NUMBER 23 APRIL 1967

ICE

GLACIOLOGICAL SOCIETY

4 & 5 May 1967

Annual General Meeting and Conference

at Churchill College, Cambridge, England

Last date for booking: 29 April

For details, see page 19 of this issue of ice

COMMISSION OF SNOW AND ICE

8-25 August 1967

Glaciological Training Course

in Kebnekaise, Swedish Lapland

Last date for booking: 1 May

For details, see page 21 of this issue of ice

NORWEGIAN GLACIER TOUR

26 August - 4 September 1967

Glacier sightseeing tour from Narvik to Oslo

Last date for booking: 1 May

For details, see page 20 of this issue of ice

ICE

NEWS BULLETIN OF THE GLACIOLOGICAL SOCIETY

APRIL 1967 NUMBER 23

CONTENTS

ANNUAL GENERAL MEEETING. The 1967 Annual General Meeting will be held on 4 May, in Churchill College, Cambridge, England, and will be followed by a Dinner in the College. On the 5 May, there will be a one-day conference. For further details, please see page 19 of this issue of Ice.

BINDING CASES for Volumes 1-5 of the Journal of Glaciology are available from the Secretary, price 12/6 or $2.00. The cases are made of maroon cloth, with the title and snow crystal in gold.

HAVE YOU PAID your 1967 dues? These have been paid by many members already, but members who have not paid by June are reminded once more that they WILL NOT RECEIVE THEIR JUNE JOURNAL. Make sure of your copy and pay now.

We are sorry to report the death on 28 February 1967 of Professor Kaare Strøm, head of the Department of Limnology in the University of Oslo. An obituary will appear in the Journal of Glaciology.

COVER PICTURE: Photograph taken by James H. Zumberge of the inside of a crevasse at Camp Michigan, Ross Ice Shelf, Antarctica, 1958.

FIELD WORK

CANADA

INTRODUCTION

(a) The Sub-Committee on Glaciers held meetings on 3 March and 26 October 1966. On 1 April F. Müller became chairman, succeeding G. Hattersley-Smith who had successfully guided the Sub-Committee through its first and second three-year terms.

(b) The proceedings of the IUGG-IASH Commission of Snow and Ice Symposium on Glacier Mapping have been published as a special issue of the Canadian Journal of Earth Sciences. A supplement containing 14 large-scale glacier maps is included.

(c) In the reorganization of the Department of Energy, Mines and Resources a Glaciology Section was established in the recently formed Water Research Branch. It is planned to have a staff of about twenty in this unit, which is to conduct "research into glacial processes and the relation between glaciers and meteorological conditions".

(d) Consequent upon the rapidly growing importance of glaciology as a science of interdisciplinary nature there is now an urgent need for an adequate academic training programme. Reference is made to a statement to this effect by the Council of the Glaciological Society in the October 1966 issue of the Journal of Glaciology (Vol. 6, No. 45).

SOUTHERN CORDILLERA, BRITISH COLUMBIA AND ALBERTA

(Glaciology Section, Water Research Branch, Department of Energy, Mines and Resources: A. D. Stanley)

In April 1966, the Glaciology Section was transferred to the Water Research Branch, but the field programme followed that established in the Geographical Branch by G. Østrem (see Geographical Bulletin, Vol. 8, No. 1).

In 1966 the programme included five glaciers located along an east-west transection of the southern part of the Canadian Cordillera — Ram River and Peyto Glaciers near Lake Louise, Woolsey Glacier near Revelstoke, and Sentinel and Place Glaciers north of Vancouver. For each the winter accumulation was measured in mid-April. From early June, parties of 2-3 men made continuous observations until the first week of September. Data collected included daily meteorological observations, ablation measurements every 5-10 days according to weather conditions and continuous gauge records of melt water streams. When parties left the field the net budget was positive for most glaciers, but summer weather continued for 2-3 weeks and final ablation figures cannot be calculated until the glaciers are again visited in November.

In preparation for more extensive studies next year automatic stream gauges were installed at Peyto and Sentinel Glaciers.

Ground control was established and low altitude aerial photographs were taken of the three eastern glaciers in mid-August. High altitude photographs were obtained for several parts of the transect to record the state of glaciers and establish the snow limit at the start of this long-term glaciological programme.

During the winter the collected data will be processed and a comparison made of various methods of mass balance measurement in order to ascertain the most accurate and economical one.

A glacier map for the northern part of British Columbia will be prepared. Work on the inventory of glaciers in Canada is being continued.

Maps of Sentinel and Place Glaciers on a scale of 1:10,000 have been prepared for reproduction and initial work has been completed on maps for the remaining glaciers in the transect.

A joint study with the Water Resources and Topographic Surveys will be undertaken to determine possibilities for more extensive use of terrestrial and aerial photography to obtain volumetric measurements, particularly within accumulation areas.

ROCKY MOUNTAINS, ALBERTA

(a) Drummond Glacier (University of Calgary: J. G. Nelson and I. Y. Ashwell)

Measurements of the recession of the Drummond Glacier made from a number of frontal and surface stakes since 1963 were continued. One frontal stake had disappeared. Measurements from the three remaining frontal and five surface stakes indicate little or no recession of the Drummond ice from 2 September 1965 to 21 July 1966. Because of deep snow and other difficulties, no measurements could be made after 21 July. However, little recession is expected after that date as snow remained on most peaks all summer. Geomorphological studies and discharge measurements were continued, with emphasis on the character and origin of terrace and associated deposits in the middle and lower part of the mountainous section of the Red Deer Valley. An M.Sc. thesis

on "The Drummond, Hector and Peyto Glaciers, their wastage and deposits" was completed in September 1966.

(b) Athabasca Glacier (California Institute of Technology: Charles Raymond)

A study of deformation on the Athabasca Glacier, Alberta, was initiated in the summer of 1966. The project is sponsored by W. B. Kamb. Nine holes, eight of which reach the bottom of the glacier, were drilled thermally. The configuration of these holes was determined by standard survey and inclinometry techniques. A weighted aircraft cable was lowered down each hole to help recovery in the following field season.

The holes are arrayed transversely about 0.7km below the base of the lowest ice fall in a region of constant but non-zero longitudinal surface strain-rate. They lie in a roughly rectangular grid pattern with an initial spacing of approximately half the centerline depth, which in this reach is 315 m - 320 m.

COAST MOUNTAINS, STEWART AREA, BRITISH COLUMBIA

(University of British Columbia: W. H. Mathews)

Glaciological studies initiated in 1965 in the Granduc area of the northern Coast Mountains of British Columbia were continued in 1966. Wire-netting mats were laid in 1965 at 12 sites on the snowfields to mark the surface at the end of the melting season, and targeted with, among other things, lengths of drill pipe mounted vertically in the snow. Most of these were successfully re-located in September 1966, mostly with the aid of a magnetometer, and depths and densities of the snow overlying the net were determined. Stakes set in drill holes were used to measure melting in areas below the firn line. Although the stake record is incomplete, reasonable figures for specific net budget for the year were obtained for altitudes of from 1000 to 2000 m, within which range is concentrated most of the glacier-covered area. An analysis of the dynamics of Berendon Glacier was undertaken to establish what increase in net mass budget, compared with the present budget, would be necessary to develop an ice advance such as could interfere with operations of the Granduc mine during its expected life. W. H. Mathews supervised field operations: N. Untersteiner (University of Washington) and J. F. Nye (University of Bristol) performed computations of the response of the glacier to an assumed extreme increase of the net mass budget in the next few decades.

GLACIER MAPPING IN BRITISH COLUMBIA AND ALBERTA

(Water Resources Branch, Department of Energy, Mines and Resources: I. A. Reid)

During July and August 1964, five glaciers in British Columbia were surveyed by stereoscopic terrestrial photogrammetry. The five glaciers mapped at the scale of 1:2500 with their National Topographic Map sheet reference are as follows: Bugaboo 82K, Kokanee 82F, Nadahini 114P, Sentinel 92G, Sphinx 92G.

These maps were made using a Wild A-5 plotter and cartographically depicted by personnel of the Surveys and Mapping Branch, Department of Energy, Mines and Resources.

During August 1966, the same glaciers were surveyed again by terrestrial photogrammetry and maps will be produced as previously. From these two series of maps, volumetric changes and other measurements may be made.

During July 1965, the Saskatchewan and Athabasca Glaciers were surveyed by stereoscopic terrestrial photogrammetry. Work is in progress on the plotting and cartographical depiction and maps will be ready for publication in the near future.

ICEFIELD RANGES, YUKON TERRITORY

(a) Icefield Ranges Research Project (American Geographical Society and Arctic Institute of North America: R. H. Ragle)

The IRRP continued its field operations for the sixth consecutive summer under the direction of Walter A. Wood and the field leadership of Richard H. Ragle, who supervised the glaciological and morphological programme with the help of Melvin G. Marcus, University of Michigan, and J. Peter Johnson, Carleton University. Though the work began 1 June and did not terminate until the first week in September, most of the 1966 investigations were carried out between 29 June and 20 August. For the first time a Bell G-2 helicopter was used in addition to the Helio Courier aircraft, to cope with the increasingly complex logistic problems of the project.

Cation content of snow and ice: In the area of the Divide Station, which has marked climatic contrasts, a project was initiated to measure absolute concentrations of Ca, Na, Mg and K ions in the annual snow layer — particularly the winter layer — to assess any systematic changes in ion concentration with elevation, and to determine the amount and extent of local chemical migration or diffusion in snow and ice. Atomic absorption spectroscopy will be employed for cation analysis. Standard pit observations of snow temperature, density, hardness

and stratigraphy were carried out in conjunction with the collection of snow samples for cation analysis. Four shallow pits, two deep pits and a crevasse wall were sampled.

Snow and ice sampling for analysis of ^{210}Pb: Snow and ice samples were also collected for analysis of ^{210}Pb content to establish the chronology of the accumulated snow and the world-wide distribution characteristics of ^{210}Pb. Total lead concentration and composition will also be determined. Samples will be analysed for vertical particulate mineral phases.

