of permafrost distribution and geometry in areas to be mined in the future for iron ore. A joint study between the Iron Ore Company of Canada and the Laboratory has been established and it involves:

1) seismic and resistivity geophysical surveys, 2) installation of thermocables to depths of 50—300 ft, 3) analysis of moisture content, ice structure and rock properties in frozen pit faces, 4) vegetation mapping, 5) recording snow depths and densities along snow courses over frozen and non-frozen terrain, and 6) an examination of geomorphic properties of the active layer over permafrost. The projects are an elaboration of work conducted in the late fifties and sixties by Ives, Annersten and others. Particular attention is being given, during the winter of 1968-69, to the distribution of snow in the Schefferville area. Besides the work with the permafrost programme attempts are being made to document changes in snow distribution at a variety of topographic and ecologic sites, and also to study changes in snow stratigraphy at these locations. The evolution of snow dunes and sastrugi under different meteorological conditions is also being examined.

EXPERIMENTAL STUDIES

(a) **Ice Science Section, Glaciology Sub-Division,** Department of Energy, Mines and Resources: S. J. Jones.

(i) An X-ray topographical technique—the Lang technique—is used to look at the dislocations which cause deformation in ice crystals, studying particularly the effect that impurities have on the number and velocity of the dislocations. (S. J. Jones.)

(ii) Investigations have started to study the effect of impurities on the mechanical properties of ice using compressive and tensile tests with an Instron machine. Initially single crystals of ice will be used but it is also intended to use polycrystalline specimens. In some respects this is a continuation of the work done at Birmingham University by Jones and Glen (1968), but the present work will use a greater variety of impurities, and implications for glacier flow will be investigated. (T. Nakamura)

(b) **Snow and Ice Section,** Division of Building Research, National Research Council: L. W. Gold.

(i) An investigation of the Rate Theory of Deformation Mobility was completed and the results reported. A study was undertaken of the application of rate theory to strain relaxation, and a theory was developed for ice. Experiments were carried out on polycrystalline ice at a stress of 4 kg/cm^2 and a temperature of -9°C. Good agreement was obtained between the theory and the experimental results. It was concluded from the study that strain relaxation in ice is controlled by one of the following mechanisms: Peierl's mechanism, dislocation intersection, non-conservative motion of jogs.

J. Muguruma, a visiting scientist with the Snow and Ice Section for the past one year period, carried out a study of the effect of surface condition on deformation behaviour. This study showed that the yield stress for easy glide of single crystals could be very significantly lowered by the presence of surface damage such as that due to mechanical polishing. The maximum yield stress observed in the study was obtained with crystals whose surfaces had been chemically polished with alcohol. This study was reported to the Conference on Ice Physics held in Munich, September 1968.

A study was undertaken on the buckling of ice plates (66 x 30 x 2.5 cm) due to end loads. The results of this study are being analyzed.

(ii) A study has been undertaken to define the role of various factors in the melting of lake ice and to develop a basis for predicting break-up dates of lakes. A statistical analysis of weather and lake break-up records for selected Canadian lakes is being continued. It is planned to make measurements of the amount of solar radiation penetrating lake ice, and to continue observations of water temperature and rate of melting of the ice cover.

A study has been undertaken to assess methods of predicting frazil ice formation from weather records and water temperature measurements. Observations are being made in the Ottawa River on the formation of frazil ice and the temperature of the water.

(iii) Observations were continued on the properties of avalanches and their dependence on weather and the characteristics of the avalanche site. Some observations were made on the speed of avalanches. Preliminary measurements on avalanche pressures were unsuccessful because of failure of the stand upon which the pressure measuring device was mounted.

(c) **McGill University:** J. J. Jonas and F. Müller

Deformation of ice at high reductions and strain rates has been studied. A range of extrusion containers and dies has been constructed, both of metal and of transparent plastic, which permit extrusion of ice to be carried out over the temperature range −20 to 0°C. A system of sectioning of extrusion butts and samples has been perfected which enables the very fine grain structure of extruded ice to be clearly delineated. Also a technique of photomicrography has been developed which permits high resolution micrographs to be made of the structure. An Instron environmental chamber, cooled by liquid nitrogen and capable of being operated at temperatures down to −70°C has been set up. In conjunction with an existing Instron compression tester, this will permit extrusion under carefully controlled temperature and strain rate conditions.

The purpose of these experiments is:—

1. To deform ice by extrusion to elongations of 1000% or more, and to study the stress and temperature dependence of the strain rate under these conditions.
2. To investigate the mechanisms of flow and the microstructural changes taking place during and after deformation.
3. To study the flow conditions leading to the formation of cracks and of crystalline fragments and powdered ice.

(d) The **Laboratoire de Mécanique des Glaces, Université Laval,** Québec, has several projects, including:

Loi de rupture de la glace sous charges triaxiales.

FLOATING ICE

McGill University's Marine Science Centre was actively engaged in ice forecasting in the Gulf of the St. Lawrence where wind and water stresses on the ice cover and the resulting ice movement are being measured.

The **Laboratoire de Mécanique des Glaces, Université Laval,** Québec, is studying the flow of ice on rivers and lakes.

The **Department of Transport, Canada,** continued its observations and studies regarding ice conditions in the Eastern Canada Seaboard, Hudson Bay and approaches, as well as in the Canadian Arctic waters.

F. Müller

NEW ZEALAND

ANTARCTICA

With the occupation of the new Vanda Station in the Wright Valley, a number of new glaciological projects have been started. During the 1968-69 summer, preliminary mapping of the immediate Vanda Station area and the eastern third of Lake Vanda was undertaken. Permanent bench marks were established and the lake water level measured throughout the summer. The Onyx river began to flow into Lake Vanda on 19 December 1968 and stopped on 8 February 1969. A survey of the river profile and cross-section between Lakes Vanda and Bull had earlier been made with the intention of constructing a simple weir. However, the requirement that there be no possibility of chemical contamination of the Lake water ruled out concrete as weir material. Alternative materials will be used in a continuing hydrological programme during the 1969-70 summer.

A preliminary survey was made of the glaciers to the south of Vanda Station in the Asgard Range. A long term project of glacier budget investigations will begin during the 1969-70 summer. This will complement the Ohio State University project further east along the Range.

A short time was spent on the McMurdo Ice Shelf drilling for further brine samples. Several elevation profiles were made north of White Island but this part of the project was disrupted by bad weather and has been postponed until the 1969-70 summer.

A. J. Heine

NORWAY

The current programme of glacio-hydrological measurements on Norwegian glaciers was continued in 1968 on all the glaciers previously investigated. In addition, the mass balance was measured on Vestre Memurubre, so that ten glaciers in southern Norway and three glaciers in northern Norway were included in the programme this year. On five glaciers meteorological observations were made during the main part of the summer season.

MASS BALANCE STUDIES

The mass balance studies were carried out by the standard methods previously described and the mass changes in the glacier during a glaciological year were calculated. The field measurements were made as in previous years. The winter balance was found by making a large number of snow-depth measurements, normally by sounding, but the snow density was measured only at a few points. As one is seldom able to do the field work exactly at the change from the winter to the summer season, the deviations from the final values are found by additional measurements or calculations from available meteorological observations. For each glacier a map showing the positions of stakes, pits and sounding profiles, and another covering the distribution of the winter balance were compiled. The summer balance was found by fresh measurements of the snow and firn density, in addition to stake observations.

