NUMBER 26

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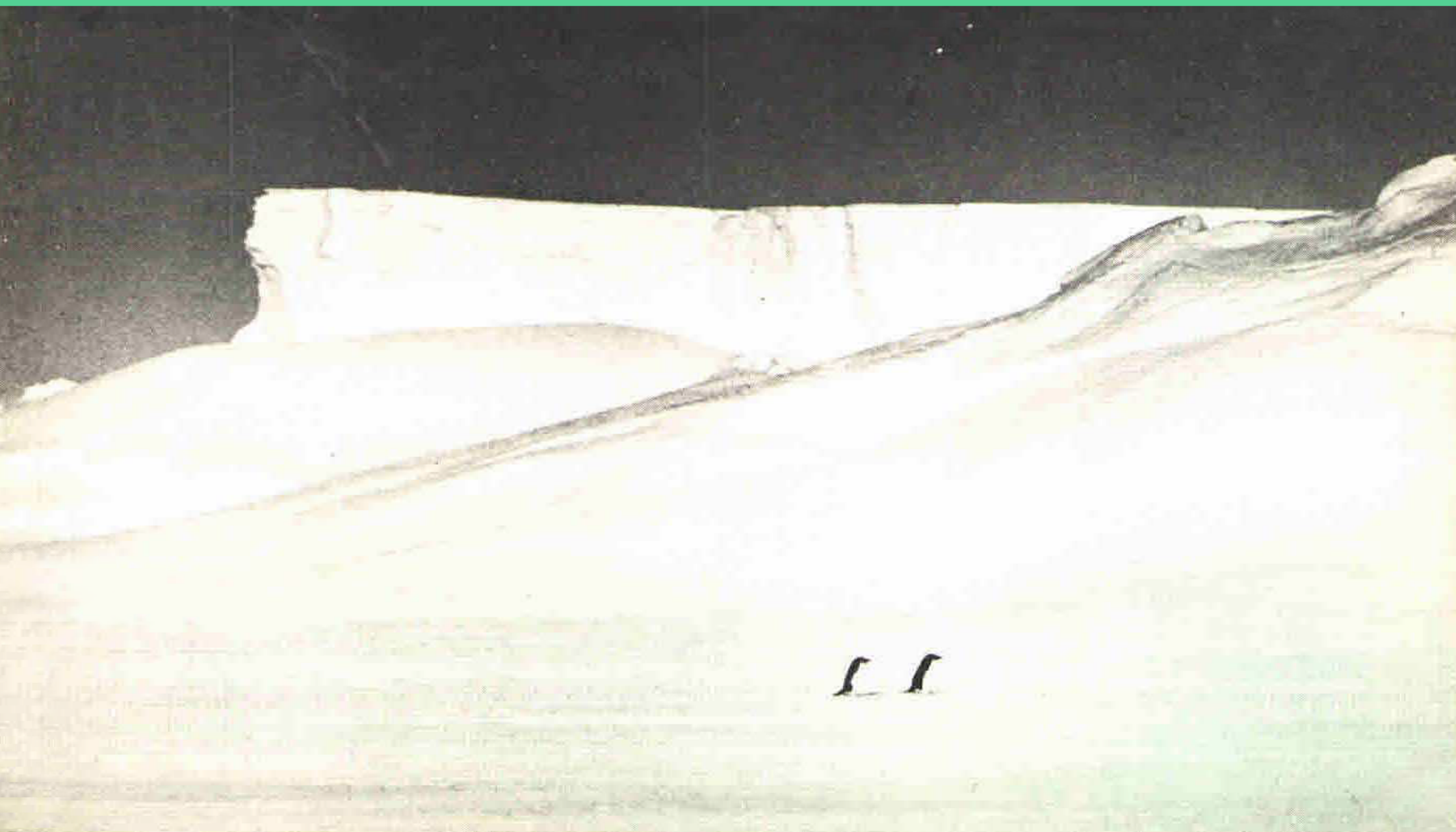
ICE



GLACIOLOGICAL SOCIETY

25 & 26 April, 1968

Annual General Meeting and Conference

at

Scott Polar Research Institute

Cambridge, England

For details, see page 21 of this issue of Ice

SYMPOSIUM ON THE PHYSICS OF ICE

9-14 September, 1968

München, Germany

Last date for booking: 22 July

For details, see page 22 of this issue of Ice

ICE

NEWS BULLETIN OF THE GLACIOLOGICAL SOCIETY

APRIL 1968 NUMBER 26

CONTENTS

AUTHORS: In view of the retirement of Dr Gerald Seligman from his Editorship of the Journal of Glaciology, authors are requested to send their manuscripts to: Dr J. W. Glen, Physics Department, University of Birmingham, PO Box 363, Birmingham 15, England and **not** to Dr Seligman.

MOVING. The Society's Library has been moved from Dr Seligman's house in Kent to the Society's office in the Scott Polar Research Institute, Cambridge, England. The move and subsequent organization will mean that its contents will not be accessible to members during the first six months of 1968.

Members who wish to donate reprints, reports, books, &c. to our Library are asked to note the change of address.

We apologize for any inconvenience to members during these moves and hope that we can make amends later.

We are sorry to report the death on 6 March 1968, at the age of 73, of Jón Eythórsson, the pioneer Icelandic glaciologist.

1968 DUES. Have you paid? No dues by June—no June Journal.

1969 SYMPOSIUM. The first circular has now been published. See p 23 of this issue.

COVER PICTURE. Penguins in Terre Adélie, Antarctica. Copyright: Photo Illulstration-Films, André Gamet Sarl, Lyon, France.

AUSTRIA

VARIATIONS OF GLACIERS

In 1966 and 1967, measurements of variations in length of numerous glaciers in the Austrian Alps were repeated in late summer. As in 1965 many of the smaller glaciers remained snow covered in 1966, so that exact determination of the glacier terminus was impossible in some cases. The percentage of advancing or stationary glacier fronts increased slightly in 1966, but recession dominated again in 1967, owing to predominantly fine summer weather. Traditionally, this work was organized and sponsored by Österreichischer Alpenverein. Summary reports were published by H. Kinzl in Mitteilungen des Österreichischen Alpenvereins, Jahrgang 21, 1966, pp. 61-62, and Jahrgang 22, 1967, pp. 32-33. For location of glaciers and mountain groups mentioned in the following reports see map Fig. 1 in P. Kasser, Fluctuations of Glaciers 1959-1965, IASH 1967.

Hintereisferner (Ötztaler Alpen)

Mass balance investigations on Hintereisferner were continued as part of the Austrian IHD Programme. As in the balance year 1964/65 (+92 g/cm^2) a positive mass balance was again observed in 1965/66 (+34 g/cm^2). In 1966/67 a slightly negative mass balance is expected. Field work in the firn basin of the Hintereisferner will be greatly facilitated by the building of a new refuge hut on the left bank of the Hintereisferner at 3026 m asl. Transportation of material was done by commercial helicopter. In 1967 a new recording stream gauge in the Rofenache near Vent was constructed and put into operation. Precipitation in the drainage area of Vent was measured using 12 collecting gauges. Field work was carried out by staff members, Institut für Meteorologie und Geophysik, Universität Innsbruck, and sponsored by Österreichische Akademie der Wissenschaften. The Austrian Ministry of the Interior supplied a ski-plane for transportation. Climatological observations at Vent (1900 m asl) were carried out in 1966 and 1967. A comprehensive report containing detailed results of mass balance investigations on Hintereisferner in connexion with climatic conditions for the balance years 1963/64, 1964/65 and 1965/66 was finished in fulfillment of a UNESCO contract.

A similar programme of mass balance investigations was initiated on the adjacent Vernagtferner and Guslarferner in 1966 by O. Reinwarth and collaborators, Kommission für Glaziologie, Bayerische Akademie der Wisserschaften. This also included a seismic survey of Vernagtferner and of Guslarferner in the summers of 1966 and 1967. For details see report by W. Hofmann, Ice No. 22, Dec. 1966 and following reports.

A new map of Hintereisferner was surveyed in October 1967 by means of terrestrial photogrammetry by H. Rentsch, Kommission für Glaziologie, Bayerische Akademie der Wissenschaften. Professor H. Schatz and collaborators from the Institut für Mathematik, Universität Innsbruck, resurveyed transverse profiles Nos 1, 3 and 6. Speed of surface movement was found higher in 1966/67 than in 1965/66.

Between 18 July and 7 August 1966, 15 tons of ice were collected near the terminus of Hintereisferner and of Kesselwandferner and samples prepared on the spot. These were later sent to Professor Dansgaard, Universitetet København, for ^{32}Si-dating. Field work was carried out by W. Ambach and collaborators, Physikalisches Institut, Universität Innsbruck. Transportation was by helicopter. At the same time, B. Stauffer, Universität Bern, tested a new method for collecting ^{14}C samples, which was developed by Professor Oeschger, Universität Bern.

Kesselwandferner (Ötztaler Alpen)

The 20 m pit from 1963 was reopened in the summers of 1966 and 1967, and measured for deformation. In 1966 a new 12 m pit and 1967 a new 20 m pit were dug and firn samples were collected for analysis of gross-beta-activity and of tritium content. In 1966 ice samples from a longitudinal profile in the ablation area and snow samples from the 1965/66 accumulation season were collected for ^{18}O analysis. Melt water percolation in firn snow was studied, using sodium-dichromate. Variation of tritium content was checked in the melt water stream at the terminus of Kesselwandferner throughout the year. Field work was carried out by H. Eisner and collaborators from the Physikalisches Institut, Universität Innsbruck.

H. Schneider of the Institut für Mathematik, Universität Innsbruck, studied surface movement in five transverse profiles. H. Queck finished a thesis on the mass balance of Kesselwandferner in 1966. The Kesselwandferner is included in the Austrian IHD Programme of combined water, ice and heat balance investigations. As a consequence of the mass gained in three consecutive years with a positive mass balance the terminus of the glacier is slowly advancing.

For many years the Tiroler Wasserkraftwerke AG, Innsbruck, have been conducting hydrometeorological studies in the upper part of the Tyrolean Inn Valley and in the Achensee area. These include measurements of precipitation with collecting gauges, of discharge, and observations of winter snow cover on and near Gepatschferner (north-west of Kesselwandferner, draining into the Kaunertal), on Taschachferner (north of Vernagtferner), and on Mittelbergferner (both draining into the Pitztal, northern part of the Ötztaler Alpen).

Sonnblick-Kees (Granatspitzgruppe)

Mass balance investigations on Stubacher Sonnblick-Kees were continued as part of the Austrian IHD Programme. The strongly positive mass balance of 1964/65 (+219 g/cm^2) was followed again by positive mass balance in 1965/66 (+88 g/cm^2) owing to frequent falls of fresh snow in July and August. Detailed results are included in the final report, UNESCO—Contract NS/2803/65. In the balance year 1966/67 a moderately positive mass balance is expected. As a consequence of the mass gain the terminus of the glacier is slowly advancing. A 12 m pit was dug in the firn area in 1966 in order to obtain information on net accumulation back to 1960 and to collect firn samples for analysis of gross-beta-activity as a contribution to W. Ambach's programme. A new map of Sonnblick-Kees was surveyed by means of terrestrial photogrammetry in the summer of 1967. A longitudinal profile and three transverse profiles were resurveyed on Ödenwinckelkees in the summers of 1966 and 1967, showing an increase in the speed of surface movement. Climatological observations were continued at Rudolfshütte (2315 m asl); a recording anemometer was installed in October 1966. Work was carried out by Heinz and Werner Slupetzky and collaborators from the Geographisches Institut, Universität Salzburg and Universität Wien, and sponsored by Österreichische Akademie der Wissenschaften.

Pasterzen-Kees (Gross-Glockner-Gruppe)

In late August of 1966 and of 1967 four transverse profiles in the ablation area and one in the accumulation area were surveyed by H. Aigelsreiter and E. Neuer in collaboration with students from the Geographisches Institut, Universität Graz (Professor H. Paschinger). The observed average rise of the glacier surface in the ablation area by four metres in 1966 indicated a positive mass balance in 1965/66, whereas in 1967 a lowering of the glacier surface by 0.3 metres seems to indicate a slightly negative mass balance. This is supported by investigations of net accumulation and changes of firn surface elevation, carried out by H. Tollner, Wetterdienststelle Salzburg. Mass balance of several small glaciers in the Gross-Glockner-Gruppe was found moderately positive in 1965/66, and mostly balanced in 1966/67.

