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ICE



INTERNATIONAL GLACIOLOGICAL SOCIETY

1977 SYMPOSIUM

PHYSICS & CHEMISTRY OF ICE
11-16 September, Cambridge, England

The Second Circular was issued to members in August 1976. Extracts are published on pages 11-13 of this issue of ICE. Further copies of the Circular may be obtained from the Secretary of the Society.

1978 SYMPOSIUM

DYNAMICS OF LARGE ICE MASSES
21-25 August, Ottawa, Canada

The First Circular will be sent to members at the beginning of December 1976 and will be printed in ICE 52.

During the previous week, 15-19 August, another symposium will be held in Ottawa, on:
GLACIER BEDS: THE ICE-ROCK INTERFACE

This symposium will be organized by the Sub-Committee on Glaciers of the Canadian National Research Council.

The two 1978 Symposia will be held in Carleton University and are designed to make a useful "pair" of meetings. To assist participants from the east side of the Atlantic, a special tour will be organized by the Society and will be based on London: it will represent very good value and will allow some flexibility in travel after the Symposia. Further details will be announced in due course.

ICE
NEWS BULLETIN OF THE
INTERNATIONAL GLACIOLOGICAL SOCIETY

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1976 DUES. If you have not received numbers 74 and 76 of the Journal of Glaciology and number 50 of ICE, it is because you have not yet paid your dues for this year. Your copies are held in the Society's office and will be mailed to you as soon as we receive payment. Number 74 was the special "bonus" issue for members in good standing: the proceedings of the Symposium on Thermal regime of glaciers and ice sheets. The first normal issue in 1976 (number 75) was sent, in accordance with our usual practice, to all members. But the second normal issue, number 76, was sent only to those members who had paid their dues.

COVER PICTURE. Depth hoar crystal formed in a wind tunnel. Federal Institute for Snow and Avalanche Research, Weissfluhjoch, Davos, Switzerland.

RECENT WORK

POLAND

POLAND

Special systematical investigations on snow cover and hoar frost were continued in 1975.

Meteorological and Climatological Department of Wrocław University made observations from the Mountain Branch Observatory on Mt. Szrenica (Karkonosze Range in Silesia) along different trajectories connecting with the observatory. The programme has been given in previous numbers of ICE. Work was also continued in the region of Mt. Śnieżnik (in middle Sudetes Mountains, Silesia).

State Institute of Meteorology and Water Economy made observations from the Mountain Observatory on Mt. Śnieżka. Avalanches were also studied. The Institute also worked in the West Karkonosze Range; from the Tatra Mountain Observatory on Kasprowy Wierch (2000 m), where avalanches were studied, and in Hala Gasienicowa (Tatra basin).

SPITSBERGEN

Two Polish Expeditions were working here during the 1975 summer.

a) One in SW-Spitsbergen, mainly in the Hornsund region (on behalf of the Geophysical Institute of the Polish Academy of Science in co-operation with Universities, mainly Wrocław University), continued the Polish investigations carried out in the period IGY-IGC 1957-1960, then 1962 and 1970-1975. In the 1975 Expedition were 18 members, under leadership of mgr Ryszard Czajkowski. The Polish Expedition ship reached SW-Spitsbergen on 13 June but the 55 km wide pack ice made the entry into Hornsund Fiord impossible; only on 2 July could the ship enter the Isbjørnhamna, where the main base is located.

The investigations in 1975 ranged from Sørkappland in the South to Torell and Wedel Jarsberg Land in the North. The expedition worked in 6 sections: Geophysics, Paleontology (including Geology), Geomorphology, Oceanology, Climatology-Glaciology, Ornithology and Pedology.

Geophysics: seismic measurements in different parts of glaciers—with greater movement, with many crevasses and without crevasses. This seismometry has given valuable coefficients of differentiated velocity of reflexion seismic waves in glaciers.

Geology: collected rock samples for paleomagnetic investigations in Precambrian, Ordovician, Devonian, Carboniferous, Permian and Triassic. Samples of effusive rocks were

taken from dolomitic veins of the Jurassic-Cretaceous period.

Geomorphology: gravitational slides on the ice cored moraines of Weddel Jarsberg and Sørkapp glaciers; quantitative changes on the surface of marginal moraines, mainly in dead glacier parts; rocky debris movement; genesis and forms of structural soils; thickness of active layers of structural soils.

Oceanography: physico-biooceanological investigations. Two mareographs have been used in Hornsund Fiord. Systematical meteorological and oceanographical observations in Isbjørnhamna were carried out and occasionally in other inlets of Hornsund.

Climatology: continuation of Polish meteorological and glaciological investigations in former years in Hornsund region, and particularly of Werenskiöld Glacier, with automatic registration of temperature, humidity, precipitation, global solar radiation and flow changes of glacier rivers.

b) The other Polish Expedition worked in the summer of 1975 in west Spitsbergen, in the marginal belt of glaciers in the Kapaffiöry region of Oscar II Land (lat. 78°36'N, long 12°E). It was organized jointly by the Turan branch of the Geographical Institute of Polish Academy of Sciences and the Geographical Institute of N. Copernicus University of Torun, with 12 members under leadership of Prof. dr. J. Szupryczyński.

Investigations were concentrated mainly on the foreground of Eliza Glacier and Andreas Glacier, linking with the terrain studied during the Polish investigations of 1938. The programme in 1975 included the following investigations: genesis of ground and ablation moraines, pushed front moraines and icecored moraines. Comparative investigations were carried out on the Waldemar, Irene, Oliver Auvatsmark and Dahl Glaciers; and the isostatic Holocene movements based on marine terraces in Kapaffiöry and on Hermansern Island were studied.

Oceanographic studies in Hornback concerned mainly temperature and salinity along the front of Auvatsmark Glacier and hydrographic studies of the river outwashing from the Waldemar Glacier, considering the relation between glacier ablation and tides. Rich samples of fossil molluscs fauna from isostatically raised beaches and samples of glacial and fluvioglacial sediments were collected for laboratory studies.

A. Kosiba

U.S.S.R.

CAUCASUS

The Institute of Geography, the USSR Academy of Sciences, continued investigations of the Marukh, Bezengy and Kolka glaciers.

MARUKH

Measurements of winter accumulation and summer ablation of the whole glacier surface; studies in pits of infiltration of meltwater and the compaction process of the snow-firn sequence; hydro-chemical studies; reconstruction and fixing of the network of reference points established on the slopes of valleys in 1967; repeated surveys of all the stakes on the glacier; and lysimetric observations (which showed for the first time the relationship between the components of water flow in the firn along the vertical and horizontal axes and the gradient of the glacier surface). These latter results will be significant for the calculation and forecast of the glacial and snow run-off.

A set of experiments was performed with the object of investigating the methods of geographic interpretation of aerospace information about glaciers. The experiments are aimed at establishing the relationship, if any, between the phototone and the albedo of snow and ice surfaces, and at studying the nature of this relationship. The studies were performed on various natural and two artificially-dusted surfaces with the use of terrestrial and helicopter surveys. Preliminary data show the stable relationship between the factors in question and consequently prove that remote studies of the albedo field of the melting surface are possible using space data.

BEZENGY

Meteorological, actinometric and aerial measurements were made in summer of the 12-kilometre longitudinal profile along the glacier axis in order to estimate the influence of glaciers on mesoclimate. It was concluded that the effect of separate mountain glaciers and small glacier sheets is of local importance only.

Other studies were the determination of conditions of debris formation; reconstruction of the historical background of glaciation; the location of moraine complexes, ranges and landmarks, to show the fluctuations of glacier margins; observations of the transport of fragments of ablation moraine; stratigraphic studies below the glacier lake and selection of organic remains for pollen-spore, botanic and radio-carbon analyses from the horizons at the top and the bottom of the moraines; and studies of lichens. The results obtained reveal the dynamics of glaciation in the Bezengy valley during the last 4000 years.

Calculations of mass balance based on data from the northern Caucasus show that the existence of quasi-stationary glaciers in the

piedmonts of the Caucasus was virtually impossible in the Pleistocene. The deposits in the area refer evidently to water-ice mudflows.

KOLKA

The year-long observations of the regime of the surging Kolka glacier were continued.

The Rostov-on-Don Hydrometeorobservatory continued the studies on the Marukh and Bezengy glaciers: surveys of accumulation, ablation and ice movement; meteorological and heat-balance surveys; precipitation observations in the alpine zone of 2000-3100 m (Marukh) and 2000-3500 m (Bezengy); snow surveys; and, on the Bezengy glacier, levelling of the tongue surface. Surveys of the variations of 12 glacier tongues, situated on the northern slope of the main Caucasus range, established the advance of three glaciers (Skazka, Vilpata, Bol'shoy Azau) in 1974/1975, while the rest of the glaciers retreated 3-10 m per year.

The Laboratory on the Problems of Snow Avalanches, Moscow University, continued in the Dzhankuat glacier basin the studies of the constituents of heat, ice and water balances and made repeated photo-theodolite surveys of a small corrie glacier. A map of the Dzhankuat glacier has been compiled using data from the 1974 photo-theodolite survey. During the six years that have passed since the previous survey (autumn 1968) the level of the glacier surface has lowered by an average of 2.5 m. The configuration of its tongue has also changed. Calculations of the Dzhankuat glacier mass balance for 1967-1974 show good agreement with results obtained by glaciological and photo-theodolite methods.

