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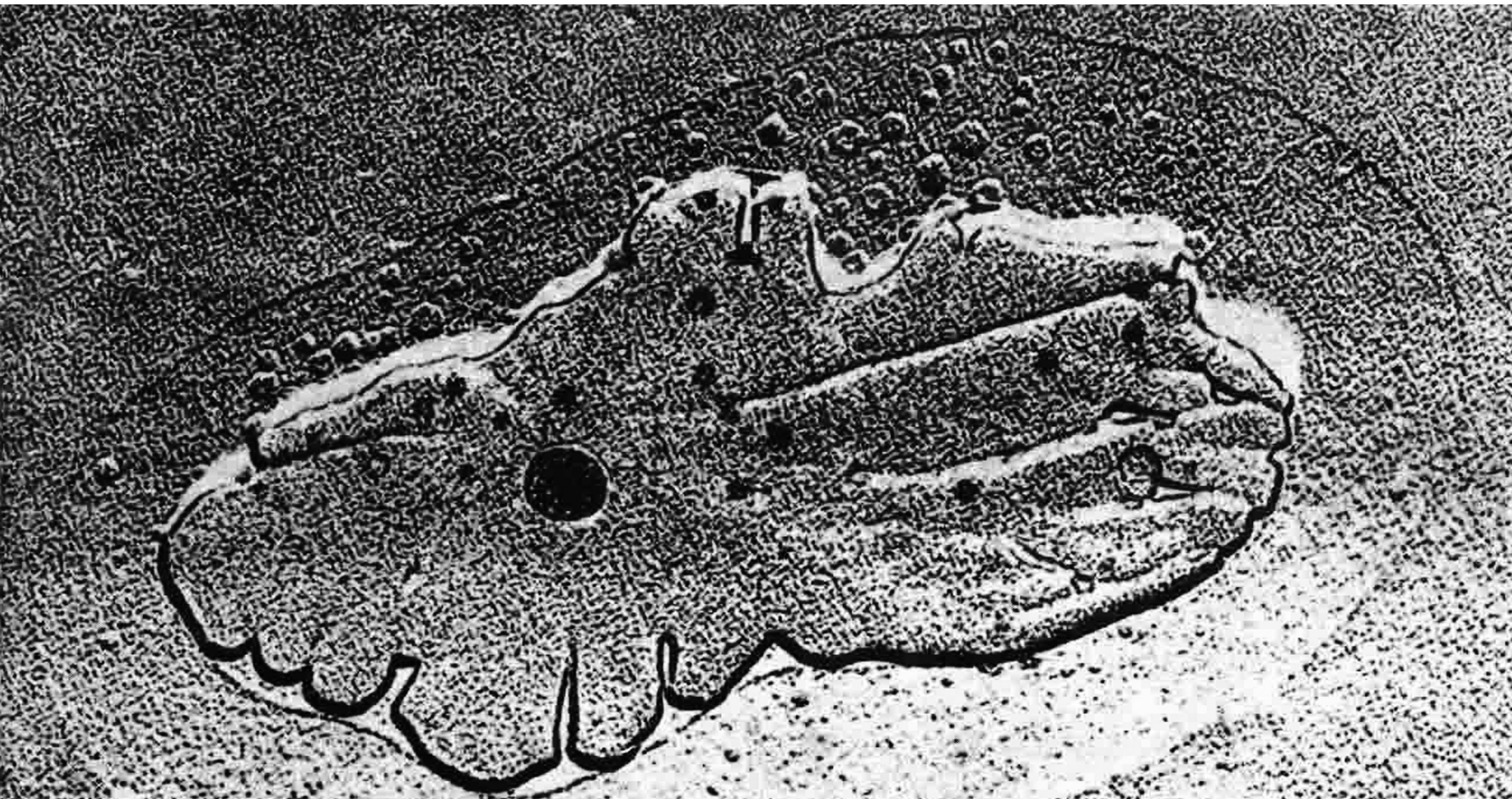


The Glaciological Society

1964

ANNUAL GENERAL MEETING AND DINNER

As announced previously the meeting will take place on **Saturday, 25 July,** at **7.0 p.m.** in the Senior Common Room of Imperial College, London, S.W.7, and will be followed by a Dinner Dance at **8.0 p.m.**

Members are urged to make their bookings for Dinner as soon as possible. Tickets are now being issued, Price **£1 10s. 0d./$4.20** each, inclusive of wines.

Please send your Cheque or Postal Order
(payable to The Glaciological Society)

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

FINAL BOOKING DATE—25 JUNE

ICE

News Bulletin of the Glaciological Society

APRIL 1964 NUMBER 14

CONTENTS

LIST OF MEMBERS AND SUBSCRIBERS. The March 1964 list is circulated with this issue of Ice. The Secretary of the Society will be pleased to receive amendments.

Membership is rising steadily, but many more members are needed if we are to be certain that the Society and its Journal can effectively serve glaciologists throughout the world. Inside the List of Members you will find a form asking for the names of people you consider should be members of the Society: we feel that personal recommendation and persuasion are the most effective means of getting new members. Can you prove us right?

1964 DUES. One third of our members have not yet paid their dues for this year. Only by prompt payment will you ensure that you receive the Journal of Glaciology regularly.

DUPLICATE PAPERS. Spare copies of papers donated to the Society's library are available free to members of the Society. A list of these duplicates may be obtained from the Glaciological Society Library, Little Dane, Biddenden, Ashford, Kent. We shall be pleased to receive spare reprints of articles published by members in other journals, so that we can continue this service to members.

COVER PICTURE. Electron micrograph (X61,500) of a nucleus (solid combustion product) of an ice-fog crystal formed at -37° C at Fairbanks, Alaska, on 3 February 1963. Electron micrograph is by Dr. Motoi Kumai, physicist, Experimental Research Branch, Research Division, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, U.S.A.

FIELD WORK

As announced in the previous issue of "Ice" (number 13, December 1963) this section now includes field reports formerly appearing in "Glaciological Notes" (published by I.G.Y. World Data Center A Glaciology, American Geographical Society, Broadway at 156th Street, New York 32, N.Y., U.S.A.) The annual review of field work will be published in "Ice" in April and August; the Southern Hemisphere reports will be included in the section appearing in August.

The Editor is grateful to all contributors for the information they have provided for this review.

AUSTRIA

The position of the terminus was measured in relation to fixed points for 77 glaciers in the Austrian Alps. All but one were found to be retreating; the Waxeggkees (Zillertal Alps) was reported to be advancing. The work was sponsored by the Österreichischer Alpen-Verein, and a summary report by Prof. R.v. Klebelsberg was published in Mitteilungen des Österreichischen Alpenvereins vol. 19 (89), No. 1/2, February 1964.

HINTEREISFERNER: Mass budget investigations were continued, including ablation measurements at 65 stakes and several snow-pits. Comparative measurements of discharge were carried out, using sodium bichromate and dye. A new recording stream-gauge was installed near Vent, and a new rain-gauge set up. Principal investigator: Institut für Meteorologie und Geophysik, Universität Innsbruck.

A network of 25 stakes was resurveyed by W. Ambach in order to analyze the vertical component of surface movement, and deformation.

Several transverse profiles were surveyed and the triangulation network completed by H. Schatz.

KESSELWANDFERNER: Between 15 July and 15 August a pit was dug to a depth of 20 m at an altitude of 3240 m.a.s.l. Density and stratigraphy of firn were analyzed and annual layers identified back to 1949, using also the pollen-content in deeper layers. 60 firn samples, each containing 2-3 litres of water were flown back to Innsbruck, in order to investigate the radio-active stratification originating from atmospheric fall-out. Principal investigators: W. Ambach and H. Eisner. (The pit is still accessible and work will be continued this summer.)

SONNBLICKKEES (Granatspitze west of Gross-Glockner): A new programme of mass budget investigations was initiated. 32 ablation stakes were set, 4 collecting rain-gauges set up, and a recording instrument for global radiation installed at the nearby climatological station Rudolfshütte-Weissee (2315 m). Sonnblickkees and Ödenwinkelkees were surveyed photogrammetrically, and terminus positions and transverse profiles were surveyed for several small glaciers. Principal investigators: Heinz Slupetzky and Werner Slupetzky.

PASTERZENKEES (Gross-Glockner): Several transverse profiles and terminus positions were surveyed by H. Paschinger (Universität Graz), and annual net-accumulation studied by H. Tollner (Salzburg). H. Tollner also estimated the mass budget values of several small glaciers in the area of Hoher Sonnblick (3106 m), and of Schmiedingerkees.

SOIL PROFILES were studied in the vicinity of several glaciers in the Stubai- and Ötztal Alps, in order to investigate the chronology of glacial advances from late Würm up to 1600 A.D. Special attention was paid to the stratigraphic relationship between Daun- and Larstig-moraines, i.e. before and after the Hypsithermal interval. Work is to be extended to the Western Alps this summer. Principal investigators: H. Heuberger and F. Mayr, Geographisches Institut der Universität Innsbruck.

H. Hoinkes

CANADA

1. INTRODUCTION

(a) In 1963 field glaciological work was carried out by Government Departments, Universities, and private organizations in the following areas: the Athabasca Glacier and Saskatchewan Glacier area in Alberta; the Monashee Mountains, British Columbia; the Icefield Ranges, Yukon Territory; central Labrador; Baffin Island; and in six areas of the Queen Elizabeth Islands, namely Devon Island, Cornwallis Island, Melville Island, Axel Heiberg Island, Meighen Island, and northern Ellesmere Island. Photogrammetric and laboratory studies, and work on the inventory of Canadian glaciers were continued. An extensive programme of mapping of glacierized areas is being continued both in the field and in the office.

(b) The Sub-Committee on Glaciology has been renamed the Sub-Committee on Glaciers. It is well recognized that glaciology covers the study of ice in all its forms, and the new name is therefore more appropriate because by its terms of reference the sub-Committee is principally concerned with research on glaciers in Canada. Other aspects of glaciology in Canada are the concern of three bodies: the Sub-Committee on Hydrology (Chairman, Mr. R.H. Clark), which among its other interests deals with the hydrology of glaciers; the Sub-Committee on Snow and Ice (Chairman, Mr. L. W Gold) of the Associate Committee on Soil and Snow Mechanics (National Research Council), which deals mainly with the properties of snow and ice as related to engineering problems; and the Working Group on Ice in Navigable Waters (Chairman, Mr. T.A. Harwood) of the Canadian Committee on Oceanography, which deals with sea, lake and river ice. There is very properly a degree of overlap of the interests of all four bodies, which roughly parallel the divisions within the Commission of Snow and Ice of the International Association of Scientific Hydrology.

2. ALBERTA

(a) Athabasca Glacier (University of British Columbia)

The work on borehole deformation which was begun on the Athabasca Glacier in 1959 is now essentially complete. The one cased borehole which remains open was resurveyed by inclinometer during the summer of 1963 by Dr. J. C. Savage. The surface movement of five semi-permanent markers on the ice was also measured. These observations were intended only to extend the time range of measurements already made. The results obtained appeared to be consistent with the trend established from the previous investigations.

(b) Saskatchewan and Athabasca Glaciers (University of New Brunswick; Water Resources Branch, Dept. of Northern Affairs and National Resources)

A terrestrial photogrammetric survey of the Saskatchewan Glacier was performed in July 1963 by a party from the University of New Brunswick, under Dr. G. Konecny, in co-operation with a party from the Water Resources Branch, under Mr. I. A. Reid. The Topographical Survey of the Dept. of Mines and Technical Surveys also assisted. Permanent control points were established around the perimeter of the glacier; their positions were determined by triangulation survey, and checked in some cases by geodimeter distances. Two borehole casings, situated near the head of the glacier, were tied into the survey, as they will be on future surveys, in order to obtain a measure of movement and ablation.