In 1968 the snow accumulation was larger than normal in all the areas concerned. The highest relative accumulation figures were found in the glaciated districts of western Norway, where, according to calculations based on meteorological observations, there was 140% of the normal accumulation. In these areas snow depths of 6-9 m were measured. On Alfotbreen and parts of Jostedalsbreen probing was possible only on the lowest parts of the glaciers. The calculation of the winter accumulation in the upper parts is therefore based on relatively few points. On Folgefonni the winter balance had to be calculated from separate measurements of the change in balance before and after 24 November. At this time a very hard ice layer that could not be penetrated by probing had formed. Fortunately an inspection of the glacier was made at this time. One Vesledalsbreen, on the glaciers in Jotunheimen, and in northern Norway there were no irregularities in the winter balance measurements. In 1968 the mean winter balance was 4.5 m on Alfotbreen, which is the largest value ever measured by us. The winter balance decreased towards the eastern and more continental areas.

In southern Norway the summer season was warm and dry; the mean temperature (1 June to 31 September) was 0,5°C higher than normal in the north-western part, close to 1,0°C higher than normal in the south-western part and almost 2,0°C higher than normal in the central and higher parts. Thus the summer balance was higher than what is calculated as "normal". In northern Norway the summer was cold and wet; in Narvik the summer temperature (1 June to 31 August) was almost 2°C lower than normal. The summer balance then was very low.

The very large winter balance in the western part of southern Norway caused a large net accumulation on the glaciers here; in Jotunheimen the glaciers were almost in equilibrium.

Also in 1968 there were quite large local variations in Jostedalsbreen. The larger winter balance on Vesledalsbreen than on Nigardsbreen and Tunsbergdalsbreen seems reasonable, judging from the general accumulation pattern in this area. The mean summer balance is highest on Tunsbergdalsbreen, although the ablation in the respective height intervals is definitely smaller here than on the other two glaciers investigated. The different area distribution causes these variations. The situation in the Jostedalsbreen area indicates that significant differences in mass balance may occur within very short distances. This must be considered when judging the glaciological conditions.

In nothern Norway there were surpluses on all the glaciers examined.

METEOROLOGICAL AND HYDROLOGICAL INVESTIGATIONS

Meteorological observations of cloud cover, air temperature, wind conditions and precipitation were made on Ålfotbreen, Folgefonni, Nigardsbreen, Austre Memurubre and Vesledalsbreen. The discharge from the glacier river was measured on Ålfotbreen, Nigardsbreen, Vesledalsbreen and Austre Memurubre.

The temperature gradient between the glacier area and the meteorological stations in the vicinity is computed, and also the gradient within the glacier area, in those cases in which measurements are available from more than one place. The observations from Nigardsbreen and Vesledalsbreen indicate that there is a discontinuity in the temperature gradient near the edge of the glacier. The temperature and wind conditions at the lower station on Vesledalsbreen seem to be influenced by glacier wind.

Daily precipitation was measured at the observation huts. The precipitation was very small in southern Norway in 1968: on Ålfotbreen there was less than half of the precipitation the year before. At some of the meteorological stations in this area there was less than 10% of the normal precipitation in August.

The distribution of summer precipitation was studied and the mean precipitation compared with those of nearby meteorological stations. As a great part of the precipitation came in the form of local showers, the correlation with nearby stations is not so good in all periods. As a mean for the whole summer, the precipitation in the Ålfotbreen basin was almost three times larger than in the valley, and on Folgefonni the precipitation was 1.4 times greater than at the best correlated valley station. These results correspond very well to what was found in previous years.

On Vesledalsbreen the precipitation pattern is very much influenced by the wind conditions. When the wind blows from the north the largest precipitation is found in the lower part of the area, and the mean value is almost twice that measured in the valley. When the wind direction is southerly, there is a precipitation maximum on the central parts of the glacier and the precipitation is more than three times that in the valley.

In Jotunheimen the precipitation was very small and evenly distributed in the area of investigation.

SURVEYING AND MOVEMENT STUDIES

Local triangulation networks have been established at all the glaciers where the Glaciology Section is conducting mass balance studies. These local networks have been connected with the Norwegian official triangulation network.

The accuracy in the co-ordinates given is 0.1-0.5 m for the horizontal determination and up to 1.0 m for the vertical determination. For the purpose of glacier-movement studies, performed from the triangulation points, this accuracy is thought to be sufficient.

During the summer of 1968 a relatively large triangulation programme was carried out to determine the annual ice movement at as many glaciers as possible. For Gråsubreen, the most continental glacier under study, the bi-annual movement ranges from 0.3 m to 8.0 m. For Nigardsbreen, the annual ice movement is of the order of 50-150 m. On Folgefonni, where many of the movement stakes are in the firn area, the bi-annual movement ranges from approximately 2 m to 35 m. On Ålfotbreen, which is situated in the maritime coastal area, it has proved very difficult to maintain the movement stakes on account of the huge winter accumulation. For three stakes that have been observed for three years, the ice movement showed surprisingly low values—only 5-7 m for these three years.

In addition to the horizontal movement studies, a vertical displacement study has been carried out on Folgefonni. Owing to the fact that in 1963 long steel wires were drilled into the glacier, using a hot point, it has been possible to keep a large number of points under continuous observations for several years.

The glacier surface has generally sunk during the years 1959-66, whereas the measurements for the last two years show a rising tendency above the 1300-m elevation.

GLACIER-MAPPING

During recent years most of the glaciers selected for mass balance studies have been covered by special glacier maps. These maps were constructed from vertical air photographs, not more than 5 years old, and the maps were produced at a large scale. For most glaciers a scale of 1:10,000 was selected, but for some glaciers a scale of 1:20,000 was selected, owing to the size of the glacier.

In 1968, two glaciers in the eastern central part of Jotunheimen were mapped from vertical air photographs taken on 21 July 1966. The air photographs were originally taken for the Norwegian Geographical Survey to form a basis for a new, modern, topographical map series (1:50,000) of this part of southern Norway. Thus, the plotting could be carried out independently for the purpose of making a glacier map. Consequently, particular glaciological features could be emphasized in the plotting procedure. Crevassed areas, moraine cover and predominant boulders are marked separately in the maps. A large number of spot elevations are given for points that may be valuable for navigation and triangulation on the glacier. Ice-free areas were plotted with a minimum of generalization.

The accuracy is estimated to be better than 2 m in relative height determination and better than 5 m in absolute height determination, whereas the maximum error in horizontal determination is less than 5 m.

CORRELATION STUDIES AND REGRESSION ANALYSIS

Visual inspection of diagrams showing daily mean air temperature, precipitation and water discharge from a glacier may give a subjective impression of the relationship between the discharge and various meteorological parameters.

A stepwise regression analysis selects the most significant parameters to describe the variation in discharge, and separate equations are given for one, two or more independent variables included in the regression. The computer print-out also gives a list of correlation co-efficients between all the variables included in the regression.

