NUMBER 22

DECEMBER 1966

ICE

COMMISSION OF SNOW AND ICE

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

XIVth General Assembly of the Union
Switzerland: 25 September — 7 October 1967

Meetings of the Commission of Snow and Ice
Berne: 27 & 28 September
3—5 October

Excursions organized by the Commission
29 September—2 October

Details are given on pages 11 and 12
of this issue of Ice

ICE

NEWS BULLETIN OF THE GLACIOLOGICAL SOCIETY

DECEMBER 1966 NUMBER 22

CONTENTS

SELIGMAN CRYSTAL. We are pleased to announce that the Council of the Society has agreed to award a Seligman Crystal to Dr. Henri Bader, in recognition of the great influence he has had on glaciological research. We hope to make the presentation during the period of the IUGG meetings in Switzerland, September-October 1967. Further details will be given later. This will be the second Crystal to be awarded. The first one was given to Dr. Gerald Seligman, Founder of the Glaciological Society, in 1963 (see Journal of Glaciology, vol. 4, no. 36, p.664).

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

1967 DUES. These should be sent to the Society in January 1967. A form to remind you of the method of making payment accompanies this issue of Ice (except for those members who pay by Banker's Order).

NO DUES BY JUNE — NO JUNE JOURNAL

COVER PICTURE. A pile of discarded cores of firn which have been taken from different depths in the Greenland ice sheet by augers and studied in the cold laboratory. (Station Jarl-Joset, 1959). Photo: Jacques Masson (copyright — Expéditions Polaires Françaises, 47 Ave. Maréchal Fayolle, Paris 16, France).

FIELD WORK

DENMARK

The geological investigations in Greenland have been carried out by the Geological Survey of Greenland, which has continued the investigations of the former extent of the Inland Ice in the Frederikshåb district, south-west Greenland, during the summer of 1966. In the Ilímaussaq area near the town of Narssaq, Julianehåb district, south Greenland, hydrological investigations were continued during 1966. This project includes measurements of the ablation of a small glacier and of the variation in lake levels, in connexion with run-off measurements of a river basin immediately north of the town of Narssaq. Earth temperature measurements have been continued throughout 1966 at the station in Holsteinsborg.

Studies of the isotopic composition of glacier ice have been continued by W. Dansgaard, Universitetets Fysiske Laboratorium II, University of Copenhagen, who has carried out:

1. Collection of big samples for an Si^{32} determination at Hintereisferner and Kesselwandferner in Austria (in co-operation with W. Ambach) and at the Inge Lehmann Station on the Ice Cap.

2. Collection of samples for a stable isotope analysis for a study of climatic change was made in connexion with the Inge Lehmann Station project (co-operation with Wilhjelm).

From the Department of Geography of the University of Copenhagen snow studies have been carried out by Børge Fristrup in Peary Land with a view to determining the amount of annual precipitation in the different regions of northernmost Greenland. Some re-surveying has also been carried out at Chr. Erichsen Iskappe, Heilprin Land.

As a member of the EGIG expeditions, Denmark has participated in planning the EGIG 1967 and 1968 expeditions to the Greenland Ice Cap. Eske Brun, former Director of the Greenland Department, has replaced Einar Andersen as President of the Direction Committee of EGIG.

B. Fristrup

GERMANY

COMMISSION FOR GLACIOLOGY

The Commission continued its annual observations and studies of the test glaciers in the Eastern Alps: the Langtalerferner (Ötztal) and the Schneeferner (Zugspitze), by glaciological and photogrammetric field work. The evaluation of the observations in 1965 showed for the first time in 4 years a positive mass budget for both glaciers. The figures for the budget year 1964/65 are:

	net budget	specific net budget
Langtalerferner	+ 1091 . $10^6 m^3$	+ 379 mm.
Schneeferner	+0.606 . $10^6 m^3$	+1800 mm.

As a contribution to the programme of the International Hydrological Decade, the observations were extended to the Vernagtferner (Ötztal), completing H. Hoinkes' work in the Rofental. A net of ablation markers was established, and a new photogrammetric survey executed. The evaluation can be compared with S. Finsterwalder's classical map of 1888, O. v. Gruber's survey of 1912 and a newly plotted survey of 1938 by Hoinkes and Schatz. Furthermore, a net of ice thickness profiles was measured by seismic sounding.

The photogrammetric survey of glaciers in the Zillertal was repeated.

The field work of the Commission required 16 trips with 147 man-days.

ROSS ICE SHELF SURVEY (RISS) II

During the southern summer 1965/66 the profiles over the Ross Ice Shelf, established by a U.S.A.-English-German group under W. Hofmann in 1962/63, were remeasured with the same geodetic and glaciological methods. The project was part of USARP, sponsored by the National Science Foundation. The field work was led by E. Dorrer, Munich, collaborating with K. Nottarp, Frankfurt, as electronic specialist and O. Reinwarth, Munich, as glaciologist.

A first evaluation of the measurements indicated movements of the ice towards the Ross Barrier at speeds up to 900 m/year.

KURS FÜR HOCHGEBIRGS- UND POLARFORSCHUNG (GLACIER COURSE) 1966:

Under the direction of W. Hofmann, H. Hoinkes and H. Kinzl the 16th Glacier Course was held between 18 and 25 September in Obergurgl (Ötztal). Thus a tradition going back to 1913, which was interrupted for 5 years by the death of R. Finsterwalder in 1963, was revived. 84 geodesists, geographers and geophysicists from 5 countries participated.

W. Hofmann.

UNIVERSITY OF MUNSTER

During the summer of 1966 seismic observations were undertaken on the Schmiedinger Kees glacier above Kaprun in the Austrian Alps by the Institute of Pure and Applied Geophysics.

B. Brockamp.

ITALY

COMITATO GLACIOLOGICO ITALIANO

Bollettino. In 1965-66, no. 12, part 1—Ghiacciai, was published. Part 2, devoted to snow research, was published in June 1966. Section I consists of three notes, the longest of which discusses the snow cover in Piedmont and is contributed by C. Capello. This note forms part of a series of studies which will eventually cover the entire Alpine region. The other two notes, by M. Vanni, are devoted to the study of avalanches, a subject on which the Snow Committee is beginning a series of studies.

Snow Committee Activities. New studies include research on the lower limit of the temporary snow cover, a phenomenon which has not yet been sufficiently studied either theoretically or practically. Study methods are based on periodic photographs taken from panoramic viewpoints and periodic air surveys linked with on-the-spot observation by scientists who are specialists in the area.

Research is also being carried out on the hydrological balance of the snow cover. Horizontal measurements are made of the various layers of the cover, previously sub-divided according to the various snowfalls. Such subdivisions are made by means of suitably positioned woollen threads. The changes in snow cover structure during the winter can thus be followed with greater accuracy. These measurements are being taken at the Fedaia and the Perrères stations. In 1966-67 it is hoped to take measurements higher up at the Goillet station (2526 m).

Other studies are being made by E. Tongiorgi on ice-melting phenomena. Samples taken at Marmolada are used for this research.

(Extracts from the minutes of a meeting of the Commission, 2 July 1966.)

JAPAN

YUKIKABE FIRN, HOKKAIDO

The Institute of Low Temperature Science, Hokkaido University, worked on the third year of a project to study the Yukikabe Firn in the Taisetsu Mts., Hokkaido, last summer. The Yukikabe Firn has been formed by drifted snow in winter without any supply of avalanche debris, and has existed through the year at a level lower than the climatic and geographical snow line. The approximate size of the Firn was 130m in length, 220m in width and 24m in depth at the centre in May, and 50m x 65m x 8m in October, 1966. Monthly observations were made during this period.

A 4-stake strain grid, a square of 10m x 10m, was set on the Firn to measure the surface movement and surface stress conditions. However, the results suggested a very complicated distribution of the surface movements and stress conditions. Dispersion of the surface movement up to 1m and the existence of tensile and compressive stress along the maximum steepness line were observed within a small area, 30m x 20m. More detailed study on the stress and strain conditions of the Firn is to be carried out in 1967.

