Number 15 August 1964

ICE

COMMISSION OF SNOW AND ICE

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

SYMPOSIUM

5 - 10 April 1965 in Davos, Switzerland

on the scientific aspects of snow and ice avalanches

Final details of the Symposium are given on pages 23—28 of this issue of Ice.

If you wish to attend, please complete the form on pages 27—28 and send it to the address given thereon NOT LATER THAN 15 NOVEMBER 1964.

FINAL DATE FOR BOOKING — 15 NOVEMBER 1964

ICE

News Bulletin of the Glaciological Society

AUGUST 1964 NUMBER 15

CONTENTS

We are sorry to report the death of Professor André Renaud on 8 June 1964. We offer our sympathy to his family and his many friends and colleagues. An obituary will be published in the "Journal of Glaciology".

Professor Lliboutry reports the sad news of Roland Vivet's death in an avalanche near the summit of the Aiguille Verte, in the Massif du Mont Blanc. The accident took place on 7 July, when 14 climbers and skiers were taking the test of the Ecole Nationale de Ski et d'Alpinisme de Chamonix, to become guides. Vivet was one of M. Lliboutry's assistants and had done field work in Spitsbergen as well as on the Mer de Glace and the Glacier de Saint-Sorlin.

BRITISH MEMBERS. The Building Research Station, Department of Scientific and Industrial Research, is trying to arrange for some measurements to be made of the depth and density of the snow on the roofs of buildings throughout the country. The work is part of a programme directed towards providing up-to-date information about loadings on buildings and is of increasing importance because of the trend towards colder winters. Members who would like to take part in this research and would be able even in the most adverse weather to make observations on the buildings they have selected are invited to write to Mr. G.R. Mitchell, Building Research Station, Garston, Herts., England. Further details will then be sent to them.

COVER PICTURE. Photograph taken by Dr. H.C. Hoinkes in September 1963 of the Black Rapids Glacier, Alaska Range, Alaska, U.S.A.

PUBLICATION OF THIS ISSUE of Ice has been delayed in order to include the important circular from the Commission of Snow and Ice, pages 23 - 28.

FIELD WORK

AUSTRALIA

ANTARCTICA

1. MAWSON

A party of seven led by R. McMahon and including E. Wishart as glaciologist carried out a 900 mile traverse with tractor trains and dogs to the southern end of the Amery ice shelf and back in 87 days. Difficult conditions were encountered near the fringe of the ice shelf where tractors had to be extracted from crevasses on 6 occasions. Accumulation stakes planted the previous year by I. Landon-Smith were re-measured between Mawson and the ice shelf but could not be located beyond the approaches to the latter. A new system of stakes was established on the ice shelf for re-measurement during the coming summer. This included three strain grids, each consisting of a square with 0.7 statute mile sides and one diagonal along the flow direction, at 69° 30.6' S, 71° 34.6' E; 70° 9.2'S, 70° 47' E; and 70° 57' S, 69° 52' E.

Firn stratigraphy and temperatures were studied in 13 two-meter pits and in holes drilled to depths ranging from 6.5 m to 10 m with a SIPRE corer. The annual mean temperature at the southern end of the Amery ice shelf was found to be around -22° C. Without the previous year's stakes no movement data were obtained, but the analysis of the 1962 results in the meantime has yielded a first estimate for the flow velocity of the ice shelf. This was derived by I. Landon-Smith from theories of W. Budd (this year's Mawson glaciologist) based on the lateral strain rate; the velocity on this basis amounts to around 1000 m/year - a figure in broad agreement with independent estimates derived from Russian and Australian astrofixes near the ice front.

2. WILKES

Following a short autumn traverse to a point 100 miles east of Wilkes (viz. 66° 15.5' S, 110° 31.9' E) a more extensive spring-summer traverse led southward through the valley behind the S2 ice dome and up the main plateau to 70° 02' S, 114° 30' E, a point 60 miles east of the route of the 1962/3 Wilkes-Vostok traverse. The original aim had been to reach the end point of the 1958/9 American traverse from McMurdo (viz. 78° S 130° E) but the necessary airdrop of fuel had proved impossible to arrange and mechanical breakdowns in combination with bad weather and difficult surface conditions further restricted the length of the traverse, which was led by R. Saxton and included M. Kirton as geophysicist and K. Gleeson as meteorologist/glaciologist.

The aim of the seismic work was in part to find a satisfactory technique for the low-temperature region south of the valley where difficulties had been experienced during the 1962/3 Wilkes-Vostok traverse. A systematic noise analysis suggested that the inland plateau is characterized by much longer trains of surface waves with much greater amplitudes and lower horizontal velocities.

The precise results of M. Kirton's seismic, gravity, and magnetic work will be published by the Australian Bureau of Mineral Resources. At the southernmost point of the traverse, 250 miles southeast of S2, at a surface altitude of 2200 metres the ice was found to be around 3200 metres thick. Good reflections were obtained there as well as nearer the coast from a combination of moderately large charges, deep holes, and KK90-K215 filter, in ice temperatures down to -36.5° C.

3. DAVIS

A three-man party led by W. Young used two dog teams to carry out a 165 mile traverse from Davis to the Munro Kerr mountains, at 70° S, 75° E on the eastern side of the Amery Ice Shelf, but found the final access to the mountains blocked by extensive crevasse systems. The first accumulation readings for this region of the ice cap are anticipated next summer from stakes established in the course of this traverse.

Uwe Radok

FRANCE

GEOPHYSICAL AND GLACIOLOGICAL LABORATORY, GRENOBLE. The laboratories are at Grenoble, with an extension in the Chamonix valley and another in the Massif du Mont Blanc. There are 8 research workers and 7 technicians, under the directorship of Prof. L. Lliboutry. The Laboratory has developed the following instruments:

a) hydrothermic drill heated by propane that will drill 3-cm holes in ice at 10 m per hour, and

b) gamma-ray densigraph that registers the density profile in a snow bed several times a day.

Two expeditions took place during the last year.

a) West Spitsbergen, in the Baie du Roi region: the glaciers were surveyed, and ablation stakes were planted on the north and south slopes of Brögger Peninsula and on the snout of the Glacier du Roi. Speeds and conditions of calving on the snout were studied as functions of meteorological variables of the tide. A sharp increase in the speed after very heavy rain was noted.

b) Vallée Blanche: the Laboratory carried out a sustained programme of drilling and coring. Cores down to 30 m were examined for crystal structure and water content. It was shown that in temperate ice there exists an annual variation of the liquid water content, which helps in studying the stratigraphy of glaciers.

L. Lliboutry

GREENLAND. The International Co-operative Field Experiments in Glacier Sounding were held in Greenland between 14 and 22 April 1963. C.J. Lorius, A. Bauer and C. Queille attended, at the invitation of the U.S. Army Electronics Research and Development Laboratory. Comparative tests of glacier sounding techniques in the vicinity of "Tuto" formed a useful basis for further investigations.

TERRE ADELIE. The 1963-64 summer field programme included a glaciological party of 2 glaciologists and 2 technicians, with 2 weasels, a trailer and a sledge. The two most important studies were of the ice next to the moraine near Cap Prudhomme and of the neve several kilometers from the coast.

a) Ice near the moraine: dating by C_{14} method was made, and liquid and solid samplings were taken to study radio activity, tritium and deuterium contents and occluded gases. Corings were made at 30 stations around the moraine, to study the origin of the ice based on its deuterium content.

b) Neve at stations A3 and A5: 7 corings from 10 m, 3 from 15 m and 3 from 19 m were taken, and studied for their physico-chemical properties: fission products, dust, tritium, deuterium, resistivity, ion content. Samples were also taken from a well 2m deep, and temperature measurements made.

C.J. Lorius

ICELAND

Brúarjökull, the biggest northern outlet of Vatnajökull, advanced along its entire front of 35 km during the 1963-64 winter. On 10 March 1964 the eastern half had advanced 9 km from the 1956 position while the western half had moved 3 km. One of the southwestern outlets of Vatnajökull has advanced in a similar way. The Iceland Glaciological Society is concentrating its 1964 summer work on Brúarjökull, with field studies and aerial photogrammetry.

NEW ZEALAND

In the 1963-64 summer field season, the annual photo coverage of glaciers from fixed ground stations has once more been obtained in the Tasman Valley by rangers of Mount Cook National Park Board, and at Mt. Ruapehu by A.J. Heine of New Zealand Antarctic Division. A feature of this glacier budget year has been the heavy and prolonged 1963 winter snowfall and the late start of summer ablation. Winter-like conditions persisted into

December in the high alpine regions round Mt. Cook, and alpine climbing during the Christmas holiday season was greatly curtailed due to bad weather, which continued till mid-January. In April 1964 firn limit on the Tasman glacier was 70 m lower than normal and crevasses at 2,500 m altitude, normally wide open in April, were just beginning to develop under the influence of a period of fine weather.

From data so far collected on the Tasman glacier, there appears to be 15 to 20 per cent less ablation than usual at 1,150 m altitude, the lightest since the start of the New Zealand Geological Survey's project on the glacier in 1957. Several 3 metre ablation stakes set in 12 metre holes in November 1963 failed to appear above the surface by April 1964, and at the time of writing a further visit to this area is needed to complete observations for the 1963-64 budget year.

It was found that during the 1963 winter (March to November) on the lower glacier where snow cover is intermittent only, specific net ablation for the coolest part of the year totalled 3.4 metres of ice, and the mean rate of melting 1.8 cm/day, so that for measurement of total annual ablation, at least at the lower altitudes, stakes need to be left in position for the full 12 months.

A feature of this year's ablation studies has been the successful use of a slightly modified version of P. Kasser's hot water thermal drill, built by the New Zealand Department of Scientific and Industrial Research's Physics and Engineering laboratory. This has enabled us to set stakes relatively easily in holes between 15 m and 24 m deep, drilling at a speed of 1.87 metres per minute. Reliable drilling to at least 30 metres should be possible with equipment totalling not more than three man-loads. This opens the way to ablation studies on the active West Coast glaciers such as the Franz Josef.

Mount Cook Park Board erected in December 1963 a 25 ft x 8 ft eight bunk hut at 7,700 ft altitude near the head of the Tasman Glacier. Funds for erection were contributed by New Zealand Department of Scientific and Industrial Research and Ministry of Works, and the hut contains lock-up space for scientific equipment and stores. It makes an excellent base for glaciological work, and because of this facility, more data has been collected this year in the higher part of the Tasman Glacier accumulation area than ever before. A measurement of total accumulation for the 1963-64 budget year was attempted last April by snow sampling with a coring auger, by study of the snow pack in crevasse walls, and by area surveying. Data reduction is not yet complete, but it is thought that in several places core drilling to 11 metres did not reach the base of the year's accumulation. Densities ranged from .52 to .75 gms/cc. Many core samples were collected for pollen studies and the filtered residues await laboratory preparation. It is hoped that the snow surface exposed during the 1962-63 ablation season will be identified by the presence of pollen from plant species such as grasses and conifers, known to flower in mid summer.

Areas of the surface exposed in April 1964 were marked with three types of dye, including Fluoroscein, in the hope that the dyed snow can be detected in cores or in crevasse walls next April (1965) and thus mark positively the base of the coming year's snowpack.

The New Zealand Geological Survey party on the Tasman project, comprising Malcolm Laird, Bruce Skinner and Ian McKellar, was capably assisted last April by Gunter Weller and Allan McLaren, Australian trainee glaciologists from A.N.A.R.E., and it is likely that this co-operation with A.N.A.R.E. and Dr. Radok's Department at Melbourne University will continue in future years.

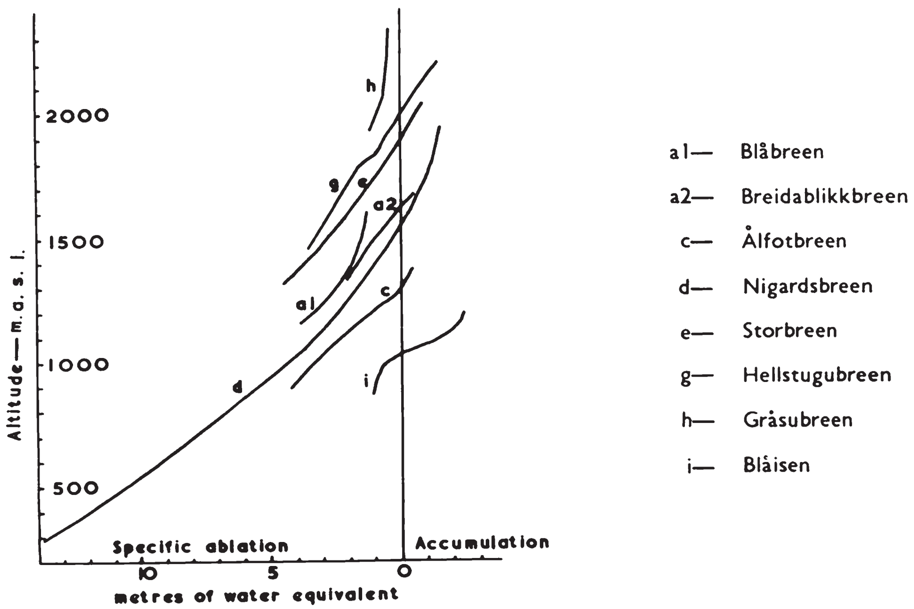
Ian C. McKellar

NORWAY

In 1963 glaciological studies increased considerably in Norway mainly due to requests from the water-power authorities, and mass balance studies were made on glaciers located in catchment areas of hydroelectric plants. A greater interest among students in physical geography made it possible to study the mass balance of a larger number of glaciers than ever before.