The Tauernkraftwerke AG, Salzburg, are continuing their long series of precipitation, discharge and snow cover observations on the upper parts of Pasterzen-Kees and on Schmiedingerkees (Kitzsteinhorn).

Goldberg-Gruppe

Kleines Fleisskees, Wurtenkees and Grosses Goldbergkees, in the vicinity of the Meteorological Observatory on the top of Hoher Sonnblick (3106 m) advanced slightly in 1966, but retreated again in 1967, according to H. Tollner, Wetterdienststelle Salzburg.

Übergossene Alm (Hochkönig)

The mass balance of this small plateau-type glacier of 2 km^2 was found to be +25 g/cm^2 in 1965/66, and almost balanced (+6.5 g/cm^2) in 1966/67. Work was carried out by J. Goldberger assisted by young students from Salzburg and sponsored by Österreichischer Alpenverein.

Dachstein

In August 1967 a seismic survey of Schladminger Gletscher and of Hallstätter Gletscher was carried out by E. Brückl and P. Steinhauser, as a contribution of Zentralanstalt für Meteorologie und Geodynamik, Wien in collaboration with Institut für Geophysik, Universität Wien, towards the Austrian IHD Programme. Equipment was successfully tested in August 1966 on Vernagtferner (Ötztaler Alpen). Eight profiles of a total length of 6.2 km were surveyed. Evaluation is in progress. Preliminary results showed that Schladminger Gletscher has a maximum thickness of only about 20 metres. Velocity of longitudinal waves was found to be only 3.3 km/sec. The Austrian Ministry of Defence supplied a helicopter for transportation of equipment.

For many years a programme in karst hydrology has been carried out on the Dachstein plateau by F. Bauer, Speläologisches Institut, Wien. This includes measurement of precipitation and of discharge and investigations of snow cover. In close collaboration with Zentralanstalt für Meteorologie und Geodynamik, Wien, and with Oberösterreichische Kraftwerke AG, Linz, this forms another contribution towards the Austrian IHD Programme.

Ankolgel-Gruppe

For many years Österreichische Draukraftwerke AG, Klangenfurt, have measured precipitation, discharge, and snow cover in selected glacierized drainage areas. Glaciers were surveyed by air photogrammetry in 1964; the survey is to be repeated in 1969.

GLACIAL GEOLOGY AND HISTORY OF CLIMATE

F. Mayr, Geographisches Institut, Universität Innsbruck, has completed investigations on the history of Würm glaciation in the Innsbruck area, resulting in a new chronology which subdivides Alt-Würm into Völs Phase and Hall Phase, and Jung-Würm into Mils Phase and Würm Phase. The paper "Über den Beginn der Würmeiszeit im Inntal bei Innsbruck" was accepted for publication in Zeitschrift für Geomorphologie.

H. Heuberger, Geographisches Institut, Universität Innsbruck, carried out studies in glacial geology and glacial morphology in the Dudh Kosi valley, Mt. Everest region, in the Research Scheme Nepal—Himalaya, in 1966. Results will be published in "Khumbu Himal". Studies of late-glacial glacier fluctuations in the western Stubai Alps have been published in the meantime: H. Heuberger, Gletschergeschichtliche Untersuchungen in den Zentralalpen zwischen Sellrain- und Ötztal. Wissenschaftliche Alpenvereinshefte No. 20, Universitäts—Verlag, Wagner, Innsbruck, 1966.

G. Patzelt, Geographisches Institut, Universität Innsbruck, has finished his thesis on glaciers in the Venediger Gruppe and their variations: Die Gletscher der Venedigergruppe. Die Geschichte ihrer Schwankungen seit dem Beginn der postglazialen Wärmezeit. Dissertation, Universität Innsbruck, 1967.

HEAT BUDGET STUDIES IN THE POLAR REGIONS

Michael Kuhn, Institut für Meteorologie und Geophysik Universität Innsbruck, spent the year 1967 at Plateau Station, Antarctica, conducting investigations for USARD in micro-meteorology and radiation. W. Ambach, Physikalisches Institut, Universität Innsbruck, and G. Markl, Institut für Meteorologie und Geophysik, Universität Innsbruck, conducted investigations of heat balance on the Greenland Ice Cap, Station Carrefour, as the Austrian contribution to EGIG in the summer of 1967.

H. C. Hoinkes

CANADA

INTRODUCTION

Long-term studies of the mass, energy and water balance of a number of selected glaciers in the Cordillera and the Arctic are being made as part of the Canadian participation in the International Hydrological Decade. Numerous maps have been produced showing perennial snow and ice masses more accurately than previously. These are a contribution to the IHD Glacier Inventory. Two pilot studies for this inventory were successfully completed: (1) on the glaciers of the Steacie Ice Cap area of Axel Heiberg Island, NWT, and (2) on the gaciers of the Waputik Range of the Rocky Mountains, north of Lake Louise.

Glacier surges, as presently occurring in the Steele Glacier in the Yukon Territory, have gained considerable interest. Several glaciological and geological investigations have been initiated, and the Sub-Committee on Glaciers plans to hold a "Seminar on the origin and mechanics of surging glaciers" on 10 and 11 September 1968 at McGill University.

The Sub-Division of Glaciology, formed in 1965 in the Department of Energy, Mines and Resources, to undertake basic research in all aspects of glaciology, was expanded during 1967 to more than double the previous complement of seven persons.

At McGill University there are, at present, 3 MSc and 4 PhD candidates enroled in the Interdisciplinary Graduate Program in Glaciology (Faculty of Graduate Studies and Research). In addition, graduates in the departments of Geology (1 PhD), Meteorology (1 MSc) and Geography (2 MSc) are specialising in glaciology.

SOUTHERN CORDILLERA AND COAST MOUNTAINS, BRITISH COLUMBIA AND ALBERTA

(Glaciology Sub-Division, Inland Waters Branch, Department of Energy, Mines and Resources: A. D. Stanley)

Studies were continued on 5 glaciers in a transect across southern British Columbia and a similar programme was started at the Berendon Glacier 500 miles to the north. For the base maps of these glaciers, special compilations at a scale of 1 to 10000 have been prepared using aerial photographs obtained in 1965 and 1966. Three maps have been published and the remainder have been drafted.

The field programme was revised to eliminate winter visits while observations were continuous during the entire ablation period.

In the winter of 1966-67 the snowfall throughout B.C. was heavy, and in some areas accumulation was 20% to 30% greater than normal. Spring run-off was late and the snow at 2000 m did not begin melting until late May. Despite the heavy snow pack on each glacier the mass balance for these glaciers was negative because ablation was exceptional in all areas but the north. Summer weather continued from late June until mid September; the lack of rain in July and August resulted in many forest fires throughout British Columbia. As a result of the unseasonal conditions in the south and continuous poor weather to the north, the requested aerial photography was not completed.

(1) Place Glacier I.W.B.-R.B.-35 B.C.-25. Accumulation measurements taken in late May gave snow depths of more than 7 m and an average specific accumulation of 220 cm water equivalent. By late September the snow line had receded to 2400 m. The mass balance was negative.

(2) Sentinel Glacier I.W.B.-R.B.-36 B.C.-26. The specific accumulation measured to 6 June was 298 cm water equivalent. By late September the snow had receded to an elevation of 1800 m. The mass balance was negative.

(3) Woolsey Glacier I.W.B.-R.B.-36 B.C.-26. The depth of snow accumulated over the winter months ranged from 3.5 m to nearly 8 m and the specific accumulation was 320 cm water equivalent. When field observations terminated on 3 September snow still remained on the upper parts of the glacier and the specific ablation was 3.05 m.

(4) Peyto Glacier I.W.B.-R.B.-33 ALTA.-73. The depth of winter snow ranged from 90 cm to 4 m and the average accumulation was over 150 cm water equivalent. During the summer most of the snow melted and by late September the snow line had receded well above the normal position exposing firn from the last three years. During the summer a party from the Geophysics Section of the Geological Survey measured ice depths for the greater part of the ablation zone.

(5) Ram River Glacier I.W.B.-R.B.-32 ALTA.-72. Snow depths on 12 June ranged from 70 cm to 280 cm and the average accumulation was almost 100 cm water equivalent.

(6) Berendon Glacier. Field work in the Granduc area was carried out in co-operation with Dr W. H. Mathews. A network of movement stakes was established. The ablation of ice below the snowline exceeded 250 cm water equivalent. Discharge from the lake below the glacier during the period 19 July to the end of August was more than 84×10^6 m^3. A recording gauge and cableway were installed on the Bowser River and 17 discharge measurements completed using a current meter.

Three lines of stakes were drilled into the lower part of the Berendon Glacier to detect anomalous movements of the ice tongue. These stakes were surveyed twice prior to the discharge of Summit Lake on 17 September.

Tiedemann Glacier, British Columbia: post-Fraser moraines (Geological Survey of Canada: R. J. Fulton)

One week was spent studying moraines on the Tiedemann Glacier, a 15 mile-long ice tongue on the west side of Mount Waddington in the Coast Mountains. The purpose of this project was to date post-Fraser glaciation moraines. The slopes of the lower 5 miles of the valley occupied by the glacier are marked by two prominent moraines. Down-valley from the present snout of the glacier there is a series of younger, small end moraines. Radiocarbon dating of samples from bogs outside and between the two older moraines and counting annual rings in cores from trees growing on the youngest ridges should make it possible to assign limiting dates to each moraine.

Snow investigation (University of British Columbia: W. H. Mathews and J. R. Mackay).

The study of snow conditions including snow pressure, creep, and temperature at Mount Seymour, B.C., was continued.

ROCKY MOUNTAINS, ALBERTA

(1) Drummond Glacier (University of Calgary: M. J. Chambers)

As part of a general study of glacial geomorphic processes in the upper Red Deer River valley of Alberta, an investigation of the mass balance characteristics of the Drummond Glacier has been carried out. The project was initiated in 1962 and has been incorporated into the IHD programme for Alberta as projects ALTA-62.

Work during the 1967 summer was concentrated on maintaining accurate records of the recession and ablation in progress at the present time. Over-all retreat is approximately 50 feet per year, but the northern edge of the tongue is receding much more rapidly. The reason for this appears to be a decrease in supply of ice from the névé zone to the northern flank of the glacier. As the overall thickness of the ice decreases, so the bedrock configuration has an increasing influence on the iceflow pattern.

Deformation of the stake line located approximately one mile above the ice front shows that movement on the northern side of the ice has also decreased, and is far less than at the centre or on the southern side, totalling only 16 feet in four years on the north, and 90 feet for the same period in the other sectors of the glacier. Measurements on these stakes show an average decrease in ice thickness of 2 feet per year.

(2) Saskatchewan and Athabasca Glaciers (Inland Waters Branch, Department of Energy, Mines and Resources: I. A. Reid)

During July 1967, the Saskatchewan and Athabasca Glaciers were surveyed by terrestrial photogrammetry. In addition, 21 six-foot metal stakes were inserted in three-foot bore holes near the 7400 ft. level of the Athabasca Glacier. A plaque was placed beside each stake. The stakes were tied in horizontally and vertically from triangulation stations 16 and 20. These stakes, if still in situ, will be resurveyed next July. If the stakes are not in the bore holes, observations will be made to the plaques. A terrestrial photogrammetric survey will be carried out at the same time. It is hoped by this method to obtain a value for the ice melt of the Athabasca Glacier.

YUKON TERRITORY

(1) The Icefield Ranges Research Project, 1967 (American Geographical Society and Arctic Institute of North America: R. H. Ragle)

The Icefield Ranges Research Project conducted its seventh field programme in the St. Elias Mountains; studies in eighteen disciplines were conducted by more than 38 investigators and their assistants.

"Fox Glacier". An intensive study of the "Fox Glacier" was begun in the anticipation that this small ice body may surge in the foreseeable future. Mass balance, surface movement, and water discharge measurements were begun. A programme of seismic and gravity profiles and hot point drilling was carried out. Conventional and ground stereophotogrammetric surveying and mapping techniques were applied to the entire glacier surface and to periglacial features. A reconnaissance of the moraine sequences of the "Fox" valley was made.

Steele Glacier. The Steele Glacier continued its surging advance, though at about half the rate of that observed in 1966. Ground triangulation in 1967 established a network of control which spans both the Steele and "Fox" glacier systems and is tied into the survey, conducted in July, by the Canadian Department of Energy, Mines and Resources.

A photo-chronology programme, begun in 1935, was continued.