The method was used on data from 5 Norwegian glaciers in 1968. The analysis was based upon daily mean figures for temperature, wind speed, cloudiness, precipitation and discharge. (The last-mentioned is regarded as the dependent variable, whereas all the others are independent variables.) The analysis comprised data from the following glaciers: Ålfotbreen, Erdalsbreen, Vesledalsbreen, Nigardsbreen, and Memurubreen. For each of these glacier basins, an attempt was made to use meteorological data both from standard meteorological stations in the area and data collected by the field parties working at the glacier during the summer season. As the melt-water may take a long time to reach the gauging station in the glacier stream, it was decided to include observations from one or two days before the actual discharge measurements were made in the river. For the glacier with the longest drainage distance, Nigardsbreen, it was obvious that a temperature observed two days earlier was better correlated with the discharge than the temperature observed on the same day.

It was found that the water discharge at each glacier was best correlated with the following factors: Ålfotbreen—wind speed, Erdalsbreen—precipitation, Vesledalsbreen—air temperature, Nigardsbreen—air temperature, Memurubreen—air temperature.

It is assumed that a similar study, carried out for the same glaciers over a series of years with varying meteorological conditions, will form a basis for future discharge predictions. It is hoped that general formulae can be developed for each glacier basin, in order to make possible a short-term run-off prediction and thus facilitate the economical operation of the hydro-electric power stations involved.

SEDIMENT TRANSPORT IN SELECTED GLACIER STREAMS

The utilization of the Norwegian mountain streams for electricity production has now reached a stage when highly glacierized areas must be considered as possible water resources for future power stations. This involves various problems, one being the special hydrological conditions in glacier streams and another the sediment load in such streams. The sediment studies that started in 1967 were continued and enlarged in 1968; in addition to the three streams studied in 1967, a new programme of sediment studies was started at Nigardsbreen in 1968.

Water samples were collected in one-litre bottles in extremely turbulent sections of the river, thus assuring the relatively good representativeness of the samples. The water was filtered in the field and the filter papers sent for ashing in the laboratory. Only inorganic particles were therefore included in the study. It is supposed, however, that the amount of organic matter in the river is very small close to the glacier.

NIGARDSVATNET, A NATURAL SEDIMENTATION BASIN

Electricity production in Norway has hitherto been based upon rivers with sediment-free water. During recent years, however, partly glacierized mountain areas have been considered for electricity production. Many of the main streams in these areas carry a heavy load of sediment, which will undoubtedly introduce new problems for the engineers. It may be necessary to build special reservoirs, in which the coarse sediment is allowed to settle before the water is used in the power-production system. The sizes of such reservoirs must be determined according to the amount of sediment, the particle-size distribution, and the mean water discharge. In Nigardsvatnet, a lake that has been uncovered by the glacier during recent years, a delta is now being formed by material moved along the bottom. Thus, it is possible to make direct observations of the increasing volume of the delta. This forms a basis for calculations of the amount of bottom-transported material in the glacier stream.

A detailed study of the rate of sedimentation in the lake was started early in 1968. This study included core-sampling from the lake bottom and a very detailed survey of the bottom topography. Parallel with these studies, a sampling programme was started, to determine the total amount of suspended sediments that was carried into the lake and out of the lake by the river. These studies showed that 70 per cent of the fine material was deposited on the lake bottom, forming a layer 3-5 mm thick. A simultaneous study of the growth of the delta indicates that a layer 26 cm thick is deposited in the inner part of the lake, i.e. the part that is closest to the glacier. A very accurate survey of the delta was made late in 1968, so that the total accumulation of coarse material can be determined in 1969. It is planned to include a direct measurement of the coarse material moved along the river bottom.

G. Østrem

SWITZERLAND

Glaciological work in 1968 was carried out under the auspices of: Gletscherkommission der Schweizerischen Naturforschenden Gesellschaft (GK), Abteilung für Hydrologie und Glaziologie der Versuchsanstalt für Wasserbau und Erdbau an der Eidgenössischen Technischen Hochschule Zürich (VAWE), Eidgenössisches Institut für Schnee- und Lawinenforschung Weissfluhjoch-Davos (SLF), Abteilung "Low Level Counting" des Physikalischen Institutes der Universität Bern (LLC), Institut de physique de l'Université de Neuchâtel (IPN) and Laboratorium für Festkörperphysik an der Eidgenössischen Technischen Hochschule Zürich (LFP).

ANNUAL SURVEY OF GLACIERS (GK & VAWE)

In the hydrological year 1967/68 precipitation was generally high and the summer was cool and had little sunshine; this resulted in a positive mass balance for all four glaciers where studies are carried out (Aletsch, Gries/Aegina, Limmern, Silvretta). This is the fourth consecutive year of positive balance. Of 98 observed snouts 35 have advanced, 6 were stationary and 57 have retreated. The average retreat of 89 glaciers has been 0.35 m as compared to 7.2 m (84 glaciers) in 1966/67 and 2.9 m (77 glaciers) in 1965/66. The results of recent years have been analyzed, and it has been possible to show that certain trends can be attributed to specific types of glaciers. (Kasser)

ALETSCHGLETSCHER (VAWE & GK)

Observations of the mass balance and the annual velocities and monthly velocities in summer were continued. Further methodical studies with the neutron probe and electrical wire markers were carried out in the area of high net accumulation. (Kasser, Röthlisberger, Aellen, Föhn)

JUNGFRAUJOCH ICE CAP (GK)

A net accumulation of 0.53 m (as compared to 1.4 m in 1966/67) was observed. (Haefeli)

STEINLIMMIGLETSCHER (GK)

A slip velocity at the terminus of 27 mm/day was observed during 2 days (1967: 10 mm/day). (Haefeli)

CONSULTING PROJECTS OF A GLACIOLOGICAL NATURE AT VAWE (Director Prof. G. Schnitter)

1. **Mass balance studies:** Investigations in relation with hydro projects were continued in the areas of Gries/Blinnenhorn (Ct. Valais) Limmern (Ct. Glarus) and Mattmark (Ct. Valais). (Kasser, Siegenthaler, Widmer)

2. **Ice avalanches:** The development of the snout of the Allalingletscher (Ct. Valais) in the fall of 1968 has been analyzed from three aerial surveys (September, October and November) in view of the possibility of a new large ice avalanche. At the glacier de Giétro (Mauvoisin, Val de Bagnes, Ct. Valais) a "glacier clock" (cryo-Kinemeter) has been installed as a warning device, in addition to annual and seasonal velocity determinations and aero-photogrammetric profiles which served to assess the safety of the artificial lake below the glacier. Investigations to estimate the danger of large ice avalanches below the Gamchigletscher (Ct. Berne) have been initiated, and a programme has been set up to serve the same purpose at the glacier de Pierredar (Ct. Vaud). (Kasser, Röthlisberger, Aellen)

3. **Various:** Further consulting activity pertained to the safety of construction sites below glaciers from ice avalanches and floods, short-term run-off forecasts for glacier torrents, the mechanical behaviour of the ice on an ice rink with a flexible base, and the probability of a glacier advance at the site of a proposed power line. (Kasser, Röthlisberger, Lang, Jensen)

SNOW AND ICE STUDIES OF SLF

An extensive study of the rheological parameters of snow was initiated two years ago. Until June 1968 the triaxial behaviour of snow was investigated in detail. Then because of a complete remodelling of the laboratories at Weissfluhjoch the experimental part of this work had to be interrupted until 1969. This urgent maintenance work also affected the development of the "tomograph"—or more precisely the practical application of this new instrument which allows an automatic analysis of ice thin sections. In the meantime the Institute was engaged in the final campaign of the International Greenland Expedition (EGIG). A number of firn and ice cores were brought to Davos for study in the tomograph. It is hoped that the stratigraphy can be followed to greater depth than hitherto with classical methods.