1. MASS BALANCE STUDIES

Accumulation and ablation have been observed at 10 different Norwegian glaciers in 1962-63, and at most of them the complete mass budget has been calculated and graphed in accordance with proposals given by M. Meier.



Norwegian glaciers—net budget curves for 1963.

The accumulation on each glacier is measured in May-June and the ablation in September-October, although in many cases several measurements and controls of the stake net were made through the whole year.

(a) On the Folgefonni glacier, mass balance studies have been made on an east-west section (approximately 20 km^2), forming one tenth of the total glacier area. The accumulation was determined by means of snow depth soundings with a steel stick, at approximately 500 points, and at the same time snow density was measured in 18 pits. The specific values for the different elevation intervals have been computed. The specific accumulation is larger on the east-facing Blåbreen glacier than on the west-facing Breidablikk glacier (two of the outlet arms of the Folgefonni glacier). The observed glacier had an average accumulation of 130 cm of water. According to the "snow accumulation map" prepared by the Norwegian Meteorological Institute, the accumulation 1962-63 was only about half of the "normal" in this part of Norway. The ablation was measured at 47 aluminium stakes, some of them consisting of several stakes chained together and placed in 20-25 m deep thermo-drilled holes. On an average, the ablation amounted to 340 cm water on the east-facing Blåbreen glacier and 230 cm water on the west-facing Breidablikkbreen glacier. The difference seems to originate from the large difference in the area distribution with elevation of the two glaciers. The mass balance was strongly negative, especially on the east-facing glacier.

(b) On the Hardangerjøkulen glacier, 78 km^2, the west-facing arm (Rembesdalsskåki) with its firn area was investigated, i.e. about 18 km^2 of the total glacier area. The measurements were carried out by the Norsk Polarinstitutt, but due to very difficult conditions - mainly a badly developed summer crust from the cold summer of 1962 - complete accumulation measurements could not be made. Also the ablation measurements were partly destroyed because several stakes had sunk in the firn during the summer. By calculations based on meteorological data from an observation station (Slirå) near the glacier, it has been possible to estimate a total ablation of 270 cm of water.

(c) The Alfotbreen glacier, which is the westernmost glacier in Norway, was expected to give the largest figures for accumulation, as it is situated in the area of largest specific river discharge in Norway, with an average of more than 150 l. sec^{-1} km^{-2}. A limited part (4.75 km^2) of the glacier has been chosen for the investigations. This part forms the main catchment area for a small river. The run-off is registered at a river gauge, and the mass balance observed in the conventional manner on aluminium stakes. But as the snow falls were expected to be heavy, the stakes in the accumulation area were extended or replaced during the winter. On the highest parts of the glacier about 6 metres of snow was observed, which is probably only 60% of a "normal" year's accumulation. The average accumulation amounted to 248 cm of water on the part of the glacier investigated. The ablation as measured on stakes placed in thermo-drilled holes averaged 358 cm of water. The maximum melting on the tongue was more than 7 metres of ice. The material balance was negative.

(d) The Nigardsbreen glacier, a part of the large Jostedalsbreen ice-cap, has been observed in the same manner as last year, but with an attempt to improve the accuracy of the measurements. As the summer crust from 1963 was very poorly developed, sheets of hard fibre plates were placed on the summer surface and anchored to the stakes. Thus depth soundings could be made at the same points the following spring, although many of the stakes were destroyed by thick layers of hoar-frost and heavy storms during the winter. The depth to last year's summer surface could also be measured by means of core drillings. The density of the snow was determined in pits, where continuous vertical sampling was carried out. The total accumulation was $79 \times 10^6 m^3$ water, or 187 cm on average based on measurements at 157 points, and was about 65% of the measured values for 1962. The ablation was observed by means of stakes on the lower part of the glacier. The maximum observed specific daily ablation, 14.6 cm of water, was measured at 375 m a.s.l.

In the firn area several of the stakes sank in the firn during the summer, and the ablation had to be measured in pits or by core drilling down to the previous summer's crust. The density of the remaining "old snow" (the rest of last winter's accumulation which had not melted during the summer) could also be determined by weighing of the cores. The maximum discrepancy between density measurements made in pits, where vertical continuous cylindrical samples were taken by a steel sampler, and density determination made on the drilled cores (taken by a SIPRE-drill) was 4%.

The total ablation was $88 \times 10^6 m^3$ water, or 209 cm on average. The maximum ablation amounted to more than 12 metres of water on the tongue. The mass balance was negative, with an average loss of 22 cm water.

(e) On the Storbreen glacier, where detailed mass balance measurements have been carried out over 15 years by Norsk Polarinstitutt, the accumulation is measured every year at about 300 fixed points evenly spread over the $5.42 km^2$ glacier surface. Up to 600 points have been used in selected years, but from experience gained the system of 300 points has proved to be satisfactory for the construction of accumulation maps. The total accumulation was $5.2 \times 10^6 m^3$ water or 96 cm on average. Ten percent of this figure is due to snow precipitation during the summer. This is the lowest accumulation in 15 years; the average 1948-63 is 136 cm of water. The ablation was measured at 27 stakes 8 times during the summer. The total amount of ablation was $11.6 \times 10^6 m^3$ water or 214 cm on average. This is a relatively large ablation figure, the average for the years 1948-63 is 176 cm. The mean summer air temperature (May to September) as measured at the glacier was in 1963 more than 1° C higher than the average in the last 15 years. The material balance was strongly negative, with an average mass loss of 118 cm.

(f) The Tverråbreen glacier in the Jotunheimen area has been investigated by a geography student, but no results are as yet available.

(g) The Hellstugubreen glacier ($3.4 km^2$) has also been studied by a geography student and the results can be summarized as follows: Total accumulation $3.2 \times 10^6 m^3$ or 94 cm, total ablation $6.5 \times 10^6 m^3$ or 192 cm, i.e. a mass loss of 98 cm on average.

(h) The Gråsubreen glacier ($2.4 km^2$) is possibly the highest situated glacier in Scandinavia, and it has an imposing end moraine system consisting of ice-cored moraine ridges. The mass balance is demonstrated by the figures: Total accumulation $0.96 \times 10^6 m^3$ water or 40 cm which is half the accumulation of the previous year; total ablation $2.6 \times 10^6 m^3$ water or 111 cm. The average mass loss is 71 cm or about equal to the previous year's mass gain.

(i) The Blåisen glacier in Northern Norway, 20 km south-east of Narvik, consists of 3 separate independent glaciers. The southernmost of these is chosen for the glacier mass balance studies in this area together with the Storsteinsfjellbreen glacier where automatic stream gauges have been installed in the melt water rivers. The accumulation on the Blåisen glacier was measured by snow depth soundings in 135 points on the $2.2 km^2$ glacier surface and density measurements in two pits. The total accumulation was $5.6 \times 10^6 m^3$ water or 225 cm on average. The ablation was measured with conventional ablation stakes and with steel wires frozen in deep holes, drilled by a thermal ice drill of the Kasser type. When large ablation is expected or when replacement of stakes is difficult, this method for ablation measurement has proved to be very convenient and accurate. The total ablation was $5.1 \times 10^6 m^3$ water or 235 cm on average.

The mass balance was slightly positive, 20 cm water on average mainly due to unusually large accumulation. The accumulation seems to be 150-160 per cent of a "normal" year's. The July temperature at the nearest weather station, Bjørnfjell, was unusually low, but the temperature in the spring and in the fall was high. The number of positive degree-days at the firn line, computed from air temperature observations at Bjørnfjell, amounted to 746 in 1963. The average for the period 1931-1960 was only 619 degree-days. Therefore the ablation figure obtained in 1963 should be regarded as being larger than "normal".

The mass balance studies made at the Storglaciären glacier in Sweden and similar measurements which are planned at a glacier between Blåisen and Storglaciären should form an interesting cross-profile from the maritime coastal area in Norway to the continental region of Kebnekajse in Sweden.

2. THE GLACIATION LIMIT AND THE FIRN LINE.

Several attempts have been made in order to determine the elevation of the "snow line" in different parts of Norway. For example, Ahlmann (1924) mapped the "glaciation limit" as defined by Enquist. Østrem has mapped the elevation of the temporary firn line on the glaciers in the Jotunheimen area by means of contemporary air photographs of all the glaciers. As Ahlmann's work was based upon old maps of less accuracy, a new map of the glaciation limit is higher than the firn line on the glaciers, possibly by about 200 metres. The "snow line" in the field outside the glaciers is expected to be situated somewhere in between the glaciation limit and the firn line.

A map of the elevation of the firn line on the glaciers (in a state of equilibrium) has been made in the following way: When applying a "normal" shaped net balance curve on the area distribution curve for a glacier, it is possible to move the curves relative to each other and determine the elevation of the firn line so that the ablation equals the accumulation. Such determinations have been made on 34 individual glaciers in South-Norway.

From the map of the glaciation limit and from some of the above-mentioned calculations, a cross-profile from Alfoten to Jotunheimen has been made, where the elevation of the glaciation limit, the firn line and some of the mass balance results are demonstrated. Generally the firn line 1963 was situated about 100 m higher than the firn line computed for a balanced budget on the glaciers. The glaciological year 1962-63 is not representative, as the accumulation was unusually low, but it is obvious that the elevation of the firn line and the glaciation limit increases when moving from the coast inland, but the accumulation and ablation are decreasing. From the Alfotbren glacier to the Storbreen glacier (in the Jotunheimen area) the computed elevation of the firn line increases 470 m. Only about 200 m of this difference is due to higher summer temperature at the Storbreen glacier (approximately 1.4° C for the months May to September); the rest is caused by smaller precipitation and possibly also caused by a higher amount of incoming radiation, due to less cloudiness in the inner part of the country.

3. MAPPING OF NORWEGIAN GLACIERS

As the topographic maps in many cases are very inaccurate with respect to the glaciers, mapping of all Norwegian glaciers has been started. Norsk Polarinstitutt and the Norwegian Water Power and Electricity Board have compiled a glacier map of Southern Norway on a scale of 1 : 500,000. Furthermore, some more detailed maps (with a scale 1 : 100,000) have been made of selected areas where good verticals are available.

The large difference between the glaciated areas, as given by topographic maps, and the true areas, as mapped from the air photographs, is not only due to the retreat of the glaciers since the topographic maps were made. Frequently the difference is due to the bad quality of the old maps but also to the fact that Norwegian topographic maps do not distinguish areas of permanent snow from real glaciers. Similar maps have previously been made for the Jotunheimen and the Skjomen districts.

Gunnar Østrem and Olav Liestøl

POLAND

1. The final work is in progress on the second section of the Werenskiold Glacier map (SW Spitsbergen) containing the middle and upper part of the glacier. The map is based on the photogrammetric surveys carried out during the glaciological investigations made by A. Kosiba on the Polish I. G. Y. and I. G. C. Spitsbergen Expeditions 1957-1960. The scale of the map is 1 : 5,000, with contour-lines every 2.5 m on the glacier and 1.25 m on the moraine. The first section of the map, containing the end part of the glacier, was published in 1960 on a scale of 1 : 5,000.
2. Work is continuing on the map of the snout and lateral moraines of the Penck Glacier, in Van Keulen Fiord, SW-Spitsbergen, also based on photogrammetric surveying carried out during the Polish I. G. Y. Spitsbergen Expeditions; it was a repetition of the first survey in 1934. The map will be published on a scale of 1 : 10,000.
3. The final work is in progress on the publication of the results of the glaciological investigations on Spitsbergen during the Polish I. G. Y. and I. G. C. Expeditions 1957-1960. The report will contain: 1) actinometry, 2) meteorological parameters, 3) density, temperature, structure, texture of firn and ice from profiles in pits and drill holes, 4) accumulation, ablation and mass balance, 5) the movement of one glacier in its different sections. The publication will be in English.
4. Investigations, begun in 1957, continue on snow falls, snow cover and hoar frost in Karkonosze Mountains, Poland, concentrated in the region of Srenica Mountain, 1500 m a.s.l., where is situated the Mountain Branch of the Meteorological Observatory of Wroclaw University. The observations are carried out in several periods during 24 hours together with systematic actinometrical and meteorological automatic registrations, and include physical and structural features of snow cover, its thickness, density, temperature, intensity of accumulation and ablation as a function of different meteorological, topographical and plant cover conditions (different density and kind of forest). Hoar frost investigations include the measuring of hoar frost mass and intensity of its accumulation by two methods, to check the wire cylinder method and the wooden cylinder method.