High oblique aerial photo coverage of the Steele Glacier—and of the "Fox"—was made on several occasions during the field season by IRRP. In addition, high altitude vertical aerial coverage was flown on behalf of the Department of Energy, Mines and Resources by Spartan Air Services for large scale (1:25000 and 1:50000) photo mapping purposes.

Rock glaciers. Two of six rock glaciers, instrumented in 1966, showed appreciable motion. The 1967 programme included: fabric studies of surface material for one glacier: lichen measurements; increment borings of trees; trench digging to permit examination of internal structure; seismic soundings; and a plane table survey on a scale of 1:1000.

Geomorphology. A PhD dissertation programme was begun on the importance of environmental factors on the occurrence and development of solifluction lobes.

Radio echo-sounding. Appraisal of the Scott Polar Research Institute's airborne radio echo-sounder for the study—and perhaps mapping—of glaciers in the St. Elias Mountains was begun. Flights over an established seismic profile gave promising results.

Gravity measurements (Dominion Observatory, Department of Energy, Mines and Resources: J. R. Weber). A gravity survey was carried out on the "Fox Glacier" in July to determine its thickness. A similar survey planned across the upper part of the Steele Glacier had to be abandoned because the glacier moved so fast that it was quite impossible to level the gravimeter.

Hydrological observations (Glaciological Sub-Division, Inland Waters Branch, Department of Energy, Mines and Resources: A. D. Stanley). In co-operation with IRRP, hydrological measurements were obtained for the melt water stream from the "Fox Glacier" basin. A recorder was installed on the main stream and over 17 discharge measurements were taken with a current meter. The daily discharge varied from 0.1 to 0.3 x 10^6 m^3, and the total discharge from 19 July to 18 August is estimated at 6 million m^3.

(2) South-western Yukon: Pleistocene geology (Geological Survey of Canada: V. Rampton)

The final field season was completed on a project to trace the extent of different glacier advances and to establish a Pleistocene and Recent chronology in an area bounded on the west by the Yukon-Alaska boundary, on the south by the St. Elias Mountains, on the east by the Donjek River, and on the north by the all-time limit of glaciation.

Photographs were taken of some glaciers in the area and the ages of neoglacial moraines adjacent to the Klutlan and Natazhat Glaciers were investigated by lichenometry and dendrochronology.

(3) Moraines of the Bighorn and Grizzly Glaciers (Geological Survey of Canada: N. W. Rutter)

The purpose of this study was to point the contrasts in deposits formed by known surges and normal advances of alpine glaciers, thus to provide criteria for recognition of these deposits in the glacial record. This was deemed necessary in order to prevent the erroneous interpretation that evidence of a glacial advance automatically implies a regional climatic change.

A recent "surge" moraine of the Bighorn and recent "normal" moraines of the Grizzly were selected for study because of their similarity in size and climatic and geologic environment, and because of their proximity to each other and to the surging Steele Glacier.

About a week was devoted to field studies and data collecting on the moraines of each glacier. The surficial deposits and erosional features were mapped in detail. In each area five sites were selected in undisturbed till close to the till-bedrock interface for fabric analyses. Samples were also collected from each site for lithologic and texture analyses in the laboratory. Permanent stations were established for the photographing of the glacier snouts.

The Bighorn or "surge" moraine is characterized by a thin, discontinuous, irregular mantle of drift, often composed of ice-contact stratified material by associated lateral moraines with subdued or no ridges marking the upper limit of glaciation, and by extensive mixing of lithologic types in the till. The surge has moderately eroded the bedrock surface, removing about 2 to 3 m of material from the pre-existing valley floor.

Ground moraine of the "normal" Grizzly Glacier is characterized by an irregular, but continuous and relatively thick, mantle of drift composed mostly of till. A series of lateral moraines, some ice-cored, represent repeated halts during retreat. The upper limits of ice are well marked by prominent ridges. Similar lithologic types within the till are often strung out in bands parallel to the direction of glacier flow.

Fabric analyses reveal profound differences in pebble orientation in the tills of the two glaciers. Pebbles from undisturbed till a few feet above bedrock in the valley floor of the Bighorn moraine show little preferred orientation as compared to those in similar positions in the Grizzly moraines. Furthermore, any preferred orientations in the till pebbles of the Bighorn moraine are not in the direction of glacier flow, whereas in the Grizzly moraines the pebbles are either parallel or nearly parallel to the direction of glacier flow.

Texture analyses of till from moraines of both glaciers indicate that the matrix of Bighorn till is coarser-grained than that of the Grizzly.

(4) Deposits of the surging Steele Glacier (University of Alberta and Research Council of Alberta: A. J. Broscoe)

Two weeks of observations were made on the directions and rates of flow of ice at and near the terminus, and on sediment load and rate of flow of melt water streams adjacent to the ice. The aim of the investigation was to obtain data which would distinguish the deposits of surging glaciers. The main concern was the mechanics of incorporation of debris into the surging glacier.

GLACIER MAPPING IN WESTERN CANADA

(Topographical Survey Division, Department of Energy, Mines and Resources: A. C. Tuttle)

(1) Field work

The mapping and Charting Establishment of the Department of National Defence conducted surveys along the Steele Glacier to assist in making a new plot of this surging glacier from 1967 photography.

(2) Compilations

The following were completed in 1967: (i) Ram River, Woolsey and Peyto Glaciers, in 82 M,N. Plots at 1:10000 with 10 m and 50 m contour intervals. (ii) Steele Glacier. Three separate compilations: scale 1:50000 with 40 m contour interval; scale 1:25000 with 20 m contour interval; scale 1:25000 with 20 m contour interval.

JUNEAU ICEFIELD, ALASKA

(University of New Brunswick: G. Konecny)

(1) Vaughan Lewis Glacier mapping project

The project was to provide a base map (1:10000) for various glaciological investigations in the Vaughan Lewis Glacier area, as a part of the Juneau Icefield Research Project of the Glaciological Institute of Michigan State University. The mapping area is located at the junction of the Vaughan Lewis Glacier, the Gilkey Glacier and an unnamed glacier, about 60 miles north-east of Juneau, Alaska. The first surveying attempts were made by teams from the University of New Brunswick during the field seasons of 1965 and 1966, but adverse weather during these seasons prohibited completion. This year, A. Chrzanowski completed the ground control and mapping surveys using terrestrial photogrammetry with a Wild P-30 phototheodolite. The triangulation control net consisting of 6 points was measured with a Wild T-2 theodolite. Plotting will be carried out by the Department of Surveying Engineering at the University of New Brunswick. Photogrammetric mapping will be repeated periodically to obtain more information on the movements and mechanics of glaciers in the area.

(2) Investigation of atmospheric refraction over glacial areas

P. V. Angus-Leppan and A. Chrzanowski undertook, in August 1966, some experimental and theoretical investigation into the determination of the coefficient of refraction, k, and diurnal variations in the gradient of refraction over glacial surfaces. The experimental measurements were conducted in the Juneau Icefield area over a smooth section of the Taku Glacier. Simultaneous reciprocal vertical angles between four stations at each end of a line 5.7 km long were measured with two Wild T-2 theodolites. The stations were established on solid rock giving four lines of sight which ranged from a few metres to about 70 m above the glacier surface. Observations extended over a 24-hour period. Temperatures were measured at both ends of the lines and approximately in their middle, using a 12 m high steel tower. The temperature element was a small rod thermistor which was raised and lowered once every hour, pausing at six different heights for measurement. The weather during the experiment was almost entirely cloudless, with light winds. The results of the measurements show that the co-efficient of refraction k varies from 1.0 or more for the sites only a few metres above the ice surface to about 0.3 for the highest sites in the experiment. Theoretical computations of k show the same order of magnitude. Some conclusions have also been drawn regarding the pattern of diurnal variations of the gradient of refraction.

MACKENZIE DELTA AREA, N.W.T.

(University of British Columbia: J. R. Mackay)

Permafrost measurements were taken in numerous instrumented seismic drill holes to a depth of 200 ft and, in collaboration with the Dominion Observatory, in a 2000 ft drill hole. A portable seismograph was used to delimit the ice cores of pingos. Ice fabric analyses of Late Pleistocene glacially-deformed sediments were studied by J. K. Stager. The research was supported by the Geographical Branch, Department of Energy, Mines and Resources.

CENTRAL BAFFIN ISLAND

(1) Barnes Ice Cap (Geographical Branch, Department of Energy, Mines and Resources: O. H. Løken)

(a) Mass balance measurements. The stake network was resurveyed. The 1965-66 mass balance and the 1967 winter balance were determined. Preliminary examination shows a large deficit in the 1965-66 balance year, the mean specific balance being −93 cm w.e. (error limits not yet assessed), with heaviest mass loss on the south-west side. The 1967 winter balance at the north end was approximately the same as in preceding years while the south end had clearly a greater accumulation than in 1966, thus accentuating the north-south difference in winter balance.

(b) Movement studies. The movement stakes inserted in May 1966 were resurveyed and preliminary calculations show horizontal displacement of about 30 m. None of the stakes, including one within 200 m of the ice margin, had moved less than 10 m. This proves that the ice cap is more active than previously assumed.

Movement studies near the top of the south dome of the ice cap were initiated.

(c) Ice depth measurements, using the radio sounding technique, were made over about 80 km on the southern part of the ice cap. Maximum depth was 550 m. No major rise in the underlying bedrock surface was detected. One profile along the centre of a 'slump area' was characterized by small shear stress values.

(d) Glacial meteorological studies. A study was undertaken of the seasonal and daily patterns of atmospheric vapour content and its horizontal flux over Baffin Island and environs in relation to precipitation data and mass balance measurements on the Barnes Ice Cap. Related investigations are being made into the climatology of accumulation and ablation. Monthly recording anemographs and hygrothermographs were installed on either side of the ice cap and on its crest.

(e) Mapping (Topographical Survey Division, Department of Energy, Mines and Resources: A. C. Tuttle)

A map of the southern half of the Barnes Ice Cap was completed at scale 1:50000 with 25 ft contour interval. (N.T.S. sheets 27 C/12, 13; 37 D/9, 10, 11; E/14, 15, 16.)

(2) Snow-bed distribution in eastern Baffin Island (J. T. Andrews and R. G. Barry)

Linear regression analysis of corries and snow-beds is being applied to the determination of past and present snow lines in eastern Baffin Island.

(3) Glacial geomorphology in eastern Baffin Island (M. Church, J. England, D. Hodgson, J. D. Ives, C. A. M. King and J. Ryder)

Studies of a variety of geomorphological features continued, including late-glacial moraines, raised shore features, glacial outwash deposits, inter (?) glacial deposits and possible nunatak areas.

(4) Decade Glacier and River I.H.D. I.W.B.-R B.-26 North-2 (Glaciology Sub-Division, Inland Waters Branch, Department of Energy, Mines and Resources: A. D. Stanley)

Investigations were continued in co-operation with the Geographical Branch. On the Decade Glacier work was confined to accumulation measurements in early June and a series of profile surveys in late July. The total ablation for 1966 was 98 cm, with more than 10 cm of ablation after the party left the field in 1966. The snow accumulation in 1966-67 ranged from 10 cm to 150 cm giving a specific accumulation of 25 cm water equivalent. No ablation measurements were taken but all snow had melted from the glacier by late July, and the mass balance was negative.

For the Decade River a continuous record of the stage was obtained from 21 June to 24 August The estimated discharge for the period was 4.4×10^6 m^3 with a daily peak of 250000 m^3.

DEVON ISLAND

(Arctic Institute of North America: K. de la Barre and R. M. Koerner)

A party of two carried out field investigations on the Sverdrup Glacier and on the ice cap. A long-term recording meteorological station was set up at the abandoned ice cap station on the north-west side of the ice cap at an altitude of 1317 m. Using an anemometer and a thermohygrograph the weather of the entire melt season will be recorded, thus allowing climate/mass balance relationships to be studied with only very short field visits.

A traverse was made over the north-west, south-east and south-west parts of the ice cap. The 1965-66 mass balance on the south side of the ice cap was measured and the pattern of high accumulation in the south-east and low accumulation in the north-west was again recorded. Density of the August 1966 to June 1967 snow was the lowest on record. The mean density of the previous six years' autumn-spring snow cover is 0.344 gm cm^{-3} compared to 0.291 gm cm^{-3} in June 1967. The June 1967 snow profile was unusual in that it lacked the hard, dense surface layer common to previous years. Average accumulation in autumn 1966, low accumulation during the winter and high accumulation during the 1967 spring was indicated.