Phototheodolite photographs of the Athabasca and Dome glaciers, and of the northern glacier of Mount Athabasca, taken in 1962, and velocity measurements of the Athabasca Glacier, also made in 1962, were repeated at the same positions in 1963. A new photogrammetric base line was established for the toe of the Athabasca Glacier, and two profiles were laid out across the glacier, along which gravity was measured with a LaCoste-Romberg gravimeter.

The evaluation of the 1962 Athabasca Glacier survey is partially completed; a comparison between the accuracies of terrestrial and aerial photogrammetric contouring is being made at a scale of 1:5,000 with 5 m contours. The evaluation and compilation of the 1963 surveys of the Saskatchewan and Athabasca glaciers is in progress; a Wild A-5 stereo-photogrammetric plotter is being used to prepare plots at a scale of 1:5,000 for the whole glacier and at a larger scale for the area of the toe. A map of the entire survey area of the Saskatchewan and Athabasca glaciers at a scale of 1:25,000 with 100 ft. (30 m) contours has been plotted from aerial photographs on the Wild A-5 instrument. Replotting of metric contours, scribing and editing for the map is being undertaken by Mr. G. Gloss of the University of New Brunswick.

(c) Saskatchewan, Athabasca, and Dome Glaciers (Dr. W. O. Field, American Geographical Society)

The Athabasca and Dome glaciers were photographed by Dr. Field on 9 to 11 September from four of his former photographic stations. One of these stations was first occupied in 1922, and subsequently in 1948, 1949 and 1953; two in 1948, and subsequently in 1949 and 1953; and one was first occupied in 1953. Approximate azimuth readings indicated that the terminus of the Athabasca Glacier receded at a rate of about 21 m/year from 1953 to 1963; further information on the recessions will come from a comparison of the photographs taken in the two years. Approximate azimuths from two stations indicated that the Saskatchewan Glacier had receded at a rate of about 25 m/year in the same ten-year period.

3. MONASHEE MOUNTAINS, BRITISH COLUMBIA* (Geological Survey of Canada)

Dr. J. O. Wheeler continued collecting cores from trees just below the trim-lines of the last maximum stand of several glaciers in the Monashee Mountains. He is studying these and other cores collected over the past four years in the Selkirk and Monashee Mountains.

4. LABRADOR (McGill University Subarctic Research Laboratory, Knob Lake)

The permanent programme of snow, lake ice and permafrost measurements is continuing under the direction of Mr. W. P. Adams.

5. ICEFIELD RANGES RESEARCH PROJECT (American Geographical Society; Arctic Institute of North America)

(Briefly summarised in Ice 13, December 1963, p.2)

6. BAFFIN ISLAND (Geographical Branch, Dept. of Mines and Technical Surveys)

For the second full season Geographical Branch field work was heavily concentrated in northern Baffin Island. Field parties under the direction of Mr. J. T. Andrews, Mr. G. Falconer, Dr. G. Østrem and Mr. R. B. Sagar were in the field from mid-April until late August 1963. The 18-man operation was under the supervision of Dr. J. D. Ives.

(a) Barnes Ice Cap

Studies of mass balance and energy balance were continued on the Barnes Ice Cap by Mr. R. B. Sagar, assisted by Mr. C. Bridge, from mid-April to late August. Travelling by motor toboggan in the spring, they established accumulation and ablation markers at 165 stations over wide areas of the ice cap at varying altitudes, and measured more than 800 snow profiles with a "Monte Rosa"-type sampler. From altitude interval areas for the northern two-thirds of the ice cap and from limited ablation data, rough calculations for 1962 give a specific net ablation of 0.5 m, with ablation varying from zero at the crest to 2.5 m at the margins; and for 1963 a specific net accumulation of 0.01 m with accumulation of 0.5 m at the crest and ablation up to 1.8 m at the margins. The accumulation for 1962-63 was about 40 per cent greater than for 1961-62, due mainly to heavier autumn and winter precipitation, associated with prolonged periods of easterly and south-easterly winds. Greater snow depths were encountered on the southern lobe than on the main part of the ice cap - about 160 cm as against 120 cm for mean values at the crest. Owing to persistence of easterly winds, the summer climate was appreciably cooler and the melt period shorter in 1963 than in 1962. The 1963 summer showed 340 hours with the air temperature above 32^{o} F, for a total of 810 degree-hours, and the 1962 summer 630 hours, for a total of 2,812 degree-hours. Period wind speeds and relative humidities were comparable for the two seasons. Preliminary comparison of radiative energy receipts indicated similar insolation in the two seasons, although short-wave energy receipts were rather lower in 1963 owing to the albedo effects of a longer period of snow cover in the spring. But from the cloud cover and surface temperature it would seem that long-wave energy losses in 1963 were lower than in 1962, so that net radiative energy receipts were similar in the two seasons.

* Published by permission of the Director of the Geological Survey of Canada.

Loss of sub-surface cold content was about 1,800 langleys in 1962 and 1,260 langleys in 1963, with resulting lower ablation in 1963 - 20 cm as against 35 cm (water equivalent) at the base camp. There were similar amounts of precipitation in the summers of 1962 and 1963 (4 to 5 cm water equivalent), and similar proportions of rain to solid precipitation, but in 1963 there were one and a half times as many days with precipitation.

Cores from the ice cap up to 8 m in length were studied for stratigraphic data; significant layers of iced firn were observed. Ice samples from two well-defined layers at 50-70 cm and 70 — 100 cm depths were collected, melted and brought out for dating.

(b) Lewis Glacier

Further detailed work on the Lewis Glacier at the north-west corner of the Barnes Ice Cap was carried out by Dr. G. Østrem, Mr. J. T. Andrews, and Mr. M. Church. A level survey was carried up the glacier from the terminus at 244 m to an elevation of 473 m, and 15 ablation and movement markers were set up. Ablation at the upper stakes amounted to 150 cm of ice, and near the margins 200 cm; no measurable movement of the stakes was found over a period of five weeks. A permanent base line was surveyed, and a plane-table map of the glacier on a scale of 1:2,000 was constructed. Volumetric fluctuations and silt content of the Lewis River were measured.

(c) Small ice caps of the northern interior

Three small ice caps in lat. 71° 20' N, long. 78° 45' W, about 12 miles north of the eastern end of Pilik Lake were visited by Mr. G. Falconer and Mr. K. Sedgwick. Special flights were made in order to obtain low level photographs of the ice margins for comparison with air photographs of 1962. On the west side of the largest of the three ice caps, cairns were built to show present and previous ice margins as determined from a careful study of patterned ground features in air photographs of 1949, 1959 and 1961. Lichens recently uncovered by recession of the ice were collected for radiocarbon ageing; recession of the western margin was estimated at 60 m since 1958. The ice cap is about 640 m above sea level, and probably not more than 50 m thick. Many other small ice caps and ice patches were observed and photographed within a radius of 80 km.

(d) Glaciers of the Bruce Mountains

Mr. D. Harrison and Mr. R. Cowan made a reconnaissance survey of two glacier snouts in the Bruce Mountains; the glaciers are near the western end of the pass running from Cape Adair to Dexterity Fiord, and one has a southern and the other a northern aspect. Cairns and a base line were established off the glaciers, and plane-table maps were made of the snout and terminal moraine zones on a scale of 1:2,500. The glaciers were photographed from fixed stations.

(e) Glacial geomorphology

Lichenometric techniques were used to study the recent history of the Barnes Ice Cap. Mr. Andrews, in collaboration with Mr. P. Webber of Queen's University, studied lichens at 250 stations for a distance of 80 km along the perimeter of the ice cap. Dr. R. Beschel of Queen's University also visited the area as a consultant. It would appear that the north-western margin of the ice cap and the Lewis Glacier started a steady recession about 2,000 years ago, then re-advanced in about 1700 AD to form a series of valley end-moraines. The western margin of the ice cap also receded during the earlier period, but not as much. An ice-cored moraine was formed here during the "little ice age", but since 1700 AD the ice has merely thinned without losing contact with the morainic section. On the other hand, in the case of the Lewis Glacier and the northern feathering margin of the ice cap, the recession has amounted to 3-5 km. Near the north-western margin of the ice cap above Flitaway Lake, a small peat deposit and pieces of wood from a moraine within the 1948 ice limit were found.

Dr. Østrem collected a second sample of "snowbank" ice from the ice-cored moraine on the west side of the Barnes Ice Cap, which he investigated in 1962. On this occasion 1,000 kg of ice was taken, melted in the field, and the residual impurities brought south for radiocarbon dating. A permanent snowbank was sampled in the same way for a comparative dating test. Samples were also collected for crystallographic analysis in the cold room and for tritium dating. It is hoped that this series of samples will permit the elimination of the problem of inorganic carbon contamination.

(f) Photographic survey of glaciers

Several photo-reconnaissance flights were made by Dr. Ives and Mr. Falconer. Numerous photographs were taken in colour and in black and white for inclusion in the Canadian Glacier Inventory.

7. BAFFIN ISLAND* (Geological Survey of Canada)

During Operation "Admiralty" in 1963, in addition to casual observations on many small ice caps in northern Baffin Island, three sites on Borden Peninsula (in lat. 72° 23' N, long. 82° 18' W; lat. 73° 12' N, long. 83° 12' W; and lat. 73° 14.5' N, long. 81° 14' W) were visited by Drs R. G. Blackadar and B. G. Craig. At each site cairns were built close to the snouts of small ice tongues leading down from ice caps. The distance of each cairn from the ice margin was measured, photographs were taken, and messages were left requesting the finders to make similar records.

8. CORNWALLIS ISLAND (Defence Research Board)

In September 1962 Mr. H. Serson and Mr. R. Yank visited an ice cave 3 km east of the South Camp, at lat. 74° 41' N, long. 94° 40' W in a gully which faces west and is largely filled with ice; it was first noticed in a photograph taken in August 1959. In September 1962 the cave was 41 m long and 12 m wide, with the rock floor sloping at an angle of 30°. In September 1963 it was resurveyed, various ice samples were collected, and an ice core was taken from the roof. In the interval of a year the roof of the cave had increased in thickness by about 60 cm through the accumulation of superimposed ice at the upper surface, while on the inside about 2.5 cm of ablation had occurred during the 1963 summer. The ice core showed 8 distinct dirt layers and two probable layers, spaced about 60 cm apart in a total depth of 6.8 m, while inside the cave from 10 to 20 distinct lines, which might be dirt layers, were evident on the walls. It was concluded that the ice cave formed in an ice accumulation from a snow-drift on the south side of the gully; the ice mass bridged the summer melt stream, and grew to its present size over a period of about 30 years.

9. DEVON ISLAND (Arctic Institute of North America)

Glaciological and glacial-meteorological studies were continued on the Devon Island ice cap and glaciers for the third consecutive season - from mid-May to the end of August, 1963.