It may be mentioned that in January 1968 disastrous avalanches struck certain regions of Switzerland, in particular the vicinity of Davos. The Institute was touched in various respects, in particular by engineering problems related to avalanche safety. New structures will be erected in many parts of the country. (de Quervain)

GLACIOLOGICAL INVESTIGATIONS OF LLC

1. **Ice dating project, Byrd Station, Antarctica** (Joint project with US TSC): With financial support from the US National Science Foundation, a prototype of a probe was constructed in 1968 with which it should be possible to melt 2-4 t of ice in deep drill-holes and to extract the CO_2 for ^{14}C-dating. Ions and dust particles will be collected as well. Tests were made at Byrd Station during the field season of 1968/69 showing that changes in the construction of the probe are necessary. It is hoped that specimens will be collected in 1969/70, at least down to a depth of 500 m.

2. **Gas content (Aletschgletscher):** Together with VAWE (Röthlisberger, Aellen) and guests of the Earth Science Departments of UCSD (Craig, Weiss) ice samples were collected at the Jungfraujoch ice cap and near the terminus of Aletschgletscher. The preliminary gas chromatographic analyses of the entrapped gases have shown little difference from atmospheric air at Jungfraujoch. Near the terminus a reduced gas content was noticed, whereby those components were most affected which are best soluble in water, such as Ar and O_2. The ratio CO_2/N_2 has been two orders of magnitude above the one of the atmosphere in all samples. (Oeschger)

BASIC STUDIES OF ICE

Proton channeling (IPN): An ice laboratory and special equipment are under construction at Neuchâtel. (Jaccard)

Electrical properties (LFP): Investigations of the dependence of electrical properties of pure and doped ice single crystals on hydrostatic pressure have been carried out. (Gränicher)

SWISS PARTICIPATION IN THE INTERNATIONAL EXPEDITION TO GREENLAND (EGIG)

The Swiss participation in the 1968 campaign was made possible by the support of the Schweiz. Nationalfonds. Two scientists and a technician took readings on the 1959 nivological installations, to determine the accumulation 1959/68, temperatures and deformations. Samples were brought to SLF for stratigraphic studies. The analysis is under way by GK, SLF and LLC. (Haefeli, de Quervain, Oeschger)

PERMANENT SERVICE ON THE FLUCTUATIONS OF GLACIERS (VAWE & GK)

Data from various countries were collected. (Kasser)

H. Röthlisberger

PETER KASSER

Membership of the Glaciological Society encompasses a variety of professions. Personal commitment to work in snow and ice often develops gradually, even deliberately, but sometimes the growth of interest in glaciological problems is rapid, caused by a sudden experience. Few people can have had a more dramatic reason than did Peter Kasser for specializing in glaciology.

His early training was in civil engineering, at the college in Berne and then at the Eidgenössisches Technischen Hochschule in Zürich. In 1939, at the age of 25, he graduated from the ETH with the title dipl.ing.ETH. In his vacations he had spent much time mountaineering, sometimes combining this with survey work on the Jungfraujoch with Robert Haefeli's team. It was during one of his visits to the mountains that he almost became the victim of an avalanche. In January 1939, he was the sole survivor of a party of five and only narrowly missed being left under the snow. Such an experience undoubtedly influenced his choice of research work after graduation, and he turned his attention to avalanches and snow, combined with soil mechanics and foundation problems.

In 1945 he joined the staff of the Hydrology Section of the Hydraulic Research and Soil Mechanics Laboratory, ETH, and in 1951 he was appointed head of the Section. The name was changed to the Hydrology and Glaciology Section in 1961, and reflects the development of work under Dr Kasser's leadership. With persistence and diplomatic skill he has gradually built up the Section to its present size. Although it is an annexe to ETH with no teaching obligations, numerous students have been introduced by Peter to glaciological field work — going with him as volunteer helpers and asking his advice about their expeditions.

Many of the Section's activities are concerned with consulting work for water power plant design: estimating the available water yield (Grande Dixence, Linth-Limmern, Silvretta, Gries, Grande Emosson, Bergell); investigating the economic possibilities of sub-glacial water intakes (Grande Dixence, Trient, Saleina); assessing the probability of an advance of the Griesgletscher (Aegina) and the danger of big ice-avalanches (Pierredar); investigating methods of making run-off forecasts on a seasonal, monthly and short time scale (Rivers

Rhine and Rhone, various catchment areas with storage lakes, and glacier run-off); and designing flood controls for different storage lakes and water intakes.

The map of the Aletschgletscher at a scale of 1: 10,000 is well-known to all glaciologists as a classic example of glacier mapping. What is probably not known outside the immediate circle of his colleagues is the amount of determination and diplomacy needed to complete the field operations. On one occasion it was necessary to dust the névé fields with black soot. It so happened that a movie company was also working on the Jungfraujoch and planned to shoot some scenes on the snow. In spite of threats of legal action with claims in the region of $5000 a day, of intervention by local authorities, and other dire predictions, Peter refused to be diverted from his sooty work, claiming that under no circumstances could he change his programme without the express permission of the Director of the Swiss Topographic Service. This was accepted by the movie company. But before long they discovered that they had gained nothing by their acquiescence, as the man was abroad—and by that time the snow was black and the survey team was calmly going about its work.

His capacity for hard work and long hours was well known to his companions in the early days of research on the Jungfraujoch and other mountains. Even the hotel where the expedition was staying would be kept in a state of turmoil around the clock until the preparations and packing were complete. It is an interesting fact that the hotel keeper in this instance had a much higher opinion of Peter than the complaining guests. It was during this period that he undertook some interesting climbs. In 1942, for example, he made the following climbs with André Roch from Jungfraujoch:

27 August — traverse of the Mönch east to west.

29 August — traverse of the Gletscherhorn north to east.

2 September — traverse of the Eiger Mittellegi to Scheidegg.

5 September — ascent of the Jungfrau over the east ridge in 4½ hours, (almost breaking the record), return to the joch in 1 h 40 min.

11 September — traverse of the Truberg north to south.

12/13 September — over the Mönchjoch-Eismeer to the Strahleggḧutte. Ascent of the Schreckhorn over the Anderson ridge, descent to Grindelwald and departure for home on the 1715 train.

It is hardly surprising that many organizations, both Swiss and international, should appoint Peter Kasser to serve on their committees. Glacier Commissions, Hydrology Commissions, national committees for International efforts such as the Int. Hydrological Decade, the Expédition Glaciologique Internationale au Groenland; international committees such as the Unesco Permanent Service on the Fluctuation of Glaciers, which he represents on FAGS (Federation of Astronomical and Geophysical Services, of the International Council of Scientific Unions); and the Council of the Glaciological Society.

