# NUMBER 43

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# INTERNATIONAL GLACIOLOGICAL SOCIETY

## **MEETINGS 1974**

15-21 September—Symposium on Remote Sensing in Glaciology, Cambridge, England. (The First Circular was issued to members in May 1973 and was published in ICE Number 41.)

Details may be obtained from the Secretary of the Society.

1974 Annual General Meeting of the Society will be held during the week of the Symposium, in Cambridge.

## **BRANCH MEETINGS 1974**

26 March-British Branch one-day meeting in Birmingham.

26-30 August-Nordic Branch meeting in West Norway.

6-8 September-Western Alpine Branch meeting in Italy.

(See pages 10, 11, 12, 15 of this issue of ICE for news of Branch activities.)

# ICE

# NEWS BULLETIN OF THE

# INTERNATIONAL GLACIOLOGICAL SOCIETY

## 3rd ISSUE 1973

## NUMBER 43

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1974 DUES. These should be paid in January 1974. Your prompt attention to the reminder notice that we mailed to you at the beginning of December 1973 will not only ensure that there is no interruption to your supply of Journals, but will save the Society money: in 1973 we spent £80 in postage and secretarial time sending reminders to those members who had not paid on time. There are still 70 members who have not paid for 1973, even after three reminders: mainly members in the U.S.A.

COVER PICTURE. Winter sun and shadow, by Norma Gray, Etna Village, New Hampshire 03750, U.S.A.

## **RECENT WORK**

## SWEDEN

The following table shows the main results of the routine studies during 1971-72 and 1972-73. Further information is given in the two graphs, printed on page

# MASS BALANCE STUDIES ON STORGLACIÄREN

	1972	1973
Beginning of ablation season	21 May	20 May
End of ablation season	15 Sept	14 Sept
Total winter balance in m <sup>3</sup> of water	4.31.10	5.18. 106
Total winter balance in g/cm <sup>2</sup>	139	167
Total summer balance in m <sup>3</sup> of water	7.55. 106	5.0 <b>3.</b> 10 <sup>6</sup>
Total summer balance in g/cm <sup>2</sup>	243	162
Net balance in m <sup>3</sup> of water	-3.27. 10 <sup>6</sup>	+0.15.106
Net balance in g/cm <sup>2</sup>	-104	+5
Height of equilibrium line	1550m	1490m

			Average retreat of glacier fronts in metres		
			71/72		72/73
Salajekna	67° 08′	16° 27′	3		
Hyllglaciären	67° 41′	17° 21′		12	
Årjep Ruotesjekna	67° 26′	17° 30'	13		27
Suottas-jekna	67° 27′	17° 39'	12		22
Vartas-jekna	67° 21′	17° 41′	~6		10
Mikkajekna	67° 24′	17° 42′	13		26
Pårtejekna	67° 10′	17° 43′			
Ruopsokjekna	67° 21′	17° 59′	14		27
Riukojietna	68° 05′	18° 05′	$\sim 6$		
Kårsajökeln	68° 22′	18° 21′	7		
Stuor-Räita glaciären	67° 58′	18° 23′	<u> </u>		
Västra Påssus	68° 04′	18° 24′	20		
Östra Påssus	68° 04′	18° 25′	20		
Rabots glaciär	67°55′	18° 27′	7		
Unna Räita glaciären	67° 59'	18° 27′	12		
Kuototjåkka glaciären	68° 09′	18° 34′			
Isfallsglaciären	67° 55′	18° 35′	5		3
Storglaciären	67° 54′	18° 36′	8		0

	lce and water balances of the Tarfala catchment area Total area 20.6 km², glacier area 6.3 km²		
	All figures	in million m <sup>3</sup>	
	1971/72	1972/73*	
Winter balance	14.3	17.7	
Rain during abl. season	12.1	8.3	
Glacier deficit	6.6	0.3	
		<u> </u>	
Total input	33.0	25.7	
Run-off	34.6	27	
Evaporation	?	?	
Total output	35	27+	

\*Preliminary data

V. Schytt

#### ANNUAL SURVEY OF GLACIERS

The observations collected by various agencies and individuals have been assembled for the Swiss Glacier Commission by P. Kasser and M. Aellen (Laboratory for Hydraulic Research, Hydrology and Glaciology at ETH, Zürich). Indications are that the mass balance was strongly negative in 1970-71, while it was slightly negative on the north slope and slightly positive on the south slope of the Swiss Alps in 1971-72, a year when accumulation and ablation were both well below average. In 1971-72 close to 40% of the observed snouts were advancing. The observation of accumulation on the Jungfraujoch ice cap and the strain-rate measurements at the terminus of Steinlimmigletscher were continued under the supervision of R. Haefeli (Swiss Glacier Commission).