(a) Ice cap

Mr. R. M. Koerner (glaciologist) and Mr. U. Gaustad (assistant) used a "Weasel" tractor and motor-toboggan to make six glaciological traverses from the summit of the ice cap as follows: to the north-western margin of the ice cap, to the large outlet glacier entering Brae Bay, to the glacier entering Jones Sound at long. 82° W, to the head of Hyde Inlet, to the large outlet glacier on the west side of the Cunningham Mountains, and to the margin of the ice cap above Croker Bay. Particular attention was directed to the annual mass budget by means of detailed measurements of the winter snow cover at stakes erected in 1961 and 1962, and of numerous pit studies of temperature, density, stratigraphy and grain size. The pattern found in 1962 of markedly higher accumulation on the south-east side of the ice cap than on the north-west was again noted in 1963. Detailed deep pit studies, begun in 1962 to a depth of 22 m at the top of the ice cap, were continued; the ice petrography of many cores taken at the top and along the traverses was examined with a CRREL universal stage. Englacial temperatures to a depth of 10 m at the ice cap station at 1,300 m and near the top of the ice cap were measured at regular intervals with thermocouple sets installed in 1961. During the spring traverse, 50 new ablation poles were drilled into the ice cap and observed at the end of the ablation season for total ablation and new snow cover. In the melt period several trips were made to the equilibrium line to examine the process of superimposed ice formation. Two glacial-meteorological stations on the ice cap were occupied for the season, one near the top of the ice cap at an altitude of about 1,860 m, and the other at an altitude of about 1,300 m.

* Published by permission of the Director, Geological Survey of Canada.

In April, 1963, Dr. J.R. Weber of the Gravity Division, Dominion Observatory, made gravity and seismic depth measurements on the ice cap and on the large outlet glacier entering Brae Bay. His gravity observations will allow those made in 1962 to be connected with the gravity network established in other areas of the Queen Elizabeth Islands by the Dominion Observatory. The seismic measurements were made at points selected for best comparison with the geo-electric resistivity depth measurements made in 1961 and 1962. Preliminary analysis of the seismic shots indicated a close agreement between the two methods.

(b) Outlet glacier above Brae Bay

Mr. C.M. Keeler, glaciologist, and Mr. P. Cress (surveyor) examined the 1962-63 winter snow cover at numerous stakes and in pits over the entire glacier. The amount of snow was intermediate between that of 1960-61 and of 1961-62. Englacial temperatures to a depth of 10 m were read throughout the season with a thermocouple set installed in 1961, and to 15 m with a set installed in May 1962. Detailed measurements of run-off were made throughout the melt period using the dichromate dilution method. Supplementary detailed measurements of ablation were made at a grid of stakes and with ablatometers. The glaciological measurements were complemented by a meteorological programme. The main profiles were resurveyed by resection in June and August for horizontal and vertical movements. In preparation for the 5-year international glaciological survey, the following provisions were made: three 10- m thermocouple cables were marked with pyramidal "Dexion" towers, 1.5 m square; the glacier terminus was photographed from points on the valley walls which were marked by cairns; a profile across the glacier was levelled with a "Wild" T-2 theodolite to a horizontal accuracy of ±20 cm and a vertical accuracy of ±10 cm, and the ends of the profile were marked by cairns.

10. WESTERN QUEEN ELIZABETH ISLANDS (Polar Continental Shelf Project, Department of Mines and Technical Surveys)

Glaciological studies continued to form a part of the scientific programme of the Polar Continental Shelf Project, which is under the general direction of Dr. E.F Roots with Dr. W.S.B. Paterson responsible for glaciology in the field.

(a) Melville Island

A total of 75 stakes were inserted in the four small ice caps on Melville Island, in continuation of the programme started in 1962; the stakes are arranged in rough grids with a spacing of about 1.5 km, and were surveyed, with adequate ground control, for movement and mass balance studies over the next few years. There was considerable variation in the accumulation, probably determined by wind, but the average snow accumulation on the ice caps during the 1962-63 winter was 16 cm (water equivalent). A detailed gravity survey to determine approximate ice thicknesses was made.

(b) Meighen Island

On the ice cap of Meighen Island, the winter snow accumulation and the ablation during the 1963 summer were measured at the points where Mr. K.C Arnold made measurements in previous years. The average snow accumulation on the Meighen Island ice cap during the 1962-63 winter was 22 cm (water equivalent). Plans are being made to core through the ice cap, starting in May 1964 to study the temperature and strain rate within the ice cap. A small laboratory will be available on the ice cap.

11. AXEL HEIBERG ISLAND (McGill University)

A party of four, with Dr. F. Müller as leader, carried out glaciological, glacial-meteorological and geomorphological work in the Thompson Glacier region of western Axel Heiberg Island from 20 June to 28 August. The main project was financed by a grant from the National Research Council of Canada, and support for the collection of cosmic dust samples was provided by the U.S. National Aeronautics and Space Administration under a contract.

(a) Glaciology

Measurements were made on the White, Thompson, Baby and Crusoe glaciers and on the ice cap in order to determine the 1963 regime in areas where McGill University parties carried out detailed work in 1959-62. The snout position of each glacier was surveyed and photographed from one or two base lines. About 225 glacier surface points in the accumulation and ablation areas were also surveyed. Accumulation or ablation values for some 290 sites were obtained and a detailed mass budget for the fourth year was assessed. Preliminary calculation shows that the mass budget for 1962-63 was positive. The winter accumulation was several times larger than the mean value of the previous years, and the net ablation was relatively small. Seventy-two sites in the accumulation areas were chosen for long-term accumulation measurements and equipped with aluminium masts, tall enough to record the accumulation of the next 5-8 years. In addition, 14 polyethylene "percolation trays" (1- m^2) were placed on the 1963 surface to catch the percolating melt water of future summers. In the ablation areas 8 holes were drilled to a depth of 15 m and equipped with thermocables, marked so that they will also record the net ablation and the surface movement of the next five years or so. From the reopened ice shaft at the upper ice station at 2,000 m, near the highest point of the ice cap, two 2-litre samples were taken from each year's firn layer since 1920 for examination for micro-meteoroids of lunar origin.

(b) Glacial-meteorology

Two weather stations were operated, each situated 200 m above sea-level, one on bare land at the base camp, and the other on the ice at the lower ice station.

(c) Geomorphology

The survey of glacier-dammed lakes started in 1961 was continued. Details of level fluctuations and drainage mechanism were studied. Driftwood washed out from under the Thompson Glacier has been assigned a radiocarbon age of 7,000 years.

12. NORTHERN ELLESMERE ISLAND

In May 1963 the Defence Research Board established a new field station at the head of Tanquary Fiord in lat. 81° 25' N, long. 76° 55' W; material for the new station had been taken in by the icebreaker CCGS John A. Macdonald in August 1962. This station and Hazen Camp were used as bases for glaciological and other work from mid-May until late August. Glaciological work was carried out by Dr. G. Hattersley-Smith, Mr. N. E. Cleary, and Mr. U. Embacher, with assistance from Mr. H. Serson, Mr. R. Yank, and Mr. J. J. S. Haight; glaciological observations were also made by Dr. R. L. Christie in the course of field work for the Geological Survey of Canada. A "Beaver" aircraft (first on skis, later on big wheels), tractor, motor toboggan, and dog team were available for transport in the field.

(a) Valley glaciers near Tanquary Fiord (Defence Research Board)

Surveys were made of the termini of four valley glaciers near Tanquary Fiord. Movement studies were initiated at stakes drilled into the ice, and off the glaciers monuments were built from which stereo-photographs were taken. Detailed movement and ablation studies over the ablation area of one of the glaciers were started with the intention of obtaining the mass balance by the hydrological method. The survey data are being computed in the Department of Civil Engineering at the University of New Brunswick under the supervision of Dr. G. Konecny. The greatest movement measured was 85 m/year at the steepest part of one of the glaciers. Ablation reached a maximum of 140 cm of ice on the lower parts of the glaciers in a summer which was without doubt considerably cooler than average. The late history of these glaciers is one of slight recession from moraines 50 to 100 m from the present termini; the moraines certainly represent the outermost stands in the recent period. One of the glaciers dams a large glacial lake in the north-east valley leading down to Tanquary Fiord. From a ground survey of strand lines it was found that this lake and Ekblaw Lake, 20 km to the north-east, had drained rather recently to lower the water levels by 55 and 40 m respectively. It is possible that drainage may have taken place catastrophically by the method suggested by J. W. Glen (J. Glaciol., Vol. 2, No. 15, 1954).

(b) Tanquary Fiord area* (Geological Survey of Canada)

The following glaciological features of special interest were noted: a small, steep glacier illustrating strikingly the phenomenon of active ice riding up on a basal thrust plane, marked by debris-laden ice, over relatively inactive ice; and a small glacial lake with an apparently perennial ice cover. The glacier is situated 4 km down-valley from the terminus of the Air Force Glacier. The overthrusting had produced a number of concentric moraine bands, and an outlying concentric ridge proved to be underlain by ice. The lake, about 3 km long of irregular shape, is situated in the pass between Yelverton Inlet and Tanquary Fiord at a height of about 550 m above sea level. The ice of this lake appeared to have remained intact for many years. Interesting features observed in and on the ice included: ice crystals up to 50 cm across; scattered musk-ox bones covered by up to 8 cm of moss and apparently of considerable age; rounded boulders up to 30 cm and more in diameter. The bones and boulders were partially embedded in the ice, and the boulders are presumed to have come up from the bottom, indicating at least occasional freezing to the bottom or draining of the lake to allow the ice to rest on the bottom. The surface of the ice was smooth, except for local pitting due to dust, and the lake appeared suitable as a landing area for quite large aircraft at all seasons of the year.

(c) Tanquary Fiord, McKinley Bay and Antoinette Bay
(Defence Research Board)

Snow cover and sea ice thickness were measured at a number of stations during an oceanographic traverse along the lengths of these fiords. On level winter ice the mean snow cover was about 15 cm, varying from 3 - 23 cm; it was least at the head of Tanquary Fiord, where wind action is strong, and greatest in the comparatively sheltered McKinley Bay. Winter ice thicknesses up to 250 cm were measured. In an un-named glacial lake at the head of Antoinette Bay, old sea water was found in the bottom 15 m out of a total depth of 60 m. The lake is about 12 m above sea level, and dammed by large piedmont glaciers at both ends. It is hoped that it may be possible to obtain a radiocarbon age for the sea water.

Shells were collected from an elevation of 75 m on Flora Island at the mouth of Tanquary Fiord, and from an elevation of 30 - 35 m at the head of the fiord; no shells were found at a higher level in the latter locality after careful search. It is hoped that radiocarbon ages of these shells will provide useful information on the glacial history of the area.

(d) Otto Fiord (Defence Research Board)

During a flight from Emma Fiord to Tanquary Fiord special note was made of the very highly crevassed surface of the lower 20 km of the large outlet glacier at the head of Otto Fiord. This glacier, which drains the extensive ice cap between Tanquary Fiord and Phillips Inlet, appeared most atypically fast-moving for northern Ellesmere Island, and probably the most active glacier in the whole area at the present time. Subsequent examination of air photographs taken in 1950 and in 1959 revealed a remarkable change in the appearance and terminal extent of the glacier over the nine-year period. All the crevassing took place during that period, all the surface melt streams were obliterated, and stagnant marginal ice was overridden. The terminus of the glacier, grounded near sea level in 1950, had advanced about 3 km as a floating tongue by 1959 with extensive calving of icebergs. A further report on this catastrophic glacier advance is in preparation.