Famous though he is for his professional expertise, he is as highly valued for the ambience he creates outside the office. He is a kind and friendly person, and, with his talented and artistic wife, has the gift of creating evenings rich in food and wine and relaxed conversation. He is a connoisseur of his country's wines and with somewhat diffident modesty quietly persuades his never-reluctant guests to try a selection from his interesting cellar. Soon his friends know that his judgment: "It is not bad", is praise indeed. Certainly glaciology is the better for Peter Kasser's contribution.

SYMPOSIUM ON THE HYDROLOGY OF GLACIERS

September 7—13, 1969—Cambridge, England

EXTRACTS FROM THE THIRD CIRCULAR

The Symposium on the Hydrology of Glaciers, to be held in Cambridge 7-13 September 1969, is organized by the Glaciological Society, with financial support from the Royal Society, and is jointly sponsored by the Commission of Snow and Ice (International Association of Scientific Hydrology) with financial support from UNESCO and the International Union of Geodesy and Geophysics.

Registration and the sessions will be held in the University Chemical Laboratory, Lensfield Road, Cambridge, next door to the Scott Polar Research Institute. In the evenings, the old Junior Common Room in Emmanuel College will be available as an informal meeting-place for all participants.

PRESENTATION OF PAPERS AND PUBLICATION

In order to ensure that there is ample time for discussion of each paper, authors have been asked to keep to a strict prearranged timing in presenting their papers. If none of the authors of a paper is present, that paper will not be presented at the Symposium, but it will be open for discussion.

Papers must be submitted by 1 August 1969 in accordance with the Note to Authors which authors have received. Papers presented at the Symposium will be considered for publication in the Symposium Proceedings. Papers submitted will be further assessed by referees whose opinions will be taken into account in deciding whether a particular paper should be published in the Proceedings, and whether any modifications are required. Papers considered unsuitable for publication, papers published elsewhere, papers whose authors do not submit full manuscripts in time, and papers accepted for the Symposium but not presented there, will be represented in the Symposium Proceedings by a 200 word abstract.

SOCIAL EVENTS AND TOURS

Monday

1100 - 1300: Tour of colleges, starting from Emmanuel College. No charge.

1415 - 1715: TOUR 3 Modern colleges, starting from Chemical Laboratory.

Cost = 12s. 6d., for transport and tea at Grantchester.

1800 - 1945: Civic Reception at the Guildhall, at the invitation of the Mayor of Cambridge.

Tuesday

1100 - 1800: TOUR 4 Audley End House, Tewes (manor house), and Saffron Walden.

Cost = £1, for transport and lunch.

Wednesday

1145 - 1900: GENERAL TOURS 1 and 2 (no sessions after 1145).

TOUR 1 Cost = £2, for transport and lunch. Mediaeval wool towns in Suffolk.

TOUR 2 Cost = £1 5s., for transport and lunch. Ely Cathedral, prehistoric flint mines and mediaeval villages in Norfolk.

Both tours start from Chemical Laboratory.

or - 1400 - 1630: Tour of colleges, starting from Emmanuel College. No charge.

Thursday

1430 - 1800: TOUR 5 Ely Cathedral and Anglesey Abbey.

Cost = 10s., for transport.

1915 - 1945: Glaciological Society — Annual General Meeting, in the University Centre.

2015: Glaciological Society Annual Banquet, in the University Centre.
Cost = £2 5s. inclusive of wines.

The banquet is open to visitors who are not members of the Glaciological Society.

Friday

1400: Visit to the Fitzwilliam Museum. No charge.

1530 - 1730: Tour of colleges, starting at King's College. No charge.

2130: Departure of Scottish Tour.

TOUR 6 Cost = £33 basic (extra for hotel instead of chalets, as arranged with participants.)

Saturday

0900: Departure of Norway Tour.

TOUR 7 Cost = £14 for surface transport Cambridge - Bergen, plus 715 Nor. kr. for transport and accommodation in Norway.

1000 - 1200: Tour of colleges, starting at Emmanuel College. No charge.

ADDRESS FOR MAIL

Mail should be addressed to participants c/o Symposium on Hydrology of Glaciers, Glaciological Society, Cambridge CB2 1ER. Mail boxes will be placed in the registration foyer.

PROGRAMME

(a) indicates longer papers

(b) indicates short contributions

Sunday, 7 September

1500 - 2100 Registration in the east foyer of the University Chemical Laboratory.

Monday, 8 September

0830 - 0945 Registration, in the east foyer of the University Chemical Laboratory.

0945 - 1215 **SESSION A: The glacier as a ground-water system**

Preliminaries.

(a) Campbell, W. J., Rasmussen, L. A. and Meier, M. F. —
The production, flow and distribution of meltwater in a glacier treated as a porous medium.

..... Coffee break .....

(a) Derikx, A. L. — Glacier discharge simulation by groundwater analogue.

(a) Golubev, G. N. — Analysis of the run-off and the flow routing for a mountain glacier basin.

1400 - 1730 **SESSION B: Sub-glacial hydrology and discharge**

(a) Vivian, R. and Zumstein, J. —
Hydrologie sous-glaciaire au glacier d'Argentière.

(a) Bezinge, A., Perreten, J.-P. and Schafer, F. —
Phénomènes du lac glaciaire du Gorner.

..... Tea break .....

(b) Elliston, G. R. — Water movement through the Gornergletscher.

(a) Lang, H. — Variations in the relation between glacier discharge and meteorological elements.

General discussion.

Tuesday, 9 September

0900 - 1215 **SESSION C. Water within glaciers I**

(a) Röthlisberger, H. — Water pressure in sub-glacial channels.

(a) Mathews, W. H. — The record of two jökulhlaups.

(b) Fisher, D. — Subglacial leakage of Summit Lake, British Columbia.

..... Coffee break .....

(a) Stenborg, T. — Some viewpoints on the internal drainage of glaciers.

(b) Baranowski, S. — Geyser-like water spouts at Werenskiold Glacier, West Spitsbergen.

(b) Lliboutry, L. — Observations de lacs proglaciaires dangereux dans la Cordillera Blanca, Pérou.

1400 - 1730 **SESSION D: Water within glaciers II**

(a) Weertman, J. — Can a water filled crevasse penetrate the bottom surface of a glacier?

(a) Pinchak, A. C. — Effect of diurnal flow variations on the morphological development of a glacier meltwater stream.

(b) Goodman, R. H. and Terroux, A. C. D. —
The use of radio echo-sounder techniques in the study of glacier hydrology.

..... Tea break .....

(b) Lister, H. — Glacial origin of pro-glacial boulders.

(b) Nye, J. F. and Frank, F. C. — The hydrology of the intergranular veins in a temperate glacier.

Wednesday, 10 September

0900 - 1145 **SESSION E: The influence of water on ice movement**

(a) Müller, F. and Iken, A. — Velocity fluctuations and water regime of arctic valley glaciers.

(b) Goldthwait, R. P. — Jerky glacier motion and meltwater.

..... Coffee break .....

(a) Nye, J. F. — Water at the bed of a temperate glacier.

General discussion.

1145 - 1900 General Tours 1 and 2.