Snow cores were collected by hand auger down to the bottom of the Firn. The density profile and the grain structure were observed from the snow cores. Observations of the grain structure, especially in the process of firn metamorphosis, were made from microscopic examination of thin sections of firn. As a result, it was found that the Firn was composed of two annual layers with a distinct boundary, a natural and artificial dirt layer. The density profile and the grain structure were very uniform in each layer. Distinct evidence of compression over a long period, a characteristic feature of grain boundary and grain structure, was observed in the older layer.

Surface ablation, density and free water content near the surface were observed to measure the amount of snow melt. Changes in the Firn shape and weather conditions were also observed. The total amount of ablation at the surface was approximately 15m in depth, 7m in water equivalent, from May to October. The maximum ablation rate of 2.4m water/month was observed in July.

Z. Yosida.

NORWAY

In 1965, mass balance measurements were carried out on 9 glaciers by Norges Vassdrags- og Elektrisitetsvesen and Norsk Polarinstitutt.

The accumulation was below normal in southern Norway when measurements were made in the spring, but extensive summer accumulation raised the figures to nearly normal in the western part. As a result of the cold summer, the ablation was less than normal over the whole of Norway. The result was a gain for all glaciers.

Mass Balance

Glacier	Position	Acc gm/cm²	Abl. gm/cm²	Mass balance gm/cm²
Folgefonni	W. Norway	237	233	+4
Hardangerjøkulen	,,	205	154	+51
Ålfotbreen	,,	364	316	+47
Nigardsbreen	,,	229	138	+91
Storbreen	Central Norway	154	120	+34
Hellstugubreen	,, ,,	129	77	+52
Gråsubreen	,, ,,	77	36	+41
Blåisen	North Norway	200	146	+54
Storsteinfjellbreen	,, ,,	169	125	+44

Changes in glacier fronts

Jostedalsbreen:	m	Jotunheimen:	m
Austerdalsbreen	— 8	Storbreen	— 8
Nigardsbreen	— 54	Styggedalsbreen	— 3
Fåbergstølbreen	—103		
Lodalsbreen	—120	Møre:	
Stegholtbreen	— 67	Trollkyrkjebreen	0
Briksdalsbreen	— 2	Veslebreen	— 1
Åbrekkebreen	+ 7	Finnebreen	0
Tunsbergdalsbreen	— 28		
Folgefonni:			
Bondhusbreen	0		

O Liestøl.

U.S.A.

UNIVERSITY OF ALASKA

At the University of Alaska the glaciological field season lasts all year. In particular, the Fairbanks area provides many interesting subjects for winter research. For the past several years studies have been under way on ice formation in lakes and streams, in the atmosphere and in the soil, together with an investigation of the development and evolution of seasonal snow cover in the interior, Arctic, and maritime regions of Alaska.

Ice formation in turbulent streams. A study of freezing in turbulent streams is now under way for the fourth consecutive year. It constitutes part of the field and laboratory work in a course on glaciology. The experimental site is on Goldstream Creek which is only 5.5 km north of the University campus and easily accessible in all seasons.

The complete winter cycle of the stream is studied in detail beginning with the stream's reaction to the initial formation of underwater ice (frazil ice and anchor ice). The extent of supercooling during the freezing cycle varies and appears to produce a variation in habit of the frazil crystals. Attempts to measure the extent of supercooling were more successful during this October 1966 than during the three previous years, and several photographs were made of the growing underwater ice. Freeze-up on Goldstream is followed fairly rapidly by development of pressure bulges in the ice; they occurred within one week in October. Water pressure is relieved when the stream flows out over the ice and the frozen overflow layers form aufeis deposits which sometimes extend beyond the original stream channel. The topography of the ice surface has been measured before break-up each year and G. A. Furst maintained a record of each individual overflow layer during the 1965-66 winter. The structure of the stream ice is studied by cutting sections across the stream. Cores and large blocks of last season's ice are in storage together with some ice from fall 1966, and petrofabric analyses of the individual ice layers are under way. The complexities of break-up have been observed in the past and will be measured again in spring 1967.

Ice formation in the atmosphere. Fairbanks constitutes an excellent outdoor laboratory in the winter for studying nucleation and freezing of supercooled water droplets. We have studied both man-made and natural aspects of these cloud physics phenomena since 1961. The man-made aspects result from two interacting conditions:

1. The continuous input of water vapour produced by the city into a cold (—40°C or below) air mass. Air at temperatures below —40°C can dissolve less than $0.1 gH_2O$ per m^3.

2. Strong surface inversions are always present at temperatures below —30°C and are strengthened as temperatures decrease; gradients up to 30°C per 100 m in the first 50 m are measured. This causes the air to stagnate over the city, which is surrounded by hills on three sides. Indeed, the lowest air layer is virtually decoupled from the overlying atmosphere.

As a net result the city produces and maintains a dense fog of tiny (less than 20μ diam.) anhedral ice crystals. This is the infamous "ice fog".

By viewing the problem with glaciological prejudice, one can seek a mass balance for this collection of randomly oriented ice crystals which has well defined boundaries. This "glacier" has an internal source, and loses mass from the top by evaporation and from the bottom by precipitation. The sources of water vapor (combustion products, power plant cooling waters, people and dogs breathing, &c.) have been analyzed to obtain an input rate. The area, thickness, density (mass of ice per unit volume of air) and the rate of precipitation have been measured. From these, an internally consistent evaporation rate has been measured to give a mass balance. The derived mass balance gives a reasonable value for the maximum equilibrium extent of the ice fog at various temperatures with present input rates.

Products other than water are also put into the stagnant air masses and it soon became clear that the ice fog accompanies, and is a visual manifestation of, a serious air pollution problem. We have looked into several aspects of the dynamics and chemistry of this problem. This work is continuing and possibly constitutes the first blend of glaciological and air pollution research.

The nuclei of ice fog crystals have been examined by M. Kumai of CRREL in connexion with our past studies. T. Ohtake of the Geophysical Institute is continuing the electron microscopic research on nuclei and crystal habit.

Sources and physical properties of Alaskan snow cover. Studies on snow cover were continued during the past year on the Arctic Slope, in interior Alaska and on Mt. Wrangell. They have again concentrated on measurements designed to reveal sources of snowfall and mechanisms of diagenesis. These measurements include stable isotope ratios (O^{18}/O^{16}, H^2/H^1) and specific electrical conductance.

The Arctic Slope of the Brooks Range—Studies on the Arctic Slope during May and June 1966 were confined to previously established test areas at Lake Noluck, Meade River and Barrow. At each of these sites the size, shape and water equivalent of strata formed in drifts on specific topographic features were measured for the fifth consecutive year along selected profiles. The relationship of drifts formed by storm winds (from the west) and prevailing winds (from the east) are considered separately at each site. Samples, organized according to time by relative stratigraphic position, were taken at each site and the existence (or lack) of correlation of electrical conductance and isotope ratio measurements is being examined from one site to the next.

Snow studies of interior Alaska—Studies in the interior are concentrated on diagenetic processes and constitute part of the field and laboratory work in a course on glaciology. With help from R. M. Slatt and P. S. Glovinovich, the test site at the University's Agricultural Research area was enlarged in scope during the 1965-66 winter. Our measurements concentrated on the effects of heat and mass transfer in the snow pack and in the air and soil immediately above and below it. Six tables were built before the first snowfall; their tops were painted white and stood well above the maximum expected snow depths. Snow accumulated on the tables as well as on the surrounding ground. Thus, the experiment involved adjacent snow packs with identical depositional history but vastly different diagenetic environments. Temperature gradiants, density profiles and resultant snow structures were measured throughout the winter in the snow lying on the ground and on the tables.

The temperature of the soil surface beneath the snow remained within 3 to 4°C of the melting point while the snow surface temperature dropped to —45 or —50°C. The gradients often were as high as 1°C per cm. Compared with these extreme temperature gradients there is virtually no gradient across the snow lying on the table because the air contacts it on top, all four sides, and on the bottom (through the plywood table).