Observations of avalanche and snow-cover formation were carried out in the El'brus area and in the mountains of Adzhariya. Three poles were established in the El'brus area for the studies of the snow-air wave. Forecasts of the direct time of avalanching enabled "propylactic" measures to be taken, thus preventing disastrous avalanches in the areas visited by tourists. Experiments were performed on snow retardation shields, fixed on the slopes of Cheget. Studies were made of snow creep and compaction processes and of regularities of dimensional changes in snow grains during deformation. A map of avalanche danger in the mountains of Adzhariya has been compiled.

Kharkov University studied the Baksan and Aragvi river-basins and the Terek headwaters, including traces of former glaciers and glacial mudflows. Data obtained earlier established that snow-storage and number of days and dates of expected avalanching depend upon the height above sea level. Two classifications were worked out: one of glaciers based on the inter-relation

between the main sources of heat expended on ablation, and one of topographic forms of the glacier surface caused by ablation.

Dendroclimatic studies were continued in the Teberda river-basin. They showed that annual tree accretions are characterized by weak linear connexion (correlation coefficient of 0.2-0.4) and close curvilinear connexion (correlative relation up to 0.94) with meteorological data of the corresponding years. Computer programmes were worked out with correlation formulae and the values of meteorological elements throughout the whole period of tree life since 1674 calculated.

The Institute of Geography, Georgia, carried out investigations on the glaciers of the southern slope of the Central Caucasus. A photo-theodolite survey of the surface of the Yuzhnyy Marukh and Klych glaciers (the Kodory river-basin) was made and surface velocities of glaciers, their vectors, ablation values and positions of glacier lobes determined by geodetic and pseudo-parallax methods. Interpretation of the data shows that the glaciers of the southern slope of the Central Caucasus continue to retreat.

Snow and ice melting was studied on the Tbilisi glacier, including the surface run-off and the values of water balance constituents of the glacial river during the ablation period. Snow surveys were made in the headwaters of the Tbilisi and Bubistkaly rivers (the Riony river-basin), while in the alpine zone of the Tbilisi and Buby glaciers (3500-3600 m) precipitation was measured with the help of totalisers and gradient observations were undertaken. The zone of temperature jump, indicating a change from rocky surface to ice, was determined.

Glaciological studies by the **Transcaucasian Hydrometeorological Institute, Hydrometeorological Services of Azerbaidzhan and Armenia,** embraced the Yuzhnyy, Yugo-Vostochnyy, Tikhitsar and Murkhar glaciers. Velocities of ice, its ablation and fluctuations of glacier tongues were measured. It was established that after the extremely hot weather of 1975 the glaciers changed their positions considerably and supplied rivers with 2-3 times more water than before. The survey of the Aragats mountain has been completed. 28 previously unknown glaciers were mapped; the largest of them has an area of 0.87 km².

CENTRAL ASIA

The Section of Physical Geography of the Academy of Sciences, Kazakhskaya SSR, continued studies of the Zailiyskiy, Dzhungarskiy and Kungey Alatau on 10 glaciers: glacier mass balance and ice movement, the surface level, values of ice and firn compaction; thermo-sounding of the upper sequence of a glacier and meteorological surveys. The data of 1964-1974 showed the relationship between fluctuations of

glacier regime, changes of meteorological factors and circulation of the atmosphere.

Studies of atmospheric precipitation and snow accumulation in the alpine zone were also carried out. New ways of showing instrumental error caused by wind when measuring precipitation have been developed; corrective coefficients applied to different types of precipitation gauges were then calculated, the measured precipitation totals corrected, and the humidity evaluation of the territory given. Regime and amounts of liquid precipitation in the glacial zone of Central Asia were calculated and maps of annual and seasonal totals of precipitation and maximum snow storage compiled. In addition, the norms of precipitation and the maximum snow storage in the glacio-nival zone, and the glacial run-off on the northern slope of the Zailiyskiy Alatau were calculated.

In the Dzhungarskiy Alatau, five glaciers were studied, including snow and photo-theodolite surveys, ablation and ice movement. The mass-exchange on the Shumskiy glacier for 1967-1974, using 1082 reference points, was determined.

Conditions under which snow avalanches occur were studied in the Zailiyskiy and Dzhungarskiy Alatau. Maps of the annual totals of precipitation, mean perennial maximum snow storage and the height of snow cover were compiled. New methods of avalanche-danger mapping were developed, showing not only spatial distribution but also numerical properties, and used to make maps of the Zailiyskiy and Dzhungarskiy Alatau at scales of 1:1 000 000 and 1:300 000. A catalogue of avalanches (more than 800 of them) in the Malaya and Bol'skaya Almatinka river-basins was also compiled, using the same methods.

The Glaciological Laboratory of the Institute of Geology and Geophysics of the Academy of Sciences, Uzbek SSR, studied the regime of glaciers in the Kashkadarya river-basin. In July-August instrument observations of the heat balance constituents, ablation at various surfaces, and the run-off regime, including filtration and meltwater time lag, were made on the Severtsev glacier. In the whole basin, glacial waters constitute 80% of the total run-off in July and August. In drought years the snow cover has virtually disappeared from the glaciers at the beginning of August, and so the melting rate and water yield of the glaciers grow. The occurrence of glaciers at a low level (about 4000 m) is caused by exposure and orographic peculiarities of the Gissarskiy Range.

The Department of Glaciology of the Central Asia Hydrometeorological Institute, continues long-term studies of the Abramov glacier (southern slope of the Alay Range) under the IHD programme. Observations showed the regularities of accumulation and distribution of

precipitation for 1967-1973, gave values for snow and ice melting, depending on radiation regime, and for internal nourishment of the glacier, and helped discover the best methods for calculating heat-fluxes and evaporation in different zones. The perennial regime of the dynamics and run-off was investigated.

A large-scale map of avalanche-prone zones of Central Asia has been compiled. Development work was begun on a set of technical devices for obtaining information from the sources of avalanche formation.

The Institute of Geography, the USSR Academy of Sciences, continued multi-disciplinary studies of the Medvezhiy glacier, including meteorological observations and the melting rate of ice and its filtration properties. Hydrochemical studies showed that the waters of the lake, formed by the glacier-dammed lateral valley, reached the outlet near the glacier lobe in 1.5 hours. The studies of water filtration in the surface level showed that if there were no vertical crevasses the main meltwater run-off came from the melting crust, 10-15 cm thick.

The glacier was surveyed by photo-theodolite in the icefall area from a 600 m-high base, with ends situated on the opposite slopes of the valley. Repeated surveys will determine the rate of ice accumulation below the icefall in the upper part of the glacier lobe: useful information for forecasting the next surge of the glacier.

New methods of calculating the total solar radiation of the glacier surface throughout the ablation period were worked out according to the analysis of heat balance studies from the Medvezhiy glacier and data from the weather station Lednik Fedchenko for 20 years. The values of radiation balance and the layer of melt snow and ice in the ablation area of the glacier were calculated for 1954-1973.

The studies of the east Pamirs produced new data on the morphometry and genesis of alpine lakes the occurrence of aufeis, the dimensions and regime of the Karadzhilga river in the Karakul lake basin. On the Lenin glacier snow accumulation increases with height up to 5100-5200 m a.s.l. These data differ greatly from the existing ideas about the lower level of maximum precipitation.

Palaeographic studies were continued. The data obtained, together with the results of previous studies, showed the sequence of glacioclimatic processes in the mountains of Central Asia in the Late Quaternary period.

The Tadzhik Hydrometeorological Service made observations of the Pamir glaciers variations, in the Obikhingou, Muksu, Zeravshan and Karatag river-basins. They included tacheometric surveys of the glacier lobes and levelling of the glacier surface on one transverse profile. Other observations were made on the Skogach glacier (the northern slope of the Darvaz range)

and the GGP glacier (the northern slope of the Gissar range). They consisted of snow surveys in the firn area, levelling of the glacial surface from three profiles, tacheometric observations of the glacier lobes and meteorological observations. Velocities of these glaciers and ablation on transverse profiles were determined. The glaciers of the Surkhob river-basin were studied for ice velocities, and for surveys of the tongues and surface levelling in their central parts.

The Tien-Shan Station of the Academy of Sciences, Kirgizskaya SSR began all-the-year-round observations of the Karabatkak glacier (the northern slope of Terskey Alatau). During the cold period observations of accumulation and redistribution of snow, and changes in the structure of the snow sequence were carried out. Pronounced dependence of the changes in snow storage along longitudinal profiles on the absolute height of the glacial basin was revealed. By the end of the accumulation period the maximum snow storage made up 300-400 mm on the glacier tongue and 500-900 mm in the firn area. In winter, water run-off occurred on the glacier lobe and reached 0.02 m³/sec.

In the warm period, glaciological, hydrological and meteorological surveys were made, including surveys of all the glacier surface and repeated photo-theodolite surveys. Depending on pollution conditions, gradient and exposure, the value of melting on the glacier tongue varied from 153 to 204 cm with a mean value of 182 cm. In 1975, the snow limit reached to 3850 m a.s.l., which exceeded the minimum level of 1957 by 250 m. At 3600 m the value of summer melting did not exceed 40-60 cm.

Routine studies of a large group of Terskey Alatau glaciers were made with the aim of determining their changes since the IGY. It was found that the Dzheruy glacier (Aksay river-basin) is stationary, while the Kolker Vostochniy and Aksu glaciers shrank by 88 m and 152 m, respectively, during the last 20 years.