Thursday, 11 September

0900 - 1215 **SESSION F: The glacier as a source of stream flow I**

(a) Faber, Th. — Some results of the hydrological investigation of the Fox Glacier basin.

(b) Ambach, W., Eisner, H. and Url, M. — Seasonal variations of the tritium activity of the run-off from an alpine glacier (Kesselwandferner, Austria).

(b) Miller, M. M. and Helmers, A. E. — Glacio-hydrology of the Lemon-Ptarmigan-Thomas Glacier system, Juneau Icefield, Alaska.

..... Coffee break .....

(a) Higuchi, K. — On the possibility of artificial control of the water balance of perennial ice.

(b) Markin, V. A. — Potentialities of artificial intensification of glacier run-off in middle Asia in connection with different weather patterns.

(b) Reid, I. A. and Paterson, W. S. B. — A simple method of measuring the average amount of water produced annually by melting of ice on a given glacier.

(b) Zalikhanov, M. Ch. — The formation of outlets on the glaciers of the central Caucasus.

General discussion

1400 - 1730 **SESSION G: The glacier as a source of stream flow II**

(a) Østrem, G. — A review of present work in the field of "engineering glaciology".

(b) Kasser, P. — Influence des variations de l'aire glaciaire sur les débits estivaux dans le bassin versant de Porte du Scex.

..... Tea break .....

(b) Tsigelnaya, I. D. — The role of run-off in the water balance in the mountain area of Central Asia.

(b) Chernogayeva, G. M. — The water balance of a high mountainous glacial territory.

(b) Green, A. M. and Ivanovskaya, E. N. — Review of mountain hydrology studies in the U.S.S.R.

(b) Suslov, V. F. and Akbarov, A. A. — Hydrological regimen of glaciers in the Alai Ridge.

(b) Yemelyanov, J. N. — Ablation and run-off on the representative glacier Abramov.

Friday, 12 September

0900 - 1215 SESSION H: Water in firn, ice sheets, ice shelves, icebergs and lakes

(a) de la Casinière, A. C. — Bilan thermique de la Vallée Blanche.

(a) Kuroiwa, D. — Capillary potential of snow.

(b) Bazhev, A. B. — Infiltration and run-off of meltwater on glaciers.

(b) Krenke, A. N. — Run-off formation and water balance structure of a Caucasian glacial basin.

..... Tea break .....

(b) Losev, K. S. — Estimation of the run-off from the Antarctic and Greenland ice caps.

(b) Weeks, W. F. and Campbell, W. J. — Icebergs as a fresh water source: an appraisal.

(b) Gow, A. J. — The hydrology and compositional structure of the Koettlitz Glacier tongue, McMurdo Sound, Antarctica.

(b) Campbell, W. J. — Structure and inferred circulation of South Cascade Lake.

1400 - 1730 SESSION I: General discussion

Saturday, 13 September

See Section: Social events and tours.

FUTURE MEETINGS

GLACIOLOGICAL SOCIETY

JOINT MEETING WITH THE ICELANDIC GLACIOLOGICAL SOCIETY, mid-June 1970

The Council of the Glaciological Society has warmly approved the suggestion that there should be a joint meeting with the Icelandic Glaciological Society in 1970. Dr Sigurdur Thorarinsson has very kindly agreed to take care of the detailed arrangements in Iceland.

The best time of the year for the meeting will be mid-June, as that is the driest month in Iceland. There are cheap night flights from Glasgow to Reykjavík on Tuesdays, costing about £35 return. These could be used by members from Britain and other parts of Europe. At other times, the return economy fare is £59 from Glasgow and £74 from London. The summer rate eastbound, for North American members, from New York to Reykjavík is $160 and the thrift rate westbound to New York is $116 = total $276.

In order to keep costs as low as possible, the meeting will take place mainly outside Reykjavík. The cost for 8 days, with the first and last nights in Reykjavík, including all accommodation and transport, will be about £45. The final figure will vary according to the number of members attending. A reduction will be made for those who bring their own sleeping bags.

We give below a possible outline of the meeting to help you decide if you are interested in coming. This will be a wonderful opportunity for members of the two Societies and their families to become acquainted, in unique surroundings. As accommodation and transport is very limited, we will have to restrict our numbers to about 45 people from outside Iceland. So please return the form at the top of page 19 (not a binding commitment) as soon as possible to the Secretary of the Glaciological Society.

OUTLINE OF JOINT MEETING IN ICELAND, MID-JUNE 1970

(Arrival morning of 1st day, or previous day.)

1st day — depart Reykjavík by bus in the afternoon — Thingvellir — Skógar.
Stay 5 nights in Skógar. Bathing suits optional! (Artificially heated pool in Skógar, natural heated pool 10 miles west of Skógar.)

2nd day — Meetings in Skógar.

3rd day — Meetings in Skógar.

4th day — Excursion (a): Skógar — Skeidarársandur — Skógar. Study: Sandurs and glacier burst areas; Laki lava flow (biggest on earth); bird cliffs of Portland.

5th day — Excursion (b): Skógar — Thórsmörk — Skógar. Study: Gígjökull, which calves into a lake, the canyon of Stakkholtsgjá, which has a huge rockslide (1967).

6th day — Excursion (c): Skógar — Jökulheimer, via the inland desert to the glaciological station at the western edge of Vatnajökull.
Stay 1 night in Jökulheimar.
Note — this excursion (c) is only possible if the majority bring sleeping bags for the night in Jökulheimar.

7th day — return to Reykjavík in the afternoon. Night in Reykjavík.

8th day — breakfast in Reykjavík. Departure.

GLACIOLOGICAL SOCIETY 1970 ICELAND MEETING

(please return this form to the Secretary, Glaciological Society, Cambridge CB2 1ER, England.)

I am interested/very interested in attending this meeting in mid-June 1970 .....

I would like to bring the following family members .....

.....

My choice of dates is (please number in order of preference):

Saturday 13 — Saturday 20 June .....

Wednesday 17 — Wednesday 24 June .....

Saturday 20 — Saturday 27 June .....

I am able to bring sleeping bag/s and air mattress/es.

not able

Date ..... Signed: .....

Address: .....

.....

.....

GLACIOLOGICAL DIARY

1969

30 August - 5 September
International Union for Quaternary Research (INQUA). VIII Congress, Paris, France. (INQUA Secretariat, Institut de Géographie, 191 rue Saint-Jacques, Paris 5, France.)

7 - 13 September
Glaciological Society, Cambridge, England. Symposium on the hydrology of glaciers. Sponsored by the Glaciological Society and the Commission of Snow and Ice (IASH). (Mrs. H. Richardson, Glaciological Society, c/o Scott Polar Research Institute, Cambridge, England.)
13 - 20 September: Tours of Scotland and Norway following Symposium on hydrology of glaciers.

11 September
Glaciological Society 1969 Annual General Meeting and Banquet.

17 - 24 September
Conference on condensation and ice nuclei. Prague, Czechoslovakia (IAMAP, IUGG). (H. K. Wieckmann, Atmospheric Physics and Chemistry Laboratory, ESSA, Boulder, Colo. 80302, USA.)

14 - 16 October
Remote sensing of environment, sixth Symposium. Ann Arbor, Mich., USA. (Center for Remote Sensing of Environment, University of Michigan, Ann Arbor, Mich., USA.)