The hoar frost in the Karkonosze Mountains is very frequent and intensive and is a very important component in precipitation and water resources. There are very frequently fohn-wind complexes which during the winter cause very intensive melting and simultaneous evaporation of the snow cover; this gives negative weather resources balance, not only in the Karkonosze Mountains but also on their foothills, on the lowland of Silesia and even in the whole of west Poland. So the methodical experiments and results of investigations on snow cover and hoar frost by the Mountain Branch of Wroclaw University Meteorological Observatory are useful also in research on the water resources of the whole earth.

Aleksander Kosiba

SWITZERLAND

1. ANNUAL SURVEY OF GLACIERS

Under the direction of the late A. Renaud the usual inspection of glaciers was carried out in the autumn of 1963 in good weather. Nearly all the glaciers of the network were included: some of them showed significant advances, but the general tendency to retreat is still pronounced. In August 1963 an extensive revision of the base lines in front of the glaciers was carried out under the direction of A. Renaud. In close cooperation with the Schweiz. Landestopographie and of the Eidg. Vermessungsdirektion numerous points necessary for aerial photogrammetry were prepared in the areas in front of the following glaciers: Valsorey, Tseudet Boveyre, Gorner and Z'Mutt in Canton Valais, Paradisino, Cambrena, Palu, Roseg, Tschierva, Calderas and Morteratsch in Canton Grisons. Measurements of the new base lines on the Otemma and Breney Glaciers (Valais) were also undertaken. All principal fixed points are now provided with bolts carrying the mark GL (= glacier). The evaluation of the measurements is proceeding; the coordinates were communicated to the Commission of the Eidg. Landestopographie and the snout variations of the glaciers surveyed were made known to the Cantonal Forest Services.

2. JUNGFRAUJOCH ICE CAP

In contrast to the preceding year, at the end of the hydrological year 1962-63 a slight increase of on average 0.75 m of firn was observed at all 6 stakes. In order to investigate the strain and stress conditions at the surface of the ice cap, a so-called deformation quadrilateral of about 30 m sides was laid out and measured at the beginning of June 1963.

Inside the ice cap (cross-tunnel Q_{100}) one of the new ice melting probes developed by Dr. K. Philberth (Munich), which are sunk to great ice depths in order to measure temperature during the second International Glaciological Expedition to Greenland, was tested during a three-week expedition (Haefeli). These experiments were carried out by K. Philberth in collaboration with R. Haefeli.

3. ALETSCHGLETSCHER

On the measurement of the mass balance of the Aletschgletscher, P. Kasser (Head of the Section for Hydrology of the VAWE, ETH) reports:

In the firn region the hydrological year 1962-63 was marked by a relatively small firn accumulation. At stake 3 (Jungfraufirn, 3350 m a.s.l.) 3.25 m, at stake 11 (Ewigschneefeld, 3440 m a.s.l.) 4.15 m, and at stake 5 (Jungfraufirn, 3500 m a.s.l.) 5.00 m of firn accumulation was measured. As in previous years, repeated large ice avalanches from calving hanging glaciers on the south flank of the Mönch have penetrated to stake 5; these results must not therefore be taken as representative. On the 11 August, stake 3 had a minimum firn height of only 2.75 m, and from the middle of August to the end of September there was therefore again accumulation. The firn line lay slightly above stake 9 (2920 m a.s.l.). In the upper part of the ablation zone relatively large ablation losses were observed, for example 3 m at Konkordia, i.e. almost 1 m more than in the preceding year. From Märjelen to the snout on the other hand about average ablations were measured, similar to the preceding year's. With average to heavy ablation and the relatively small accumulation a negative mass balance is to be expected.

In order to establish a continuous record of ablation, a run-off gauge was established at the Silbersand station and controlled measurements by various methods were carried out. The prototype of an ablatograph ("Kasser system") was consequently checked so that manufacture of these instruments in quantity could be undertaken.

The attempt to establish an electrical method for determining the position of bright copper wire snowed in to the glacier was very promising (H. Röthlisberger). With a snow layer of about 4 m the position of the wire could be measured from the snow surface with an accuracy of ± 10 to 20 cm.

4. PLAN NEVE (CANTON VAUD)

The study of this small glacier was continued by A. Renaud. On 31 May 1963 the winter accumulation reached 573 cm of snow or 275 cm water equivalent. At the beginning of October the firn accumulation was only 38 cm (23 cm water equivalent). The ablation reached 125 cm of ice (112.5 cm water equivalent), or 1.5 times the value for the preceding year.

The investigation of the snow cover of Switzerland (snow map), carried out in close connexion with the investigation of the firn line of the Eidg. Institut für Schnee- und Lawinenforschung, was continued (M. de Quervain).

5. STEINGLETSCHERSEE

As the true snout of the Steingletscher plunges into this lake and is covered with young alluvium, the lowering of the glacier surface above the lake by recording a transverse profile has replaced the normal glacier survey (Renaud-Haefeli).

6. STEINLIMMIGLETSCHER

Measurements prepared in Spring 1962 were carried out in two expeditions in 1963 by R. Haefeli and his co-workers. These gave for the winter period from 11 December 1962 to 12 July 1963 (243 days) a mean sliding velocity for a point at the tip of the snout of 0.74 cm/day; during two short-period measurements, from 12 - 13 July and from 23 - 25 October 1963, significantly higher slipping velocities of 2.4 and 1.5 cm/day respectively were observed for the same point in the warmer period of the year. These sporadic measurements reveal the existence of a strong annual variation of the velocity of sliding in the region of the snout.

An attempt was also made to measure the strain-rate and stress parallel to the surface at the end of the snout using repeated measurements of a deformation quadrilateral. Finally four stakes reaching to the glacier bed were placed in collaboration with the Section for Hydrology and Glaciology of the VAWE, ETH; future observations and repeated measurements should demonstrate formal relations between ablation, retreat of the tongue, velocity of sliding.

7. GREENLAND

In the year under report preparations continued for the second expedition of EGIG planned for 1966, and the work on the results of the first expedition (1957-60) was continued; some of the manuscripts were sent to press.

a) Physics and chemistry of ice (A. Renaud)

The investigation of sample material carried out by the group under Renaud, Dr. Oeschger and Prof. Schuhmacher was continued and in part completed.

b) Surface studies (M. de Quervain)

The firn density at the station "Jarl-Joset", determined in the 40 m deep oblique tunnel Dumont by the overwintering group of EGIG, was compared with the differential equation for the settling of an alpine snow cover (M. de Quervain: Zur Setzung der Schneedecke. Interner Bericht, Institut für Schnee- und Lawinenforschung, 1945). Further evaluations were made of the temperature profiles from various stations on the ice sheet.

c) Rheology (R. Haefeli)

12 papers were ready for press in December 1963, with a total of 265 p. and 77 figs., for which the valuable collaboration of F. Brandenberger, P. Gfeller and Prof. Kobbold is acknowledged.

8. BASIC STUDIES ON ICE AND SNOW

At the Eidg. Institut für Schnee- und Lawinensforschung (M. de Quervain), snow mechanics measurements are in progress in connexion with the rheological problems of the Arctic ice caps. They are concerned with the specific densification velocity of snow and the corresponding cross-strains, and also with measurement of the static pressure ratio in natural snow covers. For snow of density 0.36 g/cm^3, the coefficient of the static pressure ratio found up to now is 0.18.

R. Haefeli

U.S.A.

DEPARTMENT OF ATMOSPHERIC SCIENCES, UNIVERSITY OF WASHINGTON.

1. BARROW, General

The investigations at the Arctic Research Laboratory (ARL), Barrow, proceeded as planned until the storm of 3 October 1963. On this day, a small wave cyclone passed north of Barrow, causing wind gusts of 130 km/h in the early afternoon, resulting in a surge of about 3 m height which washed away the entire micromet installation, including wanigan, generator, radiometers, recorders, masts, tools, spare parts, etc. Further, it breached the sand spit between the ocean and Elson Lagoon and made the micromet site at Niksiruk sand spit temporarily inaccessible. The CO_2 wanigan, situated close to the beach near the north end of the runway, was saved and the instruments suffered only minor damage. When ice had formed on Elson Lagoon, Niksiruk was visited on foot. An iron rod in the sand, previously used as an electrical "earth", showed there had been about 1 meter of sand erosion. The former wanigan site is now under 50 cm of water.

Considerable effort has been expended in the first half of 1964 in setting up the new micrometeorology-atmospheric chemistry field station at North Meadow Lake, 211 km south of the ARL. The station is located about 85 m north of the lake on a prehistoric tundra-covered beach ridge. It is believed that the elevation of about 10 m makes the site the highest ground within a radius of 6 km. The micromet and atmospheric chemistry wanigans are about 100 m apart on an ENE line. During December and January an existing 2300 volt power line from camp was extended by cable and poles about 570 m to North Meadow Lake, and a transformer bank was installed to give the two wanigans power capability of 15 kw. On 2 December 1963 the vestibule of the missing Niksiruk micromet wanigan was located on Martin Island, 45 km ESE of ARL.

2. ICE ISLANDS, General

The Station on Arlis II was operated throughout 1963, without major interruptions or set-backs. By the end of the winter the laboratory hut was completely covered by snow drifts. Contamination of the snow surface by stoves and generators had altered its albedo by 15-20%. This fact and the anticipated flooding of the laboratory with the onset of melting necessitated its relocation. The new location was chosen 700 m counter-clockwise from the old one, 50 m from the bay-shaped edge of the island. The new site affords easy access to the sea ice which fills the bay.

The last landings of ARL aircraft took place in the third week of June. Subsequently, the runway became unusuable due to the formation of a large pond. The first aircraft after the summer landed on a new runway on 26 September. It was observed during the summer that several ponds, which had formed in the vicinity of the line of ice hills crossing the island, drained rapidly through cracks. This indicates incomplete hydrostatic adjustment and an increased probability of general fracture in this area.

Starting in early March 1964, the plate temperatures have been taken on both the Beckman and Whitley net and total radiometers. It was felt that these plate temperatures were necessary to help in reducing the data. Routine observations have been made of the net radiation, total radiation and global radiation. Continuous recordings of the snow surface temperature were also taken.

The problems of soot from the generator and the huts caused the net radiometer to be moved off the bay ice and on to an area of clean ice near the edge of the island ice.

Arlis II is at latitude 86° N, 30° W, in July 1964.

A small, short-term (4 months) station was established by small aircraft on Arlis III, about 150 miles north of Barrow, by the Arctic Research Laboratory. Its efficiency of operation and proximity to shore made it especially useful for investigations in the field of sea ice physics. It is hoped that similar installations will be planned for the future.

3. RADIATION

(a) Barrow

Data were gathered at the Niksiruk site from November 1962 to 30 October 1963. Located 0.5-1 m above sea level on a sand spit 5 km ENE of the ARL, the Niksiruk installation was washed away during the October 1963 storm.

Continuous measurements of short-wave, reflected short-wave (gravel and sea), net (gravel and sea) and total radiation were taken. Acquisition of two Funk net radiometers made possible a study of net radiative divergence; the high sensitivity of these radiometers allows a direct measurement of radiative divergence. They were installed in April 1964 at a height of 2 m above the ground. A Kipp and Zonen solarimeter has been in continuous operation since the first sunrise on 24 January. Air temperature is recorded continously, the thermocouple sensor being located inside a Stevenson screen. A programmer was designed and built which enables the two mechanical integrators to pulse two Sodeco printers, thereby printing the half-hourly averages of global short wave and net/tundra radiation on adding machine tape. The daily energy sums of these two parameters are also obtained by four counters. The programmer system has operated reliably since its installation. Data can be reduced to completion within one month of the time it is taken.

Interpretation of the Niksiruk 1962 data shows that the yearly net total radiation energy sum (partially estimated) over the sea was small, and positive. Even though the Niksiruk data included three months with ice-free sea water, the yearly energy sum was less than the average yearly sum for eight years of Russian ice station data (NP-2, 3, 4, 5, 6 and 7).

(b) Arlis II

The following routine observations were continued in 1963:

Net radiation, total radiation, global radiation, reflected global radiation. These observations will be a further contribution towards a radiation climatology of the Central Arctic. To increase the reliability of data on net radiation, continuous recordings of the snow surface temperature were taken during the cold season. About 50% of the radiation charts were read and reduced at the Station.

4. SEA ICE PHYSICS

(a) University of Washington

Studies on the physical chemistry of sea water at temperatures near the freezing point have continued. Normal sea water that is permitted to stand in a separatory funnel for periods of about two weeks in a slightly super-cooled state shows distinct salinity concentration differences. In order to examine the structural association in the liquid near the freezing point, some infra-red absorption was initiated. After temporary suspension due to equipment difficulties these investigations have been resumed.

(b) Arlis II

Beginning September 1963, numerous determinations of ice salinity have been made on re-frozen leads in the vicinity of the ice island. In order to obtain a coherent series of observations only ice of the same age, that is, ice which formed in September, is being sampled. The frequent fracturing of the young ice made it difficult to meet this requirement, and sampling sites had to be changed 6 times. If these observations can be carried on until spring 1964, they will be of great value in explaining the mechanism of the migration of salts in ice.