Terrestrial photogrammetric investigation of the terminal area of the Kaskawulsh Glacier: Seven photogrammetric bases and nine camera stations were set up around the Kaskawulsh Glacier terminus to complete a network from which a detailed investigation of ice flow and wastage was initiated to allow estimation of the probability of radical change in the drainage pattern. These observation stations will be re-occupied over a number of years in a continuing surveillance programme watching particularly for any significant changes in the form of the ice body which might precipitate capture of the Slims River system by the lower-lying Kaskawulsh River. This work is part of the Canadian contribution to the International Hydrological Decade.

Morphological analysis of streams on a glacier surface: The investigation is a continuation of work begun in 1965 which emphasized the defining and mapping of important parameters contingent upon the nature and pattern of glacier surface streams. Stream evolution and development was plotted from oblique aerial photographs taken about every two weeks during the 1965 field season. The objective of the research in 1966 was to explain glacier stream hydrology and morphology in terms of operative environmental processes. One stream in particular was studied in detail. Vertical aerial photographs were taken; ablation measurements were recorded daily and standard synoptic weather observations at 3-hourly intervals. In addition, observations were made on cyroconite holes and on the formation of a moulin.

A study of the Kaskawulsh Glacier medial moraine: A morphological study of the distinctive medial moraine at the confluence of the north and middle arms of the Kaskawulsh Glacier was started. A 1700 m longitudinal profile was run down the moraine from the base of the nunatak with seven cross-profiles. Four triangulation stations provide control. Vertical aerial photography was flown for mapping purposes. Thirty-one ablation stakes were set at 15 m intervals across the moraine and local change in moraine morphology noted. Rock samples were collected at each stake site. Transverse crevasses across the moraine, longitudinal lineation of different rock types, and longitudinal shear zones in the moraine were noted and vegetation samples were collected.

Steele Glacier observations: In July and again in late August parties were flown by helicopter to the Steele Glacier to observe the surge which was seen to have started in 1965. Gross surface features were plotted, the rate of surface movement measured, and qualitative observations recorded. The Canadian Surveys and Mapping Branch, Department of Energy, Mines and Resources, flew two vertical air-photograph runs in August and in September. Later, in early November, an oblique photograph reconnaissance flight was made by the Water Resources Branch, Whitehorse, Yukon, to observe and estimate activity of the Steele Glacier.

Cloud sequence across a major topographical divide: A project of photography cloud sequences was undertaken to aid weather forecasting across a major glacier-covered mountain range, which involves defining the climatic or "weather" divide and its relation to the snow/hydrologic divide.

(b) Isotope studies (University of Alberta: E. R. Kanasewich)

A final report is being published on $^{18}O/^{16}O$ ratios in snow and ice of the Hubbard and Kaskawulsh Glaciers by D. S. Macpherson and H. R. Krouse of the University of Alberta. The isotope ratios have a mean value which correlates with latitude on the basis of studies by R. P. Sharp and others. The precipitation appears to be derived from the Pacific Ocean rather than from inland sources.

(c) Pleistocene chronology and comparative landforms study (Geological Survey of Canada: V. Rampton)

This project includes establishment of a Pleistocene chronology and the comparative study of glacial landforms extending from ice-cored moraines at the snout of Klutlan Glacier to the all-time limit of glaciation north of Snag.

During this second season slope analyses were carried out on three moraines of pre-Hypsithermal age and on two moraines of neo-glacial or post-Hypsithermal age to test the feasibility of such techniques for determinng the extent of different ice advances, for approximating the ages of moraines which are older than the limit of radiocarbon dating, and for correlating moraines from different montane areas. The most effective technique involved the measurement of slope at 200 points with a 4×10^6 sq. ft. morainic area with no external drainage.

A reconnaissance of the neoglacial moraines adjacent to the snouts of the Klutlan and Natazhat Glaciers was made to assess the possibility of lichenometric and dendrochronologic dating of these moraines, which range in age from modern to less than 1400 years old. The latter date is based on the relationship of certain moraines to a volcanic ash dated at 1400 B.P.

This ash buried and killed many trees in its area of maximum thickness near Natazhat Glacier. Dead tree stumps were noted at elevations 100 m above the present tree line. Work on this project will be continued in 1967.

SCHEFFERVILLE, QUEBEC: SNOW AND LAKE ICE SURVEY

(McGill Sub-Arctic Research Laboratory: B. F. Findlay)

The long-term snow and ice studies at the McGill Laboratory were continued during 1965-66 by J. A. A. Jones (lake ice), R. J. Rogerson (snow), under the direction of W. P. Adams.

The characteristics of the ice cover of many lakes in Schefferville vicinity were investigated during the winter. Particular attention was directed toward: freeze-up and break-up processes, buckling and white ice formation, crystallographic characteristics of various ice types, and lake meteorology. A new ice thickness measuring device was utilized to supplement through-ice drill holes. Methods of processing data were studied.

A Mount Rose snow-sampler was used to evaluate depth and water content variations of the snow pack in a 400 m plot which contained many of the common vegetation-slope associations of the region. A complete survey was undertaken twice during the winter, and the results were correlated with regular snow-course observations. A late season survey of preselected lines in the Knob Lake watershed (area 35 km^2) showed that the mean basin snow-cover was remarkably similar to the 12-point snow course average. In a sheltered location metamorphic changes in the snowpack were measured, and described cartographically in the time-profile form.

The snow programme was augmented in the autumn of 1966 by the installation of a 3.7 m diameter "snow pillow" and a Fischer-Porter totalizing precipitation gauge. More detailed research into local differences in pack metamorphism processes is planned.

SOUTHERN BAFFIN ISLAND: RECENT GLACIER FLUCTUATIONS

(Geological Survey of Canada: W. Blake, Jr.)

On 17 and 23 August 1966 special air photography flights at 9000 m were made to cover all the ice caps between Cumberland Sound and Hudson Strait. This repetition was necessary as the 1965 photographs were taken so late in the season (1 Sept.) that new snow obscured nearly all the high-level ice/land boundaries. The new air photographs provide a basis for comparison with those taken in 1948, 1952 and 1958-59, and it is hoped that re-photographing will be carried out at intervals in the future.

SOUTH CENTRAL BAFFIN ISLAND: PENNY ICE CAP

(Observatories Branch, Department of Energy, Mines and Resources: J. R. Weber)

Observations carried out in 1962 and 1965 were continued. The relative positions of the 14 aluminum poles across the crest of the ice cap were resurveyed, the gravity differences between the poles and the "gravity base" were remeasured, and the gravity change along the direction of movement of the centre pole was observed.

Stratigraphic snow analysis, density and temperature measurements were carried out at the centre station, elevation 1838 m a.s.l. The accumulation from fall 1962 to May 1966 was 254 cm of snow, 116 cm water equivalent, and the temperature was −13.1°C at 9.6 m depth on 15 May.

No trace could be found of the red nylon cord that had been strung along the southern row of poles in 1962 to mark that year's snow level. Presumably it had been removed by foxes.

The 15 stakes across the outlet glacier were recovered and movement and ablation measured. The average yearly rate of flow was again the same at the rate determined for April and May 1962.

CENTRAL BAFFIN ISLAND

(Geographical Branch, Department of Energy, Mines and Resources: J. D. Ives)

(a) Barnes Ice Cap (O. H. Løken)

Two glaciology parties worked on the ice cap between 26 May and 13 June 1966. J. T. Andrews and D. M. Barnett were in the vicinity of the ice cap for shorter periods during the summer, studying respectively lichen growth and the bathymetry of Generator Lake.

For the mass balance study the existing stakes were re-measured and additional ones inserted to provide a better coverage of the ice cap, giving a total of 282 stakes. The winter's accumulation was less than that of the preceding year, e.g. maximum accumulation along the south dome profile was 45 cm w.e. (50 cm in 1965) and the overall average was 31 cm (41 cm in 1965). The northern part of the ice cap had much less accumulation than the southern part, to the north-west of the culmination only one stake showed more than 30 cm of accumulation, and values between 20 and 25 cm were typical. The distinct north-east/south-west asymmetry of the accumulation pattern on the south dome, which was detected in the spring of 1965, was again apparent this year. Only four stakes were resurveyed at the end of the summer; they indicate very large ablation, thus a negative budget year is anticipated.

Three sets of movement stakes were inserted near the ice margin and surveyed by tellurometer and theodolite from base lines off the ice cap. One set runs across an area where surface forms indicate that relatively rapid movement is occurring or has occurred. The two other sets were so placed as to enable comparison of the pattern of ice flow behind a well-developed shear moraine with that in a section of the ice margin where no such moraine exists.

Further lichen measurements were made by J. T. Andrews in order to date moraines around the southern part of the ice cap. These measurements confirm the view that there has been no recent retreat along the north-east margin of the ice cap.

To investigate the possible extent of cross-valley moraines in the western part of the proglacial Generator Lake, echo-sounding profiles were made by D. M. Barnett.

(b) Decade Glacier and River (K. Simpson and W. Rannie)

The glacio-hydrological investigations continued this year in co-operation with the Water Research Branch. The average accumulation was 25 cm w.e. as compared with 26 cm during the preceding winter. The maximum recorded ablation was 184 cm, which is more than double the highest value recorded in 1965. Average ablation in the 1966 summer (up to 25 August) was 87 cm compared with 21 cm in 1965. The glacier thus had a strongly negative budget year, mainly due to high ablation.

The condition of the glacier is reflected in the river measurements, which in 1966 showed a 74% increase in run-off over the preceding year for the period 22 June-17 August, despite the fact that the precipitation in 1966 was only one-third that of 1965.

(c) Glacial geomorphology (J. T. Andrews, D. M. Barnett, R. W. Feyling-Hanssen, J. D. Ives, J. Philpot)

Studies of the glacial geomorphology of the area continued, including work on moraines, raised shore features, possible nunatak areas and on the interstadial (?) sediments near Cape Christian.

(d) Meteorological studies

Increased attention is being given to glacier-climate relationship. R. Barry recently started a study of the moisture flux over Baffin Island in connexion with the mass balance studies presently under way. The distribution of cirques, glaciers and snow fields is being investigated in the Home Bay area of Baffin Island and the Torngat Mountains of Northern Labrador by J. T. Andrews and O. H. Loken respectively.