23 - 24 October
Conference on snow and ice problems, sixth conference. University of Calgary, Alberta, Canada. (National Research Council Associate Committee on Geotechnical Research, Ottawa 7, Canada.)

10 - 12 November
Geological Society of America & associated societies, annual meeting. Atlantic City. (GSA headquarters, Box 1719, Boulder, Colo. 80302, USA.)

26 - 31 December
American Association for the Advancement of Science, annual meeting. Boston. (AAAS, 1515 Massachusetts Ave. NW, Washington, D.C. 20005, USA.)

1970

3 - 7 February
Symposium on winter construction. Edmonton Alberta, Canada. (Mr M. K. Ward, Secretary, Winter Construction Symposium, c/o National Research Council of Canada, Ottawa 7, Ontario, Canada.)

9 - 13 March
Symposium on the use of isotopes in hydrology. Vienna, Austria. (International Atomic Energy Agency.) (J. H. Kane, Division of Technical Information, US Atomic Energy Commission, Washington, D.C. 20545, USA.)

6 - 10 April
International symposium on snow and ice control on roads and runways. Hanover, New Hampshire, USA. (Highway Research Board, Division of Engineering, National Research Council, USA, and CRREL of US Army, Mr. David Minsk, Applied Research Branch, US Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755, USA.)

20 - 23 April
American Geophysical Union, annual meeting. Washington, D.C. (AGU, 2100 Pennsylvania Ave. NW, Washington, D.C. 20037, USA.)

Mid-June
Icelandic Glaciological Society and Glaciological Society, joint meeting, (see page 18 of this issue of Ice.)

15 - 23 July
Symposium on the world water balance. Reading, England. (Unesco/IASH.) (Professor R. C. Sutcliffe, Department of Geophysics, University of Reading, Building No. 2, Earley Gate, Whiteknights Park, Reading, RG6 2AU, England.)

August
Glaciological Training Course (Unesco). Kebnekaise, Sweden. (Dr V. Schytt, Naturgeografiska Institutionen, Drottninggatan 120, Stockholm Va, Sweden.)

11 - 13 November
Geological Society of America, annual meeting. Milwaukee. (GSA headquarters, Box 1719, Boulder, Colo. 80302, USA.)

1971

2 - 13 August
XVth General Assembly of IUGG, Moscow, USSR. Symposium on environmental and interdisciplinary studies of glaciers and of snow in mountain regions. (IASH/Unesco.) Symposium on air-water reactions involving floating ice. (IASH/Unesco.)

(dates not announced)
Pacific Science Association, congress, Australia. (Geography Chairman: Akira Watanabe, Dept. of Geography, Ochanomizu Univ., Bunkyo-ku, Tokyo, Japan. Meteorology Chairman: J. F. Gabites, Director, Met. Service, P.O. Box 722, Wellington, New Zealand. Solid Earth Sciences Chairman: W. H. Mathews, Dept. of Geography, Univ. of British Columbia, Vancouver 8, B.C., Canada.)

1972

(early August)
International Geological Union Congress
International Geographical Union Congress
} both in Montreal, Canada, on successive weeks.
(Secretariat, 22nd International Geographical Congress, P.O. Box 1972, Ottawa, Canada.)
International symposium on snow and ice, hydrology and forecasting. Banff School of Fine Arts, Banff, Alberta, Canada. (Dr I. C. Brown, Secretary, Canadian National Committee for IHD, No. 8 Building, Carling Avenue, Ottawa 1, Canada.)

NEWS

ANNUAL SUMMER COURSES IN HYDROLOGY, USSR

A series of international higher-level summer courses in hydrology will be given annually at the Moscow State University in June and July of the next five or six years. The courses are sponsored by Unesco, the USSR National Committee for the IHD, the USSR Commission for Unesco, the USSR Ministry of Higher and Specialized Secondary Education, and the USSR Chief Meteorological Service Administration. Academic and administrative guidance is provided by the Director of the Courses, Professor V. D. Bykov, of the Geography Department, Moscow State University.

The announcement of the programme of courses makes the observation that modern hydrology considers the earth's water regime as it correlates with the processes of the atmosphere and lithosphere, and that man's 'interference with nature' must be reckoned as well. The importance of hydrological research in connection with the growth of world population and the rapid increase in the needs of human society for water for industrial, agricultural, and domestic activities is emphasized.

A major objective of the programme of summer studies is to familiarize participants with achievements in hydrology in the USSR and in other countries, with trends in hydrology, and with methods of meeting a number of hydrological problems.

Research facilities and laboratories of the State Hydrological Institute and of the Moscow State University will be used to familiarize participants with techniques, instruments, and equipment for field laboratory studies. Academic studies and practical work will be carried out in June and part of July of each year at the Moscow State University, and the remainder of July will be devoted to study tours to experimental and research centres.

Dr Emanuel D. Rudolph, Professor in the Academic Faculty of Botany, has been appointed Director of the Institute of Polar Studies, The Ohio State University.

Dr Colin B. Bull, former director of the Institute, has become Chairman of the Department of Geology, The Ohio State University. Former Assistant to the Director of the Institute of Polar Studies, Dr Garry D. McKenzie, has been named Executive Officer of the Department of Geology, Dr Richard P. Goldthwait, former Chairman of the Department of Geology, will continue as Professor of Geology.

Dr W. O. Field has been awarded the 1969 Explorers Medal of the Explorers Club, New York, U.S.A., an honour which he now shares with such famous explorers as Admiral Peary and Admiral Byrd. Since his first trip to Alaska in 1925, Dr Field's interest in and contributions to mountaineering and glaciology have continued to grow. He has helped to organize some twenty field research programmes and has served on several scientific panels. In the citation, the Explorers Club describes him as the "dean of glacial geographers in the Western Hemisphere" and "a great humanitarian" inspiring colleagues as well as young men new to the field.

Dr J. F. Nye has been appointed to a chair of physics at the University of Bristol.

Miss C. A. M. King has been appointed to a chair of geography at the University of Nottingham.

REVIEWS

B. FRISTRUP, The Greenland Ice Cap. København, Rhodos, 1966. 312 p., illus., maps, 28 cm.

A work of art may stand without revision to be admired indefinitely in its original form—in comparison, a scientific paper resembles a progress report. Fristrup has done a fine job of blending art and science in this book. It is a somewhat revised English translation of his "Indlandsisen" which was published in Danish, also by Rhodos, in 1963. The 1966 English edition differs from the 1963 Danish one in that it has a larger format (28 x 24.5 cm compared with 24.5 x 16.5 cm), contains more line drawings and maps (23 compared with 17), and more black and white plates (36 compared with 28). The most striking difference is the inclusion of 54 beautiful

colour photographs compared to none in the original Danish edition. The additional 54 colour prints and 8 black and white plates were included without modification of the text. Thus, they are scattered throughout the book without being numbered or keyed to the text. However, they do an excellent job of setting the stage for the book which is well organized, informative and very readable.

Fristrup has thoughtfully subdivided the history of Greenland exploration into pre-1850, 1850-1888, 1889-1912, 1912-1920, 1920-1940 and post-1940. All expeditions before 1920 are summarized on one map. Another map shows expedition routes traversed between 1921 and 1939; another summarizes expeditions between 1921 and 1939; and following 1940, the British and French expeditions are combined on one map, and U.S. expeditions on another.