(c) Arlis III

Several points of the sea ice physics program were studied at the Arctic Research Laboratory and on ARLIS III during the 1963-64 winter by K. L. Bennington. Some new procedures were used in the examination of the origin and persistence of brine drainage channels. Several dye markers, fluorescent, wettable and non-wettable, were employed to determine permeability of sea ice of different ages at different temperatures. In conjunction with the permeability study, a sampling program was conducted to determine differences in the included brine retention by the subtle bending and similar structural features in young sea ice. Brine samples from the crystal interface were collected to evaluate the extent to which sea ice is able to grow from normal composition sea water. A study of efflorescence crystals, the crystal flowers growing on the surface of young sea ice, was also initiated.

5. WEATHER

Arlis II

Standard synoptic weather observations were continued in 1963 on a 3-hourly schedule. Exceptionally low temperatures were encountered during the past winter:

	Monthly Average °C	Minimum °C
Dec. 1962	-33.4	-46.1
Jan. 1963	-39.1	-51.2
Feb. 1963	-36.2	-44.5
Mar. 1963	-38.9	-46.1

The warm spell in January, typical of arctic climate, did not occur in 1963.

6. OTHER INVESTIGATIONS, 1963-1964

(a) Supercooling

Some preliminary results have been reported by N. Untersteiner and R. Sommerfield. In view of the possible significance of supercooling in the maintenance of large-scale roughness features at the underside of the ice, these investigations are being continued at ARLIS II. An experimental procedure to measure supercooling with a high degree of accuracy is used to ascertain the spatial extent of the supercooled layer and, possibly, the rate of ice accretion.

(b) Theory of steady-state ice drift

By June 1964, W. Campbell had concluded his investigation of the ice drift in the Arctic Ocean, a major contribution towards an understanding of the interactions of wind field, ice flow and ocean currents. The investigation covers the movement of the ice, influenced by frictional forces at both its upper and lower boundary, and solves the equations of motion numerically for the mean annual case.

(c) Harmonic analysis of ice temperature

As part of the data reduction and evaluation program, R. Sommerfield has made an harmonic analysis of two years of ice temperature measurements at sites with thicknesses of 18 and 3 meters, respectively. It was found that the data from the thick island ice lend themselves particularly well to this kind of formal treatment. A short report on this work is in preparation.

(d) Model of temperature and heat flux in old sea ice

All considerations of heat conduction, strength, electrical properties, permeability and brine diffusion require knowledge of the temperature of the ice. If it is taken from field data, which are inevitably affected by random local irregularities and instrumental errors, difficulties with spatial or temporal inconsistencies are often encountered, particularly in the first and second derivatives of temperature. In order to provide an idealized, consistent model case of the variation of ice temperature with depth and time, the equation of heat transport through the ice has been evaluated. The equation contains terms for heat conduction, internal absorption of radiation, and heat advection by the upward flux of ice associated with ablation and accretion. It allows for the annual thickness changes, as well as for the variation of heat conductivity and specific heat as functions of temperature and salinity. Boundary conditions and salinity distribution are taken from field data. The investigation was conducted by N. Untersteiner, who has used the theory to establish an annual heat budget of the Central Arctic.

(e) Wave phenomena

A number of interesting waves were recorded in 1963 by A. Hanson using a mechanical water level recorder at the edge of ARLIS II. In order to detect possible phase changes of these waves, two recorders were installed at some distance. During the cold season their operation requires a relatively large amount of power to keep them from freezing and occasional power shortages caused extended interruptions of these observations. The waves recorded had periods of 5 to 60 minutes, and relative amplitudes of up to 1 millimeter. Their absolute amplitude is, so far, unknown as only relative motions between ice and water level can be recorded. Future plans include continuous recordings of water temperature at various levels below the ice where the occurrence of internal waves may be expected.

(f) Drifting snow

An instrument to measure the amount of snow suspended in the air has been designed by R. Sommerfeld and built in the Department of Atmospheric Sciences. It is based on the attenuation of light which should be proportional to the amount of scattering obstacles. The instrument was used for several successful runs on Arlis II from 21 November 1963 to the spring of 1964. Besides the vertical profile of snow concentrations, the wind profile and the settling speed of the snow particles were measured. The snow density profile predicted with the aid of the wind profile and the settling speed, assuming that the turbulent transfer coefficient of blowing snow is the same as the eddy viscosity, disagrees strongly with the measured profile. The measured snow densities seem to indicate a turbulent transfer coefficient that is about ten times as large as the eddy viscosity derived from the wind profile. Observations by Mellor and Radok in Antarctica indicate a similar discrepancy. A paper on these experiments by R. Sommerfeld and J. Businger is being prepared for publication.

From a report published by the Department of Atmospheric Sciences,
University of Washington, Seattle.

AERIAL PHOTOGRAPHY IN 1963

(The following informal report has been prepared so as to give one some of the feeling of the photo' flights. Although weather was much better this year, this is otherwise very typical of the aerial photo' flights since the project was started in 1960).

We flew about 12,000 miles this year and covered most of our previous targets and also extended the coverage a little to get a few areas missed before. By making more direct flight paths and omitting many secondary areas we were able to cover more ground than any year previously. Weather has been phenomenally good for the work and we hit it so good in Alaska that we lost only one day's work once we started. The flights went as follows:

1. Over Mt. Rainier and on to Idaho Falls with a look at the Wallowa and Salmon River Mtns. Next day, Tetons and Wind River Mtns., then the eastern fringe of the Rocky Mtns. in a new area south of Great Falls. Weather over Glacier Park was no good so we came home over Coulee Dam and Chelan. Got nice views from around 10,000'. Cascades under a solid cloud deck, though.

2. North up Coast Mtns. Weather-broken clouds until about half way to Alaska, so that we flew low and had very grand scenery - just clearing the passes and turning here and there to find a route through. The mountains are so much more spectacular when one is well below the summits. From there on it was brilliantly clear and we made several photo' runs before stopping at the Alaska border - Stewart, B. C. Next day, on up the Coast Mtns. mostly in clear skies, with local layers of cloud forming from time to time, often while we watched. Photographed to Juneau; gassed up and immediately continued on. Did Glacier Bay in completely clear skies and out around Lituva Bay and on to Yakutat. Though it was getting late, we immediately took off again, photographed the Malaspina, getting as far as Icy Bay before we began to hit the storm front we had been warned was moving in from the westward. We then turned north inland into the Chitina-Copper River country and immediately noted a glacier undergoing a rapid movement: the Walsh, which I'd checked before. So in very late evening light we photographed it and then went on north over the crest of the Icefield Ranges (peaks 15,000') and landed at Northway, Alaska, on the Alaska highway just as dusk was falling. Total flying time for the day: $11\frac{1}{2}$ hours.

Next day - the storm front had moved in but we went up for an hour to reconnoiter and were chased back by squally, rough air over cloudy mountain areas.

4th day - some clear weather reported west of the front so we took off early and flew under the storm by following "thru-valleys" in the mountains. It was a bit tight in the middle of the storm, with fog and rain which forced us down almost to tree-top flying for 50 miles, or so, but presently we caught a glimpse of snowy mountains thru' a break and turned in that direction and soon climbed out again to see the Mt. Hayes area of the Alaska Range glittering in brilliant sunshine. We climbed on to 17,000' and made photo' runs over two target glaciers then went on to look over the Black Rapids, Susitna and Yanert Glaciers - all old familiar landmarks from the "Muldrow Report". The best weather we had yet seen over this area was found, although the lower Black Rapids Glacier was covered by a nasty looking deck of storm clouds well below us. We then headed on west for "Polychrome" Glacier in McKinley Park, but a solid storm front to 13,000' diverted us south and without further photography we dropped down to Anchorage for fuel just at noon. We were now in the fringe of the fair weather reported and could see clear skies to the westward and soon were off for the western Alaska Range. While making a photo' run over a target the big K-17 magazine stopped running so we swung westward for an oblique photography reconnaissance before going to an airport to check the camera. Had good photo' weather around Mt. Spur, Redoubt and Illiamna - all beautiful volcanoes though at present rather quiet. Penetration westward was discouraged by a dull-colored cloud layer thru' which a few high peaks extended so we turned across Cook Inlet and landed at Homer to refuel. The Kenai Mountains were well on the way toward breaking out of the clouds - we could see this on the horizon when working over the Alaska Range - so we photographed the south-western side in the evening light, landing at Kenai for the night. After lugging the camera magazine into the hotel we found a sheared gear pin to be the trouble and with a rusty pair of pliers, a hammer, 3 nails and a paper clip plus the help of my jackknife to whittle a nail to proper size, we were able to extract the old pin and install a new one fashioned from the best nail. By the time this was fixed it was again well after midnight, our usual "to-bed" time on this trip.

5th day - Off early over the now clear Kenai Mtns. and with everything apparently working okay we made runs over various glaciers, including the Bear Lake Glacier where the survey party, Jim Case, Dick Long and myself, had cut devils club and crossed torrential rivers in 1957. A high, thin overcast spelled the probable end of the clear skies ahead so we sped on east to Prince William Sound and hurriedly made runs over the main targets, continuing on to do Worthington Glacier and others in the Valdez area. We then dashed to Bering Glacier and climbed to the highest altitude of the trip: 20,300'. At this altitude we made runs over the more interesting portion of the terminus and also the Martin River Glacier and then, low on gas, coasted most of the way down to Cordova "Mile 13" field just a few miles from familiar Sheridan Glacier.

By the time we were off, the skies were very dull and forbidding so we headed across hoping to catch the Wrangell Mtns. before the storm front hit. We were unable to get ahead of it and settled for some late afternoon runs across the "Skolai Pass Glaciers" where Jim and Dick worked in 1958, but were unable to produce a map because the Navy photography apparently was defective. Then on to Northway for the night.

6th day - Off early for another try at the Wrangells as the sky had broken in that direction. From 10,000 feet, however, it looked better westward so we headed for the Gulkana Glacier and succeeded in making better runs than on the early flight when it was found to be under a "deck" at 16,000'. We then went on to the Black Rapids again and succeeded in making a run over the missed portion just ahead of a fog layer which blanketed the area only minutes later. With further photography impossible here we then drifted down to Gulkana and stopped for gas. Then off again to the south side of the Wrangells - and able to do some work although clouds hid most mountain tops. We re-ran the Skolai Glaciers in much better conditions and headed east to check the northern St. Elias - now committed to our return trip home since this was the "route". Some storm clouds held us off the Skolai Mtns. and we skirted the northern fringe to the immense Klutlan Glacier and discovered that the indifferent views of it on the late evening crossing on the 24th (2nd day) had failed to disclose the extent of its changes; evidently a full-scale movement was taking place. So we delayed to make quite extensive photo' runs and then went on Steele, Donjek and Kluane Glaciers and the discovery that the "Little Kluane" was showing evidence of renewed energy, so made a run over it, too. Then on past the head of the Kaskawulsh and a circle and look down on the Arctic Institute's campsite but no sign of life, and then over the immense icefields which form the head of the Hubbard and Lowell Glaciers to the Alsek River. We then photographed the Tweedsmuir Glacier and swung west to Yakutat for gas. Weather there was, as before, ideal and this being one of the worst weather ports on the whole coast we couldn't help looking west to Mt. St. Elias gleaming brilliantly, perhaps 60 miles away, and east to Mt. Fairweather 100 miles in that direction and quite as sharp - just as they had been during our stop previously. We took off quickly and dropped down the coast to Alsek Glacier and then went over the hump of the Fairweather Range for a run over "Tenas Tika" Glacier, noting several small ones nearby which clearly had advanced since our 1961 visit. Then an abortive turn toward Little Jarvis Glacier, but late afternoon shadows made it evident that we would waste time there so a brief turn over Muir Glacier again and on to Juneau, dropping out of the sky just before sunset. The night was spent near the field in our sleeping bags with the stars for company as the motels wanted too much for what they offered, and next morn we had a bite when the snack bar on the field opened and then again were airborne now with hopes of making Stewart, B.C. and then on for home. We swung eastward and took in the big glacier near the mouth of the Stikene River, worked across ridges to Salmon Glacier, planning to make a 16,000' run with the F-56 camera which immediately jammed so, instead, dropped westward for Annette as we had much altitude. We were unable to raise them by radio and felt some concern as Annette had been fogbound earlier and the fog was plain enough to see ahead over the ocean but, as luck would have it, the field had cleared (as it had done in 1961 when we came in low on gas) so we had no trouble. Refuelling, we were off now with plans to make Port Angeles non-stop so as to avoid Canadian Customs delays, so did not attempt to photograph the same target areas hit on the way north and only paused for photos in the Mt. Waddington area. Since we would pass over most of Vancouver Island, it was hoped for a chance to photograph the glaciers there to use the small amount of K-17 film remaining and, in some thick forest fire smoke, we made runs over several; then south of the smoke had photographed all but the last one when the film ran out. It was but a long wait then, as we coasted down by degrees over the remainder of the Island, and with the same fogbank skirting the coast which we had first glimpsed near Juneau, we headed across the Strait of Juan de Fuca with all below obscured. Would the fog cover Port Angeles? It didn't look like it at first but the farther we went the more likely it appeared and when we got there the fog was just offshore and coming in fast. And, so home.