The density profiles measured at least once a week showed upward migration of water vapor in the snow lying over the ground as depth-hoar formed in it. Before melting began, the depth-hoar layer spread upward to occupy nearly three-quarters of the snow pack overlying the soil whereas no depth-hoar formed in the snow on the table. These observations have also been made in previous years. However, during the 1965-66 winter we included soil moisture measurements as part of the experiment. The moisture content of the upper soil layer increased from 25 to 38 per cent (per cent of dry weight) during freeze-up when water was being drawn from below to form ice lenses in the freezing soil. After mid-October the moisture content of the upper 4 cm began to decrease and reached a minimum value of 7.6 per cent at the end of March. Just before melting began, the top 4-5 cm of soil was dry dust whereas it had been solidly frozen in October. Thus, the upward movement of water vapour caused by the temperature gradient in the snow establishes a drying action which extends to the underlying soil.

During October 1966 we installed a snow pressure pillow in hopes of determining how much of the upward migrating moisture actually escapes from the snow pack.

Wrangell Mountains, Alaska—Glaciological and volcanological studies begun in 1961 on the summit of Mt. Wrangell (62°N, 144°W, 4200 m above sea-level) were continued in 1966. Studies of surface motion in the summit caldera were started in 1961, refined and extended in 1965, and re-examined in March, July and August of 1966. Two new techniques have proved very useful in this work. First, a small research station built at the north rim of the caldera was designed to use volcanic heat as the sole source of heat. This has been successful and makes an excellent field camp. Second, a computer program written for the University's IBM 1620 computer provided x, y, z coordinates for each movement stake from angular data measured with a Wild T-2 Theodolite. With excellent co-operation from Alaskan ham radio operators, raw data for up to 80 stakes were sent to Fairbanks, and computed x, y, z coordinates were returned to the top of Mt. Wrangell, sometimes within 24 hours.

The above procedure gave completely calculated flow vectors in the field while the work was under way. This made it possible to check out anomalous areas with more detailed observations and it was even possible to re-examine these supplementary observations. This has proved to be a great advantage over the normal procedure of completing calculations at the end of the field season. Douglas K. Bingham has made the flow studies since 1965. In July-August 1966 he succeeded in a special effort to measure some basal melt rates where the glacier overlies warm volcanic rock. Unfortunately, due to heavy snow accumulation this summer, very few of the 1965 caldera stakes remained visible; some new ones were set in August 1966.

Stratigraphic studies were continued to determine more accurately accumulation rates and other facies parameters. Two snow pits were dug to depths exceeding 3 m and temperature, density and stratigraphic profiles were made. A string of thermocouples set at 5, 10, 15, 20 and 25 m below the 1965 snow surface in the north crater was remeasured. The 1966 pits intersected the levels studied in 1965 and two of the 1965 pits extended deep enough in the north crater to include layers studied in 1961. Physical properties of the top 10 m of snow measured in 1961 and 1965 differed in ways which seem to be consistent with differences in the accumulation rates during these years. Efforts have been made to relate accumulation units with the specific storms which deposited them and to study active diagenetic processes responsible for development of extreme types of strata. Pronounced seasonal variations occur in the accumulation rate. George B. Wharton concentrated on the snow stratigraphy studies in 1965 and Gerd Wendler assisted in 1966. Dr. Wendler, of the Institut für Meteorologie und Geophysik, Universität Innsbruck, Austria, joined the staff of the Geophysical Institute at the University of Alaska in July 1966.

Carl S. Benson.

UNITED STATES GEOLOGICAL SURVEY, TACOMA, WASHINGTON

International Hydrological Decade

Symposium on glacier mass budget studies — This symposium was held at South Cascade Glacier and Tacoma, 7-18 March 1966. The purpose of this symposium was to increase the significance, accuracy, and comparability of the representative glacier basin studies in the United States and Canada as part of the International Hydrological Decade. The symposium had three main objectives: one was to review and reformulate glacier mass budget concepts and definitions, another was to discuss heat-, ice-, and water-budget programs in representative glacier basins, and the third was to test field techniques and equipment used for measuring mass budgets.

Those attending the symposium were Gunnar Østrem, Olaf Løken and Allan Stanley, all of the Department of Mines and Technical Surveys, Ottawa, Canada; Larry Mayo (Fairbanks), David Scully (Sacramento), and Meier, Campbell and Tangborn (Tacoma) of the U.S. Geological Survey.

Research projects — As part of the international program to establish chains of glacier stations at which combined heat-, ice- and water-balance studies are to be made, the Geological Survey established two new stations in Alaska and one in California, and is using the South Cascade Glacier facility as an index station and as a station for testing techniques and instruments to be used at other locations. Mass balance and water balance instruments were installed at Gulkana Glacier (Alaska Range) and an unnamed glacier (Kenai Peninsula) by L. R. Mayo, and at Maclure Glacier (Sierra Nevada) by D. R. Scully. At South Cascade Glacier, pressure pillows have been installed to see if they can provide a reliable and accurate continuous record of mass budget changes, and long-term air thermographs are being tested. The search still continues for a reliable, portable, digitizing recorder for the heat balance instruments. A. Stanley, S. Patterson, and S. Outcault, who are involved in the Canadian IHD glacier-station program, discussed instrumentation and techniques for mass and heat balances at Tacoma and South Cascade Glacier during the summer, as did three members of the Department of Atmospheric Sciences, University of Washington.

Another international program, the inventory of perennial and seasonal snow and ice, has been started for the United States with an inventory of glacier ice in Alaska.

South Cascade Glacier

General—The transient mass budget in mid-May, 1966 (the "apparent accumulation") was about 14 per cent less than the 1958-65 average; only 2.7 m of water equivalent was measured at the midglacier index station. Ablation rates were high in late July, August and September, especially at higher elevations. As a result most of the winter snow cover was removed from the glacier by mid-September. On 30 September the mean transient budget was about —0.76 m and high ablation rates were continuing.

In July, tests were made of several types of snow survey samplers. Some improved versions showed much promise, and may eliminate the need for pits or coring augers for some types of mass balance studies. Digital recorders were installed in parallel with the analog recorders on the two streamflow gaging stations, in order to reduce the data-reduction time and expense. Lichen, tree-ring, and geomorphological evidence of the Neoglacial history of South Cascade, LeConte, Dana, and Chickamin Glaciers was collected by Dan Miller, a graduate student at the University of Washington.

Remote sensing test flights — Continued studies of the remote sensing of snow and ice were carried out as part of a joint Geological Survey/Office of Naval Research/National Aeronautics and Space Administration program to investigate the possibilities of using spacecraft in glaciological research. The September 1965 flights were reported previously in ICE. In October 1965 side-looking radar images were obtained of South Cascade Glacier. These revealed that ice, firn and rock could be distinguished even when covered with a thin layer of new snow. In April 1966, South Cascade Glacier was overflown with the NASA aircraft, and photographic (colour, colour infra-red) and thermal infra-red imagery was obtained at the time of maximum snow cover.

Another series of four remote sensing test flights were held over South Cascade Glacier on August 11 and 12, using the NASA aircraft. Instruments in the airplane included a cartographic camera utilizing both panchromatic and colour infra-red film, imaging scanners operating in the ultra-violet and in the 8-14 micron band of the infra-red, a radar scatterometer, and microwave radiometers operating at four different wave lengths.

An exceptional amount of ground-truth information was collected by field parties on the glacier. Air temperature was continuously recorded at four locations ranging in altitude from 1610 m to 2260 m. Snow temperature profiles from the surface to 30 cm below were measured hourly during the night and early morning at two locations on the glacier. At these sites measurements of snow density, hardness, grain size and crust development were also made. Wind and precipitation were also measured. During each flight and hourly from 1900 August 11 to 0800 August 12 apparent radiant temperature measurements were made using a portable infra-red thermometer on representative patches of snow, ice, lake, rock, moraine, talus, meadow and timber. All of the airborne and ground instruments operated satisfactorily, and consistent and interesting results were obtained.

Lake studies — A limnological study of South Cascade Lake was started in March when its temperature structure was measured; it was found to be a cold lake (no water at the temperature of maximum density) with a thermocline of 10 to 20 m depth suggesting circulation. In August the three-dimensional distribution of temperature, dissolved oxygen, conductivity, and suspended sediment was measured. All this time the entire lake, with the exception of a stable surface layer several metres thick, was at the temperature of maximum density. Experiments were performed on means to obtain the temperature distribution of the lake surface. Thermistor probes and an infra-red radiometer were used simultaneously in close proximity and with the radiometer scanning from a point approximately 100 m above the lake. Synoptic lake surface temperature distributions were measured for various wind and sky conditions.