The English edition seems to be aimed at a wider audience which may account for the net increase in the number of illustrations. But I was sorry to see the omission of the plan of Koch-Wegener's station "Borg" in the 1966 edition. Unfortunately, less proofreading was done in this English edition: shear stress appears as "solar" stress near the bottom of page 270; on page 266, ϵ should be ϵ; on page 267, P. Niggli becomes P. Nigglis. These errors did not appear in the 1963 Danish edition. Some of the added drawings are part of the expanded section on glacier flow. On page 250, the schematic diagram for plastic flow shows the velocity profile the decreasing to zero at the top of the glacier, but the profile is correctly drawn on page 251. The drawing on page 253 shows the viscous flow range extending to a stress of 1 kg/cm^2, which is a bit high.

I consider these to be small criticisms and regard this as an excellent book for both the scientist and layman. Fristrup has mined information from libraries as well as from his own extensive background. The SIPRE-CRREL reports are well summarized in the text, along with more readily available papers. By including such material, Fristrup has done a great service to everyone. The emphasis on research, especially on climatology and glaciology, combined with the history of exploration gives a wonderfully wide scope to this comprehensive geographical book on the Greenland Ice Sheet.

There is a good bibliography and the English edition has been expanded to include a carefully prepared index to both author and subject, and a useful chronology of expeditions and other major events in the history of Greenland. This book is to be recommended to anyone with an interest in Denmark's big and beautiful ice sheet.

Carl S. Benson

C. P. PEGUY. Ces montagnes qui flottent sur la mer. Glenoble and Paris, Arthaud. 1969. 340 p., illus., 30 F.fr. (coll. sempervivum)

Few places in the world are visited by the same variety of scientific expeditions which go to Spitsbergen each summer. Some of the larger expeditions, both from Western and Eastern Europe, have now established semipermanent bases there and return each year to continue intensive research programmes.

Such has been the series of French expeditions from 1963 to 1967, directed by Jean Corbel of the Centre National de la Recherche Scientifique. Their studies have included geology, glaciology, meteorology and biology, with pioneering work on the use of sub-aqua techniques in Arctic conditions.

"Ces montagnes qui flottent sur la mer" begins with a general account of the geography and history of Spitsbergen, and goes on to describe the initial establishment of the CNRS base near Ny Alesund in 1963, and the subsequent experiences of the French expeditions. A couple of chapters discuss the glaciological work, and emphasise the relationship between topography and glacial history. Submerged beaches have been discovered by French divers down to depths of 25 metres, and raised beaches measured up to approximately 234 metres above sea level.

The book is directed more towards the general reader than the scientist, but makes interesting reading for anyone involved in Arctic work.

W. Horsfield

NEW MEMBERS

Carter, Donald, Département Génie Civil, Université Laval, Québec 10, P.Q., Canada.
Cooper, D. A., 14 Dorchester Road, Garstang, Preston, Lancashire, PR3 1FD, England.
Crompton, Miss P. A., Geography Department, Whiteknights, University of Reading, Reading, Berkshire, England.
Drouin, Marc, Département Génie Civil, Université Laval, Québec 10, P.Q., Canada.
Eames, J., "Ty Celyn", Llanasa, Holywell, Flintshire, CH8 9DH, Wales.
Eavis, A. J., Manor Farm, Corston, Malmesbury, Wiltshire, England.
Goodman, Dr. R. H., 97 Carling Avenue, Ottawa 1, Ontario, Canada.
Graf, A. N., 2257-16th Avenue, San Francisco, California 94116, U.S.A.
Gudmundsson, A. T., Skolavordustig 43, Reykjavik, Iceland.
Kerr, R. J., 77 Croft Road, Kelso, Roxburghshire, Scotland.
Keys, J. E., Defence Research Establishment, Ottawa, Ontario, Canada.
Koller, Miss Karen, 68 Rosemont Road, Acton, London W.3, England.
Krimmel, R. M., 1302 N. Alder, Tacoma, Washington 98406, U.S.A.
Markl, Gerhard, Lanserstrasse 56, A-6080 Igls, Austria.
Martin, P. J., 5 Nursery Close, Woodham, Weybridge, Surrey, England.
Mayewski, P. A., Institute of Polar Studies, Ohio State University, 125 South Oval Drive, Columbus, Ohio 43210, U.S.A.
Metge, Michel, Civil Engineering Department, Queen's University, Kingston, Ontario, Canada.
Morris, Miss E. M., c/o H. H. Wills Physics Laboratory, University of Bristol, Tyndall's Park Road, Bristol BS8 1TL, England.
Patzelt, Dr. Gernot, Institut für Meteorologie, Schöpfstrasse 41, A-6020 Innsbruck, Austria.
Raymond, S. O., Benthos Inc., Edgerton Drive, North Falmouth, Massachusetts 02556, U.S.A.
Skinner, R. G., c/o Department of Geology, University of Washington, Seattle, Washington 98105, U.S.A.
Smith, Michael W., Department of Geography, The University of British Columbia, Vancouver 8, British Columbia, Canada.
Stenborg, Thorsten, Naturgeografiska Institutionen vid Uppsala Universitet, Box 554, S-751 22 Uppsala 1, Sweden.
Stidham, H. D., 17 Shumway Street, Amherst, Massachusetts 01002, U.S.A.
Street, Miss F. A., Church Farm, Langford, Near Biggleswade, Bedfordshire, England.
Thompson, K. S. R., Department of Geography, University of Edinburgh, High School Yards, Edinburgh EH1 1NR, Scotland.
Totten, S. M., Department of Geology, University of Birmingham, P.O. Box 363, Birmingham 15, England.
Wheatley, T. J., 6 Stafford Terrace, London W.8, England.

THE GLACIOLOGICAL SOCIETY

c/o Scott Polar Research Institute, Lensfield Road, Cambridge, England

President: Dr. J. F. Nye

Secretary: Mrs. H. Richardson

DETAILS OF MEMBERSHIP

Membership is open to all who have scientific, practical or general interest in any aspect of snow and ice study. Members receive the Journal of Glaciology free. Forms for enrolment can be obtained from the Secretary. No proposer or seconder is required. Annual subscription rates are as follows:

Private members—	Sterling:	£3 0s. 0d.
	U.S. dollars:	$8.00
Junior members (under 25)	Sterling:	£1 0s. 0d.
	U.S. dollars:	$3.00
Institutions, libraries—	Sterling:	£6 0s. 0d.
	U.S. dollars:	$16.00

(The dollar rates include Bank conversion charges)

Further details may be found in the Journal of Glaciology, published in February, June and October

---

I C E

Editor: Mrs. H. Richardson

This news bulletin is issued free to members of the Glaciological Society, and is published in April, August and December. Contributions should be sent to Mrs. H. Richardson, c/o Scott Polar Research Institute, Lensfield Road, Cambridge, England.

Annual subscription for libraries, &c, and for individuals who are not members of the Glaciological Society:

US. dollars	$3.00
Sterling	£1 0s. 0d.

Printed by Metcalfe & Co. Ltd., Cambridge