Austin S. Post

1. *ALASKA TERRAIN AND PERMAFROST STUDIES OF THE U.S. GEOLOGICAL SURVEY. For many years the Survey has been engaged in aerial geological mapping (1:50,000 to 1:250,000 scale), largely in areas of Alaska and other parts of the Arctic that have been glaciated and are underlain by Pleistocene deposits. Many other related studies have also been undertaken in Alaska. Among these are studies of the character and distribution of permafrost and seasonal frost, the thermal regime of the supra-permafrost zone and the permafrost zone, engineering problems related to frost conditions, textural characteristics and engineering properties of unconsolidated materials, past and present positions of regional snow lines, and the character and distribution of vegetation.

In recent years field work has been concentrated in and peripheral to the Copper River Basin and the Tanana Valley. H. W. Coulter, O. J. Ferrians, Jr., D. R. Nichols, H. R. Schmoll, J. R. Williams, and L. A. Yehle have worked in the Copper River Basin, an intermontane lowland drained by the Copper River through a gorge in the Chugach Mountains to the south. An extensive proglacial lake formed in this basin during each major glaciation when the drainage was blocked by glaciers. In one or more of the older glaciations ice filled the basin and then flowed out in several directions. During the last two glaciations, however, the ice was less extensive, and the center of the basin was filled with a variety of lacustrine sediments, including many that resemble till but which were deposited in water. The lesser extent of ice during these glaciations was not previously recognized, and many constructional forms have apparently survived from older glaciations.

The fabric of diamicton (till-like) deposits of the Copper River Basin has been studied in detail by H. R. Schmoll in an attempt to distinguish between several similar-appearing deposits of diverse origins. This work is not yet complete, but preliminary results indicate that distinctive fabric patterns may be established for at least some types of such water-laid sediments.

A. T. Fernald, H. L. Foster, G. W. Holmes, D. B. Krinsley, and H. R. Schmoll have investigated the Tanana Valley to the north of and on the opposite side of the Alaska Range from the Copper River Basin. Glaciers extended northward into the Valley, which was filled with considerable outwash and aeolian material. The Tanana River may have been dammed by glacier ice, but probably only for relatively short periods. The Yukon-Tanana Upland, a lower mountain complex to the north, was glaciated only very locally, in the highest parts. Reports on these areas are being prepared.

Pingos of the open-system type have been discovered by H. L. Foster, G. W. Holmes, and D. M. Hopkins in interior Alaska in the zone of dis-continuous permafrost. The pingos appear to range in age from a few decades to a few thousand years. Cores of ice have been observed in some.

Ground temperature, air temperature, and snow cover studied in the Copper River Basin, the Tanana Valley, and the Yukon-Tanana Upland are continuing.

Two statewide maps are being prepared by the Geological Survey. One, the "Surficial Geology of Alaska" (1:1,584,000; compiled by T. N. V. Karlstrom and others) is in press; the second, which will show the extent of Pleistocene glaciations in Alaska at 1:2,500,000, is being compiled by a committee of six members. These maps are based on the integration of all available data, especially those derived from the field work of the past 20 years, and on extrapolation to areas that have not been thoroughly investigated.

O. J. Ferrians, Jr., is preparing a map (scale 1:2,500,000) showing the general character and the distribution of permafrost in Alaska. This map will be considerably more detailed than previously published permafrost maps.

T. N. V. Karlstrom led a brief multidisciplinary investigation of a Pleistocene refugium site on Kodiak Island. The existence of the refugium, originally delineated from geologic data, is seemingly reflected by the character of the vegetation (studied by E. Hulten), ground insects (G. Bull and C. Lindroth), and fish (J. D. McPhail), but apparently not by existing mosses (H. Persson), lichens (H. Krogh), algae (D. K. Hilliard), and mammals (R. Rausch),

A report on parts of the Cook Inlet region, based on field work by T. N. V. Karlstrom and D. B. Krinsley has recently been released; a report on the Kobuk Valley, by A. T. Fernald, is being prepared for publication. Fluctuations of presently existing glaciers since the last major glaciation have also been studied locally in Alaska, on the Kenai Peninsula, and in the Matanuska Valley. Field work by W. E. Davies, H. L. Foster, and D. B. Krinsley is now underway in the Yukon-Tanana Upland, and studies of other areas west of the Copper River Basin will be initiated in coming years.

D. B. Krinsley spent one summer in the Yukon Territory, Canada, mapping the surficial deposits and studying the glacial geology of the Wellesley Basin and adjacent area.

* Publication authorized by the Director, U.S. Geological Survey

From 1953 to 1960 W. E. Davies and D. B. Krinsley conducted field studies of glaciated areas in Greenland. The area around Thule was mapped at a scale of 1:100,000. Glacial geology studies in northern Greenland covered Kronprins Christian Land, Peary Land, and intervening areas and will result in preparation of a report and a glacial geology map at 1:500,000 scale. Similar mapping on Polaris Promontory was done at a scale of 1:50,000. The work in northern Greenland has revealed that the maximum extent of the Greenland ice cap was not much greater than at present, and that long outlet glaciers occupied the major fjords during the maximum.

Henry R. Schmoll

ALASKA GULKANA GLACIER

In 1963 the map showing the recent advances of the glacier was made available. The positions of the glacier in the last 300 years were dated by lichenometry.

Donal M. Ragan has begun a three-dimensional study of a cone of ice in the ice fall, from observations in a tunnel which will be dug during the summer. The study will help determine the orientation of foliation.

U.S.S.R.

SOVIET ANTARCTIC EXPEDITION, 1963-64

Operations this year were on a large scale. The Ninth Soviet Antarctic Expedition, leader M. M. Somov, consisted of over 400 men, with representation from France, Czechoslovakia, Great Britain, Hungary and the United States. The wintering party in 1964 numbered 158 men. Transport to Antarctica was provided by two ships, Ob' and Estonia, and two IL-18 aircraft which flew in from Moscow via New Zealand, returning the same way.

Two major scientific traverses were undertaken. One was led by A. P. Kapitsa, and included the seismic surveyor O. G. Sorokhtin and the glaciologist V. K. Nozdryukhin in a total of sixteen men. The team flew into "Vostok" station, the starting point of the traverse, and set off in two Kharkovchankas and one other tracked vehicle on 4 January 1964. The objective was "Molodezhnaya" station on the coast of Enderby Land, and the route lay over unexplored territory for virtually the whole way. Early in February the Pole of Inaccessibility was reached, and the hut built by a Soviet party in 1958 was occupied. Continuing towards "Molodezhnaya", the party received air-dropped supplies, and then found itself in a difficult crevassed zone as the coast was approached. Air and ground assistance from "Molodezhnaya" helped it get through this zone, and the destination was reached on 21 March. The journey lasted 78 days and covered 3300 km. The main scientific task was seismic sounding.

The other traverse was led by P. A. Shumskiy, and included A. Bauer and four other Frenchmen in the party of 20. The route was the well-known one from "Vostok" to Mirny by way of "Komsomol'skaya", "Vostok-I" and "Pionerskaya". The scientific tasks were: tellurometer measurements of large pentagons laid out on the ice surface, especially in the region of the iceshed between "Vostok" and "Komsomol'skaya", in order to be able to determine strain rates on re-measurement in two years' time; and the taking of ice cores for density and isotope studies. The party left "Vostok" (to which they had been flown) on 16 February, and reached Mirny on 3 April. 2300 km were covered in 48 days.

Apart from these operations, four stations were occupied during the season, and will remain occupied for the winter of 1964: Mirny, "Vostok", "Molodezhnaya", and "Novolazarevskaya". Glaciological studies will certainly be undertaken at the last-named, since it is there that C. W. M. Swithinbank, the first British exchange scientist with a Soviet expedition, is wintering.

Marcel de Quervain

Marcel R. de Quervain has been a glaciologist almost from birth. He was born in Zürich, Switzerland, on 17 May 1915, the son of the geophysicist, Alfred de Quervain, who is famous for his early crossing of Greenland. Marcel soon found his way to the nearby glaciers, and earned his first money as a glaciologist when he was only 7 years old: working with his elder brother as an assistant in measurements of the Grindewald Glacier, which at that time was in full advance.

de Quervain was educated in Zürich, and after a year of practical work entered the Eidg. Technische Hochschule in 1935. He was lucky there to be the assistant of both P. Niggli and J. Scherrer, both of them important in the history of geology and glaciology. In 1940 he gained his Diploma in Physics, and in 1944 his Doctor's degree, for his X-ray studies of ferro-electric substances. Throughout these years of study, de Quervain served for some 1000 days as an officer in the Swiss Army.

In the years before World War II, R. Haefeli and his associates had begun their researches into the snow cover at the Weissfluhjoch, above Davos. After the war the Federal Institute for Snow and Avalanche Research was established at the Weissfluhjoch, and in 1943 de Quervain went from Zürich to work there. His researches covered the metamorphism and the visco-elastic and thermal properties of snow, and the evaporation and run-off from the snow cover. Then in 1948 and 1949 he crossed to the Western Hemisphere, to play his part in the rapid growth of glaciology there at that time. In the U.S. this growth led to the formation of the Army S. I. P. R. E.; but de Quervain's main work lay in Canada, where he worked as a Senior Research Officer for the National Research Council, investigating Canadian snow problems. A product of this period was the draft of the international snow classification, written in association with U. Nakaya, V. J. Schaefer and C. J. Klein.

In 1950 de Quervain returned to the Weissfluhjoch Snow and Avalanche Institute as Director, and since then his fortunes have been the Institute's. Following the disastrous "avalanche winter" of 1951, special emphasis was laid on the practical problems of avalanche protection. An invention of this period was the artificial snow slideway at the Weissfluhjoch, used by W. Kennel and B. Salm to study the dynamic effects of snow. This slideway is the silvery chute that visitors notice to the right of the Weissfluhjoch building. The avalanche warning system was put on a new basis, and members who have ski-ed in Switzerland will have heard the Institute's snow bulletins broadcast daily. In 1954 the Institute extended its research into hail and frost problems. de Quervain himself has continued his experiments and publications into the artificial metamorphism and heat conductivity of snow, and has developed a sun path recorder.

In 1959, nearly 50 years after his father crossed Greenland, de Quervain made his own crossing of the ice sheet. He joined the International Glaciological Expedition to Greenland as head of the "Glaciology Inlandsis" group, studying the stratification and structure of the neve. This must have been a welcome break from administrative routine, for besides giving courses at ETH on atmospheric physics, nivology and avalanche protection, de Quervain is a member of commissions and committees all over Switzerland. In Davos itself he is President of the Swiss Research Institute on Mountain Climate and Medicine.

Many members of the Society will have met de Quervain at international meetings. Conferences on meteorology and glaciology have taken him all over the world, and in particular he has been a regular attender at successive I.U.G.G. conferences, at Oslo, Brussels, Toronto, Helsinki and Berkeley, having worked as a committee member for three of these. Some members of the Society have been lucky to visit or work with de Quervain at the Weissfluhjoch, at the summit of which he and his staff are enthroned amongst some of the most wonderful scenery and ski-runs in the world. In winter, when the day's work is done, de Quervain's is one of the most agile figures that skis down the 1000 m drop into Davos. There he lives with his wife, Rita Wismer, and three children, and practises his hobbies of music and painting. He is now actively engaged in organizing the Commission of Snow and Ice symposium on avalanches, to be held at Davos in April 1965.

MEETINGS

INQUA. The Seventh Congress of the International Association for Quaternary Research will take place in the U.S.A. in August and September 1965. The complete Congress programme will extend over a period from 14 August - 19 September. The General Assembly, plenary sessions, meetings of sections, commissions and some symposia will be held in Boulder, Colorado, 20 August - 5 September. Technical Field Conferences and related symposia will be held 14 - 29 August and 5 - 19 September. Facilities for the General Assembly and meetings at Boulder will be provided by the University of Colorado in co-operation with the University of Denver, Colorado School of Mines, Colorado State University, Colorado College, University of Wyoming, U.S. Geological Survey, Rocky Mountain Association of Geologists, and Colorado Scientific Society. Information about the Congress may be obtained from the Secretary-General, VII INQUA Congress, Building 25, Denver Federal Center, Denver, Colorado, U.S.A. Registration for the Congress should be completed before 1 February 1965.

1. CONGRESS SECTIONS. Group 1 is concerned with present-day biological and physical environments and processes, with Group 1c devoted to Glaciology. Group 2 is concerned with local or regional data on Quaternary environment and history, and Group 3 is concerned with world-wide interpretations of Quaternary phenomena.