(e) Ice cap traverse (Defence Research Board)

During the first three weeks of August a traverse was made by dog sledge from the terminus of the Gilman Glacier to the ice divide at the head of the M'Clintock, Henrietta Nesmith and Air Force glaciers, a distance of about 100 km, and return. Ablation measurements were made at 12 stakes on the Gilman Glacier, and accumulation measurements at 20 stakes. A total of 6 stakes, set in 1957 and 1958, were resurveyed to give movement and change of height of the glacier surface. From a rough preliminary comparison with previous years it would appear that the budget of the Gilman Glacier was strongly positive in 1962-63, although the data have not yet been worked out quantitatively. The equilibrium line was situated at an elevation of about 975 m, as compared with about 1,200 m in an

* Published by permission of the Director of the Geological Survey of Canada.

average year. At an elevation of 1,040 m, where a single summer's ablation up to 80 cm of ice had been recorded, accumulation in the form of a few cm of superimposed ice took place in 1962-63. For the first time in the period since 1957, when observations were started, the snow pack was completely dry above an elevation of about 1,550 m; the mean accumulation was about 60 cm (ca. 20 cm water equivalent) which is a little above average over the last seven years. Exceptionally low accumulation and high ablation for the 1961-62 budget year were evident from pit studies and ablation measurements. On the ice cap to the west of the Gilman Glacier snow accumulation was measured at three stakes set up in the area of the ice divide.

(f) Ward Hunt Ice Shelf (Defence Research Board)

A party of four men were air-lifted to Ward Hunt Island, and there worked from 13 to 24 June. The 1960 line of poles across the ice shelf, 10 km west of Ward Hunt Island, was resurveyed, and six full oceanographic stations were established along the new ice front between Cape Alexandra and Cape Albert Edward. A Tucker "Snow Kitten" and a dog team were used for travel. Very little melting of the snow pack had occurred up to 24 June and travel conditions were generally good. Air temperatures ranged from -1 to -5° C during the period of stay. Measurements of snow accumulation and ablation were made at 20 stations on the 1960 survey line and at 42 stations on the Ward Hunt Ice Rise. Full data from the 1960 survey are not yet available to enable a comparison to be made with the 1963 data, but it appears likely that the strain rate on the ice shelf is so low that more accurate methods than chaining and triangulation are necessary for measuring it. Mean accumulation on the ice shelf along the line of survey was 86 cm snow or 29 cm water equivalent (in 1960, 22 cm), and on the ice rise 81 cm snow or 27 cm. The total mean ablation for the two summers 1961 and 1962 was 64 cm with a maximum of 101 cm.

13. ICE ISLANDS

(a) Ice Island "T-1" and others (Polar Continental Shelf Project and Geographical Branch, Dept. of Mines and Technical Surveys)

The following movements of ice islands were reported by Mr. W.A. Black from observations on sea ice patrols. The ice island "T-1" passed the 1962-63 winter in the northern part of Viscount Melville Sound. It since drifted across the sound, and by the end of August had entered M'Clintock Channel, where it was located off the south end of Stefansson Island. It has suffered very little fragmentation, and still has an area of more than 300 km^2. An ice island, about 40 km^2 in area, which was lying in the Arctic Ocean off Sverdrup Channel during the summer of 1962, moved south through Hassel Sound during the summer of 1963 to a point off the south coast of Ellef Ringnes Island. This island is heavily laden with rock debris, mainly of grey-banded gneissic quartzite, and may possibly have originated from the Alert Point area on the north coast of Ellesmere Island, where floating glacier tongues merged with remnants of ice shelf. The ice islands which calved from the Ward Hunt Ice Shelf in 1961-62 and drifted westward ("WH 1-4") for the most part appear to have broken up or moved far out to sea. Many fragments but only two ice islands of any size (about 60 and 40 km^2) were seen. They were first observed off the mouth of Nansen Sound, and during the summer of 1963 were seen to pass down the west coast of Axel Heiberg Island, before moving westward in late August. When last seen in mid-September they were lying about 100 km north-west of Cape Isachsen, Ellef Ringnes Island.

(b) Ice Island "WH-5" (Royal Canadian Air Force; United States Naval Oceanographic Office; United States Navy; United States Coast Guard)

(See brief report in Ice 13, December 1963, p. 18)

14. MAPPING AND PHOTOGRAPHY OF GLACIERIZED AREAS (Topographical Survey, Surveys and Mapping Branch, Dept. of Mines and Technical Surveys)

A new plot of the Athabasca Glacier was completed in December 1962 at the request of the Water Resources Branch of the Department of Northern Affairs and National Resources from air photographs of 31 July 1962. Plotting was done at a scale of 1:4,800 with a contour interval of 10 feet (3m), as on the previous plot from air photographs of 1 August 1959. A trace was also prepared to show the difference in position of 32 common image points of the 1959 and 1962 photography. Profiles between common image points were provided.

Map compilation of the northern part of the Barnes Ice Cap, and adjacent areas in Baffin Island have been completed at a scale of 1:40,000, and it is expected that similar compilations will be made for the southern part of the ice cap. Compilations of the Hell Gate area have also been completed on the same scale, and cover glacierized parts of northern Devon Island, North Kent Island, and south-western Ellesmere Island. Progress is being made with the mapping of the Arctic Islands by the Topographical Survey and the Army Survey Establishment to effect coverage at the 1:250,000 scale by 1967.

15. PHOTOGRAMMETRIC STUDIES (Photogrammetric Research Section, National Research Council: Mr. T.J. Blachut)

In 1962-63 work on two 1:5,000 glaciological maps of the White Glacier and of the terminus of the Thompson Glacier was continued. The map of the White Glacier was published in six colours with relief shading. The scribing technique was used throughout the project, and the final printing was done by the Army Survey Establishment in Ottawa. A model of the expedition area at a scale of 1:25,000 was also constructed.

16. INVENTORY OF CANADIAN GLACIERS (Geographical Branch, Dept. of Mines and Technical Surveys)

In cooperation with Dr. W.O. Field of the American Geographical Society, Mr. G. Falconer is making a selection of photographs of glaciological interest from the collection of the International Boundary Commission. With the assistance of the International Boundary Commissioner, Mr. A.F. Lambert, 100 photographs have so far been reprinted; a complete set is filed at the Geographical Branch, and another set has been sent to the IGY World Data Center A (Glaciology) in New York.

A preliminary examination of photographs of the Pangnirtung Pass area of southern Baffin Island has been made in preparation for a proposed study of glacier variations in the area. Aerial mapping of the limits of glacier ice in the Coutts Inlet-Clyde Fiord coastal sector of northern Baffin Island has been completed to provide a basis for the second paper in the "Glacier Inventory" series.

"A list of glaciological features in Canada compiled from National Topographic System maps and other maps" has been completed, and is to be published in the "Gazetteer" series of reports.

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

(a) Heat exchange at surfaces

The heat exchange at a grass-covered surface was observed over a two-year period at Ottawa. During the summer, about 48% of the solar radiation absorbed at the surface was dissipated by evapotranspiration, about 42% by long-wave radiation, about 6% by convection and about 3% was stored in the ground. In winter, the average daily net radiation and sublimation are about as great as the error in measurement with present equipment.

(b) Deformation behaviour of ice

A study of crack formation in ice plates due to thermal shock was completed. Analysis is now proceeding on observations on the initial creep behaviour of columnar-grained ice under constant compressive load. A study was made of the bending of ice beams and the results were published.

(c) Ice dusting

Small scale trials of ice dusting were undertaken at Ottawa in the spring melt periods of 1962 and 1963. These experiments indicated that the weather conditions that prevail during the period immediately preceding spring break-up will determine, to a large degree, the success or failure of ice-dusting operations. A study of past weather records at several widely separated localities in Canada indicated that the amount of ice that can be melted by ice dusting varies considerably from year to year. In southern Canada "poor" ice dusting years occur about half the time.

G. Hattersley-Smith

GERMANY

COMMISSION FOR GLACIOLOGY AT THE BAVARIAN ACADEMY OF SCIENCES

Under Prof. R. Finsterwalder as Permanent Secretary two scientific collaborators were appointed to the Commission: Dr. Herbert Lang and Dipl.-Met. Oskar Reinwarth. In collaboration with the Institute for Photogrammetry, Topography and General Cartography of the Technical University of Munich they undertook the following work in 1963:

1. Determination of net accumulation and net ablation of the Langtalerferner (Oetztal) as a new test glacier in the Eastern Alps; photogrammetric survey of the glacier at the beginning and end of the budget year.
2. Measurement of ablation and photogrammetric survey at the Schneeferner (Zugspitze); geodetic measurement of surface deformation in the test field of 5 markers.
3. Discharge measurement of the Hintereisferner (Oetztal) with current meters and salt dilution; comparison of the two methods.
4. H. Lang compared in detailed studies the results of photogrammetric and direct measurements of the mass budget of the Hintereisferner and found satisfactory conformity.
5. O. Reinwarth continued the evaluation of his meteorological observations during the International Glaciological Greenland Expedition (EGIG) 1959-60.

After the death of Prof. Finsterwalder on 28 October the Academy elected Prof. Dr. R. Geiger, Munich, for the office of the Permanent Secretary of the Commission.

RESEARCH SCHEME NEPAL HIMALAYA

The 6th working group of the Research Scheme Nepal Himalaya (leader Dr. W. Hellmich, Munich) consisted of two meteorologists, one botanist and one physician. In March and April 1963 the meteorologists (Dr. Helmut Kraus and Konrad Hackl, Meteorological Institute of the University of Munich) were in charge of a complete energy-balance-station at an altitude of 4750 m. The station was situated on a plain in the broad Imja Khola Valley in the Khumbu Himal. Here the energy balance at the snow surface and - after melting and evaporating of the snow - at the bare surface was investigated. The following quantities were recorded or measured: the shortwave and longwave radiative fluxes coming from the hemispheres above and below - that is, the total radiation balance, the temperature of the air, the water vapour pressure and the wind velocity at heights of 0.2 m, 0.5 m, 1.0 m and 2.0 m above the ground, and the soil temperature at six different depths. It is hardly possible to build up a reasonable energy-balance-station in the ablation zone of a glacier in the Khumbu Himal because the glaciers there are carrying a cover of debris which has an extremely uneven and heterogeneous surface and which is in places very thick. The working group also studied the formation of ice penitentes.

W. Hofmann

ITALY

The glaciological survey took place as usual in 1963. 114 glaciers were checked in the Alps and 1 (the only one) in the Apennines. 52 of these glaciers were regressing, 52 were stationary or uncertain and 11 were advancing. These results confirm what has been said in previous years, namely it is growing ever more evident that the long phase of regression which began in 1925 is coming to an end. This phenomenon is in accord with the behaviour of the two main factors in the development of glaciation: the annual firn level and the mean summer temperature. From measurements and calculations made at the meteorological station of Goillet (2526 m above sea level, in the Aosta Valley) on annual snowfall and mean summer temperatures over the period 1930-62, it can be observed that the last ten years 1952-1962 show an increase in winter and summer snowfall of respectively 46 mm and 8.2 mm and a fall in the mean summer temperature of about 1.4° C compared with the general trend of events in the thirty-year period.

Meteorological conditions in the last decade, therefore, at least partly justify the theory of an arrest in the regression of glaciation. It can also be noted that the summer of 1963 marked a further reduction: from a decade mean of 6.3° C there is a further fall to 4.8° C. It can therefore be concluded that the regression phase is about to end because of a slight reduction in the mean summer temperature; this is confirmed by a slight increase in the firn level both in winter and summer.