DEVON ISLAND

(Arctic Institute of North America: R. M. Koerner)

R. M. Koerner and Mrs. A. E. Koerner were transported to Devon Island by Polar Continental Shelf "Otter" on 29 June 1966. By this date some melt had occurred at all elevations on the ice cap. A snow accumulation survey was conducted on the north-west traverse from the ice cap top to the transient snow line at 850 m a.s.l. Specific accumulation in that zone was then 9.8 cm w.e. Two further mass change measurements were made between sea-level and 1300 m a.s.l. before the final mass budget measurement in mid- and late August. Melt water percolation above the firn edge was considerable (50 cm at 1750 m a.s.l., 90 cm at 1500 m a.s.l., and to the basal ice mass elsewhere). Positive mass change was measured, by using a dye and percolation trays placed just below the surface in August 1965, at 20 positions above the 1966 equilibrium line. Negative mass change was measured at 48 positions. The final net and gross mass change/altitude relationhip for 1966 is similar to that which was obtained in 1961. The specific net mass change was approximately —15 cm w.e. Summer rainfall and accumulation was considerable (ca. 12 cm w.e. at 300 m a.s.l. and 10 cm w.e. between 1300 and 1800 m a.s.l.).

Trials were run on various types of wire/tripod ablation devices. In August each ablation position was redrilled and either a stake or wire (its position at the surface marked with a tripod) inserted. The rate of glacier movement was followed by daily resection observations from one position in the centre of the glacier. Concurrently daily mass change was measured by ablatometer and by measuring melt stream depths. Levelling between two fixed points on the rock at the glacier edge determined elevation changes since 1963. These measurements are complementary to similar ones made by P. Cress in 1963. The results show increased movement in summer and variations during the summer. Regular meteorological observations were taken at 300 m a.s.l. on the glacier and temperature was recorded continuously at 1300 m a.s.l. between early June and late August.

MELVILLE ISLAND

(Polar Continental Shelf Project: W. S. B. Paterson and F. P. Hunt)

Mass balance measurements were continued on the four ice caps, all of which had positive budgets for 1964-65. Values of mean specific budget ranged from 10 gm cm^{-2} for the south ice cap to 15 gm cm^{-2} for the north ice cap. The mean specific accumulation from the start of the 1965-66 budget year until mid-April 1966 varied little from one ice cap to another, the average value being 14 gm cm^{-2}. This is about

the same as the accumulation in 1962-63 and in 1964-65. The positions of several markers on each ice cap were re-determined to see whether any measurable movement had occurred since the previous survey in 1963. The planned aerial photography had to be cancelled because of the large amount of snow which remained on the ice caps and around their margins during the summer.

MEIGHEN ISLAND

(Polar Continental Shelf Project: W. S. B. Paterson and R. M. Koerner)

Mass balance measurements were continued on the ice cap. The mean specific budget for 1964-65 was a gain of 6 gm cm^{-2}. The mean specific accumulation for 1965-66, as measured in early June 1966, was 15 gm cm^{-2}. Temperatures in the borehole through the ice cap were again measured; they agreed closely with those of the previous year. The diameter of the hole was also remeasured, at depth intervals of 7.6 m, to determine the rate of closure. Approximately 50 m of the 121 m core obtained in 1965 were examined in the field. Thin vertical sections were photographed using polarized and transmitted light. Close-up photographs of firn samples and unusual bubble structures were taken. The orientation of at least 200 c-axes was measured on a Rigsby Universal Stage at each 20 m interval throughout the core. Samples from 22 dirt layers in the core were brought back for laboratory analysis. In addition near-surface cores from two other locations, one at the eastern margin of the ice cap, the other in the area of maximum surface slope, were studied. Results so far suggest that the ice cap, at the deep core site, has not been very much thicker than it is now. There is no evidence of past or present ice movement.

AXEL HEIBERG ISLAND

(McGill University: F. Müller)

The McGill University research project on Axel Heiberg Island (in progress since 1959) had parties in the field during two periods in 1966: from 11 April to 3 June and for a shorter time in August. The first party of three — C. Simon L. Ommanney (in charge) and J. N. Ommanney, McGill University, and Julian Paren, Cambridge University — was joined on 13 May by four other McGill University members (F. Müller, J. V. Gardner, W. J. Seifert and A. C. D. Terroux). The August operation (marred by bad weather and adverse flying conditions) was manned by C. S. L. Ommanney, W. J. Seifert and A. C. D. Terroux. Logistic support north of Resolute was provided by the Polar Continental Shelf Project. Socony Mobil Oil Ltd., Calgary, flew the spring party out from Eureka to Edmonton.

(a) Snow survey

During April and the first half of May a snow survey was carried out in the Expedition area in the immediate vicinity of Colour Lake. 565 depth and density measurements were made using systematic sampling techniques. Approximately 100 other sites were sampled using random profiles in a 9 km^2 area. In the latter part of May the survey was extended to the White Glacier (250 points) and the Baby Glacier (28 points).

(b) Mass balance

Readings on the stake network on the White and the Baby Glaciers, established in 1960 and 1961 and maintained more or less at the same level since, were continued and supplemented by pit studies during the spring and again in the fall of 1966. An effort was made to assess not only the net mass balance but also the gross values for these two glaciers in order to relate more directly glacier mass changes to climatic fluctuations.

Remarkably little snow fell during the preceding winter. Most of the budget year's accumulation occurred in May 1966. First melting had been observed on the White Glacier before the heavy snowfall (12.7 cm) of 10 May. The 1965/66 gross accumulation was less than that of the two preceding years. The ablation quantities were about average in spite of the delaying snowfalls in spring and the early end of the melt season. The equilibrium line on the White Glacier was at approximately 1000 m, i.e. several hundred metres higher than in the three preceding years. The glacier was thus reverting to a slightly negative budget having taken the 1965 year to recover from the strongly positive season experienced in 1964.

(c) Radio echo sounding

(G. de Q. Robin and S. Evans, Cambridge University)

A joint programme of the Scott Polar Research Institute and the Defence Research Board used high-frequency radio echo equipment from an "Otter" aircraft to measure continuous profiles of glacier depth on the McGill Ice Cap, the Thompson Glacier and the Hidden Ice Field. (For further comments see report on Northern Ellesmere Island.)

(d) Automatic weather station

The automatic weather stations established in the summer of 1965 at the Base Camp and at the equilibrium line of the White Glacier operated well through their first winter. The six meteorological parameters (temperature, humidity, wind run and direction, sunshine duration and air pressure), recorded every sixth minute for the period 10 August 1965 to 25

August 1966, are presently being analysed. The percentage of sensor errors seems to be very small; some electro-mechanical failures did, however, occur. All the power units except one had been buried in 11 m deep ice holes. The one unit left on the glacier surface had functioned perfectly well. Based on this experience, the power and timer units for the 1966/67 winter were left on the ice surface. To facilitate the data analysis the present electro-mechanical recording system (metal-backed strip charts) will be replaced by digital tape recorders in the spring of 1967.

(e) Glacier surveying

Some 40 old and 8 new points of the White Glacier were twice surveyed for movement, once in May and once in August. The stadia levelling of the White Glacier tongue was repeated for the 7th year.

(f) Push moraine

Both the snout of the Thompson Glacier and the push moraine in front of it are still advancing at approximately the same rate as observed during the last 6 years. A second new rim of outwash gravel is being added to the periphery of the push moraine. In May overthrusting was observed and measured. Two stadia levelling profiles were each surveyed twice and the movement of cairns was measured three times from base lines. A repeat of the 1960 low-level aerial survey, from which the 1:5000 map of the push moraine was produced, is in preparation for the 1967 summer.

(g) Electrical measurements in glacier ice (J. Paren, Cambridge University)

A series of field tests and experiments to study the relationship between glacier temperatures and the dielectric properties of snow and ice were carried out during the months of April and May in three profiles in the ablation area of the White Glacier. The aim of this investigation is to develop a technique of temperature measurement in glaciers by studying the relaxation spectrum with electrodes placed on the surface of the ice body.

(h) Glacier inventory study

As an official project in the Canadian programme for the I.H.D., an inventory is being made of the snow and ice masses of Axel Heiberg Island. A definitive classification has been produced which, together with the inventory techniques used, should provide a basis for similar studies in other areas. This systematic investigation into the problems of snow and ice inventories is closely connected with the efforts of the I.H.D. working group on this subject.

NORTHERN ELLESMERE ISLAND

(Defence Research Board: G. Hattersley-Smith)

The Defence Research Board operated Tanquary Camp from early April until early September. The field programme was directed by G. Hattersley-Smith of the Defence Research Board until the middle of May and by H. Serson of the Defence Research Telecommunications Establishment from mid-May until the end of the summer. In April logistic support was provided to S. Evans and G. de Q. Robin of the Scott Polar Research Institute, Cambridge University, for the test-flying of radio echo sounding equipment, the aerial arrangement for which was designed and installed by H. Serson. From mid-May until the end of the summer mass-balance studies were conducted on the Per Ardua Glacier by U. Embacher and T. Badenduck, both of McGill University, who also investigated the small ice cap, 8 km south-east of Tanquary Camp, and the ice-dammed Rollrock Lake. In June and early July snow cover and ablation measurements on the Ward Hunt Ice Shelf were made by H. Serson, assisted by J. Robinson of McGill University. In late August and early September a movement survey of the Per Ardua Glacier was carried out by K. C. Arnold of the Water Research Branch of the Department of Energy, Mines and Resources. Logistic support was provided by an RCAF C-130 aircraft for the initial airlift from Ottawa to Eureka, and subsequently by an "Otter" aircraft under commercial charter.

(a) Radio echo sounding

Between 10 and 20 April very-high-frequency radio echo equipment was successfully used to sound the depth of glacier ice, and provide a complete profile of the bedrock surface by continuous recording from the "Otter" aircraft. The same equipment had been used in Greenland in 1964 from a vehicle moving over the ice, but not from an aircraft. A number of flights covered some major glaciers and included several crossings of ice caps in areas of Ellesmere Island north of lat. 80°N. Measured depths ranged from 660 m in the deepest section of the Gilman Glacier to 40 m in the Ward Hunt Ice Shelf.