Glaciers in the Pacific Northwest

Snow accumulation on glaciers during the 1965-66 winter in the Northern Cascade Range of Washington was considerably below normal. At higher elevations accumulation was exceptionally low but at lower elevations the deficit was not so great, probably due more to lowered freezing levels during winter storms than to any unusual precipitation patterns.

The ablation season began later than normal and several light snowfalls in June retarded heavy melt by raising the albedo. Ablation was very high during the latter part of July, August, and September. The slow retreat of the snowline during the early part of the summer was compensated by a very rapid retreat later in the season.

The result of these conditions was negative mass budgets over most of the glaciers in the Northern Cascade Range. The glaciers on Mount Rainier, Glacier Peak, Mount Adams and Mount Hood all had negative to extremely negative mass budgets.

Out of all the glaciers observed only the Coleman-Roosevelt (Mount Baker), Nisqually and Kautz Glaciers (both on Mount Rainier) showed strong advances and the South Mowich, Puyallup, and South Tahoma Glaciers on Mount Rainier made slight advances. Most glaciers maintained approximately equilibrium positions. The Nisqually Glacier's advance of 40 m demonstrated the continued effect of the kinematic waves first observed in 1946 on the upper profile of the glacier. But it appears that the advancing condition observed during the past few years will not continue much longer as thinning at all three profiles occurred this year.

Glaciers in Alaska

Aerial reconnaissance studies recorded a remarkable number of surges this year. Glacier surges, also known as catastrophic advances or "galloping glaciers", are sudden movements of glaciers at speeds of 10 or 100 times faster than normal glacier flow. The number of surges in progress in 1966 is greater than has been recorded since Austin Post's studies began in 1960.

In the Glacier Bay area, the large Carroll Glacier is just beginning to surge, the surging Tyeen Glacier has exhibited a remarkable advance down to tidewater, the Rendu Glacier was surging in 1966, and the surge of the Tikke Glacier (British Columbia) may be completed, while two nearby glaciers have begun to advance rapidly.

In the Yakutat-Disenchantment Bay area, the Miller and Lucia Glaciers are surging; the latter surge is particularly spectacular. Farther to the northwest, the Walsh Glacier surge is continuing, and it has pushed the Logan Glacier terminus ahead about 400 m. The Walsh Glacier surge has been in progress for four years, an unusually long period of time.

In the Wrangell and Skolai Mountains, the Sheep Creek Glacier (near the Russell), the Hole-in-the-Wall Glacier south of the Fredrika, and a branch of the Nesham Glacier are now advancing. The Middle Fork Glacier surge apparently ended this spring. The surge of the Steele Glacier (Icefield Ranges, Yukon Territory), which has been widely reported in the press, appears to have nearly run its course; this particular surge was predicted by Post who recorded the beginning stages of it in September 1965. Several smaller glaciers in this area are now surging.

The Bering Glacier, perhaps the biggest single glacier in North America, is now advancing spectacularly along a front 42 km wide. The terminus has advanced about 300 m since 1963 along most of its width, and about 1,200 m in one location. As a result the large marginal river draining Hana Lake has been blocked and diverted into the Tsivat River. The glacier surface is exceptionally crevassed, indicating abnormally rapid movement for at least 100 km above the terminus. This crevassing and the advance have resulted from the rapid passage through the glacier of a wave of increased ice flow. Post's researches have discovered evidence of repeated pulses of activity in this huge glacier. These may be related to the spectacular surges in valley glaciers. However, the Bering Glacier is so large, 203 km long and 5,800 km^2 in area, that the ice volume involved in its surges is at least 20 times greater than any other observed surges in valley glaciers.

Mark F. Meier. Wendell V. Tangborn.
William J. Campbell. Austin Post.

MEETINGS

THE GLACIOLOGICAL SOCIETY

BRITAIN

28 October 1966, Geography Department, Bristol University:
Uwe Radok—Australian research in Antarctica.
Joint meeting with the University Geographical Society.

17 November 1966, Imperial College, London, S.W.7:
Uwe Radok — Wind deposition and erosion of snow.

25 November 1966, Cambridge University:
C. J. Lorius — Isotope research in Terre Adélie, Antarctica.
A. Bauer — Problems of mass balance studies of the ice sheets of Greenland and Antarctica.

13 December 1966, Geology Department, Birmingham University:
Uwe Radok — Australian research in Antarctica.
Joint meeting with the Lapworth Society.

NORTH AMERICA

Northeastern North America Branch of the Society. The following papers were read at the first annual meeting of the Branch, held in Hanover, New Hampshire on 1 and 2 October 1966:

O. Løken — Glaciological work in the Geographical Branch, Canadian Department of Mines and Surveys.
M. Mellor — Thoughts on slope stability.
E. R. Pounder — Acoustic attenuation in ice.
R. Haugen — Dendrochronologic dating and climatic inference.
S. L. Bear — An improbable cause of the ice age.
C. M. Keeler & W. F. Weeks — Mechanical properties of an alpine snow pack.
B. L. Hansen — Deep drilling in the Greenland ice sheet.
C. C. Langway — Some geochemical aspects of the Greenland ice sheet.
J. Weertman — The rock-ice interface problem.
W. S. B. Paterson — Glaciological work on Meighen Island, Arctic Canada.
S. J. Mock — Accumulation patterns on the Greenland ice sheet.
F. Müller — Automatic weather stations.
J. Brown and P. V. Sellman — Ice wedge stratigraphy.
R. O. Ramseier — Diffusion in ice monocrystals.
P. Hoekstra — Interfacial water in frozen soils.
A. Kovacs — Some aspects of construction in Greenland snow.

The meeting approved the following administrative details:

1) The officers of the Branch will be elected at the Annual Meeting and will consist of a President, Vice-President and Secretary/Treasurer. Under normal circumstances the Vice-President will become President the following year: this will provide a small amount of executive continuity.

2) The primary responsibility of the Officers is to arrange the next meeting at a suitable site. In this they will have complete freedom in scheduling and, where desirable, in developing temporary liaisons with other meetings in allied areas of interest. They are also responsible for arranging the annual cocktail party and dinner.

3) The annual dues of the Branch will be $0.25.

The officers of the Branch for 1967 were elected: President, W. F. Weeks; Vice-President, E. F. Roots; Secretary/Treasurer, C. M. Keeler.

SYMPOSIUM ON THE ARCTIC HEAT BUDGET AND ATMOSPHERIC CIRCULATION

The symposium was held at Lake Arrowhead, California, U.S.A., 31 January-4 February 1966, and was organized and sponsored by the University of California at Los Angeles and by the Rand Corporation, with the financial support of the National Science Foundation. The Symposium was initiated by Mr. J. O. Fletcher (Rand Corporation, Santa Monica, California), who was mainly responsible for the creation of the programme and for getting together participants from Australia, Canada, Israel, Norway, U.S.S.R. and U.S.A. 23 technical papers were presented and 5 working groups established to study the needs for future investigations; these activities will be reported in the proceedings of the symposium, to be published at the end of 1966.

Papers:

M. I. Budyko — Polar ice and climate.
J. O. Fletcher — The Arctic heat budget and atmospheric circulation.
M. R. Bloch — Volcanism, polar albedo and climatic change.

M. I. Yudin — Use of natural othogonal functions when studying dynamics and thermal regime of the atmosphere.

Y. Mintz — Climatic experiments with a two-layer model.

G. Leith — Climatic experiments with a six-layer model.

J. Businger — Transfer of momentum and energy in the planetary boundary layer.

P. Crowley — Numerical experiments on ocean/atmosphere interactions.

L. Berkofsky and R. Shapiro — The effects of heating at high levels in an auroral ring.

J. Bjerknes — Teleconnections by way of the atmospheric circulation from Equatorial regions of anomalous ocean temperature.

W. Munk — The formation of bottom water and its climatic implications.

J. M. Mitchell — Stochastic models of air/sea interaction and climatic fluctuation.

L. K. Coachman — Distribution of super-cooled water and heat flux.

J. Katzbach — Evidence of extent of ice cover during the warm period of 1000 A.D.

H. G. Farmer — Gravity waves in a non-circular Arctic Ocean.

P. Putnins — The influence of Greenland on the general circulation.

F. Müller — The climatic history of northern Canada.

A. A. Girs — The heat regime of the Soviet Arctic and the main forms of atmospheric circulation and their long-term fluctuations.