2. TECHNICAL FIELD CONFERENCES. There are 12 of these. The following examples show their value for glaciologists.

NEW ENGLAND - NEW YORK STATE

Conference A Before Boulder

Reservation: 13 August arrival at Kennedy International Airport, N.Y., through 29 August, breakfast in Buffalo, N.Y.
Maximum Registration: 38 or 76 (one or two buses).
Organizers: J.H. Hartshorn, E.G. Muller, J.P. Schafer.
Local Leaders: A.L. Bloom, D. Byers, C.J. Cazeau, R.B. Colton, D.L. Cox, P.P. Cox, E.S. Deevey, Jr , R.P. Goldthwait, F. Johnson, C.A. Kaye, R.G. LaFleur, W.H. Lyford, W.A. Ritchie.
Topics: New England - Wisconsin and pre-Wisconsin stratigraphy and ice push structures of Martha's Vineyard. Wisconsin end moraines of Rhode Island and western Cape Cod. Middletown readvance, glacial-lake deposits and dunes of Connecticut Valley. Pre-Wisconsin weathered bedrock. Morphology and chronology of retreatal dead-ice, glaciolacustrine and glaciofluvial deposits of Rhode Island and eastern Massachusetts. Periglacial aeolian and frost features. Drumlins and till stratigraphy of north-eastern Massachusetts. Glacio-marine clays of northeastern Massachusetts and southwestern Maine. Effects of cirque glaciers and continental ice sheet in White Mountains of New Hampshire; fossil and modern

frost features and alpine ecology. Pedology and slope movement in the Harvard Forest. Bog chronology and archaeological sites depending on work available.

New York State - Glacial Lake Albany and stagnation features of Hudson glacial lobe. Preglacial and interglacial saprolite in Adirondack valleys. Relationship of local Adirondack glaciers to continental ice sheet. Meltwater erosional features including marginal and subglacial channels and plunge pools. Glacial modification of dissected Applachian Plateau in the Finger Lakes region. Pre-Farmdale stratigraphy of the Otto and Gowanda interglacial sites. Chronology of late Wisconsin recession from the unglaciated Salamanca re-entrant north to Niagara Falls. Proglacial lake history, post-glacial bog succession, and archaeological site investigations depending on work in progress.

UPPER MISSISSIPPI VALLEY

Conference C   Before Boulder

Reservation: 13 August, dinner at Lincoln, Nebraska, through 29 August, lunch at Lincoln, Nebraska.
Maximum Registration: 36, 72 or 108 (one, two or three buses).
Organizers: R. F. Black and E. C. Reed.
Local Leaders: C.N. Brown, E.J. Cushing, J. E. Freeman, J. C. Frye, H. G. Hershey, F.D. Hole, R. V. Ruhe, J. Stone, S. V. Steece, H. B. Willman, H. E. Wright, Jr.
Topics: Type localities and other significant exposures of continental glaciation in eastern Nebraska, eastern South Dakota, Minnesota, Wisconsin, Illinois and Iowa. Nebraskan, Kansan, Illinoian and Wisconsin glacial deposits and Aftonian, Yarmouth and Sangamon interglacial deposits and associated palaeosols. Glacial features including moraines, eskers, crevasse fillings, outwash, drainageways, tunnel valleys, kame complexes, sand plains, glacial lakes. Sand dunes; seasonal frost; Pleistocene permaforst and periglacial phenomena. Archaeological sites including a rock shelter in the driftless area of Wisconsin. Soils on Pleistocene materials. Lake and bog sites, including pollen and seeds; plant-geographic transect from prairie to conifer forest. Glacial Lake Agassiz - its strandlines and outlet. Loess stratigraphy of Illinois. Radio-carbon-dated localities.
Symposia: At University of Nebraska, Lincoln, Nebraska.
"Classification and chronology of the U.S. mid-continent glacial drifts".
"Loess areas of the world and their interpretation".
At University of Minnesota, Minneapolis, Minnesota.
"Relations of the late-Wisconsin vegetation history to the glacial sequence in the Great Lakes region".

NORTHERN AND MIDDLE ROCKY MOUNTAINS

Conference E   Before Boulder

Reservation: 13 August, dinner at Denver, Colorado, through 29 August arrival at Boulder, Colorado.
Maximum Registration: 160, two separate sections of 80 persons (two buses) each.
Organizers: A. J. Eardley, R. Fryxell, J. de la Montagne, G. M. Richmond.
Local Leaders: D. L. Blackstone, R. C. Bright, R. F. Daubenmire, R. D. Daugherty, L. M. Gard, J. M. Good, H. D. Goode, R. W. Lemke, J. D. Love, H. E. Malde, R. B. Morrison, G. E. Neff, L. A. Nobles, W. S. Osburn, W. E. Powers, H. W. Smith, D. W. Taylor, D. E. Trimble, O. L. Tweto, P. L. Weis, S. E. Williams.
Topics: Tertiary and Quaternary erosion surfaces and related deposits of the Colorado erosion surfaces and related deposits of the Colorado High Plains and mountains of Central Wyoming. Vegetation and soils of the Colorado short-grass prairie and Wyoming semi-arid basins; ecology of mountain forests and alpine tundra. Type localities of the five Rocky Mountain glaciations in the Wind River Mountains; Pleistocene faulting in the Teton Mountains; relation of Quaternary volcanics and geyser activity to glaciation in Yellowstone Park; relations of mountain glaciers to continental ice sheet in Glacier National Park. Vegetation and soils of the tall-grass prairie; forest types east and west of the Continental Divide in Montana. Pleistocene advances of the Western Cordilleran ice sheet, and their relations to deposits of Glacial Lake Missoula; evidence for flood origin and age of the "channeled scablands" and Grand Coulee. Pleistocene loesses and interlayered soils of the Columbia Plateau. Pliocene-Pleistocene boundary, early and middle pleistocene sedimentation, palaeontology and volcanism of the Snake River Plain. Stratigraphy and geomorphology

of successive deposits of the pluvial Lake Bonneville and their relation to the glacial advances of the Wasatch Mountains. Periglacial and aeolian deposits and interglacial soils of the Colorado Plateau. Glacial and outwash sequence at Aspen and Leadville in the Rocky Mountains of Colorado.
Symposium: At Glacier National Park.
"The Quaternary of the Alps and comparison with that of the Rocky Mountains".

CENTRAL AND SOUTHERN ALASKA

Conference F   Before Boulder

Reservation: 18 August, dinner at Fairbanks, Alaska, through 29 August, breakfast at Anchorage, Alaska.
Maximum Registration: 30 or 60 (one or two buses).
Organizer: T. L. Péwé
Local Leaders: O. J. Ferrians, Jr., T. N. V. Karlstrom, L. R. Mayo, D. R. Nichols, L. A. Verieck, J. R. Williams.
Topics: Glacial and periglacial deposits; active glacial and periglacial processes. Quaternary stratigraphy in non-glaciated central Alaska. Loess deposits with periennially frozen retransported loess with large ice wedges; vertebrate fossils, fragments of frozen carcasses of extinct animals. Solifluction, altiplanation, patterned ground, pingos in the active stage. Non-glacial deposits and processes traced southwards to the Alaska Range where the glacial sequence can be examined. Examination of loess being deposited in forested areas. Dating of recent moraines by lichenometry. Examination of glacier foliation, flow and possibly internal features. Eskers and kamekettle topography above tree line. Pleistocene lake beds and glacial deposits in Copper River Basin. Glacial sequence in Palmer-Anchorage area.
Symposium: At University of Alaska:
"Arctic environment and processes".

GREAT LAKES - OHIO RIVER VALLEY

Conference G   After Boulder

Reservation: 5 September, from dinner in St. Louis, Missouri, through 19 September, after breakfast at Toronto, Canada.
Maximum Registration: 70 (two buses).
Organizer: R. P. Goldthwait.
Local Leaders: A. Dreimanis, R. H. Durrell, J. Forsyth, J. C. Frye, A. M. Gooding, P. Karrow, L. L. Ray, C. B. Shultz, W. J. Wayne, G. W. White, H. B. Willman.
Topics: Illinois - Stratigraphic sections of Kansan-to-Wisconsin-age drifts and moraine sequences in the type mid-continent areas. Loess relationships, fossil molluscs, the Altonian and Farmdale beds of recent literature. Indiana - Multiple Wisconsin (C-14 dated) beds with intercalated fossiliferous silts, pollen sequences and outwash deposits; Kansan and Illinoian tills and interglacial soils. Kentucky - Ohio River terraces and glacial deposits, vertebrate fossils at Big Bone Lick. Ohio - Kansan (?) and Illinoian till and lacustrine beds in or near ancient Teays system valleys in Cincinnati area. Wisconsin drift boundary from southwestern to central Ohio; Indian mounds, loess cover, dated (C-14) wood localities, and Wisconsin till over Illinoian till. Two main sheets of Wisconsin drift demonstrated by use of stratigraphy, terrace-soil systems and related bog and pollen stratigraphy. Other Wisconsin advances in northern Ohio, demonstrated by character of soils and textural differences of tills. Pre-Wisconsin beds and fossiliferous loess near Cleveland. (Air flight across Lake Erie). Canada - Older Wisconsin drifts and dated (C-14) interstadial beds differentiated by lithologic and granulometric study, along the shore of Lake Erie. Former glacial-lake strandlines, young Wisconsin end moraines, and Sangamon interglacial and early Wisconsin exposures near Toronto.

NORTHERN GREAT BASIN - CALIFORNIA

Conference I   After Boulder

Reservation: 5 September, after breakfast in Boulder (train departs Denver, Colorado at 8.30 a.m.) through 19 September, breakfast in San Francisco, Calif.
Maximum Registration: 74 or 110 (two or three buses).

Organizers: R. B. Morrison and C. Wahrahftig.
Local Leaders: H. G. Baker, P. W. Birkeland, W . B. Bull, H. Bonham, A. Cox, G. B. Dalrymple, A. J. Eardley, H. D. Goode, R. J. Janda, I. E. Klein, L. Langham, B. E. Lofgren, G. B. Maxey, E. A. Naphan, J. F. Poland, R. P. Sharp, G. M. Stanley, R. Van Horn.
Topics: By day train through the Rocky Mountains, alpine to semi-arid basin geomorphology, glacial geology, vegetation; lake Cainozoic: volcanism and deformation. Near Salt Lake City - geomorphology, vegetation and soils of the deserts and Wasatch Mountains. Pleistocene Lake Bonneville beaches, stratigraphy, radiocarbon chronology, and relation to glacial geology. Engineering and ground water geology of the Salt Lake City area. Nevada - Pleistocene Lake Lehontan shorelines, stratigraphy, and radiocarbon chronology. Hydrogeology, desert soils and vegetation. Basin-and-Range deformation and volcanism. California - Quaternary volcanism, faulting, and glacial geology along the east side of the Sierra Nevada. Radiometric and palaeomagnetic chronologies. Yosemite Valley: Sierra Nevadan erosion surfaces and processes, and vegetation zones. Alluvial sequences and soils of the western foothills of the Sierra Nevada and the Great Valley. Central Valley water project; subsidence problems in Quaternary sediments. Deformed Pleistocene deposits and marine terraces in the Coast Ranges. Sequoia forests and other relict vegetation. Universities in the San Francisco Bay area.
Symposia: At University of Utah, Salt Lake City.
"Means of correlation of Quaternary successions".
At University of Nevada, Reno.
"Soil stratigraphy and its applications to correlation of Quaternary deposits and land forms, and to soil science".

PACIFIC - NORTHWEST

Conference J After Boulder

Reservation: 5 September from dinner in Portland, Oregon, through 19 September after breakfast in Seattle, Washington.
Maximum Registration: 78 (two buses).
Organizer: S. C. Porter
Local Leaders: J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, R. J. Fulton, S. P. Gessel, R. E. Greengo, C. J. Heusser, E. R. LaChapelle, M. F. Meier, D. Molenaar, D. R. Mullineaux, H. H. Waldron.
Topics: Pleistocene and Recent igneous geology of Cascade volcanoes. Glaciology of Mount Rainier and Mount St. Helens. Recent lahars: their identification and significance. Tephrochronology of post-Wisconsin events in the Cascades and Interior Ranges of British Columbia. Crustal movements and antecedent streams of eastern Cascade foothills. Contrasts in the Alpine glacial geology on east and west flanks of the Cascades. Late Wisconsin substages based on valley moraines. Relation of alpine glaciers to Puget Lobe. Drift stratigraphy and chronology of Puget Lowland. Interglacial and postglacial pollen stratigraphy. Periglacial features near the drift border. Recession of the Puget Lobe. Late glacial drainage and ice-damned lakes. Glaciomarine drifts and associated invertebrate faunas. Forest zones of Western Washington. Weathering profiles on late Wisconsin and older drifts. Drift stratigraphy and late glacial features of Lower Frazer Valley. Elevated marine features. Interglacial stratigraphy of Frazer Lowlands and Interior British Columbia. Landslides and related phenomena of Cascades and Interior British Columbia. Deglaciation features, drainage, and development of late glacial lakes in Interior British Columbia. Archaeology of Western Washington and Southwestern British Columbia. Soils of the Cascades and Puget Lowland.
Symposium: At University of Washington, Seattle, Washington.
"Late Pleistocene environments of the Pacific Northwest".