(b) Tanquary Fiord area

In the mass balance study of the Per Ardua Glacier, undertaken for the third year in succession, measurements were made at about 100 stakes spread over the whole glacier. More than 50 stakes were surveyed for movement, and the results are being analysed on a computer. An attempt to gauge the run-off at a weir in the melt stream from the glacier was frustrated by the large amount of sediment. A limited assessment of snow cover and ablation was also made

on the small ice cap, 8 km south-east of Tanquary Camp. Observations were made of drainage phenomena of the ice-dammed Rollrock Lake; the level of the lake was shown to have been lowered by about 25 m since the early spring 1965 and most of this lowering is believed to have taken place during a period from the end of July through August. The lowering continued after the onset of freezing weather and seepage resulted in Aufeis in the river bed about 12 m thick and 3 km long.

(c) North coast

Snow cover and ablation measurements were made at a total of 42 stakes, which have been standing on the Ward Hunt ice rise and adjoining ice shelf since 1960. A number of additional stakes were installed on the ice shelf for future measurements. Observations from the "Otter" aircraft in April showed that the M'Clintock and Ayles ice shelves had completely disintegrated since 1962. Oceanographic stations were taken in both these fiords and in Disraeli Fiord, the mouth of which is still completely blocked by ice shelf. Whereas Arctic Ocean water occurs from the surface downwards in M'Clintock and Ayles fiords, in Disraeli Fiord a 45-m layer of fresh water rests on the Arctic Ocean water.

INVESTIGATIONS OF THE ICE ENVIRONMENT BY CHEMICAL TESTS

(McGill University: M. Kahn)

This work was carried out in collaboration with various branches of the Department of Energy, Mines and Resources. The effect of the ice environment was investigated, for the first time in the Arctic, by carrying out chemical tests simultaneously within the ice and on the ice surface, along the lines of the work pioneered by G. Piccardi.

The tests were performed in 1965, on the Penny Ice Cap of Baffin Island, on the Meighen Ice Cap, and on the White Glacier, Axel Heiberg Island.

Preliminary results may be summarized as follows:

A very strong influence from the auroral and polar environment is confirmed, as theoretically anticipated, in spite of the minimal solar activity. Geomagnetic effects are substantiated.

The chemical tests carried out simultaneously inside an ice cave and at the glacier surface show completely different behaviour patterns. Considerable differences were found by P. Andrieux between the electrical conductivity of the ice in the Meighen Ice Cap and the White Glacier; the chemical tests inside the ice reflect a similar pattern and varations could, to some extent, be related. The rate of sedimentation of a colloidal precipitation was found to differ at the surface and inside the ice cave.

The staff of the Arctic Weather Station (Department of Transport) at Resolute Bay assisted this study by daily observations of experiments from February to May 1966.

AVALANCHE RESEARCH

(Photogrammetric Research Section, National Research Council: M. Van Wijk)

A joint project between the National Research Council and McGill University (M. Kahn) was undertaken in 1965 to study some physical and dynamical aspects of snow avalanches. Photogrammetric techniques were used to determine the snow volumes and velocities of the avalanche and to provide the maps of the slope before and after its descent. The investigations were carried out on an avalanche that was artificially released in Banff National Park.

The project was continued during the winter of 1966. Stereo-photographs were made of snow-covered slopes, using black-white, colour and false colour emulsions. Unfortunately, attempts to release an avalanche were unsuccessful due to unfavourable snow conditions at the selected site.

The photogrammetric operations have been completed and the results are presented in a N.R.C. report. A résumé of the experience gained from the project is in preparation.

Ice Pressures

Photogrammetric techniques were applied in a study of the forces that act on structures such as bridges as a result of ice cover movements. The results of this study were presented at a conference on ice pressures at Laval University, November 1966.

EXPERIMENTAL STUDIES

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

(a) Deformation behaviour of ice

Observations are continuing on the dependence of the failure process in ice on stress, time and temperature. Studies have been completed on the dependence of crack propagation on crystallographic orientation and on the time to formation of the first large cracks. Studies on the plastic behaviour of single and polycrystalline ice are being continued.

(b) Ice pressures

Results of a model study of the "static" force that ice covers can exert against a bridge pier, and of the movement of ice about a pier of the MacDonald-Cartier Bridge in Ottawa, were presented to the conference on ice pressures at Laval University.

(c) Avalanche research

A programme of research has been undertaken on the properties of avalanches and their dependence on the characteristics of the site. Several avalanche sites at Rogers Pass, B.C., have been chosen for this study. Correlations are being sought between the amount of snow brought to the valley bottom by avalanches, and the size of the accumulation zone, amount of snowfall and other factors. It is hoped that these studies will provide a basis for estimating the extent of danger from avalanches in areas where few if any records are available; and for estimating the maximum size of avalanche that might occur at a given site and the maximum amount of snow that may be brought down by them in one winter. Attention will be given also to snow profile and weather observations, to improving methods of estimating and predicting the avalanche hazard and to improving techniques of building in deep snow areas.

(d) Heat exchange at surfaces

Observations are being continued on the exchange of heat and moisture between the atmosphere and the surface of a bog near Ottawa, and between the atmosphere and other natural and man-made surfaces such as ice covers, lakes, rivers and roads.

(e) Ice-dusting

In 1961 a study of the use of dust to accelerate the melting of ice covers was undertaken. The literature available on the subject was reviewed and it was concluded that under some conditions dusting would accelerate the melting of ice but that field trials were required to establish its effectiveness. Small-scale dusting trials were performed at Ottawa in the spring-melt periods of 1962, 1963 and 1965. More extensive trials were conducted at Inuvik, N.W.T., in 1964 and 1965. Some small-scale tests were undertaken at Milne Inlet, Baffin Island in 1965. The results and conclusions from these field experiments will be published soon. The success of ice dusting varies from site to site, and from year to year at a site, depending upon the snowfall, ice cover and weather conditions. Under favourable conditions a significant acceleration of melt can be obtained.

Fritz Müller

DENMARK

GRØNLANDS GEOLOGISKE UNDERSØGELSE

In 1966 the Geological Survey of Greenland continued the preparation of geological maps: (a) regional maps at scales 1:500,000, 1:2,500,000 and 1:5,000,000; (b) survey map sheets at scale 1:100,000; (c) detailed maps of selected areas. In conjunction with this, investigations in Quaternary deposits and glacial geology were carried out. These were primarily concerned with establishing the earlier positions of the Inlandsis margin and the related rise and subsidence of the land mass. In addition, certain aspects of the nature and extent of permafrost were studied.

In addition to its work on mineral deposits, the Survey maintained close contact with a large number of institutions, both Danish and foreign: the Mineralogical-Geological Museum of København University, the Danish Atomic Energy Commission, the Geological Institute of Århus University; the universities of London (Imperial College), Edinburgh, Durham, Exeter and Lancaster, Portsmouth College of Technology (U.K.); Charles University, Prague (Czechoslovakia); Lausanne University (Switzerland); and the Geological Survey of Canada. Several foreign expeditions visited Greenland during the summer. Much of the work in Greenland forms not only part of the Survey mapping programme but also a contribution to various international research projects. For example, a study of water balance and permafrost has been started in connection with UNESCO's International Hydrological Decade.

(From the Survey's
"Report of activities, 1966",
Grønlands Geologiske Undersøgelse,
Rapport No. 11 København 1966.)

ITALY

VARIATIONS IN ITALIAN GLACIERS DURING 1966

141 glaciers were measured, 36 in the Western Alps, 93 in the Central Alps and 12 in the Eastern Alps. The table shows an increase in both retreating and advancing glaciers. A considerable drop was seen in glaciers under snow. There was still a large percentage of retreating glaciers (49%) although this figure is not so great as that of a few years ago when it fluctuated between 73% and 81%. There are no signs that the retreating phase is drawing to a close.

Variations in 1965 and 1966

	1965	1966
Retreating	63 (44%)	70 (49%)
Advancing	10 (7%)	21 (15%)
Uncertain	3 (2%)	12 (9%)
Stationary	16 (12%)	14 (10%)
Under snow	50 (35%)	24 (17%)
Total investigated	142	141

There follows a list of the glaciers investigated; numbers correspond to the Register of Italian Glaciers.

M. Vanni

Legend: + advancing, — retreating; stat. stationary; ? uncertain; +? advance uncertain; —? retreat uncertain; snow = under snow; = not measured.

WESTERN ALPS

Register Number	Hydrographical Basin	Glacier	Variations in m 1965	1966
Maritime Alps				
1	Stura (TO)	Clapier	—0.5	—2
2	,,	Peirabroc	stat.	—1.5
3	,,	Maledià	—0.7	—2
4	,,	Muraion	stat.	—1
5	,,	Ciafrajon	stat.	—1
6	,,	Gelas	snow	—1
Cottian Alps				
27	Dora Riparia	Galambrá	—4	stat.
29	,,	Agnello	—8	—2
32	,,	Bard	=	snow
Graian Alps				
34	Dora Riparia	Lamet	snow	snow
40	Stura di Lanzo	Bessanese	—4	stat.
43	,,	Ciamarella	—4	stat.
57	,,	Nel	—?	—?
61	,,	Della Capra	—2	—1
64	,,	Basei	snow	—15
112	Grande Eiva (Dora Baltea)	Tribolazione	—?	snow
111	,,	Gran Croux	—12	snow
130	Valsavaranche (Dora Baltea)	Gran Paradiso	—2.2	stat.
131	,,	di Moncorvé	—43.4	—6.6
132	,,	di Monciair	—18.1	—2.9
148	Valsavaranche (Dora Baltea)	Goletta	=	snow
155	Dora di Rhêmes	del Torrent	snow	—0.75
144	,,	di Lavassey	snow	—16
145	,,	del Fond	snow	—?
147	,,	Seches-Centelina	snow	—9.1
189	Dora di Vernei	Butor	stat.	+4
204	,,	Chavannes	—5	snow
(Mont Blanc)				
235	Dora de Firret	Pré de Bar	+5	+6
234	,,	Triolet	stat	+?
229	,,	Frebuzie	stat.	+?
226	,,	Grandes Torasses	+7	+?
225	,,	Planpinceux	stat.	+?
224	,,	Rochefort	stat.	+?
222	,,	Mont Frety	+?	+?
223	,,	Colle del Gigante	+?	+?
221	,,	Toula	stat.	+20