SOUTH-WEST ELLESMERE AND NORTH-WEST DEVON ISLANDS: GLACIER FLUCTUATIONS
(Geological Survey of Canada: W. Blake, Jr., and R. A. Souchez)

A study of glacial history in southern Ellesmere Island and on Colin Archer Peninsula, Devon Island, was initiated during 1967. Samples were collected for radiocarbon dating (Blake) and shear moraines were studied at various locations around the main ice cap in south-western Ellesmere Island (Souchez).

Well-rounded pebbles and cobbles occur in several shear moraine ridges along the north-west margin of this ice cap, and the presence of this material, derived from outwash deposits now buried beneath several lobes of the ice cap, indicates a relatively recent expansion of these lobes. Likewise, in Sydkap Fiord, Ellesmere Island, and at the eastern extremity of Colin Archer Peninsula, marine shells are present within the basal zones of certain glaciers, and a number of glaciers are now impinging on undisturbed marine deposits. A number of outlet glaciers now appear to be close to their maximum extent since general deglaciation.

MELVILLE ISLAND
(Polar Continental Shelf Project: W. S. B. Paterson)

Mass balance measurements were continued on the four ice caps. All showed a net loss for the balance year 1965-66, the loss being greater than in any year since the start of measurements in 1963. Values of mean specific balance ranged from -13 gm cm^{-2} for the south ice cap to -31 gm cm^{-2} for the north ice cap. Mean specific accumulation, from the start of the 1966-67 balance year until mid-April 1967, ranged from 14 gm cm^{-2} on the west ice cap to 19 gm cm^{-2} on the north ice cap. These figures are not representative of the 1966-67 balance year as a whole because there was considerable snowfall during the summer of 1967.

ELLEF RINGNES ISLAND: SEMI-PERMANENT SNOW BANKS
(Geological Survey of Canada: D. A. St-Onge)

A two week period was spent on Ellef Ringnes Island during early August 1967 in order to continue the study of nivation process on gabbro. Several nivation terraces and associated snow banks on the gabbro mesas and ridges north-west of Isachsen were photographed and their dimensions were recorded.

MEIGHEN ISLAND
(Polar Continental Shelf Project: W. S. B. Paterson)

Mass balance measurements were continued. The mean specific balance for 1965-66 was a loss of 7 gm cm^{-2}. The mean specific accumulation for 1966-67, as determined in May 1967, was 9 gm cm^{-2}. Temperatures in the bore hole through the ice cap were measured; they agreed closely with those of the previous year. The diameter of the hole was also remeasured, at intervals of 7.6 m, to find the rate of closure.

AXEL HEIBERG ISLAND
(McGill University: F. Müller)

Parties from McGill University carried out field work from 16 May to 8 September in the Expedition Fiord area on Axel Heiberg Island for the ninth consecutive summer. The Polar Continental Shelf Project provided air transport from Resolute Bay onwards.

(1) Mass balance

The stake network on the White and Baby Glaciers was maintained and surveyed twice. Pit studies were carried out on both occasions in an effort to assess not only the net mass balance of these two glaciers but also, in approximation, the gross mass exchange.

The 1966-67 winter snowfall in the area was average. The melt started early, but bad weather in late June and July resulted in a low equilibrium line on the White Glacier, at approximately 750 m asl. The mass balance of the glacier was positive, though less markedly so than in 1964.

(2) Weather observations and automatic climatological stations

Six-hourly synoptic observations were made from 17 May until 8 September and automatic climatological stations were tested at the Base Camp and near the equilibrium line on the White Glacier. In this period 2500 man-observations were collected under various weather conditions for evaluation of the automatic stations. Part of the time, tests were made on a new German automatic climatological station which records the data on a digital punch tape capable of storing a year's three-hourly interrogation of eight sensors. So far only two sensors, humidity and temperature, have been tested; the overall performance proved to be excellent.

(3) The Thompson Glacier push moraine

The snout of the Thompson Glacier and its push moraine, still advancing at approximately the same rate as observed since 1959, were successfully rephotographed from 8000 ft and 11600 ft levels. Two stadia rod levelling profiles were each surveyed twice, as in previous years, and the movement of seven cairns was measured twice from base lines. In the frontal portion of the Thompson Glacier tongue six 10 m strain gauges were established and surveyed from the same base lines.

(4) Glacier surveying

Some 40 points in three profiles on the White Glacier, under observation since 1960, were twice surveyed for movement. The computer processing of approximately 1600 velocity values measured on the White Glacier during the period July 1959 to August 1967 is near completion and velocity-time curves have been plotted for about 50 stakes. The stadia levelling of the White Glacier tongue, repeated for the eighth year, indicates a slowly increasing retreat.

The Good Friday Glacier, for which a rapid advance of about 2 km over the last two years has been observed, was prepared for low-level aerial photography: 12 aluminum plates were placed on the surrounding ground and surveyed together with 7 terrain points on the inaccessible south side of the glacier tongue. Aerial photography of the front of the largest, and only tide-water, glacier on Axel Heiberg Island, the Iceberg Glacier, which is clearly shrinking in its tongue area, was successfully completed.

(5) Snow survey

Snow quantities and distribution in the Base Camp area were mapped by G. Young and four standard snow courses established between Expedition Fiord and the White Glacier, in preparation for an investigation of snow survey methods in the High Arctic mountain terrain. The study covers the Wolfe River catchment and the White and Baby Glaciers.

NORTHERN ELLESMERE ISLAND
(Defence Research Board: G. Hattersley-Smith)

The Defence Research Board operated Tanquary Camp from early April until early September.

(1) Tanquary Fiord area

Mass balance and movement studies were continued on the Per Ardua Glacier for the fourth successive year. Terrestrial photogrammetry, with a Wild P-30, was used to determine the mass changes.

(2) Gilman Glacier, central ice cap and Air Force Glacier

A 130 km glaciological traverse by motor toboggan and dog-sled was made from the snout of the Gilman Glacier via the ice cap to the snout of the Air Force Glacier, conducting accumulation measurements and pit studies at about fifty stations up to an elevation of 2000 m. The main conclusions from this traverse were that the four summers 1963 to 1966 were the coldest sequence of summers since before 1925, that the former percolation facies of the ice cap above 1,800 m had been changed to an almost dry-snow facies, and that the equilibrium line on the glaciers had been lowered to about 900 m from a mean of about 1200 m asl in the years 1957-63. At the same time K. C. Arnold carried out a resurvey of the Gilman Glacier to determine height changes over a longitudinal and several traverse profiles, originally surveyed in 1957-58.

(3) Ward Hunt Ice Shelf and Ice Rise

Measurements were made at stakes set in the Ward Hunt Ice Rise and Ice Shelf by H. Serson. Net ablation values of 16.8 g cm^{-2} on the ice rise (mean of 42 stakes) and of 37.1 gm cm^{-2} (mean of 23 stakes) on the ice shelf were obtained for the period June 1966 to June 1967. For the period June 1964 to June 1967 the net ablation on the ice shelf was 21.2 g cm^{-2} (mean of 4 stakes). A 1 km^2 grid of 100 thin aluminum stakes was completed on the ice shelf, about 5 km east of Ward Hunt Island.

SEA ICE RECONNAISSANCE
(Polar Continental Shelf Project: D. Lindsay)

During the 1967 season the systematic aerial reconnaissance program initiated in 1961 was continued, with 300 hours of flying. Coverage and flying time during the season were considerably reduced by the unusually poor weather and the large snowfall in the region. The northern channels including Nansen Sound, Peary Channel, Sverdrup Channel, Prince Gustaf Adolf Sea and Ballantyne Strait did not break up in 1967. None of these channels has broken since 1963. The remaining channels and bays under survey broke up and moved in their usual fashion with the exception of M'Clure Strait. This area showed little movement and remained relatively closely covered throughout the season.

Radar markers were set up on 3 ice islands. Five clusters of empty 45-gallon gas drums were placed on WH-1 on 26 March when the island was at 74° 48′ N, 124° 15′ W. The second island, WH-6, was reached and marked with 8 empty drums on 20 May when it was at 83° 02′ N, 79° 50′ W. This 5 x 7 km ice island probably broke away from the western end of the Ward Hunt Ice Shelf sometime in late March 1967. The last ice island to be marked with two clusters of drums was a small fragment (1600 m per side), located near Alert on 1 June. The designation LT-1 (Alert number 1) is suggested for this fragment. LT-1 was last seen on 17 July 1967 at 82° 30′ N, 60° 30′ W.

EXPERIMENTAL STUDIES

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

(1) Deformation behaviour of ice

Studies continued on the plastic behaviour of single crystal and polycrystalline ice, and on the dependence of the failure process in ice on stress, time, and temperature. A method was developed for growing ice needles and tubes that are suitable for deformation studies. Experiments are being initiated on the factors controlling crack formation in ice and on the behaviour of ice under conditions of constant rate of straining.

(2) Ice pressures

A study was initiated on the buckling of ice covers due to a lateral load.

(3) Avalanche research

Observations continued at Rogers Pass, B.C., on the properties of avalanches and their dependence on the characteristics of the avalanche site. Correlations are 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. Observations are made on the speed and impact pressures associated with avalanches. Attention is also given to improving methods of estimating and predicting the avalanche hazard, and to problems associated with building in deep snow areas.

(4) Ice melting

Results and conclusions from field studies on the usefulness of dust for increasing the rate of melting of ice were published. These observations were undertaken at various sites during the period 1962 to 1965 inclusive.

Field studies on the break-up of lake ice are in process near Ottawa, Ontario, and Thompson, Manitoba. The observations are related to the weather conditions that occur during break-up. An analysis of break-up dates and weather conditions is being undertaken for several lakes in Canada.

ICE EXTRUSION EXPERIMENTS

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

The deformation of ice at high reductions (1000% or more) and high strain rates (in the order of 1/sec) is being studied using metallurgical equipment. A range of containers and dies has been constructed, both of metal and of transparent plastic, which permit extrusion over a temperature range of −10°C to 0°C. The extruded butts have been sectioned and photomicrographed to investigate the substructural changes and their mechanisms. From the work carried out to date on mono- and polycrystalline ice it seems that the flow of ice by extrusion involves five or more independent slip systems including non-basal as well as basal gliding. The operative slip systems were not determined, due to the occurrence of recrystallization during or immediately following the deformation. This latter observation is considered an important finding in itself.

GLACIER INVENTORY

(McGill University: F. Müller, and Glaciology Sub-Division, Inland Waters Branch, Department of Energy, Mines and Resources: A. D. Stanley and C. S. L. Ommanney)

For the "Guide to the world inventory of perennial ice and snow masses on and beneath the land surfaces" which gives instructions for a glacier inventory, two pilot studies were conducted in Canada—one in the Arctic and the other in the Rocky Mountains. The pilot study located in the SW part of Axel Heiberg Island (79° N, 90° W) included some 200 polar glaciers of many different types. The Rocky Mountain study was carried out in the Waputik Range (52° N, 116° W) where 100 temperate glaciers, mainly of the valley or cirque type, were assessed. In each area the critical problems of inventory making—identification, area delineation, snow line assessment and error estimation —were investigated. Reproduction of results to ±2% was obtained for area measurements using a dot planimeter and a random grid overlay.

A map was prepared by the Glaciology Sub-Division in late 1965 to show the distribution of existing glaciers in southern British Columbia and Alberta. This was the first of a series of 7 maps to cover all glacierized areas in Canada at a scale of 1 to 1 million. Significant data including location of meteorological stations, snow courses and stream gauging stations are shown as well as the outline of glaciers as represented on the best available maps at the 1:250000 scale or larger. All maps of the series have now been compiled and will be available early in 1968. On existing 1:250000 maps the area of Canada covered by glaciers is 204 000 km^2.

F. Müller

GROUND TEMPERATURE MEASUREMENTS IN WEST GREENLAND
(Greenland Geological Survey)

As part of the UNESCO International Hydrological Decade programme three stations for ground temperature measurements were established in West Greenland during the summer of 1967. One station was established in Holsteinsborg, where a similar station has already been in operation since September 1964. The other two stations were established in the Søndre Strømfjord area near the air base, which is almost due east of Holsteinsborg and about 135 km inland.