S. Orvig — Possible variations in the radiation budget in the Arctic.

F. Badgley — The heat budget at the surface in the Arctic.

N. Untersteiner — The thermal regime of pack ice.

J. Schule and W. Wittmann — The mass budget of the pack ice.

R. Popham — Satellite observations in the Arctic.

Working Groups:

1. Summary of the main issues concerning climatic change and possible ways of resolving them.
2. Atmospheric advection of heat and moisture. Turbulent heat exchange and evaporation.
3. Radiation climate and cloud conditions in the Arctic.
4. Oceanic heat, water and ice exchange.
5. Heat and mass budget of the pack ice.

SYMPOSIUM ON ARCTIC DRIFTING STATIONS

The symposium, sponsored by the Office of Naval Research, was held at Airlee Conference Center, Warrenton, Virginia, U.S.A., 12-15 April 1966. Three main topics were covered: ONR Drifting Stations — origin and development of a program; ONR Drifting Station operations, techniques and problems; scientific results from ONR Research Program on Drifting Stations. The proceedings of the symposium are to be published in the spring of 1967. The following papers are of interest to glaciologists:

K. O. Bennington — Crystal and brine relationships in sea ice.

W. J. Campbell — Sea ice dynamics.

R. D. Ketcham and W. I. Wittmann — The role of drifting ice stations in sea ice prediction studies.

C. A. and N. C. Knight — Orientation fabrics in sea ice.

H. R. Peyton — Sea ice strength-rate of loading and salt reinforcement.

FUTURE MEETINGS

GERMAN SOCIETY OF POLAR RESEARCH

The 1967 meeting will be held in Stuttgart, 9-11 October. Please send titles of papers to: Prof. Dr. B. Brockamp, 44 Münster/Westf., Steinfurter Strasse 107, Institut für Reine und Angewandte Geophysik, GERMANY.

INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGICAL EXPLORATION (IS-AGE)

Sponsored by the Scientific Committee for Antarctic Research (SCAR), with support from the Commission of Snow and Ice, the symposium will take place at Dartmouth College and the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) at Hanover, New Hampshire, U.S.A., during the summer of 1968. A steering committee consisting of A. Bauer, J. A. Bender, C. R. Bentley, G. de Q. Robin, P. A. Shumskiy and U. Radok (Secretary, SCAR Working Group for Glaciology) has drawn up a tentative programme which will be further discussed by the SCAR Working Group and finalized at its meetings during the I.U.G.G. meetings in Switzerland in 1967. Correspondence concerning the programme should be directed to the Secretary of the Working Group at the Meteorology Department, University of Melbourne, Parkville N.2, Victoria, Australia, and concerning local organization to Mr. J. A. Bender, U.S. Army CRREL, Hanover, N.H. 03755, U.S.A.

INTERLUDE IN JAPAN

In August 1966, glaciologists from many countries met in Sapporo, Hokkaido, to celebrate the 25th anniversary of the founding of the Institute of Low Temperature Science. The Symposium on the Physics of Snow and Ice was very successful and enjoyable.

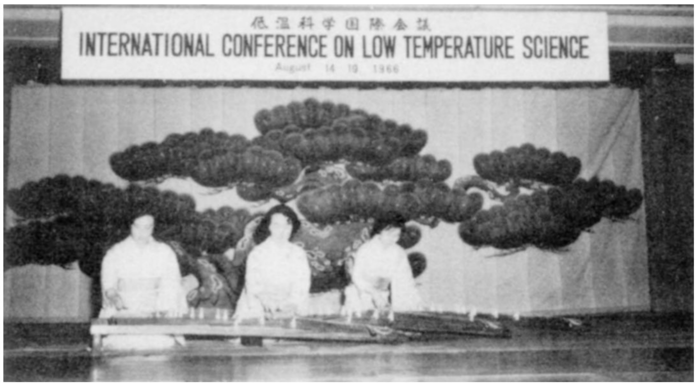
Dr. Zyungo Yosida, Director of the Institute, opened the Symposium.

In the mornings, we met en masse —

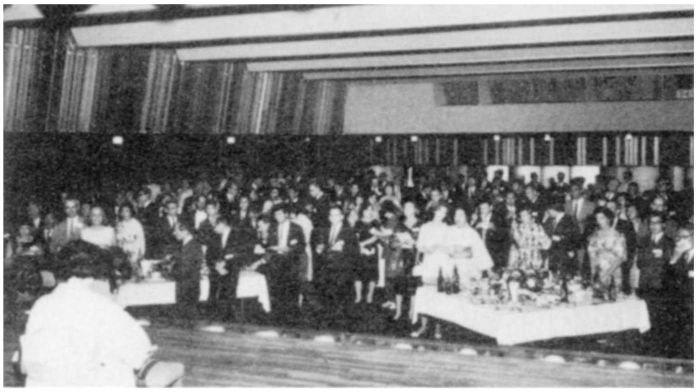
while in the afternoons we split into more specialized groups.

The staff of the Institute showed us their latest work.

We were entertained by charming **young ladies—**



and we received wonderful hospitality from the University, the Governor of Hokkaido, and our friends —

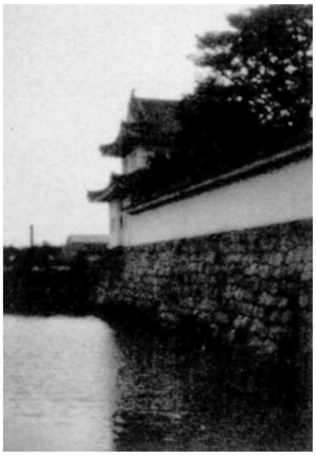


and had many happy parties.

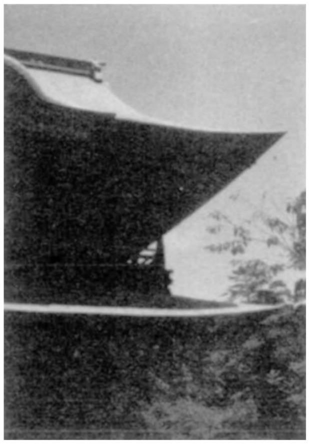
We were taken to see the active volcanic features of south-west Hokkaido—

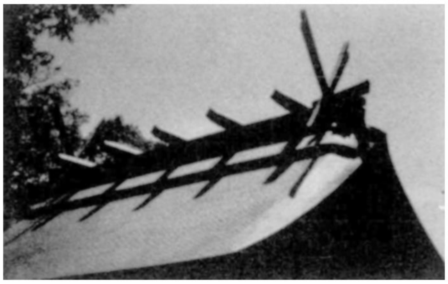
and watched the Ainu dance

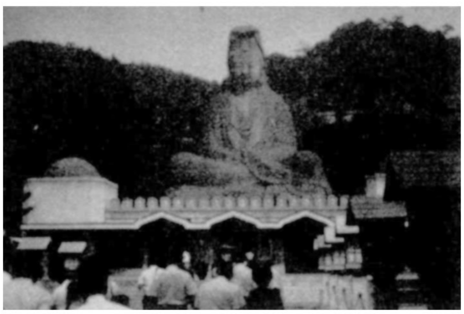
Later, after visiting Tokyo, some of us saw the beautiful country near Fujiyama—



and the temples and palaces of Kyoto: a fitting climax to our stay in beautiful Japan.







COMMISSION OF SNOW AND ICE

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

XIVth GENERAL ASSEMBLY OF THE UNION TO BE HELD IN SWITZERLAND 24 SEPTEMBER — 7 OCTOBER 1967

FIRST CIRCULAR—ABSTRACTS AND PAPERS

This circular gives complete and final details of the submission of abstracts and papers for presentation before the Commission of Snow and Ice during the XIVth General Assembly of the International Union of Geodesy and Geophysics in Switzerland. The meetings of the Commission will be held in Berne on the 27 and 28 September 1967 and again on the 3 to 5 October. During the intervening days, namely 29 September to 2 October, there will be two separate study tours to glaciers and research institutes.