CENTRAL ALPS

Pennine Alps				
244	Buthier	Mont Gelé	+8	+5
259	,,	Tza de Tzan	—20	—13
259b	,,	Grandes Murailles	—18	—130
267	,,	Chavacour	—30	—?
266	,,	Balanselmo	—?	—?
272	Marmore	la Roisette	—3	—?
281	,,	Montabel	—5	—8
282	,,	Cherillon	snow	—1
284	,,	Tyndall	stat.	stat.
285	,,	Cervino	stat.	stat.
286	,,	della Forca	—10.6	stat.
289	,,	di Valtournanche	—7.5	stat.
290	,,	della Gran Sometta	snow	+?
297	Evançon	Grande Verra	—23	—5
298	,,	Piccolo Verra	snow	+6
299	,,	del Castore	snow	stat.
325	Anza (Toce)	Belvedere	—18	—10
324	,,	Nordend	—10	stat.
Lepontine Alps				
338	Diveria (Toce)	Aurona	snow	?
337	,,	Leone	—?	?
339	,,	Rebbio	—?	—?
340	,,	Taramona	—?	—?
341	,,	Mottiscia	—?	—?
342	,,	Boccareccio	stat.	—?
363	Scelp (Toce)	Basódino	stat	—?
361	Sabbione (Toce)	Siedel	—?	?
354	,,	Gemelli di Ban	snow	—10
355	,,	Costone	snow	snow
356	,,	Hohsand South	—50	—40
357	,,	Hohsand North	?	—?
360	,,	Blinden-horn	snow	snow

Register Number	Hydrographical Basin	Glacier	Variations in m 1965	1963
Rhaetian Alps				
365	Adda	Pizzo Ferret	—8	—6
371	,,	Sud Suretta	—3	—?
367	,,	Val Loga	snow	?
368	,,	Passo Zoccone	snow	—?
372	,,	Orsareigls	snow	—?
408	,,	Preda Rossa	snow	stat.
409	,,	Corna Rossa	snow	stat.
416	,,	Ventina	—90	—81
439	,,	Fellaria West	—10	—10
443	,,	Pizzo Scalino	=	—67
468	Viola (Adda)	Cordonnè East	—3	—15
469	,,	Cordonnè West	—1.5	—1
471	,,	Verva Maggiore	+1	stat.
473	,,	Dosdè East	—8	—46
483	Braulio (Adda)	Vitelli	—7	—14
503	Adda	Cedeh	=	—12.5
507	,,	Forni	=	—30.5
511	Gavia	Tresero	—6.7	—4.5
512	,,	Dosegù	+4	—2
516	,,	Sforzellina	—1.5	snow
517	,,	Lago Bianco	—19	+47
518	,,	Gavia	snow	snow
567	Serio	Trobio	snow	+17
566	,,	del Gleno	snow	?
549	Vernina (Adda)	Porola	snow	?
550	,,	di Scais	snow	—4
577	Narcanello	Tisgana West	—7	—19
581	Coleasca	Venezocolo	=	+7
583	,,	Centrale d'Avio	=	+23
604	Salarno	Salarno	=	—15
649	Sarca di Vallesinella	Vallesinella	snow	?
650	Sarca	Tuckett	snow	?
652	Brenta alta	Brentei	snow	?
653	,,	Sfulmini	snow	—2
655	,,	Crozzon	snow	snow
657	Lagol	Lagol	snow	—6
658	,,	Prafiori	snow	—2
659	Dalgone	XII Apostoli	snow	?
632	Sarca	Carè Alto	stat.	?
633	,,	Niscli	—4.7	?
634	,,	Lares	—2.6	—7
637	,,	Lobbia	+22	+3
639	,,	Mandron	—5.1	—4
640	,,	Nardis	—8.7	—8
644	,,	Amola	—16.7	—1.9
646	,,	Cornisello	—23	—?
678	,,	Presanella	stat.	—0.3
699	Noce (Adige)	La Mare	—8	—11
700	,,	Marmotte	snow	snow
701	,,	Caresér	+13	stat.
702	,,	Cavaion	snow	snow
729	Plima	Vedretta Ultima	=	—4.5
731	,,	Forcola	=	—22
732	,,	Cevedale	=	—11
733	,,	Vedretta Lunga	=	—14.5
762	,,	di Solda	=	—11
777	Adige	Vallelunga	—5	—7
779	,,	Barbadorso di fuori	snow	snow
780	,,	Fontana	snow	—4.5
794	,,	Saldura South	snow	+10
795	Adige (Saldura)	Ramudla North	snow	+3
813	Senales (Adige)	Giogo Alto	—1	—4.5

EASTERN ALPS

Dolomites				
937	Adige	Cristallo	—0.4	snow
963	Piave	Cresta Bianca	snow	snow
973	,,	Sorapis East	snow	snow
974	,,	Sorapis Central	snow	snow
975	,,	Sorapis West	—0.7	snow
Julian Alps				
985	Tagliamento	Canin West	snow	snow
984	,,	Canin East	snow	snow
979	,,	Montasio circo minore	snow	snow
980	,,	Montasio East	snow	snow
981	,,	Montasio West	snow	snow
Livignasco				
996	Inn (Spöl)	Val Nera West	—2	—1
997	,,	di Campo	—1	+6

NETHERLANDS

1966 ARCHAEOLOGICAL RESEARCH FOUNDATION EXPEDITION TO MT. ARARAT, EASTERN TURKEY

During this American archaeological expedition N. A. van Arkel, of the Mathematisch Institut der Rijksuniversiteit te Leiden made glaciological observations on Mt. Ararat (Büyük Agri Dag), which he had previously visited in 1964. During July and early August 1966 a theodolite survey was made of the ice cover of the volcano itself, and photographs were taken from some of the theodolite stations. A map has been prepared at a scale of 1:5400, and this and a report containing numerous photographs have been deposited with the Glaciological Society. Apart from a general description of the 12 km^2 ice cap on and near the summit of Mt. Ararat, there is a more detailed description of the distributary glacier in the Cehennem Dere or Ahora valley. This glacier has been observed since 1840 when, following a disastrous outflow of mud consequent upon an earthquake, the Austrian geologist Abich made an investigation and reported the position of the snout of this glacier. The snout of the glacier appears not to have retreated much since Abich's time, though the thickness of the glacier near the snout seems to have decreased.

NEW ZEALAND

ANTARCTIC GLACIOLOGICAL PROGRAMME 1965-66-67

Following the measuring of strain triangles on the McMurdo Ice Shelf in the summer of 1965-66, strain rates have been calculated. The maximum compression and extension rates have been calculated, and as a check against the method used, additional strain lines have been set out in the 1966-67 summer. Ten-metre density profiles were made at each strain station as well as annual accumulation measurements. Preliminary examination of the data suggests little direct relationship between the orientation of maximum compression and absolute speed of movement and direction. Although a variation in average density has been found again, this does not clearly relate to the variation in compression rates. Further resection stations are being set out during the 1966-67 summer.

Certain areas on the boundary of the McMurdo Ice Shelf have been found to have had the wet "brine layer" squeezed out. Density profiles are extremely high. Further work will be done across the transition zone between the "wet brine" and "dry brine" areas.

Sub-surface melting in the clear ice ablation area was further investigated, and assistance was given to the U.S. Navy in siting a wheeled runway along the edge of this area.

A. J. Heine

NORWAY

NORGES VASSDRAGS- OG ELEKTRISITETSVESEN

Glacier mass balance studies are an integral part of the hydrological investigations for the planning of a future hydro-electric power plant near the Jostedalsbreen ice cap in south-western Norway. Until now the glaciological work has been concentrated on Nigardsbreen, a map of which was published by the Hydrology Division of the Norwegian Water Resources and Electricity Board in 1965. To increase the representativeness of the mass balance data, some supplementary measurements were necessary on Tunsbergdalsbreen, and this involved the construction of a new glacier map on an appropriate scale. The International Symposium on Glacier Mapping held in Ottawa 1965 recommended a scale of 1:10,000 and contour intervals of 10 m for glacier maps. Because of the size of Tunsbergdalsbreen this scale would result in a map almost 2 metres long, and therefore a scale of 1:20,000 and 20 m contour intervals was selected, i.e. the same as for the previously published map of Nigardsbreen. The new map overlaps the latter in the firn area near the highest point of the ice cap (Høgste Breakulen).

The new glacier map was constructed in 1964 in a Wild B-8 Stereoplotter by Widerøes Flyveselskap A/S from vertical aerial photographs taken 2 September 1964 for the upper part of the glacier, and in 1955 for the tongue below 1300 m. This combination was necessary because of the incomplete coverage of the 1964 photographs. No great difficulties in contour construction occured in the transition zone between the two sets of stereomodels. Only very small glacier changes, therefore, seem to have taken place in the 1300-1400 m interval during the years 1955-1964.

A new aerial photographic survey was flown in 1966 and a completely new set of topographic maps is planned for the whole area. This makes possible future studies of the variation of Tunsbergdalsbreen from 1937, the year when W. Pillewitzer made the first terrestial photogrammetric map of the lower part of the glacier.

Contours are drawn as accurately as possible

on all glacier-covered surfaces but in areas that were not included in the 1964 photographs the glaciers are shown on the map as white surfaces only. The height determinations are believed to be accurate to within 3 m, in general, for relative height differences within the map area, and to 10 m for absolute elevation. The accuracy is best in the areas covered by the 1964 photography due to the high quality and larger scale of the photographs.

UTM-coordinates are marked for every 5000 metres; the geographical latitude and longitude are indicated along the margin. Borders between various drainage basins are drawn for hydrological purposes. Large crevasses and crevassed areas are sketched from the aerial photographs, but moulins and minor surface details are not marked on the map.

Enquiries should be addressed to the Hydrology Division, Norwegian Water Resources and Electricity Board, P.O. Box 5091 Mj., Oslo 3, Norway.

J. Otnes
G. Østrem

SWEDEN

STOCKHOLM UNIVERSITY SVALBARD EXPEDITION 1966

During the last few years there have been vivid discussions between Scandinavian biologists and earth scientists about the possible existence, during the entire Würm period, of ice-free areas along the western and northern coasts of Norway, large enough and warm enough to support a fairly high flora and fauna. Most biologists believe in their existence because of the present distribution of various plants and insects: most glacial-morphological phenomena (tills, striae, erratics, &c.) support the idea of a more complete ice cover. Some glaciologists and glacial morphologists now want to go a step further: they do not any longer accept as the final truth the old concept of separate ice sheets over Scandinavia, the British Isles and Spitsbergen but are looking for possible evidence of one single ice sheet in north-west Europe.