It can also be noted from the 1963 data that these symptoms of the revival of glaciation are more evident in the Western and Eastern sections than in the Central section. This corresponds to a trend already noted in the past by Monterin regarding variations in Alpine glaciers. In the Western Alps the revival is influenced by winter snowfall due to the wet South-West winds, while in the Eastern Alps the diminution in summer temperature is generally more important, as this section of the Alps is hit by the coldest North-East winds.

However several years' observations will be needed before it can be safely affirmed that a new phase of glaciation has begun; for the moment there are only symptoms which 1963 has confirmed.

Frontal variations in Italian glaciers in 1963

	regression	advance	stationary	Total
WESTERN ALPS	10	8	8	26
CENTRAL ALPS	41	3	34	78
EASTERN ALPS	1	-	9	10
APENNINES			1	1
TOTAL	52	11	52	115
Percentage	45.2%	9.6%	45.2%	
Percentages Years				
1959	80%	4.5%	15.5%	
1960	50.5%	6.93%	42.5%	
1961	59.4%	10.4%	30%	
1962	68.1%	4.1%	27.8%	
1963	45.2%	9.6%	45.2%	

It can be seen how the percentages of stationary glaciers has increased rapidly after 1959.

M. Vanni

SWEDEN

KEBNEKAISE

1. Mass balance

The accumulation period ended on 24 May and the total accumulation for the 1962-63 winter then amounted to $4.5 \cdot 10^6 m^3$ of water ($1.45 \cdot 10^6 m^3/Km^2$ or 145 g/cm^2) which is 10 per cent more than the average for the 18 years 1945-63 (average $4.0 \cdot 10^6 m^3$ or 130 g/cm^2).

The summer was cool during June and July but intense melting during August brought the total ablation up to $5.1 \cdot 10^6 m^3$ of water ($1.65 \cdot 10^6 m^3/km^2$ or 165 g/cm^2), more than twice the amount of the previous summer but still $0.8 \cdot 10^6 m^3$ less than the average ($5.9 \cdot 10^6$) for the period 1945-63.

The balance was thus $-0.6 \cdot 10^6 m^3$ (-19 g/cm^2), not quite as bad as during most of the preceding 17 years.

Average retreat of glacier fronts since 23 August 1962:

Storglaciären - 11 m, 24 August
Isfallsglaciären - 13 m, 8 September
SE. Kaskasatjåkkoglaciären - 5 m, 8 September

2. Surface profile

One longitudinal and two transverse profiles were levelled on Storglaciären at the end of August. They can now be compared with other profiles levelled in July 1961 and July - August 1962.

During the first period (1961-62) glacier flow had added more material to the glacier tongue than ablation processes had removed, and the net result had been a rising surface. During the second period, however, the profile had become lower.

This combination of mass balance and surface profile studies has revealed some interesting facts with a bearing on glacier flow. Repeated levellings will be included in the routine programme and be carried out once or a few times a year.

3. Glacier variations

In accordance with the resolution adopted by the Obergurgl symposium (Commission of Snow and Ice, 1962) steps have been taken during 1963 to increase the number of Swedish glaciers for which annual measurements are made of the position of the front.

a. The Kiruna Glaciological Club was founded by a number of laymen, who will assume the responsibility for simple routine observations at certain glaciers.
b. About 40 selected glaciers were photographed from the air, by the courtesy of the Swedish Air Force, in August and September 1963. All pictures taken were verticals at various scales between 1:6,000 and 1:20,000, permitting the identification of large boulders outside the ice fronts. This photographic programme will be repeated at the end of each summer for several years.
c. Fixed points were marked and surveyed outside 6 more glaciers west and north of Kebnekaise on 31 August 1963.

For additional information see the preliminary report published in Geografiska Annaler 1963 (4).

V. Schytt

UNITED KINGDOM

1. AUSTERDALSBREEN EXPEDITION, 1963. A party composed of Dr. J. F. Nye and three students, J. Ling, A. R. Cobbe and J. Fitton, from Bristol University, and Dr. W. H. Ward and Mr. A. J. Butler of the Building Research Station visited Austerdalsbre for about three weeks in July 1963 with the aid of a grant from the Royal Society to conclude the present flow studies on that glacier. They were helped by a Royal Norwegian Air Force helicopter, which made several landings on the glacier, by Konrad Nes who provided his usual hospitality at Veitastrond, and by Norske Braendselolje A/S who sent fuel for the generator.

A third complete survey was made of the axis of the 400 ft. long pipe which was inserted into the ice at approximately the centre of the main glacier tongue in 1958. The ice which had formed inside the pipe since the second survey in 1959 was first thawed out with an electro-thermal drill designed for the purpose. This operation was unexpectedly stopped for several days by two rocks inside the pipe, presumably dropped in by curious visitors. A cast of these tiresome and expensive rocks lying at the bottom of the hole was taken in a mould of stiff grease. Accordingly a special extractor was made and it collected both rocks together at the first attempt. There was evidence during the thawing operation and later during the inclinometer survey to suggest that the glacier, supposedly temperate, contained one or more low temperature zones.

The ice surface profile and the surface velocity distribution along a transverse line across the glacier through the original position of the pipe were measured again. In this area the glacier has decreased in thickness by about 10 per cent and its velocity decreased by about 30 per cent since 1959.

As a result of the considerable retreat at the snout it was possible to make a contour map of the very irregular bed rock at the site of the detailed ice motion studies made by Dr. J. W. Glen and Dr. Cuchlaine King in 1959.

Measurements of the slip of the ice over the bed rock were made at a few points near the snout by ordinary surveying methods and by means of a remote-recording wheel inserted at the bottom of a borehole. This work was not pursued as far as had been intended on account of unfavourable changes in the condition of the snout.

W. H. Ward

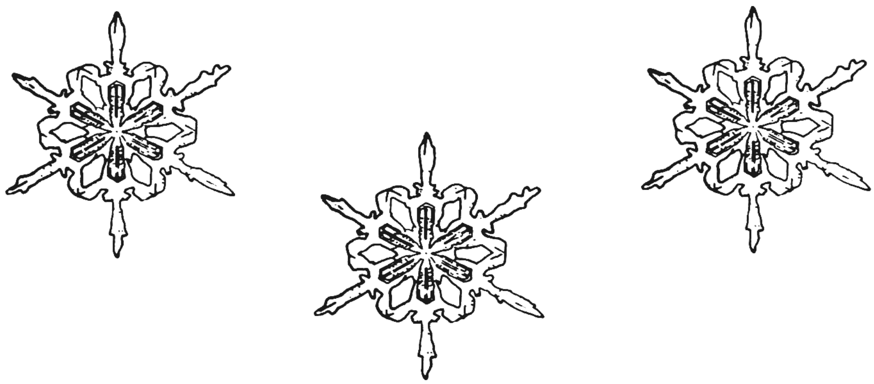
2. IMPERIAL COLLEGE EAST GREENLAND EXPEDITION, 1963. A group of eight students from Imperial College, London, led by Mr. M.H. Key spent July and August in the Stauning Alps 72° 15' N) of East Greenland. They travelled from Iceland to Mestersvig by a chartered aeroplane, sharing the charter with four other expeditions. Half the party spent their time mountaineering and climbed 17 peaks for the first time, the other half made glaciological studies and collected rock specimens for paleomagnetic work.

Working from a base camp at the snout of Bersaerkerbrae they established three transverse lines and a longitudinal line of stakes on the lower four miles of the glacier and made several measurements of the surface velocity and the ablation. The positions and elevations of the stakes were also fixed.

In the area between Mestersvig and Segelsällskapets fjord exploratory surveys were made of some 15 glaciers. This included photographing the snouts from fixed cairns, measurements of the ice and bedrock slopes, and elevations at the snouts. Generally they report that the glaciers had retreated considerably with one or two steady periods, or possibly minor advances.

(Based on a preliminary report dated Jan. 1964
received by the Glaciological Research Committee)

ERRATUM. In Glaciological Notes No. 15/16, page 22, it was stated that seven hydrographic charts of Antarctica had been issued by the Hydrographic Office of the Geographical Survey Institute, Tokyo. We are now in receipt of information that these charts were issued by the Hydrographic Division, Maritime Safety Board, 5-Chome, Tsukiji, Chuo-Ku, Tokyo, and that not all of them are at present on sale.



Sir Vivian Fuchs

Sir Vivian Fuchs, known to his friends as "Bunny", celebrated his fiftieth birthday in 1958 at the head of a column of Sno-Cats slowly making their way across the polar plateau on the first land crossing of Antarctica. His leadership, with its blend of boldness and tenacity, enabled the Trans-Antarctic Expedition to carry out its planned scientific programme against considerable odds.

By profession a geologist, Fuchs admits that he chose his profession as a means to an end, since it gave purpose to his love of outdoor life and hard physical exertion. A tough six-footer with an air of great vitality, he has many interests - among them sailing and gardening; but perhaps he is happiest when driving his E-type Jaguar, a thing he does with a calculated verve which would be the envy of any youngster. It is at once apparent that his natural sphere of activity is not at an office desk but in the field. He is deft with his hands and delights to exercise his skill. To him the chores of making and mending things are both a challenge and a satisfaction, and he will happily spend hours doing the most intricate repairs to a worn out article rather than replace it with something new.

Fuchs has a severely practical approach to all problems. He is as unaffected by public adulation as he is unruffled by uninformed criticism, and is uninterested in personal publicity. On the other hand, whilst planning the trans-Antarctic journey he had sufficient worldliness to realise the value of publicity to an expedition which was struggling to close a financial gap. He was therefore always willing to give press conferences or to be interviewed by reporters, one of whom wrote: "At such times one is reminded of a well-bred lion giving polite attention to a deputation of domestic mice".

Born in 1908, Fuchs was educated at Brighton College and St. John's College, Cambridge, where his tutor was the late Sir James Wordie, who was to become his lifelong friend and counsellor in all matters pertaining to the many expeditions in which Fuchs took part. He first visited polar regions in 1929 when Wordie took a party of undergraduates to Greenland, but it was to be nineteen years before his polar career was resumed. He went on four expeditions to East Africa, as Leader on two of them, to study the geology and archaeology of the Great Rift Valley. These gave him a sound knowledge of field craft and provided him with the material for a Ph.D. thesis. In 1933 he married Joyce Connell, a gay and adventurous person, and set up home in Cambridge. Their rambling and comfortable house, with large well-kept garden, has resounded many times to the lively conversation and laughter at informal parties for visiting scientists and explorers.

When war broke out Fuchs joined the Army, serving in West Africa and later on the General Staff in northwest Europe. When he was demobilised in 1946 the Colonial Office appointed him the Leader of the recently established Falkland Islands Dependencies Survey, an organization responsible for research in the British sector of the Antarctic; six Bases were then occupied on the Graham Land Peninsula. The two years he spent in the Antarctic gained him the Royal Geographical Society's Founder's Medal in 1951, and it was during this period, when lying up for four days tent-bound in a blizzard, that he began to plan his crossing of Antarctica.

Returning to England in 1950 Fuchs was given the task of setting up and directing the Falkland Islands Dependencies Scientific Bureau, which was to handle all information coming from the F.I.D.S. Bases and to arrange for publication of the scientific results. When in 1955 his plans for the Trans-Antarctic Expedition had matured, the Colonial Office gave him leave of absence to lead it, and upon its conclusion he returned to his old organization, to become Director of what has now been re-named the British Antarctic Survey.