The Kirgiz Hydrometeorological Service worked on the Golubin glacier (the northern slope of the Kirgiz range) and established that the glacier continues its insignificant advance, with an increase in surface level of its tongue of 5-8 m. During the ablation period, the value of melted ice equalled on average 2500 mm water equivalent. The most intense melting took place in July and was caused by high air temperatures. In 1974-1975 ablation generally prevailed over accumulation.

Surveys of the lobes of three glaciers and the levelling of their longitudinal and transverse profiles were carried out on the northern slope of Kungey Alatau. The Aksu-Zapadniy glacier, which advanced abruptly in 1971-1973, reduced its speed of advance considerably: in 1975 it advanced 25 m only. Its total advance from September 1971 up to September 1975 was

445 m in length with an area of 100 000 m². The Aksu-Vostochniy glacier retreated 45 m during the period under survey. The rate of its retreat was nearly twice that of 1974. The Dolonata glacier continues to retreat with the same speed of 25 m per year, and its area decreases 8000-10 000 m² annually.

ALTAY

Tomsk University continued the studies of the mountain glacier Aktru basin and fulfilled routine observations in the Katun river-basin and the Bish-Irdu mountains. The main observations were made on the Maliy Aktru glacier and the station "Uchitel" and comprised meteorological, aerological, actinometric and gradient surveys, and also surveys of hydrometric sections. Between 2240 m and 3300 m a.s.l. pits were dug, snow surveys made and the following measurements undertaken: accumulation, ice velocity, firn sequence and structure, and the altitude of the seasonal snow limit. Radio echo sounding and thermo-drilling of the glacier were completed down to a depth of 15 m. A chain of temperature sensors was fixed, which revealed that at a depth of 6-7 m ice temperature drops to -3°C, and then at a depth of 11-15 m rises to -1°C.

Ablation surveys with the help of a couple of stakes, one of them screened with a sun blind, providing separate registration of melting factors, showed that 86 cm of ice melted due to direct solar radiation. The value of melted ice near the unscreened stake was 222 cm. The meteorological conditions of 1975 were close to the mean perennial conditions. The glaciers continue to retreat. During 1974/1975 the Maliy Aktru glacier lost 560 000 tons, which corresponded to the mean loss of 160 mm water equivalent (the mean annual value for 20 years makes up 135 mm). The annual volume of the run-off made up 5.6 million m³ and was slightly higher than the mean perennial run-off.

The studies in the Bish-Irdu mountains and Kurayskiy range were carried out with the goal of evaluating the validity of the data obtained on the Aktru glacier. Palaeoglaciological observations were continued in the valleys of the Central Altay to help delineate the boundaries of the former Altay glaciation.

The Geographical Institute of Siberia and the Far East studied the processes of debris formation on small glaciers in the Bish-Irdu mountains.

The Section of Geography of the Academy of Sciences, Kazakhskaya SSR, continued the studies on the glaciers of the Berel river-basin: heat and radiation balances, hydrological properties of the alpine zone of Altay, and changes in the surface height, velocity and ablation of the Bolshoy, Maliy Berel'skiy, and Popovich glaciers.

MOUNTAINS OF CENTRAL AND EAST SIBERIA

The Geographical Institute of Siberia and the Far East continued studies of the snow cover at stations in the Minusinsk basin. Large-scale snow surveys on polygons and a snow survey profile on the northern slope of Zapadniy Sayan were carried out in the period of maximum snow storage, and also experiments on snow retardation by tree crowns.

Studies of aufeis, snow avalanches and mudflows in the Kodaro-Udokanskaya mountain system were carried out in the zone of the main Baykal-Amur line, and showed that these phenomena are well-pronounced in every valley and are dangerous. The pattern of aufeis zonation at the Lena-Amur interfluvium and abutting areas was worked out and some of the problems of forecasting aufeis processes were solved. The first numerical data were obtained on silt accumulation in aufeis and the melting rate of ice lenses in frost mounds.

The Novosibirsk Institute of Railway Transport tested avalanche-retardation shields and made snow avalanche studies in Kuznetskiy Alatau.

POLAR URALS

The Institute of Geography, the USSR Academy of Sciences, continued the studies of the mountain-glacier basin of the Bol'skaya Khadata river. Observations of surges were carried out on the Obruchev and IGAN glaciers. Other studies included snow surveys at the end of the accumulation period, photo-theodolite and geodetic surveys, melting of the glacier surface (measured with the help of ropes and pits throughout the ablation period), heat balance surveys on the Obruchev glacier, and ice deformation (measured in a 40 m long tunnel driven through the glacier). A set of experiments was performed with the aim of determining how the albedo field could be studied by remote sensing, in particular according to space images. Terrestrial and helicopter surveys of ten differently contaminated snow plots were used in the experiments.

The studies of glacial morphogenesis and the historical background of the Polar Urals glaciation have been completed.

KAMCHATKA AND SAKHALIN

The Institute of Volcanology, the USSR Academy of Sciences, carried out studies of the present-day glaciation in areas of active volcanism. The main work was concentrated on the Kozel'skiy glacier (the Avachinskaya group of volcanoes), where a set of hydrometric, glaciological and geophysics studies was made. In the period of maximum snow accumulation, snow surveys were undertaken and the winter balance calculated; it averaged 454 g/cm² for the glacier. In pits, at the absolute heights of 850, 1200 and

1800 m, the structure of the snow-firn sequence was observed and ice temperatures measured. Seismic and gravimetric surveys were made along longitudinal and transverse profiles.

Big values are typical of glacier melting here, measured at 30 stakes on longitudinal and transverse profiles from the accumulation area down to the glacier tongue. Near the firn line the melted layer equalled 5-6 m, and at the tongue 7-10 m. At the end of melting, the summer balance was found, in crevasses and pits, to average 78 g/cm² for the whole glacier. Observations of the water discharge in the Kozel'skiy stream showed that the maximum flood occurs from the second half of August to the middle of September. Fluctuations of the water level in the stream are essential, with the maximum discharge 4 m³/sec. The stream run-off continues in winter, when it measures 50% of the mean summer run-off.

These studies gave a mass balance of the Kozel'skiy glacier for 1973/74 of +190 g/cm² and for 1974/75 of 54 g/cm² (it was the first one to be calculated in the Avachinskaya group of volcanoes). On the basis of meteorological data at the Petropavlovsk station the mass balance of this glacier was reconstructed for 1929/30-1972/73: it turned out to be mainly negative.

Routine observations of the occurrence of snow-drift glaciers and glaciers in the north-western area of the Avachinskaya group (Aag and Arik volcanoes) were made in the second half of August. Snow-drift glaciers occur here at a height of 400-500 m, higher than in the south-eastern area. The glaciers have smaller dimensions and, as a rule, are corrie type. In the Kluchevskaya group of volcanoes, the surface of the surging Bilchenok glacier has been lowered by 60-80 m since 1964, and partial melting of ice down to the bedrock was revealed.

Novosibirsk Institute of Railway Transport continued the studies of dynamics of artificial avalanches along a 100 m long avalanche trough in south Sakhalin, and also of snow drifts and their mechanism, with regard to high wind velocities.

ARCTIC

The Institute of Geography, the USSR Academy of Sciences, studied Spitsbergen glaciers from May to September. Radio soundings of 15 mountain glaciers from helicopter and by ground transport were made in the region of continuous Z-indication. On one of the glaciers, a 211 m deep borehole was drilled down to the bedrock with the help of new equipment for cold-ice drilling. Ice cores were sampled at all the depths. An automatic record of drilling was obtained, to help define some details of the structure of the ice cover. The water-ice balance of some glaciers was determined, including the glaciers used for

supplying water to the Soviet mines Barentsburg and Pyramiden. Several surging glaciers were detected.

The Arctic and Antarctic Institute continued investigations of the regime of the Severnaya Zemlya glaciers from data obtained by the glaciological station, established in 1974. Terrestrial and aerial radio echo soundings of subglacial bedrock embraced about half of the glacial cover of the archipelago. An estimation of the mean thickness and storage of ice in the glaciers was made from these data. On the Vavilov dome, temperature regimes within the firn-glacial, the glacial and the ablation areas were investigated. The thickness of the active layer makes up 18 m, with an ice temperature at its bottom of -11.8°C. Glaciogeomorphological studies were made in the periglacial zone of the Ostrov Oktyabr'skoy Revolyutsii, where new accumulation forms of glacial relief were discovered.

ANTARCTICA

The studies under the International Antarctic Glaciological Project (IAGP) were continued. **The Institute of Geography of the USSR Academy of Sciences together with the Arctic and Antarctic Institute** completed isotope-oxygen studies of ice cores down to a depth of 950 m, obtained from the Vostok borehole. The isotope profile obtained covers 46 500 years. Interchanges of several colder and warmer periods with temperature differences up to 3°C were revealed in its lower part against the general background of the cold Pleistocene. The isotope shift, determined between 15 and 11 thousand years ago, equals 5‰ and is totally caused by 5° warming at the verge of the Late Pleistocene and Holocene. Comparison of the profile obtained and similar profiles from Camp Century station and from Greenland shows that the basic temperature changes in the polar areas of both the hemispheres occurred synchronously during the last 50 000 years.

The Soviet Antarctic Expedition made radio echo soundings on the route Mirny-Vostok 1, and snow survey and meteorological observations. A 105 m deep borehole with a selection of continuous core was drilled at the Vostok 1 station and two boreholes were drilled on the Lazarev ice shelf. One of these reached to the rocky ground at 374 m depth; in the area of the other borehole the 357 m thick glacier appeared to be floating.