Contents of papers

The papers should be original, of high quality, should not have been published previously, and may cover the following subjects:

1. Any glaciological subject, particularly the physical properties of snow and ice and phenomena occurring at the bed of a glacier.
2. The measurement of the mass budget of very large ice sheets.
3. Development of the themes in the programme of the International Hydrological Decade, namely: (a) the World Inventory of perennial and annual ice and snow masses, (b) the measurement of glacier variations on a world-wide basis, and (c) combined water, ice and heat balance measurements at chains of Stations around the world. Results of data collection and descriptions of national I.H.D. programmes are **not** required.

Text, diagrams and photographs

The complete paper, including abstracts (maximum 300 words) in English **and** French, diagrams, tables and photographs, must not exceed 15 pages of typescript, each page containing not more than 300 words with double spaces between the lines.

The paper must be clearly written in good English **or** French. Where these languages are not the native tongue of the author he should ensure that an accurate and clear translation is made. Experience shows that many translations are of very poor quality.

Photographs must be sharp glossy prints and their number must be kept to a minimum; the diagrams must be drawn with firm black lines on white paper, or tracing linen, and be suitable for direct reproduction. The lettering on the diagrams must be of a size that remains legible when the longest overall dimension of the diagram is reduced to about 10 cm.

The paper must be accompanied by a list of all the figure titles in numerical order.

The name and address of the author should be written in the top right-hand corner and the number of reprints required in the bottom right-hand corner of the first page.

Procedure to be followed in the submission of papers

The following procedures are to be followed in submitting a paper:—

1. Preliminary brief abstract — National Committees should submit to the Secretary of the Commission the names and addresses of intending authors of papers, together with the title and a preliminary brief abstract in English **or** French of each paper (not exceeding 300 words) **not later than 1 May 1967.**

2. Extended summaries — National Committees should approve and submit extended summaries of each paper in English **or** French, together with the names and addresses of the authors, two copies to be sent to the Secretary of the Commission, and 100 copies to Ing. P. Kasser, Abteilung für Hydrologie und Glaziologie, Voltastrasse 24, 8044 Zürich, Switzerland, to arrive **not later than 14 August 1967.** The extended summaries should be written in either English **or** French and be in typescript on not more than 3 sheets of paper, preferably dimensions 210 x 297 mm (A.4 size). The final programme of meetings will be arranged on the basis of these extended abstracts and one copy of each will be handed to participants on arrival in Switzerland.

3. Reports on recent work — In addition, any participant who wishes to report on the results of any recent field work or new developments in glaciology should give notice in writing to the Secretary not later than the first meeting of the Commission in Berne so that arrangements can be made for its presentation at a later meeting. Only important results and

development can be accepted and these contributions may be submitted as complete papers for publication.

4. Complete papers — Three copies of the complete papers approved by the National Committees, together with the author's replies to the Discussion, should be delivered to the Secretary before the closure of the meetings at Berne, or may be sent to the Secretary. **Complete papers will not be accepted after 30 November 1967.** The papers will then be screened, edited and published in the Spring of 1968. **Not more than about 40 papers can be accepted. Acceptance of extended summaries and of recent reports at Berne does not guarantee that a paper will be published.**

Address for correspondence

All correspondence relating to the submission of papers should be addressed to: Dr. W. H. Ward, 147 Rickmansworth Road, Watford, Hertfordshire, England.

November 1966

W. H. Ward
Secretary
Commission of Snow and Ice

EXCURSIONS

1. Bernese Oberland — Grisons

1st day — Friday 29 September:
Berne—Interlaken—Grimselhospiz (from there boat trip on Grimsel lake to the snout of Unteraar Glacier)—Grimselpass—Rhone Valley—Belvedere.

1st day — alternative:
Berne—Interlaken—Lauterbrunnen or Grindelwald—Kl. Scheidegg—Jungfraujoch (visit to ice tunnel, Research Station and Sphinx observatory) — Kl. Scheidegg — Grindelwald — Interlaken — Grimselpass—Belvedere.

2nd day — Saturday 30 September:
Belvedere (Rhone Glacier) — Furkapass — Oberalppass (avalanche problems)—Upper Rhine Valley — Julierpass — St. Moritz — Pontresina (Valley of Engadin).

3rd day — Sunday 1 October:
Pontresina—Diavolezza (air cable; glaciers of the Bernina massif) — Zuoz (avalanches) — Flüelapass—Davos.

4th day — Monday 2 October:
Davos — Weissfluhjoch (funicular railway; 2760 m a.s.l. Snow and Avalanche Research Institute) —Prättigau Valley—Sargans—Zürich—Berne.

Remarks: Total bus mileage: 450 miles.

The itinerary will be subject to changes if any of the pass roads are closed. Warm clothing but no mountaineering boots necessary. Maximum number of participants for boat trip on Grimsel lake: 32.

2. Bernese Oberland—Valais

For hikers and mountaineers only.

1st day — Friday 29 September:
Berne—Interlaken—Grindelwald (visit to the Grindelwald glaciers)—chairlift to First—3 hours walk to Grosse Scheidegg and Schwarzwaldalp —by bus to Meiringen—Handegg.

1st day — alternative:
Berne—Interlaken—Lauterbrunnen or Grindelwald—Kl. Scheidegg—Jungfraujoch (visit to ice tunnel, Research Station and Sphinx observatory)—Kl. Scheidegg—Grindelwald—Interlaken—Handegg.

2nd day — Saturday 30 September:
Handegg—Grimselhospiz (visit to Unteraar Glacier as far as Lauteraarhütte, 6 hours walk) — Grimselhospiz — Rhone Glacier — Riederalp/Bettmeralp.

3rd day — Sunday 1 October:
Riederalp/Bettmeralp — Forest of Aletsch — snout of Aletsch Glacier—runoff gauging station on the Massa river—Blatten—Brig.
(From Riederalp/Bettmeralp to Blatten ca. 8 hours walk).

4th day — Monday 2 October:
Brig—Zermatt—Gornergrat (glaciers of the Zermatt region, eastern part of the Grande Dixence water power development)—Zermatt—Brig—Berne.

4th day — alternative:
Brig—Berne (private excursion from Brig or direct return to Berne).

PROCEEDINGS OF THE SYMPOSIUM ON GLACIER MAPPING, OTTAWA, 20-22 SEPTEMBER 1965

The Proceedings of the Symposium on Glacier Mapping, sponsored by the IUGG/IASH Commission on Snow and Ice and the National Research Council of Canada, will be published in a special issue of the Canadian Journal of Earth Sciences in November 1966. The issue will include twenty papers and a folio of fourteen glacier maps.

Copies of the issue can be obtained from: Administration, National Research Council Ottawa 7, Ontario, Canada. The price is Can.$2.00.

BILL FIELD

Bill Field's impact on glaciology in the U.S.A. is hard to define, but is real: many glaciologists consider him to be the integrator and catalyst of North American glaciology.

William Osgood Field was born in New York City on 30 January 1904. He graduated with a B.S. degree from Harvard College in 1926, where he majored in geology. In 1926 he began his studies of glacier variations in south-east Alaska and continued with field trips in 1931 and 1935. In 1940 he joined the staff of the American Geographical Society and except for three years military service during World War II has been there ever since. During this three-year period he served in the photographic branch of the U.S. Army Signal Corps. His assignments included service as a photographic officer with the Air Force Cold Weather Test Detachment in Alaska in the winter of 1943 and with a photographic company in India and Burma in 1944 and 1945.

In 1947 he became the head of the Society's Department of Exploration and Field Research, which has specialized in polar regions studies and various aspects of glaciology. The activities of the Department have included observations of glacier variations in Alaska and the Canadian Rockies, library research, the assembly of archive material and the operations of World Data Center A Glaciology. The studies of glacier variations were continued as American Geographical Society projects in 1941, 1950, 1957, 1958, 1959, 1961, 1964, 1965 and 1966. Similar observations were made for the Society in the Canadian Rockies in 1948, 1949 and 1953. Field also visited sites of glaciological activity in the Alps in 1960, 1961 and 1962, in New Zealand and Antarctica in 1957, and in Greenland in 1964. In 1961 he was awarded an honorary D.Sc. degree by the University of Alaska.