Three small expeditions from the Department of Physical Geography (Stockholm University) first studied glacial-morphological features, raised beaches and lake sediments on the Shetlands Islands (1964), and on Björnöya (1965) and Hopen (1965), two small and isolated islands in the Barents Sea.

During July and August 1966 a larger expedition (in total 28 men) operated from the old IGY base Kinnvika at Murchisonfjorden in the north-western corner of Nordaustlandet (Northeast Land). The expedition worked in close cooperation with Norsk Polarinstitutt, which took care of all transportation of personnel and supplies between Longyearbyen and Kinnvika and also laid out some fuel depots. Three Swedish Army helicopters (with civilian registration) were put at the expedition's disposal, and they made it possible for the field parties to cover a very large area.

Four field parties were responsible for most of the field work:

1) The northern party (under Weston Blake, Jr.) —glacial morphology and raised beaches;
2) The southern party (under Bo Strömberg in July and Peder Knape in August) — same programme;
3) The lake party (under Hannu Hyvärinen) — investigations of sediment cores from lakes between the present sea level and the highest marine limit;
4) The ice sheet party (under Erkki Palosuo) — continuation of crystallographic ice studies on Vestfonna, started in 1958.

Blake's group covered all the north coast of Nordaustlandet, Sjuöyane (the Seven Islands) included, as well as Rijpdalen and the Murchisonfjorden area. The southern party worked for two weeks on Kong Karls Land and during the rest of the time along the shores of Hinlopenstretet and of Wijdefjorden. Samples of drift wood, whale bones and shells were collected from various levels above present sea level, and a great number of these samples are now being ^{14}C dated. Some dates have already been obtained and an interesting example is offered by an easily identified beach, 6500-7000 radiocarbon years old, which is found at 5 m elevation at the northern end of Hinlopenstretet and at about 30 m at its southern end.

A few observations of the extent of the present glaciers were made. The front of S. Franklinbreen had receded a few hundred metres since 1957 and looked more like it did in 1938. Three of the accumulation/ablation stakes from 1957 (in a profile SE of Celsiusberget) were found and remeasured by Erkki Palosuo. The net loss between 14 August 1957 and 4 August 1966 was:

Elevation	Net ablation 1957-66
405 m	230 cm
415 m	156 cm
445 m	5 cm

A set of thermistors at Stake O (Geogr. Annaler, 1964: 3, page 275) at 314 m a.s.l. had partly melted out and showed a net ablation of more than 6 m but less than 8 m since 8 July 1958. Our previous conclusion, founded upon observations in 1957 and 1958, that the equilibrium line on Vestfonna inside Murchisonfjorden lies at about 450 m a.s.l. certainly agrees very well with the above observation of 5 cm net loss at 445 m over the last 9 years.

V. Schytt

SWITZERLAND

ABTEILUNG FÜR HYDROLOGIE & GLAZIOLOGIE DER VERSUCHSANSTALT FÜR WASSERBAU UND ERDBAU (VAWE, Direktor Prof. G. Schnitter) AN DER EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE.

ALETSCHGLETSCHER
(with support by Gletscherkommission der S.N.G.)

Mass budget and surface velocity observations continued as usual. Special attention was again given to methodical studies for measuring large amounts of accumulation.

Much time has been devoted to analysing the data collected in 1965 during the detailed ablation and heat balance studies at 2200 m a.s.l. (Ice No. 20). A 16 mm movie film of the field work has been edited.

CONSULTING PROJECTS ON VARIOUS GLACIERS

Budget studies for hydro projects were continued in the following areas:

1. Gries/Blinnenhorn (Ct. Valais): Probability of glacier advance within the next decades.
2. Limmern (Ct. Glarus).
3. Mattmark (Ct. Valais).
4. Silvretta (Ct. Grisons).

The studies of the snout of the Allalingletscher (Ct. Valais) were continued and advice on the danger of further ice avalanches was given throughout the year to the engineering firm supervising the construction of the Mattmark dam.

An extensive programme has been started to study the glaciers around the lac de Mauvoisin in the val de Bagnes (Ct. Valais) in view of potential dangers of ice avalanches into the lake.

At the Griesgletscher (see above) the snout became submerged for the first time in the new artificial lake after the dam was finished during the summer. A special study has been carried out on the wastage of ice in the lake as well as on water waves caused by the calving glacier.

PILOT STUDY ON THE FLUCTUATIONS OF GLACIERS
(jointly with Gletscherkommission der S.N.G.)

The study has been conducted with a view to the creation of a permanent service at the suggestion of the International Commission of Snow and Ice (IASH) for FAGS with a grant from UNESCO. It is at the same time a continuation on an extended basis of the International Reports on the Variations of Glaciers 1894/95 — 1958/59 (Nos. 1-65) and includes a collection of measured data for the years 1959/60 — 1964/65 (Nos. 66-71) with addenda from earlier years. Copies of a manuscript were submitted to FAGS and UNESCO in December 1966.

P. Kasser
H. Röthlisberger

UNITED KINGDOM

THE BREIDAMERKURJÖKULL PROJECT: UNIVERSITY OF GLASGOW

During the summer of 1966 ten weeks were spent working near Breidamerkurjökull, south-east Iceland. The 1:15,000 photogrammetric maps of the area of study based on aerial photography taken in 1965 were completed by R. Welch and P. Howarth during the winter of 1965/66 and were used as base maps during the summer of 1966. The main efforts during the summer of 1966 were directed to the study of geomorphological problems. Morphological and stratigraphical mapping of the proglacial area was completed and over 4,000 observations of the orientation of the long axes of pebbles in the ground moraine and moraine ridges were made. Large scale maps (1:4,000) of eskers emerging at the ice front were constructed.

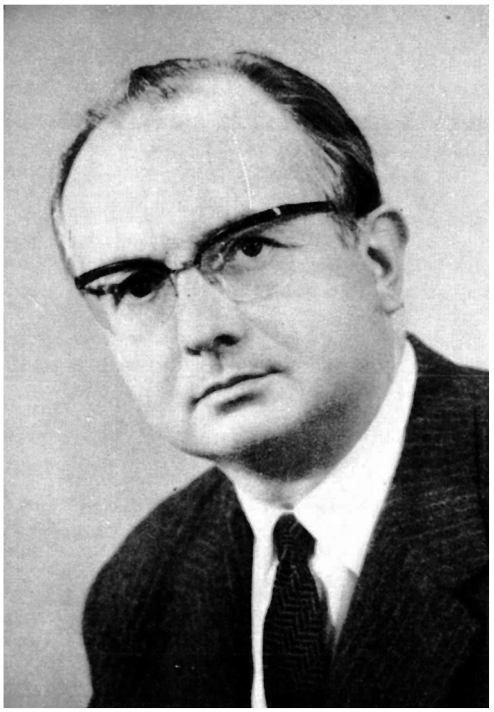
In two localities near the ice margin rates of movement of the ice and ablation were measured over a period of eight weeks. The depths of three large proglacial lakes were determined by means of a battery operated echo sounder carried in a rubber boat. Additional ground control for aerial photography taken in 1965 was established and all points on the proglacial area which were used as ground control were permanently marked with cement blocks. The reflectance values of surface materials were measured for the purpose of evaluating for photo-interpretation purposes the various types of photography (panchromatic, colour, false colour and infra-red) taken in 1965.

Two seasons of field work have now been completed on this project. The data obtained are now being analysed and will be published in the near future. The photogrammetric maps produced by Welch and Howarth and based on photography taken in 1945 and 1965 will enable the amount of ice wastage to be calculated and the changes in the proglacial drainage and land forms to be studied over the 20-year period.

R. J. Price

BRITISH ANTARCTIC SURVEY

Dr. Charles Swithinbank returned to the Scott Polar Research Institute in March after a successful season of radio echo sounding with the British Antarctic Survey. The apparatus was fitted in an "Otter" and a "Porter" aircraft which flew a total of 75 hours from a base on Adelaide Island. Continuous ice depth profiles were obtained across Larsen, Wordie, and George VI Sound ice shelves, where ice depths were found to reach 600 metres. Land glaciers were successfully sounded only south of latitude 71°S.



LOUIS LLIBOUTRY

Louis Lliboutry was born in Madrid in 1922. His father was at the time a representative in Spain of a French metallurgical company, and so Louis Lliboutry learned to speak both Spanish and French and went to school at the French Lycée in Madrid. His ancestry, however, is neither French nor Spanish but Catalan — his father came from Perpignan in French Catalonia, and his surname is Catalan in origin — though he has by now given up trying to persuade people to pronounce it corectly since, although most of us know how to pronounce Chantilly, we are unused to a double-l pronounced y at the beginning of a word.

The Spanish civil war brought to an end his time in Spain—the family escaped though losing their villa and all their possessions — and he continued his studies in France at Perpignan and Paris during the German occupation, making the most of some bad health to remain at the Ecole Normale Supérieure, where he studied physics, chemistry and mathematics, and acting as an ambulance man during the liberation of Paris.

In 1945 he went to the University of Grenoble to study for his doctorate under Professor Néel in one of the outstanding departments of physics in France. His work there concerned the action of outside influences on ferromagnetism. This work continued for five years, during which time he also did a lot of ski-ing and mountaineering, including several first ascents in ski-mountaineering. This no doubt helped to fuse together the two main influences on his subsequent career—physical sciences and glaciology, so that when he obtained his doctorate in 1950, he soon became attracted to the idea of doing some glaciological research, and when the opportunity to go as a Professor to the University of Santiago in Chile presented itself, he accepted and hoped to see something of glaciers and snow in the Andes.

From 1951 to 1956 Lliboutry was in Chile, and took part in the French expedition which first climbed Mt. Fitz-Roy in Patagonia. During this expedition he made a triangulation survey of the peaks and prepared a geological map of the region. This was followed by a series of expeditions into the Andes during which he made numerous glaciological observations and corrected the existing maps, which, being based on aerial photographs taken in winter, had no glaciers shown on them. It was in this period that he taught himself glaciology in the field and made his notable contributions to the theory of the origin of "penitentes" and the nature of accumulation by refreezing. He also studied the various periglacial forms associated with ground ice.