East station consists of a small prefabricated wooden hut about 1 x 1.5 x 2 m where the measuring instrument, a Wheatstone bridge, is situated, and of 21 or 12 thermistors, permanently embedded nearby in bore holes in the ground at different levels. The measuring bridge is powered by a small 4.5 volt battery and calibrated for direct reading of the temperature in degrees C with an accuracy of ± 0.1°C; the measuring range is from $+10$ to -10°C. The thermistors are of the platinum wire resistivity type with a resistance of 100.00 ± 0.1 ohms at 0°C. They are mounted in etronite tubes, each tube holding three thermistors at different levels. In the stations with 21 thermistors (main stations), the thermistors are installed at depth intervals of 25 cm to a depth of 2 m, at 50 cm intervals between 2 and 5 m, at 1 m intervals between 5 and 9 m, and thereafter at 2 m intervals to a depth of 15 m. In the small stations, the lowest thermistor is at 4.00 m depth; otherwise the intervals are the same as in the main stations.

The station set up at Holsteinsborg is a main station but because of the shallow depth of the loose deposits only 18 thermistors were installed of which the three deepest are in bedrock.

At Søndre Strømfjord one station is a main station while the other is a small station. The stations are placed not far from each other but in quite different vegetational environments.

In all stations the thermistors will be measured once a day, preferably around midday, by local observers. It is the intention that the main stations should continue to operate on the same site for the duration of the Hydrological Decade while the small stations should be dismantled after two years and moved to other localities. In this way it will be possible to cover a larger area and a variety of physicographical settings during the decade programme.

The object of this programme is to delimit the permafrost areas of West Greenland both horizontally and vertically. Another objective is the study of permafrost behaviour under the influence of different environmental factors, such as exposure, soil, moisture content, moisture movement, and plant cover, as well as under different meteorological conditions.

To fulfil this programme another four stations (two main and two small) will be established as soon as possible. The sites will be at Godhavn and probably Christianshåb. In the following years the small stations will be moved every second year to cover as wide an area as possible within the quadrangle Holsteinsborg—Søndre Strømfjord—Christianshåb—Godhavn. According to our present knowledge the boundary between continuous and discontinuous permafrost lies within this quadrangle which is why this area is of special interest. Apart from this it is hoped that contemporary climatic changes will show themselves in variations in the permafrost table or in the formation of new permafrost areas during the period of observation.

O. B. Olesen

QUATERNARY DEPOSITS AROUND HOLSTEINSBORG
(Greenland Geological Survey)

The area investigated in 1967 is situated between 66° 20′ and 67° 10′ N, 52° 30′ and 54° W, and is part of the high outer coastal terrain of central West Greenland. The greatest heights—more than 1000 m—are seen in the northernmost and southernmost parts of the area. These parts are separated by an E-W-running depression around Ikertoq fjord, the western continuation of which is seen off-shore in Holsteinsborg Dyb (the Holsteinsborg trough), a submarine canyon 500 m deep separating Store Hellefiske Banke from Lilie Hellefiske Banke. Whilst the banks are thought to be ice margin deposits which accumulated during the ice ages, the Holsteinsborg trough acted during these times as a drainage channel for the Inland Ice.

The highest Quaternary marine deposits are seen 110-140 m above sea level. Whether these limits are synchronous or metachronous has not yet been clarified. Only at lower levels (below 76 m) are shells found allowing radiocarbon dating. The frequent occurrence of shells in the marine deposits below 70 m makes it possible to correlate and date these lower levels over the entire area. The four datings hitherto done (by H. Tauber of the National Museum) indicate a trend of uplift closely resembling that described in detail for the Mestersvig area in East Greenland by A. L. Washburn and M. Stuiver in 1962. The strand lines seem to increase in height towards the east but this impression is at present only based on the general occurrence of levels, not on dated levels.

The ice margin deposits found in the area were laid down by the Inland Ice before the "fjord stages" situated farther east (maximum age 9500 B.P.), but later than the Wisconsin-

Würm moraines of the banks off West Greenland. The deposits found are characteristically less well delineated than those of the "fjord stages". The moraines in the area seem to be situated in a belt marking a stage in the deglaciation of the area and can possibly be split up into several local phases. This stage is designated the "Taserqat stage".

Local moraines have been observed around present glaciers in the northern Kangerdluarssuk (Kangerdlaurssuk ungatdleq). Their ages are unknown but they are older than historical time.

A. Weidick

ISCENTRALEN NARSSARSSUAQ (Danish Meteorological Institute)

In 1967 the Icecentral Narssarssuaq continued ice reconnaissance from Narssarssuaq of the seas around Kap Farvel, supplemented with monthly ice reconnaissance of the west coast from Søndre Strømfjord and periodical ice reconnaissances of the east coast from Kulusuk and Mestersvig. The observations have mainly been carried out by a DC-4, but also a DC-6B, an Alouette helicopter and military Catalinas (PBY) have been used. Total flight time was 823 hours (ice reconnaissance 431, ice-piloting 202, search and rescue 14, maildrop 4 and passenger transport 172).

The Icecentral has chartered a DC-4, through a new contract with Bergen Air Transport A/S running until October 1970.

The ice messages are broadcast from Angmagssalik and they are also transmitted in facsimile from Narssarssuaq for local navigational use.

The ice information is summarized and currently issued in the yearbook of the Danish Meteorological Institute: "The State of the Ice in the Greenland Waters".

J. S. Fabricius

DATING OF ICE (University of København)

In the summer of 1967, Physical Laboratory II carried through an expedition to north-west Greenland under the leadership of W. Dansgaard, on the Geodetic Institute's vessel M/GL "Tycho Brahe". The main purpose was to collect material for dating icebergs. Samples (approx. 4 tons each) for ^{14}C and ^{32}Si dating were collected from 17 different icebergs, including 10 from Jakobshavn Isfjord. At present, the material is being examined in the laboratory. The expedition was sponsored by the Carlsberg Foundation and the Danish State Research Foundation.

In August/September one of the participants, H. B. Clausen, joined H. Oeschger's group under EGIG and collected 5 ^{32}Si samples in the ablation zone east of Eqip Sermia for comparison with the Swiss ^{14}C samples.

H. B. Clausen and B. Buchmann (in collaboration with W. Ambach, University of Innsbruck) have completed a ^{32}Si dating of Kesselwandferner in the Alps. The result (1200 years for the ice in the lower part of the glacier tongue) was presented at the IUGG Conference in Berne.

In collaboration with C. C. Langway, CRREL, W. Dansgaard has initiated an investigation on past climatic conditions by stable isotope analysis of the ice cores from Camp Century.

GERMANY

COMMISSION FOR GLACIOLOGY

(1) Alpine Research

The observation and research programme in the Eastern Alps was completed by glaciological studies on the Vernagtferner (Ötztal). The photogrammetric survey of 1966 was evaluated for a new contour map of the whole glacier with 10 m contour intervals. By comparison with the photogrammetric map of 1938 the retreat of the glacier in the time interval 1938-1966 could be determined quantitatively with the following results:

loss in volume: $70.6\ 10^6\ m^3$
loss in area: $0.68\ 10^6\ m^2$
mean loss in thickness: 40.6 m over the whole period = 1.4 m per year.

The ice thickness measurements of 1966 (7 profiles) were completed by 11 additional profiles at the Vernagtferner and 9 profiles at the neighbouring Guslarferner.

In the hydrological year 1966/67 the net budget of the Vernagtferner was balanced, whereas the two other test glaciers surveyed by the Commission yielded the following figures:

	specific net balance
Langtalerferner (Ötztal)	−33 mm
Schneeferner (Zugspitze)	+57 mm

In co-operation with the Geophysical Institute of the University of Innsbruck (H. Hoinkes) a photogrammetric survey of the Hintereisferner (Ötztal) was undertaken in 1967. A partial cover with new snow made conditions unfavourable for this survey. Routine surveys of the Schneeferner and Waxeggkees (Zillertal) were continued. The analysis of the contour maps of 1959 and 1966 showed a mean gain of thickness of 2.2 m and a gain of 98000 m^2 in area for the Waxeggkees.

(2) Contribution to EGIG

As in 1959/60, O. Reinwarth was the leader of the meteorological group in the station Jarl-Joset during the summer journey 1967. The group continued the series of climatological observations of 1956/57 and 1959/60 in the period from 1 June to 14 September. In addition, the heat balance for the snow surface was studied with special attention to the measurement of the radiation components.

PARTICIPATION IN EGIG

With the 1967 summer journey the second part of EGIG began. Germany was responsible for the scientific work of the following groups:

(1) Group Geodesy A (field leader: K. Nottarp), which remeasured the markers of 1959 in the E-W Profile over the Ice Cap. The comparison of the two surveys will yield the ice movement in the profile.

(2) Group Geophysics (field leaders: B. Brockamp and F. Thyssen), which repeated and extended the studies of ice thickness by seismic and electric sounding connected with gravity measurements.

(3) Group Meteorology Jarl-Joset (see above, Commission for Glaciology).

W. Hofmann

ICELAND

By a combined effort of the Iceland Glaciological Society and the National Energy Authority a precise levelling of longitudinal and transverse profiles on Tungnárjökull was carried out under the leadership of S. Freysteinsson, civil engineer, in June 1967. The levelling was combined with gravimetric measurements. The research work had to be restricted because of bad weather.

A small group, led by G. Gudmundsson, went to Grímsvötn in June and carried out the routine work of measuring the winter accumulation and studying changes in the Grímsvötn caldera.

A new hut has been added to the glaciological station Jökulheimar. The weather station housed in the old hut and run annually from early June to late September has been taken over by the Icelandic Meteorological Office. This office now also runs a weather station at Hveravellir in the highland between Langjökull and Hofsjökull. This is the only weather station in the interior of Iceland running throughout the year.

H. Björnsson, glaciologist, and J. Sigurjónsson, geomorphologist, have begun a study of the regime of Bægisárjökull, a small glacier in the highly alpine area between Eyjafjördur and Skagafjördur in North Iceland. This area is rich in small glaciers, mainly cirque glaciers, but up to now the glacier research in Iceland has been confined mainly to the big plateau glaciers such as Vatnajökull and Langjökull.

S. Thorarinsson

NORWAY

MASS BALANCE STUDIES

Observations were carried out on the following 15 glaciers in Norway during 1967: Folgefonni, Hardangerjøkulen, Ålfotbreen, Suphellebreen, Tunsbergdalsbreen, Nigardsbreen, Vetledalsbreen, Erdalsbreen, Storbreen, Hellstugubreen, Memurubreen, Gråsubreen, Blåisen, Storsteinsfjellbreen and Cainhavarre. The three last mentioned glaciers are situated in north Norway. On Spitsbergen three glaciers were investigated but only one, Brøggerbreen, had a full mass balance programme.

In all 21 people took part in the field work, and a total of 400 stakes were used for measuring the balance. Continuous observations of discharge and sediment load were also carried out on a number of glaciers. Length variations were measured at 13 glaciers, eight were retreating and five advancing.

O. Liestøl

NEW GLACIER MAP

The glaciological programme carried out by the Norwegian Water Resources and Electricity Board mainly results from the need for hydrological data in the planning of hydro-electric power plants. Most river discharge stations have long series of observations, which provide a good basis for calculations of long-term mean discharge figures for large watersheds. But for detailed planning of the utilization of high-mountain water resources it is necessary to collect discharge data from a great number of smaller basins. To make corrections in discharge figures for those amounts of water that originate from glacier variations, it has proved necessary to start detailed mass balance studies on a number of glaciers in areas of interest for future hydro-electric power plants. In connexion with these studies some investigations have been initiated in the field of glacial meteorology, ice movement and glacier erosion. The last mentioned is related to sediment transport in glacier streams, which is of interest when water reservoirs are planned.

For the glaciological investigations it is necessary to have detailed maps of good quality. Therefore a series of glacier maps has been produced in Norway during the last few years. The latest contribution to this collection of glacier maps is a new map of Erdalsbreen/Veledalsbreen north-western part of the Jostedalsbreen ice cap. The compilation was based upon vertical air photographs taken on 19 July 1966 from 7300 metres elevation, and made for the Norwegian Geographical Survey as a basis for modern topographic maps (scale 1:50000) of this part of Southern Norway. The plotting was made independently for the purpose of making a glacier map.

Scale (1:20000) and contour interval (10 m on glacier, generally 50 m elsewhere) were selected according to the size of the glacier, and followed as far as possible the recommendations given at the Symposium on Glacier Mapping held in Ottawa in 1965.

An attempt was made to divide independent snow-banks from snow areas that were considered to be a part of the glacier's accumulation area. In general, the latter were given 10 m contours (similar to the rest of the glacier), Whereas independent snow-banks are shown on the map without contours or with 50 m contours only. (Note: Outside the contoured area, e.g. in the north-eastern corner and south-west of Erdalen, no such classification was made. Some independent snow-banks on the west-facing slope of Strynekåpa were given 10 m contours by error.)