At the American Geographical Society his department is in reality five different departments: exploration and field research, glacier studies (on contracts), glacier studies (personal efforts), World Data Center A Glaciology, and miscellaneous work on committees and in consultation and advice. His role is that of an integrator in a multidisciplined science, a role which is analogous to the role which the Society plays in geography today.

His encyclopaedic knowledge of North American glaciers is legendary, though his quiet, unassuming manner conceals the vast amount of personal effort which he has devoted to their study. As part of his work in college he read with much interest the reports on the variations of Alaskan glaciers observed by H. F. Reid in 1890 and 1892, G. K. Gilbert in 1899, and R. S. Tarr and Lawrence Martin from 1905 to 1913. Each had initiated a photographic programme and surveys of termini, based on established reference points. By 1926, none of these men had returned to follow up his studies, and this was especially difficult to understand because of the rapid changes which they had seen and which they anticipated would occur in the near future. For instance, when last studied by Lawrence Martin in 1910, many of the glaciers of Prince William Sound had been advancing.

With this in mind Field conceived the idea of following up these observations by returning to the various glaciers, relocating the old photo and survey stations, and determining what had happened during the interval. Some other observers, he knew, had been to these localities, but as far as he could tell they had not begun a systematic programme nor had they followed it up by periodic visits. His plan envisaged the desirability of extending these observations over a period of several decades or at least through a normal lifetime. Originally it was planned to attempt to make observations approximately at five-year intervals. He believed that the continuity of effort would have useful results, for the same observer returning to a locality can see changes which might easily be missed by a succession of different observers, no matter how well documented their observations might be. In developing this programme he received strong encouragement from Professors Reid and Martin and at a later date from Dr. François Matthes, of the U.S. Geological Survey, who became the first Chairman of the Committee on Glaciers, Section of Hydrology, American Geophysical Union.

The first trip for Alaskan glacier studies was in 1926 to Glacier Bay, where Reid in his 1896 report had predicted the developments to be anticipated on the basis of the trends and rates of change which he had observed. Much of what he foresaw was found to have taken place. In 1931 an opportunity was presented to begin observations in Prince William Sound where the last comprehensive studies had been made in 1910. Since those first visits Field has visited Glacier Bay another seven times and Prince William Sound five times. Other areas have also been visited from time to time, including the Coast Mountains near Juneau, the fiords at the head of Yakutat Bay, the glaciers of the Copper River area, and several glaciers along the Alaska Railroad in the Kenai Mountains. Altogether, observations have been carried out during 12 summers from 1926 to 1966.

The main objective has been the recording of the variations of glaciers by means of photography, surveying, and visual observations. Not only have the changes in the extent and volume of the ice been noted, but also the growth of vegetation in deglaciated areas and the normal processes of erosion and deposition connected with the changes in the glaciers.

The International Geophysical Year programme provided a means of revisiting all the localities previously studied and stimulated a more continuous and systematic effort. The earthquakes of 10 July 1958 in the St. Elias Mountains and of 27 March 1964 in the Kenai and Chugach Mountains have stimulated more studies to determine what effect they may have had on the glaciers and to attempt to test the earthquake advance theory proposed by Tarr and Martin after the 1899 earthquake. In 1964, 1965 and 1966 efforts were concentrated on observing the termini in the areas affected by the 1958 and 1964 earthquakes. Special attention has also been devoted to advancing glaciers and to the glaciers on which massive landslides occurred, so that the future terminal response to these slides may be measured.

The 200 or more glaciers which have been observed are mostly along the outer slope of the coastal mountains. Included are large valley glaciers as well as small hanging glaciers, tidal and non-tidal. As might be expected, recession is the general rule, but a number of the larger glaciers have been advancing slowly for several decades and these have received special attention. This year, three of the glaciers under observation are experiencing rather sudden, spasmodic advances, at least one of which can be characterized as a surge.

These variation studies have been documented by photographs which are on file in World Data Center A Glaciology at the American Geographical Society in New York City. The results of the surveys and the observations are being assembled in a final report which will summarize all Field's observations of the last 40 years. This report will be useful in the programme of the International Hydrological Decade and the long term plan of recording and analyzing glacier variations of the Commission of Snow and Ice. In all this work he has always acknowledged with gratitude the help he has received from various organizations and from many very valuable assistants.

Great though Field's contributions are in unravelling the story of North American glaciers, many people consider that his greatest contribution stems from his work on committees and panels. He has been a member of the Committee of Glaciers, Section of Hydrology, American Geophysical Union, for most of its time since its formation in 1931, and was its Chairman from 1948 to 1954. He served as Reporter on

Glaciology of the U.S. National Committee for the International Geophysical Year and later became Chairman of its Technical Panel on Glaciology. At the close of the IGY he continued as chairman when that panel became the Glaciology Panel of the Committee on Polar Research, National Academy of Sciences/National Research Council. This group has had a big influence on the growth of glaciology in the U.S.A., initially through the direction of bold, new glaciological programmes in Antarctica and the Northern Hemisphere during the IGY. After the IGY it was not necessary to direct actual programmes, and the Panel was able to undertake uninhibited and stimulating examination of current research activity. It is one of the few IGY panels still active. Membership now rotates, but the Panel refuses to allow its original chairman to step down. The considerable success of the Panel, which is now the principal group representing glaciology in the U.S.A., stems in no small part from Bill Field's wonderful ability to mediate, organize and quietly direct the ruminations of a diverse group of busy and strong-minded scientists.

His qualities are no less appreciated on international committees. He served from 1960 to 1963 as one of the Vice-Presidents of the Commission of Snow and Ice (I.U.G.G.), and from 1962 to 1964 as one of the Vice-Presidents of the Glaciological Society.

In glaciological and mountaineering circles, in community affairs and in educational groups, his "I'd love to help" has resulted in generous interest, wise counsel, and much quiet, hard work. His great personal qualities of kindness, thoughtfulness and charm ensure that his friends always enjoy his company and that of his delightful family, whether in the mountains or at his country house, at the edge of a pretty lake surrounded by woods, within sight of the manmade canyons of Manhattan.

DEPARTMENT OF POLAR RESEARCH, TOKYO

In conjunction with the progress of polar research in Japan, especially with the planning and execution of Japanese Antarctic Research Expeditions (JARE), Polar Section, a governmental organization, was established in the National Science Museum on 1 April 1962, with three full-time members. In September 1963, a Special Committee for Antarctic Expeditions (Chairman: Prof. Takeshi Nagata) was organized as an advisory committee for the Director of the National Science Museum. On 1 April 1965, the Polar Section was designated Division, with two sections composed of 11 personnel.

The Director of the National Science Museum, Dr. Yo. K. Okada, is Chief of the Polar Division. Dr. Kou Kusunoki was transferred on 1 January 1966 from the Institute of Low Temperature Science, Hokkaido University, to be Chief of the First Section. Mr. M. Murayama is Chief of the Second Section.

On 1 April 1966, in accordance with the change in the administration system of the Museum, the Division changed its name to Department of Polar Research. The Japanese Government is hoping to establish a Polar Research Institute, with about 60 personnel, under the jurisdiction of the Ministry of Education. The Department of Polar Research is assumed to be an embroyo of the Japan Polar Research Institute.

DIRECTORY OF INFORMATION RESOURCES IN THE UNITED STATES: WATER

The U.S.A. National Referral Center for Science and Technology at the Library of Congress has published this directory of 248 pages, which may be purchased at $1.50 a copy from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, U.S.A. The new publication was prompted by the growing concern over the conservation, use and quality of water resources. Focusing on fresh water, the directory lists hundreds of organizations doing research or collecting data on water and water-related subjects. Each organization's areas of interest and its information services are described. The directory includes Federal, State and municipal government offices, academic research groups, professional societies, various water commissions and committees, national associations and other organizations. For further information: Information Office, Library of Congress, Washington, D.C. 20540, U.S.A.

GREAT LAKES RESEARCH CENTER

The Lake Survey District of the U.S. Army Corps of Engineers has announced the establishment of the Great Lakes Research Center as one of the two major arms of the District. The Center will conduct investigations and publish reports in five main areas of research: water motion, shore processes, water characteristics, water quantity, and ice and snow. For example, ice studies will determine the amount and type of the Great Lakes ice cover so that the possibility of extending the navigation season can be evaluated.