During a period of leave in France in 1954 he married his petite wife, who, although she came from Grenoble, was a pianist and not a mountaineer. From this date he gave up mountaineering as a sport, acquired two sons (1955 and 1957) and gained 12 kg.!

On his return to Chile he started work on his book "Nieves y glaciares de Chile", which not only described the Chilean glaciers in considerable detail, but also included a general introduction to glaciology more comprehensive and up-to-date than any other available at that time.

In 1957 Louis Lliboutry returned to France with his reputation as a glaciologist already secure, and he joined the physics department at his old university of Grenoble. Here he took over the physics course given to biologists, geologists and medical students, which he has taught ever since. His book "Physique de base pour biologistes, médecins, géologues" based on these lectures was published in 1960 and the eminent French physicist L. Leprince-Ringuet contributed a preface paying tribute to the value of Lliboutry's work in bringing a clear understanding of physical principles at this level. This book is now in its second edition.

At Grenoble, Lliboutry had to build up his glaciological research slowly, as facilities and money became available. To begin with, all that he had was the hut used by the cosmic ray group on the Aiguille du Midi, and here, with no other technical assistance, he and W. Keeler began the work on the glaciers of the Mont Blanc massif and also the studies on the Glacier de Saint-Sorlin, that have continued ever since.

In 1959 Lliboutry was granted the title of Professor in the Faculty of Sciences, and authorized to start a geophysical laboratory with about 25 students, and in 1961 space was allocated for this in a 17th century palace in the rue Très-Cloîtres at Grenoble, and a field station was built in the Chamonix valley by C.N.R.S. From this the work has grown steadily despite two severe blows — the death in a road accident of d'Andriesens who had succeeded Keeler, and of R. Vivet in a climbing accident while training for a guide's diploma. In 1964 the laboratory on the Aiguille du Midi was renamed the "Laboratoire de Glaciologie Alpine", and now has a staff of 24 including 6 research students.

During this period Lliboutry used most of his spare time in preparing his two-volume "Traité de Glaciologie" which sprang originally from the early chapters of "Nieves y glaciares de Chile". However, as he worked on it, the size of the enterprise mounted, both because he realised that a proper treatise on glaciology must include so many different topics, and also because so much work was being done in each of these topics. At times it must have semed as if the rate at which new work was coming out would overtake him in his task, but by cutting out tourist travels, ski-ing and other social activities, he achieved his aim and finally got the second volume to the printers in 1965.

As well as directing the build-up of research and preparing this vast book, Lliboutry has still managed to continue his original research — indeed the compiling of his book has drawn his attention to many places where such research is needed. Among his most notable interests in this period has been his work on the bottom conditions of glaciers and ice sheets and the effect of water on the flow of glaciers. He has not only studied this via field work and theoretical studies, but also planned a large-scale laboratory experiment, the "viscomètre à glace", which is now beginning to produce experimental results.

Lliboutry's approach to glaciology, like that of many others in earlier times, has been an individual one, and in many ways lonely. His devotion to his subject and the command he has acquired over its many aspects have been achieved often in the face of opposition not only from other physicists (who do not always see glaciology as a proper study for a physicist) but also from other glaciologists, for Lliboutry is a man of single-minded purpose, and such men always get involved in controversy and struggle. Out of these difficulties have now emerged not only a glaciologist of unusual breadth, but also a centre of glaciological research, bringing together studies in laboratory and field glaciology, that has already achieved much and holds great promise for the future.

MEETINGS

THE GLACIOLOGICAL SOCIETY

BRITAIN

24 February 1967, Cambridge University:
S. J. Jones—Deformation of ice single crystals at low temperatures.

27 February 1967, Cambridge University and

28 February Geology Department, Birmingham University

(Joint meeting with the Lapworth Society):

R. J. Price — Landforms and deposits on Breidamerkurjökull, Iceland.

NATIONAL RESEARCH COUNCIL DIVISION OF BUILDING RESEARCH

The forces that ice can exert against structures was the topic of a Conference sponsored by the Snow and Ice Subcommittee of the Associate Committee on Geotechnical Research, National Research Council of Canada. The Conference was held on 10 and 11 November 1966 at Laval University, Quebec City, Quebec, in conjunction with a one-day Workshop Seminar on "Ice formation on lakes and rivers". The Workshop Seminar, held on 9 November, was sponsored by the Canadian National Committee for the International Hydrological Decade.

The papers presented to the Conference contained information on the properties of ice, the current practice in the design of structures with respect to forces due to ice, and on the behaviour of ice about structures. Three papers that reviewed the strength and plastic properties of ice were presented on the morning of the first day. These included a very complete review by W. Weeks and A. Assur, U.S. Army C.R.R.E.L., on the properties of sea ice. The remainder of the Conference was primarily devoted to presentations on the action of ice on structures.

Three papers were presented that respectively discussed current design practice with respect to ice for extended structures such as dams, isolated structures such as piers, and control structures such as ice booms. Papers were presented on the consideration given to ice pressures in the design of the Northumberland Strait Crossing to be constructed between New Brunswick and Prince Edward Island, and on the boom constructed to control ice formation and water level in and above the Harbour of Montreal. A particularly interesting paper was presented by H. Peyton, University of Alaska, on the effect of ice on off-shore platforms used for oil drilling operations in Cook Inlet. The remaining papers presented information on the vertical forces exerted by ice on structures due to a change in water level, forces exerted by ice on sloping structures, results of a model study of the forces that ice can exert against piles, field observations of the movement of ice about a bridge pier, and the strength properties of ice sheets. The final paper briefly described services available from the Canadian Meterological Service for providing weather and ice information necessary for ice pressure calculations.

Three papers were presented to the Seminar on "Ice formation on lakes and rivers" as a basis for discussion. The first summarized information on the formation, evolution and break-up of ice covers on lakes. The second was concerned with the evolution of ice covers on fast-flowing streams. The final paper in this series discussed factors that control the break-up of ice covers on rivers.

The papers and discussion presented to the Conference and to the Seminar are to be published within one proceedings. This proceedings will provide a useful summary of what is now known in Canada about pressures due to ice, about the ice covers responsible for these pressures and the conditions to which the covers are subject. It is hoped that the proceedings will provide a useful starting point and give direction to the field and laboratory studies that are still required to provide the information on ice necessary for engineering purposes.

It is expected that the proceedings will be printed in the summer of 1967. It can be obtained at that time by writing to The Secretary, Associate Committee on Geotechnical Research, National Research Council of Canada, Ottawa 7, Ontario.

L. W. Gold

FUTURE MEETINGS

THE GLACIOLOGICAL SOCIETY

ANNUAL GENERAL MEETING 4 & 5 MAY 1967

The 1967 Annual General Meeting will take place in Churchill College, Cambridge, England, on 4 and 5 May. The Programme is as follows:

Thursday 4 May, 5 p.m. — Business meeting, with election of new Council members.

7.30 p.m. — Dinner (Tickets price 28s./$4.00)

Friday 5 May, 9.15 a.m.-12.45 p.m.:

M. M. Prebble (New Zealand) — Aspects of New Zealand research into the McMurdo Oasis, Antarctica.

P. Barnes (U.K.) —

S. Baranowski (Poland) — Glacier deformation caused by a superimposed load of limited extent (shown by observations on a medial moraine on Werenskiold Glacier, south-west Spitsbergen).

D. Ragan (U.S.A.) — Structures at the base of an ice fall.

C. W. M. Swithinbank (U.K.) — Airborne glacier sounding in the Antarctic Peninsula area.

J. T. Hollin (U.K.) — Sea level evidence for and against Antarctic ice surges.

J. W. Glen (U.K.) — Recent work on point defects and electrical properties of ice.

1 p.m. — Lunch. (Tickets price 14s./$2.00)

2.15-5.15 p.m.:

J. F. Nye (U.K.) — New thoughts on glacial erosion.

H. C. Hoinkes (Austria) — International Hydrological Decade: glaciological programmes.
(We hope that speakers from Sweden, Canada, Switzerland and the U.S.A. will be present to speak on the same topic.)

Tickets for the Dinner on 4 May and for lunch on the 5th may be obtained from the Secretary of the Glaciological Society, c/o Scott Polar Research Institute, Lensfield Road, Cambridge, England. Last date for booking: **29 APRIL.**

INTERNATIONAL UNION FOR QUATERNARY RESEARCH (INQUA)

The VII Congress of INQUA will take place in Paris, France, from 30 August - 5 September 1969, under the patronage of the Academy of Science. Excursions will take place before and after the Congress. Details will be published in Ice. The First Circular may be obtained from the Secretary General, Prof. Henri Elhai, Faculty of Arts and Social Science, Rouen, France.

GLACIER SIGHTSEEING TOUR IN NORWAY,

26 AUGUST - 4 SEPTEMBER 1967

Primarily for participants in the Glaciological Training Course in Swedish Lapland (see page 21), a tour of glaciers is being arranged in co-operation with the Norwegian Committee for the International Hydrological Decade. Glaciologists who are not participating in the Training Course may join the Tour in Narvik (train, 'bus and domestic air connexions), or in Måloy, north of Bergen (international airport in Bergen) on the 29 August. The Tour will begin in Narvik on Saturday morning, 26 August, and finish in Oslo with visits to institutions dealing with glaciology and hydrology on Monday, 4 September.

The programme for the Tour includes boat and 'bus travel through glacierized areas and visits (by 'bus and/or by walking) to glaciers in various climatological regions in southern Norway. The current mass balance investigations on glaciers associated with hydro-electric power plants will be demonstrated. A representative I.H.D. basin will be visited and the various installations demonstrated by the Norwegian chief hydrologist, Dr. J. Otnes. Glacier variations and ice-cored moraines will be discussed and an attempt made to visit a key area in eastern Jotunheimen.

The cost of the Tour will be approximately $175.00 U.S. The final price will depend on the number of participants, which is limited to one small 'bus load. Applications should be sent to: The Secretary, International Hydrological Decade Committee, P.O. Box 5091 Mj., Oslo 3, Norway.

Last date for applications: 1 May 1967.