In connexion with the joint Soviet-American studies on the heat flux of the earth, **the Institute of Geography of the USSR Academy of Sciences** completed, in the summer 1974/75, five sinkings of a Soviet-design gradiometer in different areas of McMurdo Sound, through craters in fast ice. Observations showed that glacial sediments in the sea are very hard: the sensor of one thermo-

gradiometer did not penetrate below 10 m anywhere. The geothermic heat flux was measured in the dry valleys; in Lake Vanda it equalled $3 \cdot 10^{-6}$ cal/cm² sec.

As a result of joint efforts by American and Soviet scientists, studies in the area of Beaufort, Franklin and Inexpressible islands proved that the last glacierization of West Antarctica, coinciding with the Würm glaciation of the Northern hemisphere, covered the Ross Sea up to the outer fringe of the continental shelf, and then shrank considerably.

Theoretical calculations of the dynamics and thermal regime along the flow line from Vostok station to the Beardmore outlet glacier were carried out.

Other glaciological research completed in 1975 included construction of theories and models for various aspects of the subject. Further details may be obtained from the compiler of this report, at the Institute of Geography, Academy of Sciences USSR, Staromonetny 29, Moscow 109017, USSR.

V. M. Kotlyakov

UNITED KINGDOM

CANADA

A three-man team (M. E. R. Walford, R. G. Oakberg and P. C. Holdorf) from the H. H. Wills Physics Laboratory, Bristol University spent five weeks during May-June 1976 on the Devon Island Ice Cap in the Canadian North-West Territories. Field trials and measurements were made with a new Phase-Sensitive Radio Echo Sounding equipment developed with the financial support of a National Environment Research Council Research Grant. Excellent field support was provided by the Canadian Polar Continental Shelf Project. The main objective of the work was to measure both the amplitude and phase of radio echoes returned from the bed of the ice cap. This was successfully carried out in the vicinity of a Borehole Station located near the crest of the ice cap. Careful impedance-matching, calibration and other ancillary measurements essential to the proper interpretation of the results were made. The sites were carefully surveyed both by radio echo sounder and theodolite and various markers were buried in the snow. It is intended that this will enable a second visit to be made to the same sites after a few years which will yield information about the rate of movement and of thickening or thinning of the Ice Cap.

In addition the new observation was made that radio echoes from the bed contain many dislocations of the type previously observed in pulsed wave trains in the laboratory. These are likely to be useful in enabling us to relocate the experimental sites precisely in future years. Also it was noted that one can detect echoes using a receiving antenna oriented at right angles to the transmitting antenna and that this depolarized signal is of the order of 10 dB down on the usual signal.

We hope that techniques can be developed for synthesizing amplitude-phase information from a network of closely-spaced radio-echo sites. This would introduce into radio-glaciology some of the benefits of using sideways-looking radar, aperture synthesis and holographic techniques which are at present in use in more conventional radar methods.

M. E. R. Walford

ICELAND

This interim report describes the new techniques used during the first year of a joint Iceland University—Cambridge University two-year project to develop radio-echo depth-sounding apparatus suitable for the difficult conditions of temperate ice, on the Vatnajökull ice-cap. Following reports of work by R. D. Watts et alia the Cambridge group designed and built an apparatus in the UK during December 1975—June 1976. The equipment was brought to Iceland on 15 June and taken on to Vatnajökull for the period 19 June—13 July by the joint universities group, assisted by members of the Icelandic Glaciological Society and others. Snowmobiles Jökull I and Jaki were provided respectively by that Society and the Iceland Power Company. Logistics for the period 15 June—19 July were arranged by the Icelandic group.

The Vatnajökull expedition divided into two periods. The first was used for setting up the apparatus, the party camping on Tungnaarjökull at about 18°00'W, 64°20'N (20 June—5 July). Then the expedition moved to the Grimsfjall hut for dynamic testing over ice of varying thickness in the Grimsvötn area (6 July—11 July). The Tungnaarjökull period was broken by a 5-day retreat to the Jökullheimar hut during bad weather. This time was spent making useful modifications to the equipment.

The echo-sounding technique involved the use of an approximately rectangular, 200 nS, 1.25 kW pulse of voltage applied to a broad-band 30 m long resistively loaded dipole antenna. The rock-bed echo pulse was picked up by a similar, adjacent antenna and displayed, via a video amplifier, on a battery operated oscilloscope. The signals were photographically recorded. Both spot measurements and continuous recordings of the ice-depth were successfully made at the two locations and correlated with a simultaneous geodetic survey. Reflections from the ice-water interface of the Grimsvötn subglacial lake were studied and the thickness of the ice cover determined as 220 m. The greatest ice depth recorded was 400 m, using an antenna configuration consisting of a 30 m balanced trans-

mitting dipole and a 15 m monopole receiving antenna reflected into the towing vehicle. The measurement was made at a time of considerable broadcast interference. This depth limitation was not established until the homeward run to Jökulheimar. Greater ice-depth penetration could no doubt have been obtained with the full 30 m balanced receiving array at times of less broadcast interference. However, it may also be necessary to employ a longer transmitter antenna and higher transmitter power to achieve the required penetration for the Vatnajökull. Thus there appears to be sufficient data to determine the optimum characteristics of the equipment for a full-scale expedition in 1977.

The Expedition wishes to acknowledge financial assistance from the Science Fund of Iceland, The Royal Society of London and Trinity College, Cambridge. The Expedition is also grateful to the Iceland Power Company for assistance with transport on the glacier and the

University of Cambridge Department of Engineering for providing facilities in the 9 months prior to the expedition.

Iceland University:

Helgi Björnsson
Karl Grönvold
Aevar Johannesson
Jon Petursson
Eggert Briem

Cambridge University:

Keith Miller
Ron Ferrari
Geraint Owen

Icelandic Glaciological Society:

Carl Eiriksson
Hörthur Hafliðason
Ólafur Nielsen
Ingibjörg Árnadóttir

Iceland Power Company:

Hannes Haraldsson
Ásbjörn Eiríksson

U.S.A.

COLORADO AVALANCHE WARNINGS

Real-time avalanche warnings are being issued for the mountainous areas of Colorado again during the 1975-76 winter. This is a joint effort of the National Weather Service and the U.S. Forest Service. Weather and avalanche data are collected by a number of observers scattered over the State and are telephoned to avalanche forecasters at the Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colorado. When conditions warrant, an avalanche warning is prepared by the forecasters and released via Weather Service teletype circuits to the press, radio and television.

Emphasis is placed on alerting the public to widespread conditions of instability, especially in ski touring and mountaineering areas of the State. Avalanche conditions on "lift-served" ski areas are evaluated and control action is taken by ski area personnel. As of 30 January 1976 over 20 avalanche statements or warnings had been issued for Colorado. Many of these warnings applied to only part of the mountainous half of the State. On the average, the warnings were in effect for only a few days. This service has been well received by the press and the public and appears to be serving a true need.

M. Martinelli

BILL BUDD

Shearing sheep, harvesting wheat and measuring ice movement would appear to be an unlikely sequence of activities. Add to it an early education in a small bush school (12 pupils, all grades) and a Ph.D on the dynamics of ice masses and we have an intriguing picture of William F. Budd's background. Born in October 1938 in Mount Hope, New South Wales, Australia, he first attended the local school and then went to the Primary and High Schools at Griffith, N.S.W. He won an Education Department Scholarship to Sydney University in 1956 and spent three years there studying for a basic science degree. He majored in mathematics and completed his time at the University by taking the Diploma of Education. It was in the vacations from 1956 to 1959 that he took jobs as a shearing shed hand, a wheat farm labourer and a surveyor's assistant, and also completed National Service Training in the Army Infantry Corps. In 1960 Bill took a job as teacher of mathematics and science at a High School in Farer, N.S.W., but left at the end of the year to join the Antarctic Division (Department of External Affairs) in Melbourne. He was appointed Glaciologist at Wilkes Station for the Australian National Antarctic Research Expedition 1961, and began expedition preparation and post-graduate training in glaciology at the Department of Meteorology, University of Melbourne, under Dr Fritz Loewe and Dr Uwe Radok.



Bill's work at Wilkes, from December 1960 to March 1962, included studies of climatology, snow drift, properties of the ice sheet, snow accumulation and densification, surface topography, ice thickness, temperature depth profiles, ice movement and strain rates. On his return to Melbourne he spent the next 21 months analysing the data from Wilkes at the Meteorology Department and completing work for an M.Sc. degree. In addition to taking advanced training in meteorology, geophysics, glaciology, applied mathematics, computer programming, rheology, dislocation and creep, heat conduction, mechanics of media and optical crystallography, he planned long-term glaciological programmes for Wilkes and Mawson stations (the Wilkes Ice Cap Project and the Amery Ice Shelf Project) with Uwe Radok and the Antarctic Division.

From January 1964 to March 1965 Bill was Expedition Glaciologist at Mawson, working on climatology, ice ablation, snow drift and accumulation, and, for the Amery Ice Shelf Project, on velocities, strain rates, temperatures, accumulation, elevation, ice thickness (radar), and dynamics. On his return to Melbourne in March 1965, he worked for the Antarctic Division at the Meteorology Department, analysing Antarctic measurements and jointly planning and supervising ANARE glaciological programmes with Uwe Radok. It was at this time that he

began work on his Ph.D., which he completed in 1968, on the dynamics of ice masses. He travelled to New Zealand, to make a brief study of glaciers in the Mount Cook region of New Zealand, working with Ian McKellar on the Tasman Glacier in 1965. The next year he visited Japan, for two conferences, and in 1968 undertook a four-month tour of about 20 centres of glaciological research in North America and Europe, and also visited research sites in Greenland and the Canadian Arctic.