THE SOCIETY'S LIBRARY

WORKS RECEIVED FOR THE SOCIETY'S LIBRARY SINCE JUNE 1966

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

Ambach, W.
Derbyshire, E.
Dort, Jr., W. (6 items)
Field, W. O.
Gerhold, N.
Haurwitz, B.
Hoinkes, H.
Holmes, G. W.
Laursen, D.
Law, P.
Lliboutry, L. (6 items)
Mellor, M.
Muguruma, J.
Østrem, G. (3 items)
Sagar, R. B.
Steinhauser, F. (5 items)
Vivian, R.
Williams, G. P.

Antarctic Division, Department of External Affairs, Melbourne, Australia (2 items).
Association Internationale d'Hydrologie Scientifique.
Australian National Antarctic Research Expeditions.
Centre National de Recherches Polaires de Belgique (2 items).
Commissione Italiana del Comitato Internazionale di Geofisica (3 items).
Division of Building Research, National Research Council, Canada (3 items).
Eidg. Institut für Schnee- und Lawinenforschung, Weissfluhjoch, Davos.
Iceland Glaciological Society, Reykjavik.
Institute of Low Temperature Science, University of Hokkaido, Japan.
Institute of Polar Studies, Ohio State University, U.S.A. (6 items).
Instituto de Geografia, University Nacional de Cuyo, Argentine (2 items).
National Research Council, Canada.
National Science Foundation (Office of Antarctic Programs), U.S.A. (4 items).
Norsk Meteorologiske Institutt.
Schweizerische Meteorologische Zentralanstalt.
Société Hydrotechnique de France (16 items).
Soil Mechanics Laboratory, McGill University, Montreal, Canada (2 items).
Sveriges Meteorologiska och Hydrologiska Institut, Uppsala.
U.S. Army Cold Regions Research and Engineering Laboratory (8 items).
U.S. Forest Service, Rocky Mountain Forest & Range Experiment Station (2 items).

REVIEWS

H. E. WRIGHT and D. G. FREY, Editors. The Quaternary of the United States. Princeton University Press, 1965. x, 922 p., illus. $25.

Readers of reviews want to know what's in the book and is it any good? This volume of 922 pages and 55 articles has a lot in it. Articles are arranged in 4 groups: geology, bio-geography, archaeology, and miscellaneous studies.

The 20 articles on Quaternary geology are principally descriptive, representing for the most part up-dated digests and summaries of previously published material. They naturally have regional focus and provide a quick grasp of essential Quaternary geological relationships in the areas treated.

Much the same can be said of presentations in bio-geography and archaeology, although here an attempt has been made to synthesize large masses of information on a somewhat more philosophical basis. The final 11 articles, grouped under miscellaneous studies, are in many ways the most original and exciting.

In spite of a spectacular cover-jacket photograph of Malaspina Glacier and the fact that the Quaternary is characterized by the "ice age", glaciologists will not find much in this volume dealing directly with existing glaciers. Nonetheless, the book makes profitable reading for glaciologists. They will find it broadening and stimulating to learn about the widely dispersed interdisciplinary endeavours that bear upon Quaternary relationships.

The miscellaneous studies merit particular attention. Therein is the sole purely glaciological article by Mark Meier, "Glaciers and Climate". This is an up-to-date, competent review of the subject, which suffers a bit from its overly pessimistic tone. Glaciologists will find the approach in Murray Mitchell's article on Theoretical Paleoclimatology interesting, and Wally Broecker's review of isotopic dating methods applicable to the Quaternary can save many fruitless hours ploughing through the literature in search of this information. Readers not up to date on uses of paleomagnetic data for stratigraphic correlations and relative dating can catch up by perusing the Cox, Doell, Dalrymple article on that subject. Stan Schumm waxes philosophical on possible uses of paleohydrological relationships as a key to past environments, and Bob Ruhe summarizes recent data on ancient soils pertinent to Quaternary studies.

The reviewer owes an apology to the editors of this volume, Herb Wright and David Frey, and to the 88 authors. He felt that a compendium of this size brought together in response to a large international meeting could not be nearly as good as it is. The book brings together in one easily accessible place a wealth of information on the Quaternary. It further puts on display the products of some workers who for various reasons have not heretofore published much on the results of their investigations. Preparation of such a volume also forces scholars to stand off and take a long view of their work and its relationships to other efforts. Many students of the Quaternary will find the book well worth the considerable price of 25 dollars.

One characteristic of our present age is the "big book". This is a good one. Two companion volumes dealing with the Quaternary of Europe are or will shortly be available.

Robert P. Sharp.

R. E. MUNN. Descriptive micrometeorology. New York and London, Academic Press, 1966. xiv, 245p., illus. (Advances in Geophysics, Supplement 1.)

'This book fills the need for a comprehensive, balanced, and modern presentation of the continuing research and recent advances in micrometeorology' reads the opening of the publisher's blurb; and there is quite sufficient truth in it for the book to merit a short notice.

It is very well suited to readers who are not experts in the subject and who wish to acquire a general view of the present state of micrometeorology or who wish to study some aspect of it in detail. The former will find the writing clear and the treatment descriptive, as the title of the book indicates, rather than theoretical and mathematical. The latter will probably find the essentials of the chosen topic set in perspective, but will gain most from the well selected references.

The main themes of the book are the energy balance at the surface, wind variations, and heat and water transfer. The first part of the book deals with these generally, and the second with the effects upon them of the different nature of various surfaces, such as bare ground, forest, ocean, city. There is a short chapter on 'The air over snow and ice surfaces', but it is not from this that glaciologists will derive most benefit.

One omission may disappoint some readers. The flow of wind in mountainous regions receives scant treatment. Although there is a chapter on 'The air in valleys', neither 'föhn' nor 'katabatic' appear in the index. Katabatic winds are mentioned in the text, but by implication only as rather feeble drainage winds. However, it is unfair to criticize the book on this account since these topics probably belong to mesometeorology rather than to micrometeorology.

To sum up, the author seems to have succeeded in what he set out to do, and the book, which is well produced, is recommended.

T. H. Ellison.

Donald Wesley PATTEN. The biblical flood and the ice epoch. Seattle, Pacific Meridian Publishing Co., 1966. xvi, 336 p. $7.50.

The author of this book holds B.A. and M.A. degrees in geography from the University of Washington. He is also a Christian of fundamentalist views. In this book he seeks to give evidence that, even though the creation did not occur in a week in 4004 B.C. (the time scale for the universe that he favours stretches back over 10^9 yr.), the record of the flood and the ages of the patriarchs given in Genesis are still credible. In the course of this he supposes that the flood was a tidal wave caused by the approach to the solar system of a large astronomical visitor, and that simultaneously with this large quantities of very old, electrically charged ice were precipitated upon the Earth in the neighbourhood of the two magnetic poles to cause the continental ice sheets.

The author chides uniformitarian scientists with having closed minds when it comes to the evidence provided by ancient documents. He draws attention to the large amount of cold that would be required to form ice sheets of the size of the continental ice sheets. He does not seem to have realised that correspondingly it requires a very great deal of heat to melt them, a process he envisages as largely completed in 200 to 300 years on the basis of Genesis 10:25. Nor does he anywhere deal with the geomorphological evidence of glacially eroded landforms nor of the evidence for four or more separate glacial periods. It also seems strange to the present reviewer that Noah recorded nothing about the bumps on to land at low tide which ought to have occurred twice a day.

Glaciologists have got to worry at the problem of how the ice ages built up. We have got to explain how ice sheets invaded parts of the Antarctic deep below sea-level; but I think we have already got better explanations than Mr. Patten gives us credit for when he says: "Uniformitarians must maintain that falling snow accomplished this (the build-up of ice sheets) both at elevations of 17,000 feet above sea level and 5,000 feet below sea level, and in both the fluid atmosphere and in the fluid ocean. Is this what we are to believe?" My answer to this, in the form stated, is no, for the ice deep in the Antarctic Ice Sheet can have come from glaciers spreading from land elsewhere, or by thickening of ice shelves — but I can echo his question with respect to his own ideas. Is this what we are to believe!

J. W. Glen.

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ICE

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