Gunnar Østrem

COMMISSION OF SNOW AND ICE

(Int. Association of Scientific Hydrology of the Int. Union of Geodesy and Geophysics)

GLACIOLOGICAL TRAINING COURSE IN KEBNEKAISE, SWEDISH LAPLAND

8-25 AUGUST 1967

A training course dealing with glacier mass budget, heat budget and run-off will be given at the Tarfala glaciological station in August 1967. The course will be organized by the Department of Physical Geography, University of Stockholm, and financially supported by UNESCO and the Swedish Natural Science Research Council. The course is planned as a part of the training programme of the International Hydrological Decade and its main purpose is to train the participants for glaciological and hydrological research in high mountains. The course will also be of interest to those concerned with studying the hydrology of snowy catchment areas. The course will be open to participants from all countries, the instruction will be given in English and participants must have some previous university training in glaciology, meteorology and hydrology as well as some practical field experience.

A. Glacier mass budget

The main object of the training is to make the participants familiar with the various methods which can be used in the study of glacier mass budget. The formation of a glacier, the recrystallization of snow and firn into ice, the physical properties of ice, the glacier movement, the response of glaciers to climatic changes and similar problems will be dealt with in evening lectures.

For each group five days will be devoted to actual observations on the glacier. Accumulation measurements, as they are normally carried out at the end of the accumulation season, will be demonstrated to the participants. This demonstration will include: i) stake measurements; ii) snow depth measurements by probing with a steel or aluminium rod; iii) core drilling to the summer surface; and iv) pit digging. Under iv) stratigraphic studies will be made and densities will be measured with horizontal and vertical snow samplers as well as by the "cube method". All participants will carry out a rather extensive programme on their own in order to practise the different methods.

Ablation will be studied on both ice and snow surfaces. Ice ablation is easily studied by means of stakes drilled down deep enough in the ice. Ablation of a snow layer is more difficult to measure, especially where short-term observations are concerned. Stakes will of course be used and the readings corrected for density changes in that part of the snow cover in which the stake is planted. Isotopic methods will be used for short-term measurements of water content variations which will be correlated with observations of heat exchange.

Methods used for studies of snow and ice temperatures, ice movement, and surface profile variations will be demonstrated.

B. Heat budget

Two meteorological stations will be established on the glacier, one in the ablation area and one in the accumulation area. Radiation balance as well as incoming and reflected short wave radiation will be recorded at both sites and all radiation instruments repeatedly calibrated. Recordings will also be made of air temperature, humidity and wind velocity in one standard level at both stations. Studies of turbulent heat transfer are planned, to be carried out during certain periods every day.

During a number of lectures and seminars the theoretical background to the different observations will be discussed as well as the instruments and their calibration. Observations made on the glacier will be used to estimate its heat budget for each day of the course.

C. Run-off studies

The catchment area of the Tarfala river above the hydrological station is 23 km^2, with just over 6 km^2 of glaciers. At the normal gauging site the river is very turbulent with several falls and rapids; higher up the valley, places can be found with slow, laminar flow. In turbulent water the discharge will be measured by the salt dilution method using a conductivity meter; where the flow is laminar the velocity distribution over a cross-section will be studied with current meters. Recording gauges will be operated continuously at three or more sites along the river, and the shape of the discharge curves will be established.

Silt samples will be taken in the river at intervals depending upon rate of water discharge, but at least twice a day. Most samples will have to be processed in Stockholm, but if the silt content of the river is high, certain samples will be filtered, dried and weighed at the Station.

Since the precipitation in the area is strongly influenced by the rugged topography (station at 1130 m a.s.l. and surrounding mountains up to 1700-2100 m) regular precipitation observations will be made at approximately 10 places over the catchment area.

Staff

The Director of the Tarfala glaciological station, Dr. Valter Schytt, will be in charge of the course. The following people have agreed to act as instructors: A. Mass budget — Dr. Valter Schytt, Dr. Gunnar Østrem, Mr. Wibjörn Karlén; B. Heat Budget — Dr. Gösta Liljequist, Mr. Björn Holmgren, Mr. Lars Dahlgren; C. Run-off — Dr. Valter Schytt, Dr. Gunnar Østrem, Mr. Wibjörn Karlén, Dr. Erik Eriksson; A and B — Mr. Åke Fleetwood.

Dates

Participants will travel by bus, boat and helicopter from Kiruna to Tarfala on 8 August and return to Kiruna on 25 August.

Location, accommodation and access

The Tarfala station is situated in a rather arctic environment, at 1130 m a.s.l., 68° N. latitude, 80 km west of Kiruna (with airport and railway). Mean air temperature for August is +5°C. The tree line is situated at 700 m a.s.l.

The station has 35 beds, **which limits the number of participants to a maximum of 25.** There are 2-bed, 4-bed and 8-bed rooms and, as the station will be very crowded during the course, tents will have to be used by the station personnel. The personal comfort will, however, be much better than one normally expects during glaciological field work.

Kiruna can be reached by train (21 hours from Stockholm) and by 'plane. Participants can obtain railway tickets at 50 per cent of the ordinary price if ordered in advance. II class rail tickets will then be 106 Sw.Kr. and I class 159 Sw.Kr. for the return trip Stockholm-Kiruna. Sleepers cost extra 19 Kr. II class and 29 Kr I class for one way. The return air ticket Stockholm-Kiruna is 460 Sw.Kr. One U.S. dollar is 5.18 Swedish Kronor.

The charge for the course and the accommodation at Tarfala cannot be fixed yet, but it is believed that enough funds can be raised from UNESCO and the Swedish Natural Science Council to make the course free or at a very nominal charge. It is possible that participants from developing countries may be able to receive travel grants from the UNESCO IHD-Secretariat.

Applications

Applications, with all information about previous experience and academic training, should be sent to: Dr. V. Schytt, Department of Physical Geography, Drottninggatan 120, Stockholm Va., Sweden. They should arrive in Stockholm not later than 1 May 1967. Applications for UNESCO travel grants to participants from developing countries should be sent to: Dr. J. da Costa, Natural Resources Research Division, Department of Advancement of Science, UNESCO, Place de Fontenoy, Paris 7e, France. These should not be sent until the applicant has been admitted to the course.

W. H. Ward
Secretary,
Commission of Snow and Ice.

XIVth I.U.G.G. GENERAL ASSEMBLY — SWITZERLAND

24 SEPTEMBER - 7 OCTOBER 1967

The Second Circular has not yet been published. Details from the Circular and from the programme of the Commission of Snow and Ice will be published in the August issue of Ice. Members who wish to have earlier notice of the IUGG Assembly details may write to the Secretary General of the Assembly, V. C. Bossart, Victor Bossart & Associates, Neustadtgasse 7, 8001 Zürich, Switzerland.

NEWS

NEW RESEARCH CENTER

The University of Washington announced recently that a new interdisciplinary Research Center in Pleistocene geology and glaciology had been established. Dr. A. L. Washburn has joined the University as Professor of Geology and will help to set up the Center and to coordinate an interdepartmental series of courses in the field. The departments concerned are: Geology, Oceanography, Atmospheric Sciences, College of Forestry. Further news of the Center will be given in future issues of Ice.

AWARDS

Recent awards include:

Académie des Sciences, France
—Delalande-Guerineau 1966 Prize to Claude Lorius, in recognition of his work on 8 expeditions to Greenland and Antarctica.

U.S. Department of State.
—Superior Honor Award to Paul A. Siple, in recognition of superior service and exceptional dedication to duty as Scientific Attaché in Canberra, Australia, from July 1963-September 1966.
Dr. Siple has now rejoined the Army's Chief of Research and Development after a painful illness, and we wish him a speedy recovery.

National Geographic Society, U.S.A.
—Franklin L. Burr Prize to Maynard M. Miller in recognition of his contributions to science through his leadership of four Alaskan Commemorative Glacier Projects and for his service as deputy leader of the Mount Kennedy Survey Expedition and glaciologist on the Mount Everest Expedition. (The Prize, which includes a gift of $1,500, is awarded annually to a member or members of expeditions sent out by the National Geographic Society.)

THE SOCIETY'S LIBRARY

WORKS RECEIVED FOR THE SOCIETY'S LIBRARY SINCE OCTOBER 1966

We thank the following authors or donors of papers and pamphlets, and regret that it is impossible to acknowledge them individually. The glaciological works, with their complete references, will be listed in the "Glaciological Literature" at the end of the Journal of Glaciology and bound in the Society's collection of glaciological papers.

Ambach, W. (3 items)
Andrews, J. T. (2 items)
Bauer, A.
Bellair, P. (3 items)
Benson, C.
Brown, R. J. E. (2 items)
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Miller, M. M. (3 items)
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Post, A.
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Robin, G. de Q.
Rudberg, S.
Worsley, P. (2 items)

Académie de la République Socialiste de Roumaine.
American Association for the Advancement of Science.
Arktisk Institut, Denmark.

Association Internationale d'Hydrologie Scientifique (4 items).
Antarctic Division, Department of External Affairs, Melbourne, Australia.
Australian National Antarctic Research Expeditions (2 items).
Cold Regions Research and Engineering Laboratory, U.S. Army (11 items).
Comissione Italiana del Comitato Internazionale di Geofisica (8 items).
Division of Building Research, Canada (3 items).
Eidg. Institut für Schnee- und Lawinenforschung, Weissfluhjoch, Davos, Switzerland.
Hydrographischen Zentralburo im Bundesministerium für Land- und Forstwirtschaft, Vienna, Austria (2 items).
Institute of Low Temperature Science, Hokkaido University, Japan (2 items).
Institute of Polar Studies, Ohio State University (3 items).
McGill Sub-Arctic Research Laboratory, Montreal, Canada.
National Research Council, Ottawa, Canada (3 items).
National Science Foundation (Office of Antarctic Programs), U.S.A.
Polish Geographical Society.
Rocky Mountain Forest & Range Experimental Station, U.S. Department of Agriculture.
Royal Meteorological Society.
Royal University of Lund (Department of Geography), Sweden (2 items).
The Royal Society.
University of Michigan (Geography Department), U.S.A.
U.S. Department of the Interior, Geological Survey, Washington, U.S.A. (9 items).

NEW MEMBERS

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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:	$9.00
Junior members (under 25)	Sterling:	£1 0s. 0d.
	U.S. dollars:	$3.00
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	U.S. dollars:	$17.00

(The dollar rates include Bank conversion charges)
Further details may be found in the Journal of Glaciology, published in February, June and October

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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.

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