It was also in 1968 that Bill was appointed to a full-time position with the Antarctic Division supervising their glaciology programmes for the Amery Ice Shelf and Wilkes station. Other work included an Antarctic Map Folio project, studies on stress-strain analyses, glacier sliding and surging, periodic glacier variations, the velocity of glaciers in relation to their dimensions, numerical modelling and radio ice thickness sounding. He gave a regular annual lecture course in glaciology at Melbourne University and supervised the work there of post-graduate students. Visits to other parts of the world for workshops, conferences, and visiting professorships have broadened his experience of work in many countries. He was awarded the Edgworth David

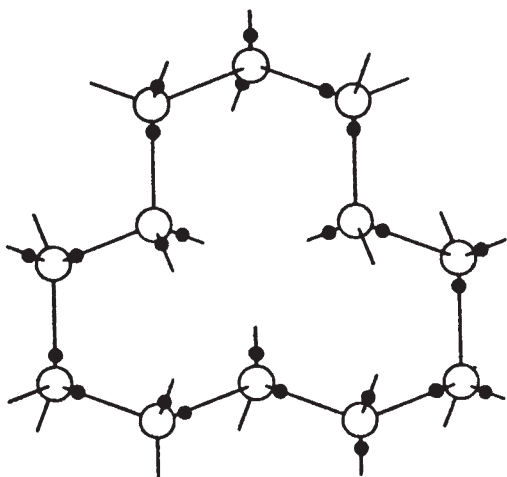
Medal for his achievements in glaciological studies in 1971.

In great demand for service on various councils, committees and advisory bodies in Australia, Bill has also served on the Council of the International Glaciological Society and on other international organizations such as the International Commission on Polar Meteorology and the Scientific Committee on Antarctic Research. His cheery presence always makes him a welcome participant. His enthusiasm for the central theme of his work: How does a large ice mass behave in real space and time? has resulted in the creation and strengthening of a group of colleagues and students searching for the answers. Their search has taken them into the physics of glacier deformation, crystallography, sliding, and surging; snow drift and evaporation from the Antarctic ice sheet; thermodynamics, isotopes, and climatic change reflected in ice cores; sea ice and temperature anomalies in the southern ocean. Whatever its final outcome, it seems already clear that the search is producing a *corpus opera* which need not shrink from comparisons with those of Bill's most illustrious predecessors and contemporaries.

INTERNATIONAL GLACIOLOGICAL SOCIETY

SYMPOSIUM ON PHYSICS AND CHEMISTRY OF ICE

Cambridge, England. 11-16 September 1977



The Second Circular was published in August 1976 and was sent to all members of the Society and to several other addresses. Copies may be obtained from the Secretary of the Society, Lensfield Road, Cambridge CB2 1ER, England. We print here some extracts from the Circular.

TOPICS

The symposium will be concerned with the fundamental physics and chemistry of ice in all its solid phases, including the clathrate hydrates. It is anticipated that the following topics will be included: molecular orbital theory, crystallography, thermodynamics of the pure phases and of phase transformations, the vitreous state and glass transitions, molecular vibrations, defects and impurities in ice, effects on electrical and mechanical properties, nuclear and electron magnetic resonance, effects resulting from irradiation, dislocations in ice, surface properties, etc. A number of speakers will be invited to give review papers on recent work in the area of the Symposium and some allied areas of interest.

ACCOMMODATION

Block reservations have been made in Colleges and some hotels.

Colleges: single rooms are available for men and women aged 18 and over, at approximately £9.00 per day for room, all meals and service. (Married couples will be allocated neighbouring rooms.) Although rooms with private bathrooms are not available in colleges, the food and wines are superb.

Hotels: approximate prices per day: Single room (without bath) and breakfast £8.25. Double room (without bath) and breakfast (2 people) £13.75. Single room (without bath) and all meals £13.00. Double room (without bath) and all meals (2 people) £23.50. Extra for private bath per day £2.75. There may be a few rooms available in small second-class hotels for bed and breakfast £4.00-£5.00.

Deposits for accommodation:

A £10 deposit per person must be paid when booking for any of the above accommodation. This deposit is returnable if notice of cancellation reaches the Secretary before 11 August 1977.

If participants prefer to make their own arrangements for accommodation, please indicate this on the booking form; no deposit will then be required by the Society. Last date for registration and accommodation bookings: 1 July 1977.

PAPERS

(i) SUBMISSION OF PAPERS

Those participants who would like to contribute to the Symposium should first submit a summary of their proposed paper in English; this summary should contain sufficient detail to enable the Papers Committee to form a judgement on the likely merit of the proposed paper, but should not exceed three pages of typescript. Summaries must be submitted on paper of international size A4 (210 x 297 mm) with wide margins and double spaced lines.

**Last date for submission of summaries
11 January 1977**

(ii) SELECTION OF PAPERS

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account scientific quality and relevance to the themes of the Symposium. The Papers Committee will then invite a strictly limited number of papers for presentation in English and thorough discussion at the Symposium (not necessarily confining themselves to authors who have submitted summaries). It is hoped to notify authors of papers during April 1977.

(iii) DISTRIBUTION OF SUMMARIES

The summaries of the accepted papers will be distributed by mail to all participants before the Symposium.

(iv) SUBMISSION OF FINAL PAPERS AND PUBLICATION

The Proceedings will appear in the Society's *Journal of Glaciology*. Papers presented at the Symposium will be considered for publication in these Proceedings, provided they have not been submitted for publication elsewhere. Final typescripts of these papers should be submitted to the Secretary of the International Glaciological Society by 1 August 1977. They should be written in English and prepared in accordance with the instructions for preparation of papers for the *Journal of Glaciology* to be found inside the back cover of the Journal. Fuller details will be sent to authors with the notification of acceptance of the papers for the Symposium. **The maximum length for papers will be 5000 words or the equivalent length including any illustrations.** The papers will be refereed according to the usual standards of the *Journal of Glaciology* before being accepted for publication. The Society can normally publish proceedings within one year after a Symposium, provided authors co-operate as indicated above.

**Last date for submission of final papers
1 August 1977**

Registration, Accommodation
SYMPOSIUM ON
PHYSICS & CHEMISTRY OF ICE
11-16 September 1977

Mail to:
Secretary, International Glaciological Society,
Cambridge CB2 1ER, England
See reverse of this form for methods of making
payment BEFORE 1 JULY 1977

A REGISTRATION FORM
(please type or print in black ink)

Name of participant
Title
Address

Accompanied by (indicate age if under 18)

Name

Name

I send registration fee/s as follows:

(i) Participants£20 each.....

(ii) Junior members£10 each.....

(iii) Accompanying
persons £5 each.....

(There is no registration fee for accompanying
persons under the age of 18.)

TOTAL REGISTRATION FEE/S =£.....

METHODS OF MAKING PAYMENT

By cheque payable to: International Glaciological
Society Symposium, and sent to:
Secretary, International Glaciological
Society, Cambridge CB2 1ER, England.

By Bank transfer to: International Glaciological
Society Symposium, Account No.
54775302, and sent to National West-
minster Bank Ltd., 56 St. Andrew's
Street, Cambridge CB2 3DA, England.

By Giro transfer to: Post Office Account No.
240 4052.

B ACCOMMODATION FORM

Please reserve the following accommodation for
the nights of 11-16 September 1977, for which I
enclose a deposit of £10 per person. (Arrival on
11 September, departure on 17 September.)

(i) Colleges (single rooms only):

.....room/s

(ii) Hotels:

(a)single room/sdouble room/s

(b)breakfast or.....all meals

(c)with bathroom orwithout
bathroom

(iii) Small second-class hotel (if available):

..... single room/s (with breakfast)

(iv) Own arrangements (delete if not applicable):

I prefer to make my own arrangements:

(No deposit required)

TOTAL DEPOSITS

FOR ACCOMMODATION =£.....

SYMPOSIUM DINNER

I hope to attend the Dinner and will wish to
reserve tickets. (Payment to be
made at time of arrival in Cambridge.)

TOTAL PAYMENT (sections A, B)
(sent by Cheque/Bank transfer/Giro transfer)
=£.....

BRANCH NEWS

BRITISH BRANCH

The 1976 meeting of the British Branch was held in Bristol on 5 April. After the morning session, which was devoted mainly to glacial hydrology, we had lunch with our hosts, the Glaciology Group of Bristol University, then returned to a full programme of papers on a wide range of topics:

D. N. Collins:

Observations on the draining of the Gornersee, Gorner Glacier, Switzerland.

M. G. C. Reap:

Some aspects of the hydrology of a small glacial catchment.

J. F. Nye:

Water flow in glaciers: jökulhlaups, tunnels and veins.

I. S. Evans:

Glacier and cirque aspects.

R. W. Whitworth, J. G. Paren and J. W. Glen:

The velocity of dislocations in ice, a theory based on proton disorder.

J. Paren:

Dielectric relaxation times in snow.

C. F. Bohren:

Why are crevasses blue?

C. S. M. Doake:

Some geophysical consequences of ice ages.

P. Wadlams:

Sea ice topography in the coastal zone of the Beaufort Sea.