He is a long-standing member of the Glaciological Society, and although he is the first to point out that he is not a glaciologist, has been Chairman of the Council for many years, apart from the period when he was concerned with the Trans-Antarctic Expedition. In 1963, when the Society's Founder President, Gerald Seligman, retired, Fuchs agreed to accept nomination as President for 1963-66.

MEETINGS

CONFERENCE ON SNOW REMOVAL AND ICE CONTROL. A two-day conference was held in Ottawa, Canada, on 17 and 18 February 1964 under the sponsorship of the Snow and Ice Subcommittee, Associate Committee on Soil and Snow Mechanics, National Research Council. The purpose of the conference was to begin to determine and discuss the factors primarily responsible for the cost of snow removal and ice control; to begin to record, in a form accessible to all, the considerable experience that is already available in Canada on the problem; and to delineate areas where research and development should be encouraged. Representatives from cities, highway departments, airport maintenance organizations and railways were invited to read papers. About 150 people attended, including observers from the U.S.A., Great Britain and Sweden.

First session: General review of the snow removal problem in Canada - R.F. Legget, G.P. Williams.
Weather and snow removal and ice control - K.T. McLeod.
Properties of snow - L.W. Gold.

Second session: Snow removal and ice control in cities
(Chairman - F.E. Ayers)
Montreal - J.V. Arpin,
and a panel discussion with contributions from other cities.

In Montreal the snow removal and ice control bill in the winter of 1962-63 was about \$8,950,000; in Edmonton, \$768,000; in Fredericton, \$169,000; in Toronto, \$1 million.

Third session: Snow removal and ice control for railways and highways.

Information was presented on the maintenance problems for railways, particularly that of keeping switches free of ice, and on the winter maintenance programme of the Canadian highways. The cost of snow removal and ice control for the Ontario Department of Highways in 1962-63 was about \$15,600,000 and for Quebec about \$19 million.

Fourth session: Air transport, military and civilian.

Papers were presented on the development of special high speed blowers and sweepers for airports.

The information presented to the conference indicated the major factors affecting the cost of snow removal and ice control and emphasised their importance in the Canadian economy. The conference focussed attention on the need for a complete record of current practices and costs, and for further study of the problems. These include the use of chemicals and thermal melting systems, the development of powerful, dependable, all-weather switches for railways, and the development of simple snow removal and ice control attachments for drive units now available.

The Snow and Ice Subcommittee are studying the papers and discussion presented and the recommendations for future action. The proceedings of the conference will be published and copies will be available by writing to the Secretary, Snow and Ice Subcommittee, Associate Committee on Soil and Snow Mechanics, c/o Division of Building Research, National Research Council, Ottawa, Canada.

(From information supplied by L.W. Gold)

INTERNATIONAL CONFERENCE ON PERMAFROST. An International Conference on Permafrost was held at Purdue University, Lafayette, Indiana, U.S.A. on 11 - 15 November 1963. This conference, the first large international meeting devoted exclusively to permafrost, was presented by the Building Research Advisory Board, National Academy of Sciences - National Research Council of the United States; it was sponsored by eleven American government and other agencies in co-operation with several other American agencies and scientific and engineering societies, and the National Research Council of Canada. The general conference chairman was Professor K. B. Woods, Head, School of Civil Engineering, Purdue University.

The total registration was 285, from 12 countries, and about 100 pages were presented.

At the opening session, delegates were welcomed to the conference by the general conference chairman, officials of the Building Research Advisory Board and Purdue University. An opening address was presented by Dr. R. F. Legget, Director, Division of Building Research, National Research Council, Canada, entitled "Permafrost in North America" in which he outlined the history of permafrost investigations in North America from the 18th century to the present. An address on permafrost investigations in the Soviet Union was given by Professor N. A. Tsytovich, Academy of Construction and Architecture of the U.S.S.R.

Following the opening session, nine technical sessions were held, each consisting of a panel discussion concerned with a particular aspect of permafrost. Each panel consisted of a moderator, assistant moderator and 4 to 6 panelists. The basis for discussion was provided by 10 - 15 technical papers submitted prior to the conference.

At Session 2-a (Soils and vegetation) Arctic and Antarctic soils, interrelationships between soil and vegetation, and vegetation features were discussed. At Session 2-b (Massive ground ice) papers were discussed under the three categories of pingo ice, ice wedges and other types of massive ice. Session 3 (Geomorphology) included papers on permafrost distribution, modification to landscapes, soil movement and mass wasting, and patterned ground. Session 4 (Phase equilibria and transitions) included papers concerned with the unfrozen water content of frozen soils, freezing point depression of soil water and nature of frost action. Session 5 (Thermal aspects) included papers under the three categories of climatic effects, thermal properties of frozen ground and thermal regime of foundations. Papers concerned with the plastic deformation of frozen soils, instability of the mechanical properties of frozen soils and strength of frozen soils were discussed at Session 6 (Physico-mechanical properties of frozen ground). Air photo interpretation, geophysical methods of subsurface investigation, drilling and sampling and site investigations in specific areas were discussed at Session 7 (Exploration and site selection). Session 8 (Sanitary and hydraulic engineering) included papers dealing with dam construction and operation in permafrost regions, water supply and sewage disposal.

At the closing session on the final day, the moderators of the technical sessions summarized the discussion of each session and indicated future research needs. Two resolutions were tabled and received unanimously, one expressing the appreciation of the delegates to the conference organizers and hosts; the other expressing the desire for a similar conference in the future. Proceedings of the conference will be available by the end of 1964 and can be obtained by writing to the Building Research Advisory Board, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C., U.S.A.

Contributed by R. J. E. Brown and G. H. Johnston

COMMISSION OF SNOW AND ICE

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

PROPOSED FIELD TRAINING COURSE IN SNOW AND ICE FOR THE HYDROLOGICAL DECADE. This notice is addressed to all National Correspondents of the Commission, Officers of the Commission and National Committees for the Hydrological Decade, and to individuals.

Realising the importance of studies of seasonal snow cover and glaciers during the Hydrological Decade, which is expected to commence in 1964, and in particular the urgent need for training personnel in the measurement of snow and glacier water budgets and glacio-meteorological parameters, the President of the Commission of Snow and Ice (Dr. H. Hoinkes) has proposed that international field training courses should be held at the Kebnekaise Field Station (Northern Sweden) belonging to Stockholm University and under the direction of Dr. V. Schytt, one of the Commission's Vice-Presidents. The Station, which is adjacent to the snouts of several glaciers, has dormitory and dining facilities for 38 people, a laboratory, a workshop and room for instructional classes. A routine programme in glacier mass-balance, run-off and silt discharge, and several special projects, such as snow density by isotopic glaciers, are in progress at the Station. Glacio-meteorological work can also be arranged.

The cost of the training course would depend to some extent upon grants which might be obtained from Swedish or international sources, but as a guide the normal cost of full pension at the Station is about 4 U.S. dollars per day and the second class return rail fare from Stockholm is about 35 U.S. dollars (including sleeper). Provided there is sufficient interest (a minimum of about 20 people) the Commission is prepared to organise a training course lasting 2 - 3 weeks in August 1964. All national correspondents are asked to inform their National Committees for the Hydrological Decade and all other parties and individuals likely to benefit from the proposed training course, and to inform the Secretary of the Commission (Dr. W.H. Ward, address below) of the numbers of people (their names and addresses, if available) likely to attend as soon as possible. The Commission is particularly anxious to help those countries where experience and facilities for training in its field of interest are inadequate.

Dr. W.H. Ward,
Secretary, Commission of Snow & Ice,
147, Rickmansworth Road,
Watford, Herts., England.

February 1964

APPENDIX TO THE REPORT OF THE SUB-COMMITTEE ON VARIATIONS OF EXISTING GLACIERS. The report[1] of the sub-committee on variations of existing glaciers, accepted at the Obergurgl meeting of the Commission of Snow and Ice in September 1962, was mainly concerned with recording the variations of mountain glaciers. A new sub-committee consisting of V. Schytt (Chairman), M. F. Meier, J. F. Nye and C. Lorius was appointed[2] at Obergurgl "to prepare an appendix to the report in terms of its application to ice caps and calving glaciers and to report to the Berkeley meeting". The report of this new sub-committee is as follows.

1 International Union of Geodesy and Geophysics, International Association of Scientific Hydrology, Commission of Snow and Ice, Obergurgl Symposium, September, 1962, pp. 306-9.

2 International Union of Geodesy and Geophysics, Bulletin of the International Association of Scientific Hydrology, 8th year, No. 2, June 1963, p. 104.

1. SCOPE OF THE REPORT

Our purpose is to consider what measurements are necessary for keeping a continuous record of the variations of existing ice sheets (that is to say, the Antarctic and Greenland ice sheets), ice caps and calving glaciers. The bulk of our report is in fact concerned only with the two ice sheets and with large ice caps. Small ice caps can be treated in much the same way as mountain glaciers; similarly, for calving glaciers the accepted report needs no revision except in an obvious way. However, the discussion of the principles of the budget method in para. 4(i) applies with particular force to calving glaciers.

Although our report is confined to glaciological measurements, it should be remembered that other geophysical studies can give information bearing on the same problem. For example, worldwide changes of sea-level are influenced by variations in the masses of the ice sheets, and so also is the period of the Earth's rotation.

We have primarily to consider variations in the total amount of ice and in how the ice is distributed. It is convenient to deal first with variations in the position of the edges of the various ice masses, then with changes in their thickness, and finally with their budget. Most of the report is concerned, directly or indirectly, with the budget problem.

2. VARIATIONS OF THE ICE EDGE

The changes in the position of the edge of an ice sheet or ice cap and in the boundaries of ice shelves are worth studying and recording for their inherent geographical interest. We should like to stress the importance of such measurements, which can be combined with geomorphological and other studies to record the past extent of the ice sheet. It may be remarked that hydrographic soundings can give information of this sort, as well as moraines and other visible periglacial features. Interpretation of ice edge changes must be made with caution; for example, a retreating ice front may or may not indicate a negative balance of the whole ice sheet.

3. THICKNESS VARIATIONS

Seismic soundings may, under good conditions, give acceptable measurements of thickness, but in some areas they may be difficult or the results ambiguous. Sample seismograms should be published, especially when the measurements have been made under difficult conditions, for example with low ratio of signal to noise. Gravity studies should be used to increase the number of thickness observations, and new methods, such as the electromagnetic wave method, should be developed so as to obtain continuous soundings in place of the present point by point measurements.

The secular changes in thickness may be measured, in principle, by repeated levelling. Near the ice edges, and on very small ice caps there is no special difficulty, but for the interior of large ice caps very great accuracy is needed. Nevertheless, repeated accurate levelling profiles reaching far inland from coastal mountains, or, as in Antarctica, between nunataks or mountain chains in the interior, are of the highest importance in establishing the behaviour of these great volumes of inland ice. Measurement of thickness changes by repeated seismic and gravity studies at the same location may also be possible in favourable circumstances.

4. BUDGET MEASUREMENTS

Budget measurements constitute an alternative method of studying variations in the mass of either the whole or a part of an ice sheet or ice cap. They are important because they show the cause of the thickness changes, and because they may be used to relate the thickness changes to the climate. The principles of the budget method will first be outlined and then the methods of measuring the various relevant quantities will be discussed.

(i) Principles. It is first necessary to fix a boundary line, P, say, which enclosed the geographical area of the ice sheet or ice cap to be considered. A budget equation for the ice inside P (that is, the ice belonging to the ice sheet and excluding ice in the atmosphere) contains the following terms.