The accuracy in the main part of the map is believed to be better than 3 m in relative height determination, and better than 5 m in absolute height determination (for spot elevations on single points better than 3 m). The maximum error in horizontal determination is less than 6-8 m. Only for a section in the north-eastern corner and in a small area around Strynekåpa is the accuracy in contours and outline less, for technical reasons. In these areas another (older) air coverage had to be used, but this is of relatively minor importance for the main purpose of the map. The combination of colours as well as other cartographic details on the present map are experimental. Any comments on the map will be most welcome.

Additional copies of the map can be obtained from the Hydrological Division, Vassdragsvesenet, Box 5091 Mj. Oslo 3, Norway.

G. Østrem

SWEDEN

MASS BALANCE

The mass balance studies on Storglaciären have been continued in considerable detail. The accumulation map of 1966 was based on 323 observations and the map of 1967 on 312 observations. Between 55 and 60 stakes have been used for ablation measurements.

	1966	1967	1945-1965 average
End of accumulation season	27 May	22 May	
Beginning of ablation season	7 June	1 June	
End of ablation season	7 Sept.	21 Sept.	
Total winter balance in m^3 of water	$3.73 \cdot 10^6$	$4.19 \cdot 10^6$	$4.03 \cdot 10^6$
Total winter balance in g/cm^2	121	136	
Total summer balance in m^3 of water	$5.36 \cdot 10^6$	$4.89 \cdot 10^6$	$5.65 \cdot 10^6$
Total summer balance in g/cm^2	174	159	
Net balance in m^3 of water	$-1.63 \cdot 10^6$	$-0.69 \cdot 10^6$	$-1.62 \cdot 10^6$
Net balance in g/cm^2	53	23	
Height of equilibrium line	1500 m	1500 m	

VARIATIONS OF THE EXTENT OF SWEDISH GLACIERS

Average retreat of glacier fronts in metres.

Glacier	1963-64	1964-65	1965-66	1966-67
Storglaciären 67° 53′ N, 18° 37′ E	0	5	10	5
Isfallsglaciären 67° 53′ N, 18° 36′ E	0	5?	11	16
Rabots glaciär 67° 53′ N, 18° 26′ E	10		33	
Stuor-Räitaglaciären 67° 58′ N, 18° 23′ E	15		approx. 0 m	
Unna-Räitaglaciären 67° 59′ N, 18° 27′ E		6		
Mårmaglaciären 68° 04′ N, 18.7° E		difficult to record because of dead-ice		
Ruopsokglaciären 67° 21′ N, 18° 6′ E			14	
Pårteglaciären 67° 10′ N, 17° 45′ E			snow	

	1965-66		1966-67
Mikkajökeln 67° 24′ N, 17° 42′ E		25	
Ruotesglaciären 67° 21′ N, 17° 30′ E		approx. 10	
Suotasglaciären 67° 27′ N, 17° 39′ E		snow	
Vartasglaciären 67° 25′ N, 17° 42′ E		snow	
Hyllglaciären 67° 41′ N, 17° 29′ E		snow	
Salajekna 67° 08′ N, 16° 27′ E		20	

A more complete report has been submitted to Geografiska Annaler and will appear in Vol. 50A (2) 1968.

V. Schytt.

SWITZERLAND

Glaciological work in 1967 was carried out under the auspices of:
Gletscherkommission der Schweizerischen Naturforschenden Gesellschaft (GK), Abteilung für Hydrologie & Glaziologie der Versuchsanstalt für Wasserbau und Erdbau an der Eidgenössischen Technischen Hochschule (VAWE), Eidgenössisches Institut für Schnee- und Lawinenforschung, Weissfluhjoch-Davos (SLF), and Abteilung "Low Level Counting" des Physikalischen Instituts der Universität Bern (LLC).

ANNUAL SURVEY OF GLACIERS (GK & VAWE)

The hydrological year 1966/67 was characterized by heavy precipitations in winter and late but strong ablation in summer, resulting for most Swiss glaciers in a moderately positive balance. About $\frac{1}{4}$ of 100 observed fronts were advancing. (Kasser)

ALETSCHGLETSCHER (VAWE & GK)

Annual observations concerning the mass balance and surface velocities were continued, while monthly velocity measurements were only carried out in summer. The methodical studies for measuring large amounts of accumulation were also carried on, concentrating on A.C. techniques for locating wire markers. (Röthlisberger, Aellen, Föhn)

A study on the glacier wind was carried out and showed little relation between wind speed at the glacier surface (2 m level) and at a station outside the catabatic wind system. (Lang)

JUNGFRAUJOCH ICE CAP (GK)

A net accumulation of 1.4 m was measured in the period 15.8.1966 - 14.8.1967—more than sufficient to compensate for the loss by wind erosion in 1960 - 1962. (Haefeli)

STEINLIMMIGLETSCHER (GK)

The longitudinal strain rate near the terminus measured between two stakes 20 m apart increased from 7% y^{-1} (1965/66) to 13% y^{-1} (1966/67). At the same time an increase of the slope at the terminus was observed. The bed slip amounted to 3.3 m (1 cm/day) in 1966/67. (Haefeli)

UNTERAARGLETSCHER (GK)

A detailed report on the changes of the Unteraargletscher from 1841-1965 has been prepared for the Kraftwerke Oberhasli A.G. (KWO). (Haefeli)

STUDIES ON ICE AVALANCHES (SLF)

Model studies were carried out on a consultant basis in order to delineate the danger zone in front of the Allalingletscher. The model was calibrated with the known catastrophic Mattmark avalanche of 1965 and extrapolated to various volumes of avalanching ice. (de Quervain)

CONSULTING PROJECTS ON VARIOUS GLACIERS (VAWE, Director Prof. G. Schnitter)

Mass balance studies for hydro projects were continued in the following areas (Kasser, Siegenthaler, Widmer):

1. Gries/Blinnenhorn (Ct. Valais): After completion of an initial 5-year study a reduced long-range programme is now is operation consisting of 1:10000 maps at 10-year intervals and profiles at 5-year intervals by aerial photogrammetry, and of annual stake and some meteorological observations.

2. Limmern (Ct. Glarus).

3. Mattmark (Ct. Valais): Annual spot observations. Aerial photographs were taken for remapping the glacierized area at the scale of 1:10000, previously mapped in 1932, 1934, 1946 and 1956.

4. Silvretta (Ct. Grisons)

The studies of the snout of the Allalingletscher were continued while the contractors finished the Mattmark dam. A long-range program has been set up to collect further data on annual pulses of the snout and to ensure some documentation on the condition of the snout previous to a large ice avalanche, should another one occur. (Röthlisberger, Kasser)

Observations were continued on the glaciers around lac de Mauvoisin in the Val de Bagnes (Ct. Valais). Ice thickness, surface and bottom relief, ice discharge and flow speed have been considered to establish satisfactory safety from large ice avalanches into the lake under present conditions. (Röthlisberger, Aellen)

Hydro-glaciological studies in relation to hourly run-off forecasts for periods of up to 3 days are under way for the Grande Dixence power company. (Lang, Jensen)

BASIC STUDIES ON ICE AND SNOW (SLF)

Creep experiments. A first set of experiments was carried out at a uniaxial stress of 1 bar at hydrostatic pressures of 0 and 300 bar. It was confirmed that the strain rate is independent of (or depends very little on) the hydrostatic pressure if a constant temperature difference to the pressure melting point is maintained. (de Quervain-Jaccard-Haefeli)

Guide on measurement and mapping of seasonal snow. This document containing definitions, methods and recommendations for an observation programme was produced on request of the Commission of Snow and Ice and UNESCO in relation with the Hydrological Decade. (de Quervain)

Tomograph. An apparatus for automatic petrofabrics analysis of thin sections of ice was designed and constructed by Dr Jaccard. After modification of technical details by Dr Good the apparatus has now to prove its performance in the cold room.

Proton channeling. An apparatus is under construction to measure proton channeling effects in ice at very low temperatures. (Jaccard)

SWISS PARTICIPATION ON THE INTERNATIONAL GLACIOLOGICAL EXPEDITION TO GREENLAND (EGIG)

Ice dating project (LLC). Preliminary experiments for the in situ CO_2 extraction were carried out at Jungfraujoch in February 1967. From 25 July till 13 August 1967 a field party of 3 extracted CO_2 and Si from a total of approximately 14 t of ice at Camp III. From 18 August till 1 September CO_2 and Si were extracted from about 3.5 t of ice in 4 bore holes at Camp IV. Specimens for the determination of the $^{18}O/^{16}O$ ratio and for gas analysis were sampled at both locations. Preliminary results are that the CO_2/N_2 ratio was higher at Camp IV than at Camp III by a factor of about 5, and that the $^{18}O/^{16}O$ ratios correspond to temperatures of -30 to -35°C for the specimens of Camp III and ca -25°C for Camp IV. The presence of ^{39}Ar in the atmosphere has been demonstrated for the first time. This is an adequate isotope for dating alpine glaciers. (Oeschger, Stauffer)

Nivology (SLF). The manuscript of the nivological investigation of 1959/64 in Greenland (EGIG I) has been submitted to Meddelelser om Grønland and preparations for the 1968 field season (EGIG II) have been carried out. (de Quervain)

Rheology (GK). The manuscript on Rheology (EGIG I) is in press and will be published in 1968. The field programme for 1968 (EGIG II) for investigations in nivology and rheology has been prepared. (Haefeli)

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

This service was established by FAGS at VAWE, with P. Kasser in charge.

14th ASSEMBLY GENERAL OF IUGG (SLF, VAWE, GK)

The excursion of the Commission of Snow and Ice to the Bernese Oberland, the Grisons and the Valais were organized by members of the GK and the staff of SLF and VAWE.

R. Haefeli
P. Kasser
H. Röthlisberger

UNITED KINGDOM

RADIO ECHO EXPLORATION OF THE ANTARCTIC ICE SHEET

A joint research programme for airborne radio echo sounding of ice depth over the whole of Antarctica has been arranged between the US National Science Foundation, the Scott Polar Research Institute (SPRI) and the British Antarctic Survey (BAS).

A three-summer-season operation is planned in order to give a much more extensive and detailed knowledge of sub-ice topography than has been possible through seismic shooting and gravity measurements. (See Polar Record, Vol 13, No 85, 1967, p 413-20 for summary of previous work.)

Scientific direction: SPRI—S. Evans, G. de Q. Robin, C. W. M. Swithinbank assisted by D. L. Petrie, Mrs. A. Fuzesy, B. M. E. Smith.

Long-range aircraft: US Navy.

Equipment and personnel funds: Natural Environment Research Council, UK.

At Christchurch International Airport, New Zealand, in November 1967 a US Navy C-121J Lockheed Super-Constellation commanded by

Lt-Cdr J. K. Morrison was fitted out for the first season with two separate radio echo instruments-SPRI Mk II type (with duplication of the 35 mm photographic recorders, the least reliable part of the system). Aerials were terminated wire dipoles carried broadside to the line of flight. Correlation with the aircraft navigation system was provided by a SFIM flight recorder using 60 mm photographic paper carrying the same time-marks and event-marks as the radio echo film.

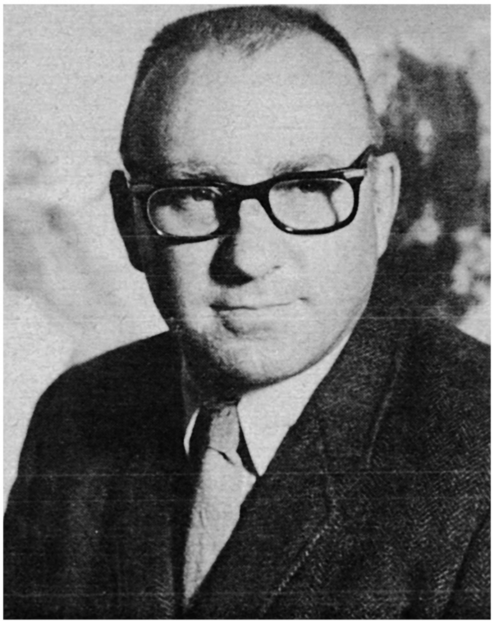
On 5 December, Robin, Swithinbank and Smith left Christchurch for McMurdo Sound, the centre from which they made over 90 hours of flights in a radial pattern ranging from 'Byrd' to 'Sovetskaya' to Ninnis Glacier. The longer flights were made principally to discover the practical limits of depth penetration for a wide range of ice temperature conditions. Longitudinal and transverse sections were made of several of the valley glaciers that feed the Ross Ice Shelf. Since weather sometimes prevented long inland flights, considerable attention was paid to the shelf itself.