D. J. Goodman:

Strain in sea ice and near the Argentière Glacier, France

G. S. Boulton and E. M. Morris:

Measurements of stress at the bed of the Argentière Glacier, France.

During a short branch meeting the president, John Glen, explained the constitution. The vice-president, Hal Lister, received the news that he will automatically become president next year with fortitude and the secretary, Liz Morris, successfully appealed for funds. Next year's meeting will be in Cambridge at the same time as the spring meeting of the International Glaciological Society.

WESTERN ALPINE BRANCH

The Branch held its 1975 meeting in Barcelonnette, France, during the period 3-6 October. The meeting was organized by F. Valla and G. Bocquet, and attracted 60 participants. One day was spent on the presentation of papers on rock glaciers, buried ice, active or fossil, and glacial meteorology. On the other two days, rock glaciers and periglacial features were studied in the field, in the Massif du Chambeyron. This year, the meeting publicised the activities of members of the Branch by holding on two

evenings an exhibition and technical films on snow and ice studies in the mountains, with contributions from members.

At the business meeting, François Valla was elected President 1975-76, Gerard Bocquet Secretary/Treasurer 1975-76, and André Roch Vice-President 1975-76. The 1976 meeting will be organized by André Roch in the Massif de la Bernina, and will concentrate on problems of the snow cover.

NORTHEAST NORTH AMERICAN BRANCH

The 1977 meeting will take place on February 11 and 12 in the Physics Building, McGill University, Montreal, Canada.

JOURNAL OF GLACIOLOGY

The following papers have been accepted for publication in forthcoming issues of the Journal of Glaciology:

M. J. Bovis:

Statistical forecasting of snow avalanches, San Juan Mountains, Southern Colorado.

G. Bocquet and J. C. Ricq:

Instruments and methods: Measurement of ice movement in subglacial cavities: a new cavitometer beneath the Glacier d'Argentière.

T. E. Osterkamp:

Instruments and methods: A method for cutting and preparing thin sections of frozen soil.

H. W. Posamentier:

A new climatic model for glacier behaviour of the eastern Alps of Austria.

W. F. Weeks, P. Sellmann and W. J. Campbell:

Interesting features of radar imagery of ice-covered north-slope lakes.

C. R. Bentley:

Electrical resistivity measurements on the Ross Ice Shelf.

A. C. Wager and A. W. Jamieson:

Energy exchange at a glacier surface: an alternative to aerodynamic methods of measurement.

J. W. Clough:

Radio-echo-sounding reflections from internal layers in ice sheets.

L. W. Morland and E. M. Morris:

Stress in an elastic bedrock hump due to glacier flow.

J. R. Addison:

Impurity concentration in sea ice.

J. Weertman:

Penetration depth of closely spaced water-free crevasses.

S. Hastenrath:

Pleistocene mountain glaciation in Ethiopia.

S. C. Porter:

Present and past glaciation threshold in the Cascade Range, Washington, USA: topographic and climatic controls, and paleoclimatic implications.

R. V. Birnie:

A snow-bank push mechanism for the formulation of some "annual" moraine ridges.

N-A. Möner:

Southward displacement of the distribution of glaciation during the three maxima of the Last Ice Age.

Short notes

W. H. Mathews:

Relocation of buried markers.

M. D. Coon and R. J. Evans:

On wind induced cracking of sea-ice sheets.

R. V. Dietrich:

Wind erosion by snow.

C. C. Bradley, R. Brown and T. R. Williams:

On depth hoar and the strength of snow.

RECENT MEETINGS (of other organizations)

1975 Forest Service Avalanche School

The US Forest Service National Avalanche School was held in Reno, Nevada from November 10 to 14 1975. This was the fourth such school in the past 5 years. Attendance was limited to 160 students even though more than twice that many applications were received. This phase of the Avalanche School consisted of a week-long series of lectures, workshops, and seminars on the entire subject of avalanches.

The seven major topics covered were: meteorological fundamentals, the mountain snowpack, avalanche phenomenon, stability evaluation, avalanche control fundamentals, safe winter travel in mountain terrain, and avalanche rescue. These topics were each covered by a 1-hour lecture plus an additional hour spent in small group discussions or workshops. In addition, about 20 electives were offered on a broad range of topics that included advanced snow physics, safety in helicopter skiing, advanced stability

evaluation, dogs in avalanche rescue work, hand explosives and military weapons for avalanche control, and avalanche zoning.

Instructors were mostly from the US Forest Service, National Ski Patrol, universities, independent consultants, National Research Council of Canada, and Environment Canada. Students were from the various federal agencies, several of the military services, the National Ski Patrol System, ski area patrolmen, guide services, mining companies, private consultants, highway departments, sheriffs departments and several mountaineering clubs.

In addition to the School, several field seminars and "on-site" training sessions were held later in the winter. These field sessions stressed field applications and illustrations of many of the points discussed in the previous classroom work.

University of Nebraska—Lincoln

The following meetings were held in 1976. Further information may be obtained from Dr J. W. Clough, Science Director, Ross Ice Shelf Project, 135 Bancroft Hall, University of Nebraska-Lincoln, Lincoln, Nebraska 68588, USA.

March 2—**Seminar on Marine Ice Sheets**, with presentations by R. Rutherford, G. Denton, T. Hughes and R. Thomas.

March 1-5—**Symposium on Arctic and Alpine Environments**, with presentations by:

John W. Clough—"The RISP Project and geophysical surveys of the Ross Ice Shelf"

Robert H. Thomas—"Ice shelves: What can we learn from them?"

Peter W. Birkeland—"Use of pedological technique in the interpretation of alpine Pleistocene deposits"

Samuel B. Treves—"Dry Valley Drilling Project, Antarctica: stratigraphic and climatic implications"

W. J. Wayne—"Comparison of patterned ground characteristics on Southampton Island, N.W.T. and the Northern Front Range, Colorado"

Colloquium on Water in planetary regoliths

For the purpose of assessing the occurrence, detection and measurement of water in the planetary bodies of the solar system, a Colloquium on Water in Planetary Regoliths was held in Hanover, New Hampshire, U.S.A., on October 5, 6 and 7, with sessions on three topics: the relevant aspects of terrestrial water; the probable status of water on planetary bodies; the methods of water detection and measurement in planetary exploration.

The colloquium was co-sponsored by NASA's Planetology office, the American Geophysical

Union Task Force on Soil Water Problems in Cold Regions and the National Academy of Sciences Committee on Permafrost. Conveners of the sessions were the Department of Earth Sciences at Dartmouth College and the U.S. Army Cold Regions Research and Engineering Laboratory.

Further information may be obtained from the Colloquium Organizing Committee, Earth Sciences Department, Dartmouth College, Hanover, N H 03755, USA.

The Second Annual William T. Pecora Memorial Symposium

This Symposium on Mapping with remote sensing data was held in Sioux Falls, South Dakota, USA, on October 25-29, 1976. It was sponsored jointly by the American Society of

Photogrammetry and the U.S. Geological Survey. For more information write to:

Dr Robert B. McEwen, U.S. Geological Survey, National Center, 510, Reston, VA 22092, USA.

FUTURE MEETINGS (of other organizations)

SYMPOSIUM ON DYNAMICS OF TEMPERATE GLACIERS AND RELATED PROBLEMS

Munich, Germany, 6-9 September 1977

The European Geophysical Society will hold its 1977 annual assembly in MUNICH, a city where, since the time of Sebastian Finsterwalder, people have been interested in mountain glacier dynamics. It will be opportune to take this occasion to have a symposium on this subject, and on any related question which may allow young European glaciologists to express themselves. Papers on the following subjects are requested:

a) Techniques of photogrammetry, geophysical exploration, drilling or dating when applied to mountain glaciers, or rock glaciers or recent (post-Würm) moraines.

b) Stratigraphy, fabrics, temperatures and chemistry of temperate or partially temperate glaciers.

c) Water within and under glaciers. Glacier sliding. Disasters related to glaciers.

d) Creep of ice. Strain rates of temperate glaciers or rock glaciers.

e) Relations between mass balance, heat balance, meso-scale climate and weather type (Grosswetterlagen).

f) Relation between mass balance and mountain glacier fluctuation. Geometrical, statistical and mechanical models for temperate glaciers.

If you are interested in presenting a paper, further information may be obtained from Prof. L. Lliboutry, Laboratoire de Glaciologie, 2 rue Très-Cloîtres, 38031 Grenoble cedex, France. The deadline for extended abstracts is 31 January 1977.

GLACIOLOGICAL DIARY

1977

11-12 February

Northeast North American Branch of IGS, Montreal, Canada. (P. Langleben, Department of Physics, McGill University, 809 Sherbrooke St. W., Montreal, P.Q., Canada H3A 2K6.)

27-28 April

Annual Conference & General Assembly of IGS, Cambridge, England.

16-18 May

Canadian Symposium on Remote Sensing, Quebec City, P.Q., Canada. (J. Kruus, Canada Centre for Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario K1A 0E4, Canada.)

16-24 August

International Union for Quaternary Research, 10th Congress, Birmingham, England. Sponsored by the Royal Society. (Dr J. W. Jardine, Dept. of Geology, University of Glasgow, Glasgow G12 8QQ, U.K.)

22-27 August

3rd Symposium on Antarctic Geology and Geophysics, Madison, Wisconsin, USA. Sponsored by Scientific Committee on Antarctic Research, Int. Union of Geological Sciences, & Inter-Union Commission on Geodynamics. Organized by US National Research Council (Polar Research Board of U.S. National Committee for SCAR). (Dr C. Craddock, Dept. of Geology and Geophysics, University of Wisconsin, Madison, WI 53706, USA.)