A_1 = the income of ice mass per unit time within P. A_1 includes the gain by precipitation of all kinds (including drift, frost and freezing rain), by refreezing of melt water, and by freezing of sea water; in short, A_1 includes the gain by all processes which deliver or produce new ice inside P.

B_1 = the wastage of ice mass per unit time within P. B_1 includes the loss by drifting, by evaporation, and by melting on the top and bottom surfaces; in short, B_1 includes the loss by all processes that remove or destroy ice inside P.

C_1 = the rate of increase of ice mass within P.

D = the discharge of ice mass through P.

Conservation of mass then requires that $$C_1 = A_1 - B_1 - D. \quad (1)$$

Next, consider the budget of the part of the ice sheet or ice cap that lies outside P, if any. (Outside P here means between P and a fixed boundary just outside the ice edge.)

A_2 = the income of ice mass per unit time outside P.

B_2 = the wastage of ice mass per unit time outside P.

B_2 includes calving, and bottom melting beneath floating ice in addition to the items of loss listed above.

C_2 = the rate of increase of ice mass outside P.

Conservation of mass then requires that $$C_2 = A_2 - B_2 + D. \quad (2)$$

Adding (1) and (2) gives a budget equation for the whole ice sheet:

$$(C_1 + C_2) = (A_1 + A_2) - (B_1 + B_2). \quad (3)$$

In equation (1) it is possible to measure $A_1 - B_1$ and D, and thus to deduce C_1. The computed C_1 may be compared with a value deduced from measurements of thickness change. On the other hand, if the edge of the ice sheet or ice cap or glacier lies in water, application of equation (2) or (3) may be extremely inaccurate because of the great difficulties of measuring B_2, which includes calving and melting beneath floating ice. In these cases equation (1) is preferable.

If the whole ice sheet or ice cap is to be studied, the obvious choice for P is the boundary of the grounded ice (hereafter called "the coastline"): that is, the area within P includes all grounded ice and excludes floating ice shelves and floating glacier tongues. (If P is chosen inside the coastline, C_1 becomes a worse approximation to the total budget $C_1 + C_2$; whereas if P is chosen outside the coastline bottom melting becomes an important part of B_1; with consequent inaccuracy).

When the total area of the ice sheet or ice cap is large, it may be more practical to study the budget of only a limited area. The boundary P may, in principle, be chosen in any way that is convenient, but there may sometimes be advantages in making it define a specific drainage area. P would then be made up of an ice divide and part of the ice edge, if the ice ends on land, or part of the coastline, if not. In other cases, particularly in Antarctica, there are advantages in choosing flow lines as the lateral boundaries. Thus the area selected might be a sector or a narrow strip bounded by an ice divide, two flow lines, and either the ice edge, if on land, or the coastline. The advantage of such a choice is that the discharge term D in equation (1) need then only be measured along the coastline. The disadvantage is that the ice divide and the true directions of the flow lines will not usually be known accurately. Theoretically the flow lines should be at right angles to the surface contours of the ice, but this has not been fully checked by observation on large ice sheets. Over long periods of time the possibility of changes in the directions of the flow lines must also be considered.

Having outlined the principles of budget measurement* we now consider how the various quantities that contribute to the terms in the budget equations may be measured.

(ii) Accumulation. Accumulation measurements can be made in several different ways. The most important are stake measurements and stratification studies.

Stake measurements must still be considered to give the most reliable values. Extensive coverage (many stakes in a suitable pattern with wide spacing) around base camps, and sufficiently high stakes at frequent intervals along inland routes, are required. Stakes must, of course, be a long way (perhaps several kilometres) from any permanent buildings. Water equivalent cannot be computed without a knowledge of snow densities. Density variations with depth, time and geographic position must be studied. Stake observations have to be corrected for the settling of the snow. This can be done if density variations are well known, but a reference surface, such as a thin net of wire or a layer of dye spread out on the snow at the time when the stake is planted, will allow a check afterwards. (Such a surface will also provide a valuable reference layer for subsequent stratification studies). Proper account must be taken of any superimposed ice formed during the interval considered.

Stratification studies should preferably be started at a station where accumulation conditions are well known, or where for some other reason the annual layers are easy to identify - this may be the case at low elevations near the coast in Antarctica, or in the lower parts of the accumulation area in Greenland. Once the stratification at one place is properly understood, the key thus obtained can be used over long distances, at least if the distance between consecutive pits or cores can be kept small. The main advantage with a stratification study is that it can give immediate information about accumulation.

As an extension of stratigraphy techniques isotope studies seem to offer a unique possibility for the study of mean values of accumulation. The explosion of the first hydrogen bomb in 1954 caused a sudden and considerable increase in the tritium content of the snow. A reliable field method for the quick identification of the "hydrogen bomb boundary" should be developed. This boundary would then serve as an ideal reference surface spread almost simultaneously over all ice bodies and providing 10-year means (in 1964) or better.

Other isotope studies - of for example the O^{18}/O^{16} ratio - can provide useful information about annual layers at selected places, but cannot yet be used for studies extending over whole regions. Nevertheless in studies of very deep cores the oxygen isotope ratio may provide the most reliable means of measuring past accumulation rates.

Apart from accumulation rates, stratigraphic studies of the abundance of stable isotopes (such as O^{18}, O^{16}; H^2, H^1) may also give evidence on past climate.

(iii) Wastage. It can be very easy to measure ablation in some places and very difficult in others.

To measure the ablation of surface ice the stake method is recommended. Since the ice temperature is below the melting point in most outlet glaciers from ice sheets and ice caps a stake will not sink in its hole but be frozen in, at least if the hole is not very shallow (less than 1m). If stakes are long and planted in deep holes they can serve for many years.

The ablation of snow can be measured in the same way, a correction being needed to allow for the settling of the snow between the surface and the bottom of the stake. In subpolar glaciers, where it is essential to take account of the refreezing of melt water lower down in the firn, the measurement may be difficult. The formation of superimposed ice on cold glacier surfaces is another factor that must be taken into account.

Melting from the bottom of ice shelves is extremely difficult to measure directly. Deep temperature profiles in the ice shelf and oceanographic studies of the heat exchange along the front may give some information.

* The budget referred to is the <u>ice</u> budget. We should also refer briefly to an alternative budget equation which might be set up for the <u>total water substance</u>. Thus the net budget of water substance of Antarctica might in principle be determined by measuring the water transport in through a specific latitude (mainly as water vapour and snow), and the water transport out (mainly as ice and snow). The measurements are interesting in themselves, and provide a link between glacier variation studies and meteorological investigations, but the accuracy appears to be too low for reliable conclusions to be drawn about budget.

Melting at the bottom of an ice sheet may also occur. In addition to direct measurement by the use of deep holes it has been suggested that the presence and the amount of melt water produced in this way could be studied by examination of the salinity, temperature, density and isotopic content of the sea water at the edge of the continent.

Melting along the front of ice shelves contributes so little to the wastage in comparison with bottom melting and calving that it can normally be ignored.

Calving represents by far the largest factor in the total ice wastage ($B_1 + B_2$) in Antarctica, and in Greenland it is nearly as important as melting. Estimates may be made by aircraft and satellite reconnaissance photography - but how difficult it is to measure calving is well illustrated by available reports (1963) which give figures for Antarctic iceberg discharge varying between 660 and 1740 km^3 of water per year. As already discussed in para. 4(i) above, direct measurement of calving can be avoided by using equation (1) for the area within the coastline (boundary of grounded ice). But this transfers the problem to the measurement of D, the discharge of ice across the coastline, which is discussed next.

(iv) Discharge across coastline. It is clear that a large number of observations of ice movement in marginal areas is of immediate need. There is some evidence that the ice velocity does not vary much throughout the year in large polar glaciers, and, if this result is found to hold generally, short-term measurements of movement would suffice. But, for the present, long-term measurements extending over at least one year must be preferred.

Repeated aerial photogrammetry and geodetic methods may be used where practicable. Another method is to measure the separation of features which are regularly produced at annual intervals, such as the large cracks in the rear parts of floating ice shelves and glacier tongues where they go afloat. The advantage of this last method, which is said to give velocities agreeing with other methods to within a few per cent, is that it can be used when only a single aerial coverage is available.

These systematic studies in marginal areas have to be accompanied by ice thickness measurements to enable the discharge to be estimated.

(v) Other ice movement studies. In addition to the measurement of ice movement in marginal areas it is also valuable to measure the movement in the interior of an ice sheet, because this makes it possible to study the budget of inland areas and not just sectors or drainage areas that reach the coast. (Such movement studies are of course also of interest for other reasons, but that is not the concern of this report.) A very high order of accuracy is needed to measure absolute movement on an ice sheet or large ice cap. The development of microwave distance - measuring equipment offers considerable possibilities in this direction. Repeated stellar observations are an alternative, and opportunities of using navigation satellites should not be overlooked. Sufficient absolute movement sites should be located, and large networks for relative movement studies should be referred to these sites in order to get good coverage over large areas.

Horizontal strain values can be measured by repeated distance surveys using microwave devices. The direction and magnitude of the principal horizontal strain-rates should be obtained. Devices for measuring vertical strain-rates should be designed for use in deep holes. Long-term variations in ice velocities in the interior of ice sheets seem to be beyond the reach of measurement at present.

(vi) Ice temperature. Snow and firn temperatures in areas with insignificant melting give information about the present climate, and to a certain extent about what changes can occur before any melting can begin. These temperatures should preferably be measured at a standard depth of 10 m, where the annual range is less than 1^{o} C. Complete profiles from the surface down to or below 10 m increase the value of the temperature data.

Ice temperatures from greater depths are also of interest because potentially they contain information about the past climate, and also because ice flow is greatly influenced by ice temperature. Deep boreholes provide one method of measurement. Seismic studies also offer a means of determining how ice temperature and other physical characteristics vary with depth.

(vii) General. The main practical problem in finding the mass balance of ice sheets and large ice caps, besides the considerable difficulties of measuring either calving and bottom melting, equation (3), or discharge across the coastline, equation (1), is the sampling technique. The problem is most acute in Antarctica, but serious on any ice cap. Antarctica, with its 12 million square kilometres, is so large that a very great number of preferably simultaneous observations have to be made of accumulation and of the various wastage processes. Moreover, the mean values have to be deduced with a high degree of accuracy if even the sign of the net balance $C_1 + C_2$ is to be established with certainty, let alone its magnitude. Most or all estimates of the net balance of Antarctica up to now have been exceeded by their probable errors.

In view of this situation we suggest that a realistic approach to the budget of large ice masses is to try first to establish the budget of only a part of the whole ice mass, as discussed above - either a specific ice drainage area, or a strip or sector bounded by flow lines.

Lastly we must refer to a problem of the highest importance: What is the appropriate time scale for the observations? Traditionally the budget is calculated for a period of one year, since there is a yearly rhythm in the supply and wastage processes. But a single favourable or adverse year makes very little proportional difference to the total mass of the Greenland or Antarctic ice sheets. What is significant for their growth or decay is the balance over some hundreds or even thousands of years. The question arises, therefore, whether the result for a single budget year is a good measure of the balance over a very much longer period. The net balance for successive budget years will naturally show fluctuations in relation to the long-term average. If the fluctuations are small the result for any one budget year can be taken as showing the long-term trend. But if, at the other extreme, the annual budget fluctuates between positive and negative in different years, then clearly the result for any one year gives little evidence for the long-term trend. In this case the budget has to be drawn up for a longer period if significant long-term conclusions are to be drawn. The proper length of time to take for the budget period in an ice sheet or ice cap of a certain size is a question that deserves further study in relation to the likely fluctuations in the various items of which the budget is composed.