On land glaciers, bottom reflections were generally continuous where ice depth was less than 2000 m but intermittent where the depth was greater. At times however, difficulties arose when recording bottom echoes from lesser depths in valley glaciers (because of swamping by clutter from heavily crevassed surfaces and by valley sidewalls on narrow glaciers). Much greater depths were recorded in the cold high plateau areas where surface elevations exceed 3500 m than in the warmer ice near 'Byrd'. The maximum depth measured was 4200 m near 'Sovetskaya'. Bottom reflections, in Marie Byrd Land, could be recorded only as far east as 'Byrd' where, at an ice depth of 2200 m, the bottom was barely discernible. In echo-weak areas a flying altitude of 300 m above terrain was normally used so that strong echoes from the ice surface and shallower horizons in the ice could be suppressed, the radio altimeter then being used to record terrain clearance. Inconvenient as the arrangement is in analysis, the extreme (sometimes as great as 60 dB) difference in strength of echoes from the upper and lower surfaces of the ice necessitated its use.

On the inland ice sheet, surprisingly strong echoes were noted from layers within the top 1400 m of ice. The layers were deeper and more extensive than had previously been reported: the interest in them is an additional incentive to improve the recordable range of echo strengths.

Bottom reflections on floating glaciers were much stronger than on land glaciers. No difficulty was found in making continuous profiles to the greatest ice depth encountered—1300 m, at the southern extremity of the Ross Ice Shelf.

The C-121J proved well suited to the task, particularly through its ability, by using an additional fuel tank installed in the passenger cabin, to make flights of over 12 hours. Comprehensive airfield facilities at McMurdo, including photo laboratories, and weather forecasting based on satellite photographs and synoptic data, made efficient operation of the aricraft possible. Effective staff planning and a keen aircrew were basic factors in the successful first season's work.



MARK F. MEIER

Mark F. Meier, contributor of that resounding and satisfying glaciological term "Gesundheitstrasse," was born in Iowa City on 19 November, 1925. He owes his early interest in mountains to his father's enthusiasm for geology. His father, Norman C. Meier, was by profession a psychologist, expert in the measurement of public opinion (George Gallup was his student) and known also for his work on creative processes in art.

In 1949, Mark received a BSc from the University of Iowa in Electrical Engineering and in 1951 an MSc in geology. For his PhD he moved to the California Institute of Technology to study under R. F. Sharp and takes pride in being one of the glaciologists produced by that distinguished professor. His dissertation on the flow of Saskatchewan Glacier in Alberta was accepted in 1957. During his student years, he worked summers in the US Geological Survey and he was instructor in geology at Occidental College, Los Angeles, 1952-55. In 1955, he led the Crevasse Study Expedition to the North Greenland Ice Cap, then went on to Innsbruck with a Fulbright grant (1955-56) to study under H. Hoinkes. He married in 1955 Miss Barbara McKinley, who had been a geology student at Occidental College; they now have three children.

From 1956 to the present, Mark has been Project Chief of the US Geological Survey in Tacoma, Washington. In making his appointment, the Survey re-established its historic interest in glaciers, which had fallen into abeyance with the death in 1948 of F. Matthes. Mark's position had, however, a new direction: the study of glaciers because they are in themselves water resources and because much glaciological evidence has direct application in hydrology. In 1964, he was Visiting Professor of Geology at Dartmouth College and, since 1965, he has been Research Professor of Geophysics in the University of Washington.

He has served on several important committees, among them the Panel on Glaciology, National Academy of Sciences (1957 to date); and the Committee on Glaciers, American Geological Union (Chairman, 1958-64). It was this last committee that first defined the concept of and need for an international effort in hydrology, which concept culminated in the International Hydrological Decade. He served on the US National Committee for the IHD (1964-66) and, since 1966, has been chairman of the IHD's Working Group on Combined Glacier Basins. He is a fellow the Arctic Institute of North America, Geological Society of America, and American Association for the Advancement of Science. He was Vice-President (1964-67) and President (since 1967) of the Commission of Snow and Ice; he was Council Member (1962-65) and Vice-President (since 1966) of the Glaciological Society. He has been an editor of the Journal of Geophysical Research (1961-63), the Bulletin of the Geological Society of America (1964-65) and, since 1961, a valued editorial advisor to the Journal of Glaciology.

His field work has produced the first structural map of a glacier (Dinwoody Glacier, 1950); the first determination of strain-rate tensor field on a glacier and an early attempt to compare flow law data from surface and subsurface deformation data (Saskatchewan Glacier, 1954); the first detailed work on deformation and temperature fields around forming crevasses (Greenland, 1955); and a mass balance study of South Cascade Glacier since 1957, including co-ordinated surface, geodetic, and hydrologic mass balance and flow measurements. Mark's comprehensive view of glaciology has always appreciated the need of a team approach that stresses interdisciplinary co-operation. He has not only worked to stimulate international co-operation, he has developed the stature to take a leading part in international programmes.

Only a scientist of careful methods and systematic habit could include such a number and variety of professional responsibilities. But he finds time also to welcome many visitors to join in family sailing expeditions and parties memorable for good music, fine wine, and gourmet food. Which of us, who climbed Mount Rainer with him in 1963, does not gratefully recall the large sack of wine he carried up on his back to ensure a relaxed appreciation at lunch of the view over Nisqually Glacier? His serious interest in art is reflected in his association with the Tacoma Art Museum and the Seattle Art League, and in his own paintings. His sense of humour, dry and oblique, is well known to his colleagues, who are frequently delighted by his clever cartoons and whimsical inventions. It was on a sketch map of the Blue Glacier that there first appeared the German name descriptive of every aspect of the constitution, structure, and other features of a longitudinal septum that ran nearly the whole length of the lower glacier. But when Mark was asked to pronounce this 10-inch word, he abandoned the attempt in favour of "Gesundheit". And Gesundheitstrasse that septum has undeviatingly remained.

MEETINGS

THE GLACIOLOGICAL SOCIETY

BRITAIN

9 February 1968, Edinburgh University:
(Joint meeting with the University Geographical Society)
J. W. Glen—Glaciers.

20 February 1968, Scott Polar Research Institute, Cambridge:
M. Vrba—Avalanches in Czechoslovakia.

THE GLACIOLOGICAL SOCIETY
FUTURE MEETINGS
ANNUAL GENERAL MEETING 25 & 26 APRIL, 1968

The 1968 Annual General Meeting will take place in the Scott Polar Research Institute, Cambridge, England, on 25 and 26 April. The programme is as follows:

Thursday, 25 April, 5 p.m.—
Business meeting, with election of new Council members.
7.30 p.m.—Dinner (Ticket prices 30s/$4.00)

Friday, 26 April, 9.15 a.m.—
G. de Q. Robin—Radio echo exploration of the Antarctic ice sheet.
M. F. Meier—Remote sense: decline and fall of field glaciology?
J. W. Glen—Electrical properties of ice.
J. G. Paren—Dielectric behaviour of glacier ice.

1 p.m.—lunch (informal, in local hosteleries).

2.15 p.m.—
G. Østrem—Glacier erosion and water power production.
H. Lister—Snow accumulation over Antarctica.
General discussion (Annual Think Session).

Tickets for the Dinner on **25 April** may be obtained from the Secretary of the Glaciological Society, c/o Scott Polar Research Institute, Lensfield Road, Cambridge, England. Last date for booking: 11 APRIL.

SYMPOSIUM ON SURGING GLACIERS

A symposium on Surging Glaciers will be held at the Banff School of Fine Arts in Banff, Alberta, Canada, from 6-8 June, 1968, under the sponsorship of the University of Alberta and the Division of Building Research of the National Research Council. The Symposium will follow the annual meeting of the Royal Society of Canada in Calgary. Topics to be discussed will include: glacial flow, geomorphologic effects, hydrology of glacial surges and related topics.

Accommodation will be available at the Banff School of Fine Arts and Centre for Continuing Education. Rates are $10 per day including meals for shared accommodation and $14-$15 per day including meals for single rooms.

The registration fee is $15 including materials but not accommodation. Application forms may be obtained from:— C. M. Lockwood, Asst. Director, Dept. of Extension, University of Alberta, Edmonton, Alberta, Canada.

INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGICAL EXPLORATION

Further to the announcement in ICE, No 25, December 1967, p 19, please note that the date for acceptance of abstracts has been extended to **1 May.**

SEMINAR ON THE CAUSES AND MECHANICS OF GLACIER SURGES

The Seminar, sponsored jointly by the National Research Council of Canada, Sub-Committee on Glaciers, and McGill University, will be held on Tuesday and Wednesday, 10-11 September 1968, at the Gault Estate of McGill University, St. Hilaire, P.Q. (by invitation only)

For details please write: Dr. Fritz Müller, Old Chemistry Building, McGill University, Montreal 2, P.Q. Canada.

SYMPOSIUM ON THE PHYSICS OF ICE

The Symposium will be held in München, Germany, 9-14 September 1968, and is sponsored by the Federal Ministry of Scientific Research and the Bavarian State Ministry of Education and Culture. An essential part of the symposium—which is to be held in English—is to deal with the electrical and mechanical processes originating from proton transfer and relaxation in ice. In this context diffusion and surface problems may be considered. Phase transitions, in particular second order transitions, are to be investigated, followed by a discussion of structure problems and lattice dynamics.

The symposium will restrict to a few review papers consideration of the application of ice physics to various problems in glaciology, meteorology and biology.

Original papers should not surpass a 20 minute limit. Participants wishing to read a paper at the symposium are asked to submit title and a 10-20 line abstract **before 1 June 1968.** Symposium proceedings will be published in book form.

The symposium fee of DM 40 (US $10) should be sent to: Dresdner Bank München/Augustenstrasse, account no. 81086, München, Germany. Forms for hotel reservations (to be returned by 22 July 1968) and information about the symposium may be obtained from: Professor Dr. N. Riehl, Physics Dept., Technische Hochschule München, Arcisstrasse 21, D-8 München 2, Germany.

GLACIOLOGICAL DIARY

1968

16 - 19 April
Symposium on the remote sensing of environment. University of Michigan, USA (Dana C. Parker, University of Michigan, Willow Run Laboratories, PO Box 618, Ann Arbor, MI 48107, USA).

25 - 26 April
Glaciological Society Annual General Meeting SPRI, Cambridge, England (See p 21 this issue).

5 - 7 June
SHF Symposium on surge prediction and flood protection, and field trip. (Details: SHF Bull. 2 & 3 Dec 1967.) (The Secretary, Société Hydrotechnique de France, 199 rue de Grenelle, Paris, France.)

6 - 8 June
Symposium on surging glaciers, Banff, Alta., Canada. (See p 21 this issue.)

2 July - 15 August
McGill University: in co-operation with the Arctic Institute of North America, Geography Summer School, Program of Polar Studies: The circumpolar lands. Professors: J. Brian Bird & D. C. Foote. Includes Arctic & sub-Arctic environments, culture respose to polar conditions, regional changes in the past 2 decades. (Dr R. N. Drummond, Director Geography Summer School, McGill Univ., Montreal 2, PQ, Canada.

19 - 28 August
International Geological Union, congress. Prague, Czechoslovakia. (Int. Geological Congress, 23rd Organizing Committee, Malostranske namesti 19, Praha, Czechoslovakia.)

2 - 7 September
SCAR Working Group on Glaciology—International Symposium on Antarctic Glaciological Exploration. (With support of Commission of Snow and Ice, IASH.) Dartmouth College, Hanover, New Hampshire, USA. (See ICE no 25, Dec 1967, p 16 for details.)

9 - 14 September
Symposium on the physics of ice. München, Germany. (See this page above.)

10 - 11 September
Seminar on the causes & mechanics of glacier surges. Montreal, Canada. (See p 21 this issue.)

11 - 13 November
Geological Society of America, annual meeting. Mexico City. (GSA HQ, 231 E 46th Street, New York, NP 10017, USA.)

1969

January or February (exact date to be announced)
Northeastern North American Branch of the Glaciological Society, Montreal, Canada. Annual meeting. Field trip at Mt. Tremblant follows. (Dr E. R. Pounder, Dept. of Physics, McGill Univ., Montreal, P.Q., Canada.)

30 August - 5 September
International Union for Quaternary Research (INQUA), VIII Congress. Paris, France. Excursions and symposia before and after the congress. (INQUA Secretariat, Institut de Géographie, 191 rue Saint-Jacques, Paris 5, France.)