4-9 September

Symposium on Sea ice — processes and models, Seattle, Washington, USA. Joint AIDJEX and ICSI symposium. (M. Mellor, Secretary ICSI, CRREL, Hanover, NH 03755, USA.)

6-9 September

Symposium on Dynamics of temperate glaciers and related problems, Munich, Germany. European Geophysical Society. (L. Lliboutry, Laboratoire de Glaciologie, 2 rue Très-Cloîtres, 38031 Grenoble cedex, France.) (See above.)

11-16 September

Symposium on Physics and chemistry of ice, Cambridge, England. International Glaciological Society. (Mrs H. Richardson, Secretary, International Glaciological Society, Cambridge CB2 1ER, England.)

21-26 September (probable date)

Conference on Condensation and ice nuclei, Galway, Ireland. International Commission on Cloud Physics and Commission on Atmospheric Chemistry and Global Pollution (both of Int. Ass. of Met. and Atmos. Physics). (A.F. Roddy, Department of Physics, University College, Galway, Ireland.)

1978

10–13 July

Third International Conference on Permafrost, Edmonton, Alberta, Canada. National Research Council of Canada. (M. K. Ward, c/o National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada.)

15–19 August

Symposium on Glacier beds: the ice-rock interface, Ottawa, Canada. Sub-

Committee on Glaciers of the Canadian National Research Council.

21–25 August

Symposium on Dynamics of large ice masses, Ottawa, Ontario, Canada. International Glaciological Society. (Mrs H. Richardson, Secretary, Cambridge CB2 1ER, England.)

REVIEW

Scotland. J. B. Sissons. 150 pp.

Northern England. Cuchlaine A. M. King. 213 pp. In *The geomorphology of the British Isles* (General editors Eric H. Brown and Keith Clayton), Methuen, 1976. Hardback £4.50. Paperback £2.00.

These are the first of a new series on the regional geomorphology of the British Isles. The series is intended as a synthesis of the sometimes bewildering flood of detailed research findings by "... the establishment of more general concepts into which this detail will fit ...". Particular stress is laid on the elucidation of the historical background to the present, especially the Quaternary period. Both books stress the evolution of the landscape in their respective regions and describe the influence of rocks and structure on relief, Tertiary landform evolution, the effects and chronology of glaciation, the role of periglaciation and the nature and results of relative sea level fluctuations since glaciation.

J. B. Sissons' book on Scotland is impressive. It is packed full of information and is a stimulating synthesis of the findings of a wide body of literature over more than a century. The book is a more concise and up to date version of the author's *The evolution of Scotland's scenery*, published in 1967. The main changes are in the glacial section and perhaps the most important new conclusion is that there is now little evidence for any major readvance of the ice sheet during the main phase of withdrawal from Scotland. Thus we may mourn the passing of readvances associated with such names as Aberdeen, Lammermuir, Dinnet and Perth. But the Loch Lomond (Zone III) resurgence goes from strength to strength and represents a dramatic environmental setback which may have had clear effects on coastal and fluvial landforms as well as on glaciers and periglaciation.

C. A. M. King's book on Northern England is tackled in a different way. It is designed to appeal mostly to someone with knowledge of the area or to students with access to large-scale maps of the area. The book lays stress on sub-regional case studies which are often used to

illustrate divergences of opinion between different researchers. An important feature is that there is consideration of current process/form relationships, for example in relation to karst, periglaciation and coasts. The latter section includes some remarkable examples of rates of coastal change induced by man-made interference.

One impression gained by this reviewer may be of particular interest to glaciologists. Any reader must be impressed by the tremendous effort expended by fieldworkers over the years in elucidating the dynamics and climatic relationships of the last ice sheet during its withdrawal from the country—i.e. during a period of non-equilibrium. In contrast to this much available glaciological theory utilised in the literature is concerned with steady-state ice sheets and one suspects that it may not always be appropriate in a non-equilibrium situation. Perhaps major advances in understanding would accompany a more theoretical and glaciological approach to some of the non-equilibrium problems discussed in these books. One might mention such problems as the role of Scandinavian ice during the last glaciation, the possibility of widespread ice sheet stagnation, the amplitude of climatic fluctuations necessary to cause and maintain ice sheet withdrawal, and ice characteristics (morphology, thermal regime, velocity) at various stages of deglaciation. Theoretical contributions in these fields could utilise an already existing body of detailed field evidence.

In summary it is good to be able to recommend the relatively low cost of the paperback edition of the books, a feature which will be especially attractive to the intended market—students. One successful cost-saving device is the use of an unjustified right-hand margin. This reviewer did not notice it until reading the last chapter of the first book. Another and more dubious device is the exclusion of all photographs. This surely restricts the appeal of the book to those already well-versed in geomorphology?

David Sugden

NEWS

AWARDS

Two Past Presidents of the International Glaciological Society have recently been made Fellows of the Royal Society:

Sir Vivian Fuchs for furtherance of science in Antarctica over a period of 26 years.

Dr John F. Nye for his contributions to the physics of crystals, particularly to the understanding of the flow of ice and the mechanics of glaciers.

Dr Elton Pounder has been elected a Fellow of the Royal Society of Canada in recognition of his contributions in physics, and especially in sea ice research.

Dr Johannes Weertman has been elected a member of the US National Academy of

Engineering—one of the highest professional honours—for his contributions and research on deformation of materials at high temperatures and strain rates, on fatigue of metals and on the flow behaviour of hot rock in the earth's mantle.

Dr Brian Roberts has been awarded the Founder's Medal of the Royal Geographical Society for polar exploration and contributions to Antarctic research and political negotiation.

Dr J. N. Jennings has been awarded the Victoria Medal of the Royal Geographical Society for contributions to geomorphology and geographical research.

Dr Keith Miller has received the Back Award of the Royal Geographical Society for explorations in Greenland and improvement of field instruments.

ARCTIC INSTITUTE OF NORTH AMERICA

(Extracts from the Summer 1976 issue of *Information North*)

The Arctic Institute of North America is now settled in its new home in the University Library Tower on the University of Calgary campus. Thanks to the University, the Institute operates within modern and spacious quarters and

enjoys, from the 11th floor, one of Calgary's best views West to the Rockies.

Since 5 March 1976, date of the official opening of the Calgary headquarters, the Institute's library has been open to members, the general public and students interested in any aspect of northern research.

ICE MODEL BASIN

With its Ice Model Basin the Hamburgische Schiffbau-Versuchsanstalt GMBH has established new standards for testing in ice.

The automated freezing system can keep any temperature between 0° and -20°C within 1°. The ice thickness is practically constant over the entire tank, the deviations from the mean are less than ±0.5 millimeters. In order to reduce the crystal size and to obtain uniform crystal structure and ice strength the formation of the ice cover is initiated by a special water-spray-method.

In a special research programme the relationship between the flexural strength of ice and its elasticity on the one hand and salinity and temperature on the other hand was investigated. This resulted in the development of a method

to produce model ice, for which both strength and elasticity are properly scaled.

Beside testing of ice breaking ships, the Ice Model Basin is increasingly occupied by tests for the investigation and optimization of fixed and floating offshore structures designed for operation in ice.

With its new material-testing-machine the HSVA carries out basic studies on the mechanical properties of ice in accordance with newly established international standards.

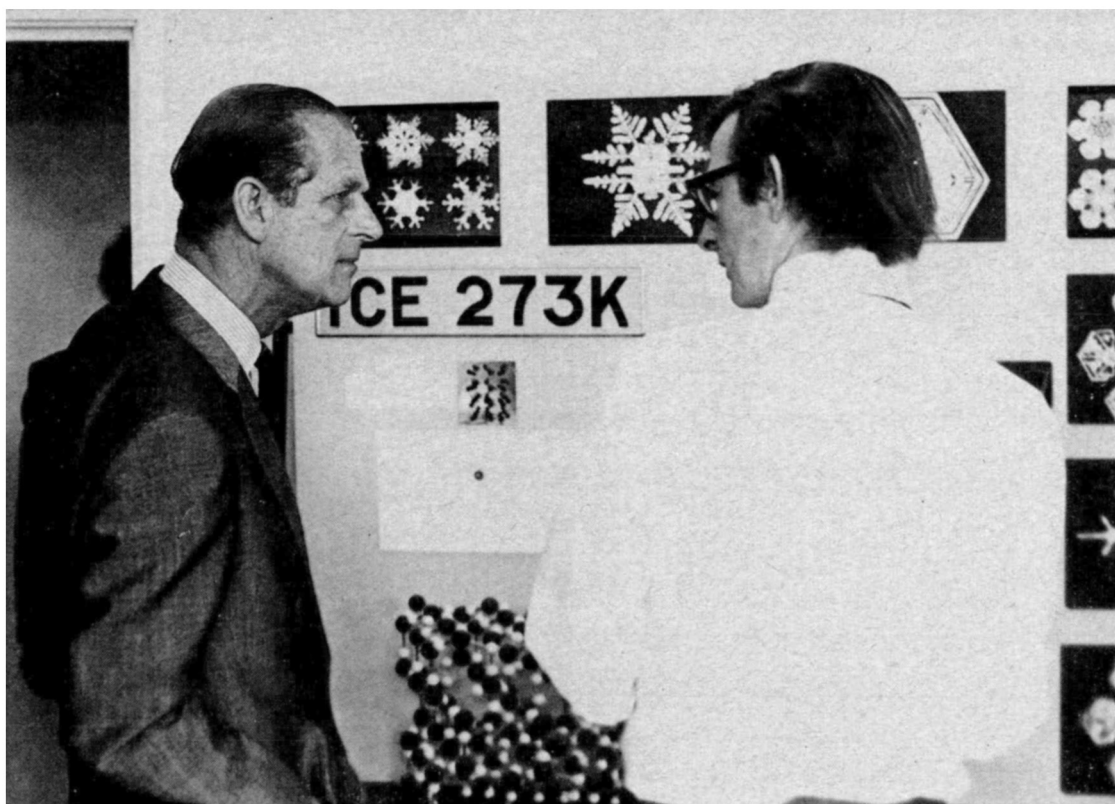
HSVA is also engaged in full scale measurements in polar regions. The experience from this activity is an important basis for solving scaling problems.