COMMISSION OF SNOW AND ICE

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

SYMPOSIUM ON SCIENTIFIC ASPECTS OF SNOW AND ICE AVALANCHES

DAVOS (SWITZERLAND), 5 - 10 April 1965

Final Circular, September 1964

1. INVITATION

There was a good response to the first circular issued in November 1963 and the organizing committees take pleasure in announcing the detailed arrangements and in inviting you to attend the Symposium.

2. ORGANIZATION

International Association of Scientific Hydrology (IASH)
President: Ir. A. Volker, Netherlands — Secretary: Prof. L. J. Tison, Belgium

Commission of Snow and Ice
President: Dr. H. Hoinkes, Austria — Secretary: Dr. W. H. Ward, England

Division of Seasonal Snow Cover and Avalanches
Chairman: Dr. M. de Quervain, Switzerland

Swiss Patronizing Committee
Mr. J. Jungo, President (Swiss Federal Forest Supervisor)
Prof. E. Brandenberger (Swiss Commission of Snow and Avalanche Research)
Prof. R. Haefeli (President, Swiss Glacier Commission)
Prof. A. Kurth (Swiss Commission of Snow and Avalanche Research)
Prof. G. Schnitter (President, Swiss Hydrology Commission

Organizing Committee at Davos
Dr. M. de Quervain, President (Director, Swiss Federal Institute for Snow and Avalanche Research (SAR))
Mr. A. Aufdermaur (SAR)
Mr. F. Duerst (Director, Tourist Office, Davos)
Dr. C. Jaccard (SAR)
Mr. H. R. In der Gand (SAR)
Mr. A. Roch (SAR)
Dr. Th. Zingg (SAR)

3. PROGRAMME OF MEETINGS AND EXCURSIONS

The numbers of papers planned for each technical session are marked with an asterisk*.

Sunday	4 April	Arrival in Davos. Registration in the Symposium office. Informal gathering in the restaurant of the Sporthotel Central.
Monday	5 April	Registration in the Symposium office.
	09.30	Opening of the Symposium (Auditorium of the Forschungsinstitut, see para. 4.)
	10.00	Introductory lecture: Problems of avalanche research, by Dr. M. de Quervain.
	11.00 - 12.00	1st Session (2*)
	14.15 - 17.30	2nd Session (5*)
	about 20.30	Informal gathering at the Hotel Terminus.
Tuesday	6 April	
	09.00 - 11.30	3rd Session (4*)
	about 11.50	Excursion to Jakobshorn: Luncheon (see para. 9.1)
	16.00 - 18.30	4th Session (4*)
	20.30	Special session No. 1 on avalanche classification.

Wednesday	7 April		
	10.00 - 12.30	5th Session (4*)
	14.30 - 17.00	6th Session (4*)
	17.30	Reception by the Community of Davos at the Rathaus (Davos-Platz)
Thursday	8 April	
	about 08.30	Excursion to Weissfluhjoch and Weissfluhgipfel, visit to the SAR Institute, demonstrations, luncheon.
	about 14.30	For skiers: Guided descent on skis to Klosters.
	about 17.30	Arrive Davos.
	20.00	Official Banquet at Hotel Terminus.
Friday	9 April	
	09.00 - 12.00	7th Session (5*)
	14.30 - 17.00	8th Session (4*)
	17.00 - 18.30	Special session No. 2 on avalanche classification.
	20.00	Presentation of films.
Saturday	10 April	
	09.00 - 11.00	9th Session (2*, resolutions)
	11.15	Symposium closed
	Afternoon	Visit to avalanche defence constructions in the vicinity of Davos, or free.
Sunday	11 April	
	about 07.30	Excursions to the Engadin (Diavolezza or Piz Corvatsch, see para. 9.3).
	about 18.30	Arrive Davos (direct return to Zürich or Buchs possible, see para. 9.3).

4. TECHNICAL SESSIONS

All sessions will be held in the auditorium of the Forschungsinstitut für Hochgebirgsklima und Medizin, Davos-Platz. If the capacity of the auditorium (90 persons) is exceeded, the sessions will be held in the Rathaus, Davos-Platz. Facilities available for demonstrations: blackboards, projector 5 x 5 cm and 24 x 36 mm, projector 8.5 x 10 cm.

A special evening session is reserved for the presentation of a limited number of films by participants (16 mm with or without sound, or 8 mm). Details about the films should be given on the application form. Papers dealing with the classification of avalanches will be given in the two special sessions.

5. PAPERS

Length: Maximum 12 typewritten pages (about 270 words each), figures and summaries included (a condensed version for oral presentation is advised).

Language: English or French with summaries in both languages.

Form: Two copies ready for print (original photos, drawings in black and white, suitable for reduction).

Address and deadline: The papers should arrive not later than 31 January 1965 at the Swiss Snow and Avalanche Research Institute, 7260 Weissfluhjoch/Davos, Switzerland.

Acceptance: The programme allows for about 34 papers with a maximum time of 35 minutes each, including discussion. Only papers of high quality will be accepted; if too many papers are submitted the screening committee will select the best ones. Acceptance will be notified to authors before 1 March 1965.

Publication: The papers accepted will be mimeographed in Davos and distributed at registration After the Symposium the papers and the discussion will be published by the IASH.

6. SYMPOSIUM OFFICE, TELEPHONE, ADDRESSES, MAIL

The Symposium office is located in the Forschungsinstitut für Hochgebirgsklima und Medizin, Davos-Platz (south entrance).

Hours open:	4 April	13.00 - 24.00
	5 April	08.30 - 12.00, 13.00 - 19.00

On all other days consult the information board at the information board at the auditorium. All persons attending the Symposium are requested to register at the Symposium office as soon as they arrive in Davos.

Address and telephones of the Symposium:

During the Symposium:	International Symposium on Avalanches, 7270 Davos-Platz, Switzerland. Tel. (Symposium office): 083 3.59.37
Before and after the Symposium:	Swiss Federal Institute for Snow and Avalanche Research, 7260 Weissfluhjoch/Davos, Switzerland. Tel. 083 3.55.06

7. ACCOMMODATION

Everyone is strongly advised to make reservations for accommodation in advance by means of the enclosed application form. Hotel reservations will be confirmed.
Hotel prices (price per person per day, including service and taxes):

Full pension	Without bath	With bath
Class A	SFr. 44	SFr. 56
Class B	34	44
Class C	25	33

SFr. 4 is refunded for each principal meal if the hotel is properly informed in advance.

Bed and breakfast	Without bath	With bath
Class D	SFr. 22	SFr. 32
Class E	18	26

The hotel bills are to be paid directly to the hotels.

8. TRANSPORT

Air: Airport Zürich-Kloten. By train or car to Davos-Platz.

Train: From Austria via Buchs-Sargans-Landquart-Davos-Platz.
Germany via Buchs-Sargans-Landquart-Davos-Platz, or Zürich-Landquart-Davos-Platz.
France via Zürich-Landquart-Davos-Platz.
Italy via Thalwil or Zürich, Landquart-Davos-Platz, or St. Moritz-Filisur-Davos-Platz.

Road:	Landquart-Davos	Always open
	Tiefencastel-Davos	Sometimes closed
	Malojapass and Julierpass	Normally open
	Other passes	Closed

9. EXCURSIONS

9.1 Jakobshorn (6 April)

Short mid-day excursion by cable car for lunch at Jakobshorn (peak south of Davos, 8495 ft). Skiing possible. See application form for price.

9.2 Weissfluhjoch (8 April)

Full day excursion by Parsenn railway to Weissfluhjoch (8725 ft) and Weissfluhgipfel (9295 ft). Visit to Swiss Federal Institute for Snow and Avalanche Research. Demonstrations, luncheon. For skiers: descent towards Davos, or return to Davos by Parsenn railway, or guided descent to Klosters. See application form for price.

9.3 Engadin (11 April)

Full day excursion to the Engadin, a famous high valley in south-eastern Switzerland with many interesting avalanche features.
Departure about 07.30, arrive Davos about 18.30, or return direct from the Engadin to Chur with connection to Zürich and Buchs (arr. Chur 18.48).

Two alternative excursions in the Engadin are available:

Diavolezza: By train Davos-Filisur-Albulatunnel-Samedan-Pontresina-Bernina-Suot. Cable car to Diavolezza (9751 ft), surrounded by glaciers of the Bernina range (13,281 ft). Impressive scenery. Excellent skiing. Price without meals about SFr. 23 per person.

Piz Corvatsch: By train Davos-Filisur-Albulatunnel-Samedan-St. Moritz. Cable car from Silvaplana to Piz Corvatsch (11,319 ft). Beautiful alpine scenery (Bernina range 13,281 ft). Bird's-eye view of the Engadin. Excellent skiing. Price without meals about SFr. 30 per person.

The prices given above are calculated for 10 to 25 persons on each excursion, prices will be less with more participants. Please tick tentatively the appropriate spaces on the application form. Final reservations must be made at the Symposium office between 4th and 7th April.

10. SPECIAL EVENTS, WINTERSPORTS, LADIES PROGRAMME

The Banquet on the 8 April is given by the Swiss Government and is the only official social evening. Wives are invited, dress informal.

On the evening of 7 April a few bowling alleys have been reserved.

Skiers: Davos is well known for its many excellent runs for all grades of skiers. At the time of the Symposium most of the runs should still be in good condition. Skiing is possible on several days between the sessions and during the excursions. The Organizing Committee takes no responsibility for accidents during the Symposium and the excursions and, in particular, skiers are advised to make their own arrangements about accident insurance. Skiing equipment, including boots, can be hired in Davos.

Ice skaters: the artificial rink is open.

There will be no special programme for the ladies, but the wives of the members of the organizing committee will be delighted to help the lady visitors enjoy their stay in Davos.

The registration card will entitle one to a discount of about 30% on the following mountain railways during the Symposium:

Davos-Parsennbahnen, Brämabüel-Jakobshorn, Schatzalpbahn, Luftseilbahn-Schatzalp-Strela,

11. WEATHER CONDITIONS

At the beginning of April the snow in the Davos valley is usually in an advanced state of melting. Snow will still be lying on shaded slopes but slopes exposed to the sun are very often free of snow up to 6000 ft. The daily mean temperature at Davos is about 36° F, average daily minimum 19° F and the average sunshine is five hours a day.

Winter conditions still prevail on Weissfluhjoch and in the large skiing areas above 6000 ft. The snow cover on Weissfluhjoch reaches its maximum thickness of 6 to 9 ft at this time of the year. Good footwear and winter clothes are advised.

12. APPLICATION TO ATTEND, REGISTRATION CARD

Each participant should send the attached application form to the Swiss Federal Institute for Snow and Avalanche Research, 7260 Weissfluhjoch/Davos, Switzerland, before 15 November, 1964.

On arrival in Davos the participants will receive their registration card, the Congress papers and tickets for the excursions on payment of the sum mentioned on their application form (including SFr. 10 registration fee).

The registration card will entitle one to the mimeographed scientific papers, admission to the sessions and the official banquet, as well as the discounts mentioned in para. 10. The wives of the participants will also receive a registration card without paying a registration fee but will not receive the mimeographed papers.

H. C. Hoinkes
W. H. Ward
M. de Quervain

September, 1964

Symposium on Scientific Aspects of

Snow and Ice Avalanches

DAVOS, 5 - 10 APRIL, 1965

APPLICATION FORM

Mail before 15 November, 1964 to:

Swiss Federal Institute for Snow and Avalanche Research,

7260 Weissfluhjoch/Davos, Switzerland.

1. PERSONAL

Family name .... Initials ....

Title, profession ....

Address ....

....

Accompanied by ....

2. SCIENTIFIC CONTRIBUTIONS

☐ Paper (deadline 31 January 1965). Title ....

....

☐ Movie film 16 mm, 8 mm

Title .... Length ......(minutes)

3. HOTEL RESERVATION

(number of rooms wanted)

.... single room .... with bath .... without bath

.... double room .... with bath .... without bath

Class .... (A - E, see para. 7)

Date of arrival .... Date of leaving ....

Special needs:

4. SPECIAL ACTIVITIES

4.1 Definite Application

Number	☐	trip to Jakobshorn (6 April)	7.20 SFr.	....
Number	☐	Lunch, Jakobshorn (a)	about 7.50 SFr.	....
Number	☐	trip to Weissfluhgipfel (b) (8 April)	8.40 SFr.	....
Number	☐	Lunch, Weissfluhjoch (a)	about 7.50 SFr.	....
Number	☐	Official Dinner		no charge
Number	1	Registration Card (registration fee)	SFr.	10.
Number	☐	Registration Card (for wife)		no charge
		Total, to pay at registration	SFr.	

4.2 Tentative Application

Number ☐ Excursion to the Engadin

Preferred alternative: Diavolezza ☐ please tick

Piz Corvatsch ☐

Date ....

SIGNATURE ....

a) Price of lunch, service included, without drinks

b) Tickets include train fare for skiers from Klosters back to Davos.