7 - 13 September
Glaciological Society, symposium on the hydrology of glaciers. (Jointly sponsored by the Society and the Commission of Snow and Ice, IASH.) Cambridge, England. (Mrs H. Richardson, Glaciological Society, c/o Scott Polar Research Institute, Cambridge, England.)

1971

Pacific Science Association, conqress. 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. Matthews, Dept. Geography, Univ. of British Columbia, Vancouver 8, B.C., Canada.)

GLACIOLOGICAL SOCIETY

SYMPOSIUM ON THE HYDROLOGY OF GLACIERS

1969

First Circular

A Symposium on the Hydrology of Glaciers will be held in Cambridge, England, from 7 September to 13 September 1969. The Symposium will be organized by the Glaciological Society and will be jointly sponsored by the Commission of Snow and Ice (International Association of Scientific Hydrology). Other Commissions of IASH are cordially invited to participate.

1. TOPICS

The Symposium will include papers on the water balance of glaciers, the movement and storage of water within glaciers, the glacier considered as a ground-water system, and the glacier considered as a source of stream flow.

2. PAPERS

Those who would like to contribute are asked first to submit a **summary** of their proposed paper, in English or French. A summary should contain sufficient detail to enable the Papers Committee to form a judgement on the likely merit of the proposed paper, but it should not exceed three pages of typescript.

Date for submission of summaries: 1 January 1969

One copy of the summary should be sent to:

The Secretary, Glaciological Society,
c/o Scott Polar Research Institute,
Cambridge, England.

On the basis of these summaries the Papers Committee will invite a limited number of papers. It is hoped to notify authors by 1 April 1969.

The **final paper** should be written in English or French, with abstracts in both languages, and should not exceed 15 pages of typescript, including illustrations.

Date for submission of final papers: 1 August 1969

3. PUBLICATION

Papers presented at the Symposium will be refereed according to the usual standards of the Journal of Glaciology before being accepted for publication in the Proceedings of the Symposium.

4. GENERAL PROGRAMME

The proposed programme will include five days for the presentation and discussion of papers, visits to laboratories and institutes, and to colleges and other historic buildings. A tour of the Scottish mountains will take place after the Symposium, beginning on 13 September.

5. FURTHER INFORMATION

You are invited to attend this Symposium and to return the attached form as soon as possible. A Second Circular will be published in due course, giving details of accommodation, tours, ladies' programme, and instructions on the preparation of manuscripts.

Requests for copies of this First Circular and enquiries about the Symposium should be addressed to:

The Secretary, Glaciological Society,
c/o Scott Polar Research Institute,
Cambridge, England.

GLACIOLOGICAL SOCIETY

SYMPOSIUM ON THE HYDROLOGY OF GLACIERS

1969

Family name ....

Title .... First name ....

Address ....

....

....

....

I hope to participate in the Symposium on the Hydrology of Glaciers, in Cambridge, England, in September 1969 —

☐

I expect to submit a summary of a proposed paper —

☐*

* without obligation

TO BE SENT AS SOON AS POSSIBLE TO:

The Secretary, Glaciological Society,
c/o Scott Polar Research Institute,
Cambridge, England.

AWARDS

The Northeastern North American Branch of the Glaciological Society was pleased to be asked by the office of the Canadian Secretary of State to nominate one person for award of a Centennial Medal in recognition of outstanding service for contributions to our area of interest. After some deliberation, keeping in mind the spirit of the award and the thought that it should have some relevance to the Centennial year in Canada, the branch proposed Mr. André Maisonneuve, a photogrammetric cartographer with the Surveys and Mapping Branch of the Department of Energy, Mines and Resources. The citation for his medal reads in part:

> "Mr. Maisonneuve has played an important part in making Canada a leader in the specialized art of producing glacier maps . . . One dramatic highlight of his service in 1967 occurred when Mr. Maisonneuve was working on a special Centennial map of south-west Yukon (the Centennial Range map) and he noted on air photographs the remains of a tent camp on the upper part of Mount Logan, Canada's highest mountain. The camp has been identified as that left by a mountaineering party some years previously. Mr. Maisonneuve's alertness has provided glaciologists and climatologists with the first positive indication of the amount of snow accumulation and storm action at very high elevations in the Yukon, and it contributed to the establishment, later this year, of the highest research station on the continent, close to where he discovered the old camp. The . . . (award) . . . is made, however, not because of a single incident, but in recognition of Mr. Maisonneuve's continued interest and contributions."

The Royal Society has recently announced the election to Fellowships of Dr. R. G. West, Cambridge University and Professor J. Tuzo Wilson, Toronto University.

INSTITUTE OF LOW TEMPERATURE SCIENCE

The Proceedings of the Conference on Low Temperature Science, 1966, is now on sale at: MARUZEN CO. LTD., PO BOX 605, Tokyo Central, TOKYO, JAPAN.

Price in Tokyo: Vol. 1—Physics of Snow and Ice; Part 1—Y 5000, Part 2—Y 4900: Vol. 2—Cryobiology, Y 1900.

NEW GLACIOLOGY SUB-DIVISION

Dr. O. H. Løken was in late October 1967 appointed Head of the Glaciology Sub-Division of the Inland Waters Branch, Department of Energy, Mines and Resources, Ottawa. Dr. Løken has been involved in glaciological and glacial geomorphological studies in Norway, Spitsbergen, Antarctica and in Arctic Canada. He was until recently with the Geographical Branch of the department and was leader of the Baffin Island Project.

AVALANCHES IN SCOTLAND

Milos Vrba of the Society and of the Czechoslovak Mountain Rescue Service taught at the Winter Survival Course of the Scottish Council of Physical Recreation at Glenmore Lodge, Aviemore, 19-29 February 1968. The course included classes in both avalanche prediction and rescue, since, with the growth of winter sports in Scotland, several avalanche accidents have occured there in recent years. Vrba lectured several times and, in the mountains, demonstrated how to make snow profiles and use the rammsonde. Other demonstrations and exercises covered radio communications, probing, and the use of dogs for rescue.

GLACIOLOGY AT THE UNIVERSITY OF WASHINGTON

The University of Washington has expanded its Geophysics programme to include a new curriculum and further additions to its diversified research program in glaciology. Glaciology, "the study of snow and ice in all forms", is an interdisciplinary science which involves all Departments participating in the University's Geophysics Program: Atmospheric Sciences, Geology, Chemistry, Physics and Oceanography. The Pacific Northwest is the only region in the United States (excluding Alaska) where significant glaciers exist. The University of Washington is ideally located to pursue glaciological research because of this proximity to glaciers and extensive winter snow covers. Furthermore, interest in glaciology by several nearby government agencies has increased the demand for people with appropriate training.

The sequence of courses briefly described below is a first step toward the establishment of a comprehensive graduate curriculum in glaciology as an active branch of geophysics.

PHYSICS OF ICE AND SNOW

Structure of water molecule. Crystallographic structure of ice. Electrical, optical, thermal, and mechanical properties of ice. Growth of ice from vapour and liquid phases. Physical properties of snow: Professor: Dr Peter V. Hobbs.

GLACIOLOGY I—FORMATION OF SNOW AND ICE MASSES

Snow climatology. Transport of snow by wind. Transfer of radiative, sensible and latent heat at the surface of snow and ice. Freezing of natural water bodies. Heat and mass budget of ice masses. Theories of ice ages. Professor: Dr. Norbert Untersteiner.

GLACIOLOGY II—STRUCTURAL GLACIOLOGY

Heat and mass transfer in snow and ice, Metamorphism. Effects of heat conduction, vapour diffusion, radiation, solid impurities, brine inclusions. Petrography of snow and ice, flow structures. Bulk physical properties of natural snow and ice. Professor: Dr Norbert Untersteiner.

GLACIOLOGY III—DYNAMIC GLACIOLOGY

Flow laws of ice, steady laminar flow. Sliding on bedrock. Kinematic waves, glacial surges. Snow and avalanche dynamics. Deformation and drift of sea ice. Relation of structures to deformation. Professor: Dr. Mark F. Meier.

FIELD GLACIOLOGY

Methods and techniques of glaciological research. Course will be conducted partly at the University of Washington and partly at the Blue Glacier research station on Mount Olympus. Professor: Dr. Edward R. LaChapelle.

Further courses will be added as the program develops. For further information on admission requirements, student support and current research projects write to: University of Washington, Graduate School: Admissions, Seattle, WA 98105, USA, or to: Dr. N. Untersteiner, Associate Chairman: Geophysics, University of Washington, Seattle, WA 98105, USA.

REVIEW

J. BRIAN BIRD. The physiography of arctic Canada with special reference to the area south of Parry Channel. Baltimore, Maryland. Johns Hopkins Press, 1967.

The area discussed in this book is both large and scenically varied. The region treated in most detail, the irregular band lying between the Arctic Circle and Parry Channel, has already been described by Professor Bird in a series of reports to the RAND Corporation. However, for his examples, the author ranges widely over the whole Arctic and occasionally mentions the Antarctic, especially in the third section of the book, which deals with geomorphic processes.

The book is divided into four sections. The first covers geology, climate, glaciers, permafrost, soils and vegetation, and provides a useful background to the physical geography of the Arctic. The present distribution of glaciers, restricted almost entirely to the eastern Canadian Arctic, is particularly striking, but the emphasis of the book is on the much larger nonglacierized area of northern Canada. A section on permafrost covers not only Canada but describes also conditions in the USSR and Alaska.

The second section deals with the chronological development of the landscape of parts of northern Canada, particular emphasis being given to an account, more descriptive than analytical, of erosion surfaces. Although some erosion surfaces are conspicuous in the field, their mode of origin and age require further elucidation. Chapters on glacial chronology and marine transgressions are based on more positive depositional evidence, for material on these topics is accumulating at an accelerating rate as more field work is carried out in many areas, such as central Baffin Island, on which the Geographical Branch of Canada has concentrated for several years. Recent work on post-glacial uplift will add much useful information also.

The third section of the book covers currently acting processes. Many interesting processes and features are mentioned, some with tantalizing briefness. For example, patterned ground resulting from sorting is covered in less than one page, and valley glaciers and ice caps have only three pages between them.

The final section of the book deals with limestone regions, arctic terrain as identificable on air photographs, and arctic coasts. The attention devoted to limestone landscapes reflects in part the author's own field work and particular interest in the effect of climate on karst landforms. The section on arctic coasts is descriptive and stresses the great variety of coastal types. A suggested classification of arctic coasts is used in the description of different types, the chief of which are upland coasts, coasts of moderate relief, and lowland coasts.

In this fairly short book (290 pages of text), the author has provided a useful foundation on which to build a more complete and detailed account of the history of the landscape of this vast area and of the processes that have modified it and are currently modifying it. It is a pity that some maps and photographs are not as clear as they could have been; some of the photographs, in particular, have not been well reproduced. The book ends with an excellent bibliography of more than 750 titles, a useful guide to more detailed information.

C. A. M. King

BOOKS RECEIVED

Geology of the Himalayas. A. Gansser. London, John Wiley & Sons Ltd, 1965. 210s.

A Survey of Neoglaciation in the Front Range of Colorado. Samuel I. Outcalt **and** D. D. McPhail. Boulder, University of Colorado Press, 1965. $5.50.

Studien zum Grundwasserchemismus des nordwestlichen Bodenseeraumes. Manfred Strässer. Freiburger Geographische Hefte. Heft 2, 1966, 82 p, illus, maps.

Das Eiszeitalter Grundlinien einer Geologie des Quartärs. Band 3. (Afrika, Asien, Australien und Amerika im Eiszeitalter.) Paul Woldstedt. Stuttgart, Ferdinand Enke Verlag, 1965, 24 cm, 328 p. DM 63.

The Origin of Continents and Oceans. Alfred Wegener (1929) (Translator: John Biram). New York, Dover Publications Inc, 1966, 22 cm. 246 p. 16s.

Aspects of the study of Regional Geographical Structure. K. Ivanicka (Ed). Bratislava, Slovak Pedagogical Publishers, (Acta Geologica et Geographica Universitatis Comenianae, Geographica Nr 6) 1966, 320 p, illus, maps.

Introduction to Geology. W. L. Stokes **and** S. Judson. London, Prentice-Hall International, 1968, 530 p, illus, maps.

Atmosphere, Weather & Climate. J. Barry **and** R. J. Chorley. London, Methuen & Co. Ltd, 319 p, illus, maps. paperback 25s. hardback 45s.

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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

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