The Head of the Ice Division is Dr-Ing Joachim Schwarz.

BRITISH ANTARCTIC SURVEY

The British Antarctic Survey building in Cambridge was formally opened on 7 May 1976 by His Royal Highness the Prince Philip, Duke of Edinburgh. About 150 people work in the building, many of whom have been working for the Survey in places as far apart as Birmingham and Edinburgh, and points between. The Survey, a component body of the U.K. Natural Environment Research Council, is responsible for British scientific activities in British Antarctic Territory and the Falkland Islands Dependencies, comprising a total area of 660,000 square miles.

Five permanent bases are maintained and are manned throughout the year. There are also three minor bases used for summer operations and transit to the field. The Administration Division controls the logistics, including two ships (one of 6,000 tons, one of 1,500 tons), two aircraft and various types of land transport. The scientific divisions have laboratory and storage space in the new building, which has brought everyone together for the first time in the Survey's 33 years of existence.



HRH the Duke of Edinburgh talks with Julian Paren about some of the glaciological exhibits at the opening of the British Antarctic Survey building in Cambridge, 7 May 1976.
(Photograph by courtesy of Cambridge Evening News)

US PERMAFROST COMMITTEE

With the investigation for petroleum in northern Alaska and Canada, the standard problems caused by permafrost have been supplemented by a relatively new phenomenon, sub-sea or offshore permafrost. The U.S. National Academy of Sciences, in recognition of the growing importance of all permafrost research has established a Permafrost Committee of the Polar

Research Board. The Committee is very active and several publications have appeared as a result of their efforts. The photograph marks the inauguration of the Committee. Troy L. Péwé, Chairman of the Committee, reports also that a group of interested scientists from China visited Canada last year and were shown permafrost features by Roger Brown and his colleagues.



COMMITTEE ON PERMAFROST of the POLAR RESEARCH BOARD

U.S. National Academy of Sciences

Front row—William M. Sackinger, Hans O. Jahns, Troy L. Péwé (Chairman), A. Lincoln Washburn (Honorary Member), John R. Kiely, Louis De Goes (Secretary), *Back row*—Oscar J. Ferrians, Leslie A. Viereck, George Gryc, Samuel I. Outcalt, Jerry Brown, Roger J. E. Brown, Duwayne M. Anderson, Arthur H. Lachenbruch.

Photograph taken at the first formal meeting, held at U.S. Geological Survey, Menlo Park, California, in January 1976.

PUBLICATIONS

Scientific Committee on Antarctic Research

SCAR is disposing of the remaining stocks of some of its earlier publications and is therefore offering these for sale at a reduced price.

	Old price	Sale price inc. postage (surface mail) and packing
<i>Antarctic Oceanography + free supplement of Ice and Water Masses</i>	£2.25	£1.20
<i>International Symposium on Antarctic Glaciological Exploration (ISAGE)</i>	£4.20	£2.00
<i>Antarctic Telecommunications</i>	£4.20	£2.00

Obtainable from: Scientific Committee on Antarctic Research, Scott Polar Research Institute, Lensfield Road, Cambridge CB2 1ER, England.

Glaciological Notes

Beginning October 1976, the Institute of Arctic and Alpine Research (*INSTAAR*) of the University of Colorado will be responsible for the operation of the World Data Center-A, Glaciology in conjunction with the Environmental Data Service of NOAA, Boulder, Colorado.

We, therefore, ask our users to direct their inquiries pertaining to subscriptions and exchange of *Glaciological Notes* to Dr Roger G. Barry at the following address:

INSTAAR
University of Colorado
Boulder, CO, USA 80309

Ice Core Drilling

Edited by JOHN F. SPLETTSTOESSER

Fifteen papers presented at an Ice-Core Drilling Symposium at the University of Nebraska-Lincoln in 1974 and one added later comprise this unique volume, representing the combined drilling experience by ten countries in Antarctica, Greenland, Arctic Canada, Iceland and other areas of the world. Several drilling methods are evaluated, and previously unpub-

lished drill descriptions and field experiences are included. Virtually any technical problem that can be encountered in ice drilling is discussed.

Further information may be obtained from: University of Nebraska Press, 901, North 17th Street, Lincoln, Nebraska 68588, USA.

Editerra

EDITERRA is the European Association of Earth Science Editors and one of its main activities to date has been the consideration of draft chapters for an Editors' Handbook to assist editors in their work. The present plan is for the Handbook to

be issued in loose-leaf form and the first chapters are due to be published very soon. Dr J. W. Glen, Senior Editor of the Journal of Glaciology, has been appointed Secretary of the Handbook Committee.

Glaciers and Landscape

A Geomorphological Approach

David E. Sugden and Brian S. John

A study of glacial processes and forms. Not only do the authors provide a creative and critical synthesis of recent research, but they also propose significant modifications to accepted theory and approach. In each chapter they introduce and explain models and hypotheses as an aid to understanding and a stimulus to inquiry. Fundamental data are given from a wide range of sources, with particular attention to current work in Greenland and Antarctica. The book is profusely illustrated with figures and photographs specially prepared and closely integrated with the text. A comprehensive bibliography contains over 1000 major references.

Cloth £12.00 Paper £5.95

Glacial Geomorphology

Clifford Embleton and Cuchlaine A. M. King

Glacial landforms and the processes of erosion and deposition associated with them are fully discussed, taking account of recent advances in glaciological research. The authors indicate directions for future study and research.

Cloth £17.90 Paper £8.95

Periglacial Geomorphology

Clifford Embleton and Cuchlaine A. M. King

Opening with a general survey of the periglacial environment, the authors go on to discuss frozen ground, patterned ground, the part played by snow, periglacial mass-movement phenomena, cryoplanation and wind action.

Cloth £8.95 Paper £4.50



Edward Arnold

25 Hill Street, London W1X 8LL

NEW MEMBERS

Edoo, Ashmead, 50 Vistabella Road, San-Fernando, Trinidad, West Indies.

Faure, P., Faculté des Sciences et des Techniques, B.P. 143, 73011 Chambéry cedex, France.

Gallie, T. M., Department of Geography, 270 OSH, University of Utah, Salt Lake City, UT 84112, USA.

Gunning, A. M., 386 Banbury Road, Oxford, U.K.

May, Dr R. W., Department of Geology, University of Alberta, Edmonton, Alberta T6G 2E3, Canada.

Morey, Dr R., Geophysical Survey Systems Inc., 217 Middlesex Turnpike, Burlington, MA 01803, USA.

Morris, C. E., "Nord-Land-Skog", Skyline Drive, Boise, ID 83702, USA.

Mulder, J. L., Department of Biological Sciences, University of Southern California, University Park, Los Angeles, CA 90007, USA.

Newman, W. A., Department of Earth Sciences, Northeastern University, Boston, MA 02115, USA.

Ödberg, Dr Lars, Department of Physical Chemistry, Royal Institute of Technology, S 100 44 Stockholm, Sweden.

Ralston, T. D., Exxon Production Research Co., P.O. Box 2189, Houston, TX 77001, USA.

Shade, J. S., Beit Hall, Prince Consort Road, London SW7, U.K.

Stein, R. S., Department of Geology, Stanford University, Stanford, CA 94305, USA.

Tann, John, P.O. Box 271, Ringwood, Victoria 3134, Australia.

Ueli, Spring, Dipl. Bauing ETH, Schulhaus, CH 3126 Kaudorf, Switzerland.



INTERNATIONAL GLACIOLOGICAL SOCIETY

Cambridge CB2 1ER, England

DETAILS OF MEMBERSHIP

Membership is open to all individuals who have scientific, practical or general interest in any aspect of snow and ice study. Payment covers purchase of the *Journal of Glaciology and Ice*. Forms for enrolment can be obtained from the Secretary. No proposer or seconder is required. Annual payments 1976:

Private members	Sterling:	£10.00
Junior members	Sterling:	£4.00 (under 25)
Institutions, libraries	Sterling:	£10.00 for Volume 16 (Number 74) £20.00 for Volume 17 (Nos. 75, 76, 77)

Note—Payments from countries other than Britain should be calculated at the exchange rate in force at the time of payment. If you pay by bank draft, rather than by personal cheque, please ensure that sufficient money is included to cover the bank charges of £0.50p per cheque. Thank you.

I C E

Editor: Hilda Richardson

This news bulletin is issued to members of the International Glaciological Society and is published three times a year. Contributions should be sent to Mrs H. Richardson, International Glaciological Society, Cambridge CB2 1ER, England.

Annual cost for libraries, &c, and for individuals who are not members of the Society:
Sterling £3.00