THE SOCIETY'S LIBRARY

Works received for the Society's library since February 1964.
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. (5 items)
Andrews, J.T. (4 items)
Bergen, J.D.
Case, J.B. (2 items)
Crary, A.P.
Dylik, J.
Fristrup, B.
Gold, L.W. (8 items)
Hamelin, L.-E.
Hattersley-Smith, G. (2 items)
Hoinkes, H. (3 items)
Kinzl, H. (5 items)
Koerner, R.M.
Legget, R.F.
Limbert, D.W.S.
Løken, O.
Lorius, C. (2 items)
Magono, C. (8 items)
Miller, M.M.
Ogasahara, K.
Østrem, G. (3 items)
Paschinger, K.
Péwé, T.L. (4 items)
Renaud, A. (2 items)
Rudolph, R. (2 items)
Swithinbank, C.W.M.
Tangborn, W.V.
Tuthill, S.J.
Whittow, J.B.
Williams, G.P.
Wundt, W.

Academiei Republicii Populare Romine (Institutal de Geografie) Roumania (2 items)
Arctic Institute of North America (2 items)
Association Internationale d'Hydrologie Scientifique (2 items)
Centre National de Recherches Polaires de Belgique
Comité National Française des Recherches Antarctiques
Consiglionazionale dell Ricerche, Roma (6 items)
Defence Research Board, Canada (5 items)
Department of Geography, University of Lund, Sweden (10 items)
Department of Mines & Technical Surveys, Geographical Branch, Ottawa
Geographical Institute, University of Freiburg
Geophysical & Polar Research Center, University of Wisconsin (2 items)
IGY World Data Center A: Glaciology (2 items)
Institute of Polar Studies, Ohio State University, (8 items)
Instituto Nacional del Hielo Continental Patagonico, Argentine
Internationale Union für Geodäsie und Geophysik, Wien (4 items)
Norsk Polarinstitutt, Oslo
Polish Cultural Institute (8 items)
Research Society of Lapland
Royal Society of New Zealand
Société Hydrotechnique de France (12 items)
U.S.Army Cold Regions Research and Engineering Laboratory (26 items)
Universidad de los Andes, Venezuela (2 items)
University of Wyoming (3 items)

REVIEW

REBECCA B. MARCUS. THE FIRST BOOK OF GLACIERS. London, Edmund Ward (Publishers) Ltd., 1963. 65 p., illus. 10s.6d.

This book was originally published in 1962 by Franklin Watts Inc., New York. It is intended as an introduction to the subject, and is useful in the teaching of the fundamentals of glaciology. Whilst there are some inexactitudes, mostly in the first half, the concise explanations will incite closer study. The latter half of the book, dealing with the geomorphological aspects of glacial action, is particularly good. There are many good photographs which fittingly illustrate each of the 34 short chapters. A brief glossary of glaciological terms summarises the basic points.

BOOKS RECEIVED

N.N.ZUBOV. Arctic Ice. Translation published by U.S. Navy Electronics Laboratory, 1963 (?), 491 p., illus., 27 cm.

MALCOLM BARNES, ed. The Mountain World. London, George Allen and Unwin Ltd. (Chicago: Rand McNally and Company). (Zürich, Schweizerische Stiftung für Alpine Forschungen). 1964, 240 p., illus., 25 cm. 36/- U.K. $6.95 U.S.A.

SIR ARNOLD LUNN. The Swiss and their mountains. London, George Allen & Unwin Ltd. 1963, 167 p., illus., 22 cm. 25/-.

ANDRE CAILLEUX. Géologie de l'Antarctique. Paris, Société d'Edition d'Enseignement Supérieur (S.E.D.E.S.). 1963, 201 p., 24 cm.

F.E.IAN HAMILTON, ed. Abstract of Papers. 20th International Geographical Congress. London, Thomas Nelson & Sons Ltd. 1964, 361 p., 25 cm.

J.COLEMAN-COOKE. Discovery II in the Antarctic. London, Odhams Press Ltd., 1963. 255 p., illus. 25s.

B.FRISTRUP Indlandsisen. København, Landsdommer V. Gieses, 1963. 240 p., illus.

P.GIŞTESCU. Lacurile din Republica Populara Romına - geneza şi regim hidrologic. Bucuresti, Editura Academiei Republicii Populare Romine, 1963. 277 p., illus.

E.IMHOF, ed. The international yearbook of cartography. III. London, George Philip and Son Ltd., 1963. 230 p., illus., maps. 40s.

R.B.MARCUS. The first book of glaciers. London, Edmund Ward (Publishers) Ltd., 1963. 65 p., illus. 10s.6d.

NEWS

PUBLICATIONS

The Associate Committee on Soil and Snow Mechanics of the National Research Council of Canada has published three small pocket guide books, each measuring about 16.5 x 10 cm, entitled:

Guide to the field description of soils for engineering purposes, 1955.

Guide to the field description of muskeg for engineering purposes, by I.C.MacFarlane, 1957.

Guide to the field description of permafrost for engineering purposes, by I.A.Pihlainen and G.H.Johnston, 1963.

Each booklet is priced at 10 cents.

In addition to their engineering purpose, they should be valuable to anyone investigating these phenomena in the field. For glaciologists the one dealing with permafrost should be of particular interest, giving a first-rate account of what permafrost is and how to investigate permanently frozen ground. Its contents are: What is meant by "permafrost"; basis of the descriptive system; surface and subsurface characteristics; field investigations and records; ice phase descriptive system; terminology; typical data sheets.

The American Geophysical Union, in its Antarctic Research Series, published Volume 2 in August 1964 - clothbound, illustrated, 280 pages, price $12.00, entitled: "Antarctic Snow and Ice Studies". The editor is Malcolm Mellor. The Volume may be ordered from the American Geophysical Union, Suite 506, 1145 19th Street N.W., Washington, D.C., 20036, U.S.A. The contents are:

Densification of snow in Antarctica - K. Kojima.

Firn stratigraphy studies on the Byrd-Whitmore Mountains Traverse, 1962-63 - R.M. Koerner

Structural glaciology of an ice layer in a firn fold, Antarctica - J.R.Reid, Jr.

Distribution of particulate matter in a firn core from Eights Station, Antarctica - L.D Taylor and J.Gliozzi.

Glaciological studies at Wilkes Station, Budd Coast, Antarctica - R. L. Cameron.

Glaciological studies in West Antarctica, 1960-62 - H. Shimizu.

Horizontal strain and absolute movement of the Ross Ice Shelf between Ross Island and Roosevelt Island, Antarctica, 1958-63 - J. H. Zumberge.

Snow accumulation on the Ross Ice Shelf, Antarctica - J. A. Heap and A. S. Rundle.

The Ross Ice Shelf Survey (RISS), 1962-63 - W. Hofmann, E. Dorrer, and K. Nottarp.

The drainage systems of Antarctica: Accumulation - M. B. Giovinetto.

The American Geophysical Union has also published numbers 1-42 of the Information Bulletins of the Soviet Antarctic Expeditions, 1957-63, translated into English. Prices on application to the AGU at the address given above.

Trans-Antarctic Expedition 1955-58. Scientific Reports. This series is appearing at irregular intervals, not necessarily in numerical order, and includes results obtained by both the Weddell Sea and Ross Sea sections of the Expedition. A number of specialists from various countries have contributed to the series, and there are likely to be about 20 reports in all. The following reports of interest to glaciologists are already available and may be obtained from the Secretary of the Trans-Antarctic Expedition, 30 Gillingham Street, London S. W. 1, England.

No. 2 - A gravity traverse of Antarctica. J. G. D. Pratt. 12s. 6d.

No. 3 - Seismic soundings across Antarctica. J. G. D. Pratt. 30s. 0d.

No. 5 - Glaciology: 1. Solid precipitation and drift snow. H. Lister. 30s. 0d.

No. 11 - Geology: 4. Geology of Victoria Land between Mawson and Mulock Glaciers, Antarctica. B. M. Gunn and G. Warren. 60s. 0d.

No. 13 - Meteorology: 1. Shackleton, South ice and the journey across Antarctica. J. J. La Grange. 42s. 0d.

No. 14 - Meteorology: 2. Scott Base, McMurdo Sound. R. W. Balham. (In press.)

ROYAL GEOGRAPHICAL SOCIETY. The following members of the Glaciological Society were elected to the Council of the R. G. S. on 8 June 1964:

Honorary Vice-President - The Right Reverend the Lord Bishop of Norwich, W. L. S. Fleming.

Vice-Presidents - Sir Vivian Fuchs, Sir Raymond Priestley.

Council - Dr. G. C. L. Bertram, Dr. K. S. Sandford.

ALASKA. The effects of the earthquake of 27 March 1964 on the glaciers of the region are already being studied by glaciologists from the University of Alaska, the Glaciological Institute of Michigan State University, the American Geographical Society and the Arctic Institute of North America. One of the first flights over the affected area was made by Troy Péwé, Head of the Department of Geology, University of Alaska. He reports that there was at that time no discernible difference in the glaciers except that the glacier flowing into Lake George had released a few bergs which had frozen into the lake ice. The most interesting feature was the presence at the end of March of elongate holes in the middle part of the glaciers, where snow normally lies for most of the year. These holes were in fact crevasses revealed when the earthquake shook loose the snow bridges which cover the crevasses; the bridges usually last until late summer when the snow thaws and the bridges then fall into the crevasses.

GLACIOLOGICAL INSTITUTE, MICHIGAN STATE UNIVERSITY. This is the fourth year that the Institute has given academic credit to graduate students. The summer research programme on the Juneau Ice Field is again under way, and is continuing the regional survey of Alaskan glaciers begun in 1961.

NEW MEMBERS

New Members of the Society since April 1964 are:

Barnes, David F., U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif., U.S.A.

Barnes, Paul, Gonville and Caius College, Cambridge, England.

Bennett, John M., Meteorology Department, University of Melbourne, Parkville N.2, Victoria, Australia.

Bondy, Richard, 1916 South Washington, Tacoma, Wash., U.S.A.

Budgett, Harvey W., 2508 Ridge Road, Berkeley 9, Calif., U.S.A.

De Long, Stephen E., Department of Geology, Severance Laboratory, Oberlin College, Oberlin, Ohio, U.S.A.

Elder, Clayburn C., 1111 Sunset Blvd., Room 215E, Los Angeles, Calif., U.S.A.

Fukai, Saturo, Pro. Dr. Sci., Toyama University, Japan.

Kinzl, Dr. Hans, Geographisches Institut der Universität Innsbruck, Innrain 52, Austria.

Knapman, Miss Roberta, Homestead, 18 Farm Fields, Sanderstead, Surrey, England.

McLaren, W.A., Department of Meteorology, University of Melbourne, Parkville N.2, Victoria, Australia.

Ogasahara, Kazuo, Pro. Dr. Sci., Toyama University, Japan.

Priebe, Ronald C., 4421 South 168th Street, Seattle 88, Wash., U.S.A.

Shapiro, Lewis H., Department of Geology and Geophysics, University of Minnesota, Minneapolis, Minn., U.S.A.

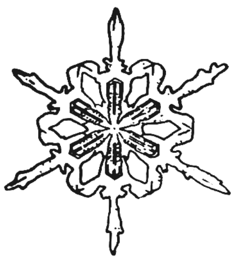
Vessey, John G., St. Luke's College, Exeter, Devon, England.

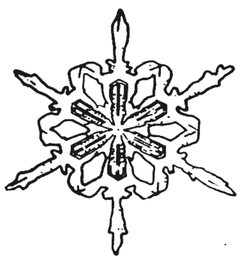
Wagner, W. Philip, Department of Geology and Mineralogy, The University of Michigan, Ann Arbor. Mich., U.S.A.

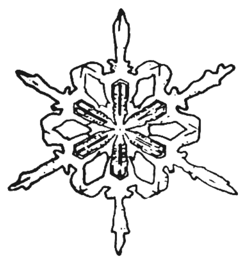
Weller, Gunter, Meteorology Department, University of Melbourne, Melbourne, Victoria, Australia.

Wharton, George B., Quadrangle, Oberlin, Ohio, U.S.A.

Yehle, Lynn A., U.S. Geological Survey, Washington, D.C., U.S.A.







THE GLACIOLOGICAL SOCIETY

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

President: SIR V. FUCHS

Secretary: MRS. H. RICHARDSON

DETAILS OF MEMBERSHIP

Membership is open to all who have scientific, practical or general interest in any aspect of snow and ice study. Members receive the *Journal of Glaciology* free. Forms for enrolment can be obtained from the Secretary. No proposer or seconder is required. Annual subscription rates are as follows, from 1 January 1965:

Private members—	Sterling:	£3 0s. 0d.
	U.S. dollars:	$9.00
Junior members (under 25)	Sterling:	£1 0s. 0d.
	U.S. dollars:	$3.00
Institutions, libraries—	Sterling:	£6 0s. 0d.
	U.S. dollars:	$17.00

(The dollar rates include Bank conversion charges)

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

ICE

Editor: MRS. H. RICHARDSON

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

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