Nevertheless, even if it were found that yearly mass budgets were quite useless as a guide to long-term trends they would still retain some importance in their own right. For they can be immediately compared with simultaneous results obtained elsewhere and with meteorological information to help in understanding the processes leading to accumulation and ablation. Thus, although the question of the proper budget period for an ice sheet is of supreme importance for an assessment of its long-term growth or decay, yearly budget measurements will continue to be of value even on the largest ice masses.

V. Schytt (Chairman)
C. J. Lorius
M. F. Meier
J. F. Nye

24 February 1964

THE SOCIETY'S LIBRARY

Works received for the Society's library since November 1963.

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

Ambach, W. (4 items)
Bauer, A.
Behrendt, J.C.
Bilello, M.A. (3 items)
Bull, C.
Gerdel, R.W.
Gold, L.W.
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Sveriges Meteorologiska och Hydrologiska Institut (2 items)
U.S. Antarctic Projects Officer, Washington, D.C.
U.S. Navy Hydrographic Office, Washington, D.C.
Universidad Nacional de Tucuman, Argentine

REVIEWS

LESTER C. KING. SOUTH AFRICAN SCENERY. A TEXTBOOK OF GEOMORPHOLOGY. Third edition. Edinburgh and London, Oliver and Boyd, 1963. xxv, 308 p., illus. £2.10s.

This is a textbook of geomorphology and, although glaciers do not exist in South Africa at present, it includes a chapter on the more descriptive aspects of "glacial and glaciated landscapes". The formation of glaciers, their classification and movement, the processes of glacial erosion and its end-products, and the resultant topographic features are neatly described and summarized in a cyclic sequence. The distinction between mountain-and-valley and continental glaciation is clearly shown and demonstrated by discussion of the Permo-Carboniferous glaciation of southern Africa. There are a number of useful plates and illustrations but unfortunately some of the better ones that appeared in the second edition have been omitted.

R. J. Adie

CHESTER R. LONGWELL AND RICHARD F. FLINT. INTRODUCTION TO PHYSICAL GEOLOGY. Second edition. New York and London, John Wiley and Sons, Inc., 1963. vii, 504 p., illus., 60s.

In one of the chapters of this excellent textbook on geomorphology the authors discuss "glaciers and glaciation". After the requisite definitions and description of glacial movement, erosion and transport, the many and various forms of glacial deposits are discussed in an interesting manner. The distribution of ice in the Northern Hemisphere during the Pleistocene and the relationship of features in the glacial drift to the former extent of ice lobes have not escaped the authors' attention. To anyone interested in glaciology the causes of glacial climates is a fascinating topic also dealt with in this chapter.

This book is admirably written and illustrated with copious diagrams and photographs from widely diverse localities. It is the kind of standard work that should be available to all geologists and others.

R. J. Adie

L.-E. HAMELIN. LA FAMILLE DU MOT "PERIGLACIAIRE" (to be published in Biuletyn Peryglacjalny, 1964, no. 14, Lodz).

Professor Louis-Edmond Hamelin, Directeur of the Centre d'Etudes Nordiques at Université Laval, Québec, has sent us a preprint of a paper in which he discusses the origin of the word "Périglacaire", which in English is translated when an adjective by periglacial. He compares it with words based on other roots for the same phenomena, and also lists a large number of terms formed using the root "périglac-" from "apériglaciaire" to "tardipériglaciaire" as well as terms consisting of more than one word with "périglaciaire" as one of their components. To a physicist, the proliferation of terms by geomorphologists always seems unending; no doubt they have similar feelings about physical usages. But this list will help those unfamiliar with the systems of etymology used to trace their way carefully through such variations as those between "modelé périglaciaire" and "paysage périglaciaire", not to mention that between a "périglacialiste" and a "périglaciologue". On occasions however Professor Hamelin lets us down, as when he just lists "monopériglaciaire" without definition - presumably it is obvious to the knowledgeable. In a work of this kind it is important that care should be taken over terms, even those not being directly studied, and for this reason I was sorry to see in the preprint the false term "inlandsis" instead of its correct Danish form "indlandsis". However I have no doubt that this careful collection of possible terms and their family history will be of use to all of us whether we are periglacialists or periglaciologists!

J. W. Glen

NEWS

ARCTIC INSTITUTE OF NORTH AMERICA. The Annual Meeting of the Board of Governors was held in Washington, D.C. on 7 December 1963. The following were elected for 1964:

Officers of the Board: Chairman - Dr. J. Ross Mackay; Vice-Chairman - Dr. Hugh M. Raup; Secretary - Walter Sullivan; Treasurer - Dr. W. A. Wood.

Governors elected by the Fellows of the Institute: Dr. G. Hattersley-Smith, Dr. Hugh M. Raup, Dr. Norman J. Wilimovsky.

Governors elected by the Board: Dr. Richard P. Goldthwait, Dr. L.-E. Hamelin, Duncan M. Hodgson, Dr. Helge Larsen.

U.S.S.R. Prof. Georgiy Tushinsky believes that the glaciers in the Caucasus and other mountain ranges in the U.S.S.R. are not remains of the Ice Age, as has generally been believed. His studies have led him to the conclusion that most of the original glaciers melted away in the 5th-10th centuries. The glaciers then returned again in the 15th century. There was a marked increase in avalanches at that time; one of these destroyed the ancient capital of the Alans in the western Caucasus. M. Grossvald, another Soviet glaciologist, established that on Franz Josef Land and Viktoriya Island there were no glaciers a thousand years ago: tree-trunks have been found there under the ice, dated to 1,000 years ago by the radio-carbon method. Prof. Tushinskiy suggests that the spread of the glaciers in the Arctic and in the mountain areas occurred at the time known in the West as "the age of terrible winters."

Artificial Glaciers. In the arid mountain region in the north of West Pakistan (which includes the parts of the Karakoram and Hindu Kush Ranges that lie within Pakistan), irrigation is essential to all agriculture. Water shortage is one of the main limiting factors, affecting both crop yields and the area under cultivation. The problem of water shortage is often more serious for those villages that are supplied from melting snow than for those villages that are supplied from glaciers, because all the snow may melt before the end of the summer and because the supply may be disastrously reduced in years of small snowfall. For this reason, the inhabitants of a village that gets its water supply from snow may decide to "make" a glacier at the head of their catchment basin.

The glacier is "planted" by burying about 80 lbs. of ice from neighbouring glaciers, in a hole, dug as high as possible in the catchment basin. According to local tradition, some glaciers are "male" and some are "female" (the male ones are distinguished by clear ice, the female ones by cloudy ice) and for an artificial glacier to grow successfully the buried ice must be of both kinds. Various substances are used to line the hole and cover the ice; these may include snow, straw, charcoal, dung, salt and herbs. If the "planting" is successful, the amount of snow remaining unmelted at the end of the summer is said to increase with each succeeding year and to develop into an apparently normal glacier.

According to the principles of glaciology, it would seem that there are only two circumstances in which the buried ice would develop into a glacier. The first is where the "planting" happened to coincide with the natural genesis of a glacier; but it seems unlikely that any new glaciers are naturally coming into existence at present, because most glaciers in the region seem to be receding, though some may be stationary or advancing. Secondly and very rarely, the buried ice might grow into a glacier if the ablation at that site only just exceeds the accumulation before "planting", so that the buried ice could sufficiently affect the micro-climate to reduce the ablation until it is exceeded by the accumulation. Many studies on recently "planted" glaciers are needed before we can assess the part played by folklore in this interesting aspect of applied glaciology.

(From information supplied by Elizabeth Staley)

John F. Nye of the University of Bristol, England, is spending January to August in the U.S.A. doing glaciological research and lecturing. From February to June he is visiting Professor at the Hammond Metallurgical Laboratory of Yale University.

Dr. Wilhelm Jost, born in 1882, died in Bern, Switzerland, on 22 January 1964. He was a physicist, alpinist and glaciologist, and had been a member of the Glacier Commission of the S.H.S.N. since 1924. He took part in the Swiss Expedition to Greenland 1912 - 13, led by Alfred de Quervain. He made an important contribution to the study of Swiss glaciers, especially in seismic soundings, and in 1931 collaborated with M. Oechslin and a group of German geophysicists on the Rhône Glacier. In 1928, Jost, with Oechslin and Mercanton, buried 19 small sealed shells containing a record of their names in crevasses near the beginning of the Rhône Glacier, which should re-appear at the snout during the 22nd century.

NEW MEMBERS

New members of the Society since December 1963 are:

Bailey, Jeremy T., Downing College, Cambridge, England.
Bennett, Roger, Beech House, Boundary, Woodville, Burton upon Trent, Staffs., England.
Blackwell, Michael, Box 548, College, Alaska, U.S.A.
Cooper, Dr. Charles F., P.O. Box 2724, Boise, Idaho, U.S.A.
Corrie, Malcolm B., St Edmund Hall, Oxford, England.
Davidson, K.D., 219 W. 9th Street, Leadville, Colo., U.S.A.
Embacher, U.H.O., 3583 Durocher, Apt. 2, Montreal 18, P.Q., Canada.
Fullerton, David S., Department of Geology, Yale University, New Haven, Conn., U.S.A.
Hamelin, Dr. Louis-Edmond, 1244 Albert-Lozeau, Sillery, Quebec 6, Canada.
Hannan, M.C.F., 29 Broomfield Lane, Palmers Green, London N.13, England.
Henery, Donald, Stephenson Hall, Oakholme Road, Sheffield 10, Yorks., England.
Hooper, Miss Mary Ann, 53 Shepard Street, Cambridge 38, Mass., U.S.A.
Hutt, Geoffrey G., 7 Stowe View, Tingewick, Buckingham, England.
Knapman, Miss Roberta, Homestead, 18 Farm Fields, Sanderstead, Surrey, England.
Lees, David, 925 Alta Pine, Altadena, Calif., U.S.A.
Mackay, Dr. J. Ross, Department of Geography, University of Columbia, Vancouver 8, B.C., Canada.
Marsh, John S., Geography Department, University of Alberta, Calgary, Alta., Canada.
Morgan, Alan V., Beaumont Hall, Stoughton Drive South, Leicester, England.
Neethling, D.C., Antarctic Division, Geological Survey, Box 401, Pretoria, Republic of South Africa.
Nottarp, Klemens, Frh. v. Steinstrasse 31, 6232 Bad Soden Ts, Germany.
Ommanney, C.S.L., Fairbourne, 9 Great Austins, Farnham, Surrey, England.
Peyton, Harold R., University of Alaska, P.O. Box 29, College, Alaska, U.S.A.
Porter, Dr. Stephen C., Department of Geology, University of Washington, Seattle 5, Washington, U.S.A.
Price, Dr. Robert J., Department of Geography, The University, Glasgow W.2, Scotland.
Schell, Irving I., Department of Geology, Tufts University, Medford, Mass., U.S.A.
Taylor, John, c/o Beit Hall, Imperial College, Prince Consort Road, London S.W.7, England.
Weber, W.M., Department of Earth Science, Montana State College, Bozeman, Montana, U.S.A.
Wheeler, D., Shackleton House, King Edward Point, South Georgia, Falkland Islands Dependencies, South Atlantic.
Wright, Dr. M.D., Saskatchewan Research Council, University Campus, Saskatoon, Sask., Canada.

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