#### SWISS GLACIER INVENTORY

(F. Müller, T. Caflisch and G. Müller, Department of Geography, ETH, Zurich) In accordance with the UNESCO/IAHS recommendations a Swiss glacier inventory was started in 1972. This inventory, which attempts to cover the status of all Swiss glaciers of a certain year, supplements the periodic observations of tongue activities of selected glaciers made by the Swiss Glacier Commission. The basic data for the inventory is obtained from new air photographs analysed in a stereo plotting instrument (PG 2).

Due to early snow on most of the glaciers in the late summer of 1972, the extensive flight programme for the determination of the height of the snowline by governmental surveys, army and private institutions could only be carried out in part. Fieldwork by the ETH team and information from numerous private people was used to find the best date for the aerial photography and to observe the shifting snowline before and after the flight. In spite of the unfavourable weather conditions it was possible to start with the inventory in SW Valais (without height of snowline). In 1973 a similar flight programme as in 1972 is planned in order to determine the height of the snowline.

With the help of the inventory it is hoped to make a contribution to the understanding of the old problem of the interaction between glacier and climate.

#### GLACIOLOGICAL RESEARCH AND CONSULTING BY THE LABORATORY FOR HYDRAULIC RESEARCH, HYDRO-LOGY AND GLACIOLOGY AT ETH, ZURICH

(P. Kasser, M. Aellen, A. Iken, H. Lang, H. Röthlisberger)

Near the tongue of the Grosser Aletschgletscher an automatic weather station has been installed and operated. In addition to the regular mass balance programme, a seismic reflection survey was carried out on Ewigschneefeld, a high alpine névé field. Excellent results were obtained by lowering the geophones and explosive charges below the water table some 15-30 m below the surface. With the aim of investigating subglacial water pressure, a hydrothermal ice drill has been developed. First tests have shown that it is possible to drill holes of 200 m or more in a few hours, using the open circuit hot water system. A visiting student of civil engineering from Britain (J. Bishop) has carried out experiments in relation to the bearing capacity of lake ice when the load is distributed along a line (people on ice).

The consulting work has mainly been connected with dangerous situations. In one case further advice was given about an ice dammed lake which had caused floods until an ice tunnel was dug in late 1970. The tunnel prevented further floods, but in order to avoid the erratic subglacial drainage altogether, an "Armco" (corrugated steel) tube was lowered into the ground moraine below the ice tunnel in 1972. Interesting results on ice temperatures and the blocking mechanism in the natural subglacial drainage channel, by a combination of ice flow, ground motion and freezing, were obtained. Investigations on the advance of the glacier du Giétro, and the possibility of a flood in the valley, in the event of an ice avalanche into the storage lake of Mauvoisin, were continued. Hydraulic model studies have shown that much larger avalanches than expected would be needed to stir up dangerous waves in the near or very likely even in the more distant future (surging phenomena are monitored by a glacier-flow recorder as reported before). In the fall of 1972 investigations on a critical development on a hanging glacier above the town of Randa were started. In this case as in the above mentioned wave modelling studies the Institute of Snow and Avalanche Research at Davos has participated (B. Salm).

#### HYDROLOGICAL TEST BASIN DISCHMA — INSTITUTE OF SNOW AND AVALANCHE RESEARCH, DAVOS-WEISSFLUHJOCH

#### (M. de Quervain, J. Martinec)

As part of the hydrological programme the development and melting of the snow pack and the mass balance of Scaletta glacier have been investigated. Repeated aerial photographs have been used beside the measurements on the ground at various test sites, and isotope studies were carried out. An automatic weather station has been installed.

#### GAS CONTENT AND ISOTOPE ANALYSES — LOW LEVEL COUNTING AND NUCLEAR GEOPHYSICS, UNIVERSITY OF BERN

(H. Oeschger, B. Stauffer, P. Bucher, H. Rufli)

As part of a joint project with U.S. and Danish agencies in South Greenland (Dye 3) the Swiss group has in 1971 extracted C14, Ar39 and Si32 for dating from various depths in a drill hole by in situ melting of large amounts of ice (3000-5000 kg). Some water samples were filtered in order to collect terrestrial and cosmic dust. A similar programme was carried out in the Antarctic summer of 1971/72 at Byrd Station. The C14 dates agree with the estimates at a given depth. Isotope studies were carried out on cores from the Jungfraujoch ice cap (tritium, O18/O16) and Plaine Morte (tritium, O18/O16, Pb210, Sr90). Ice samples from various altitudes on the Griesgletscher (Valais) were taken to the laboratory for gas content analyses (N2, O2, Ar and CO2) and isotope ratios (tritium,  $\tilde{O}^{18}/\tilde{O}^{16}$ ). In the autumn of 1972 2500 kg of ice from two locations at the snout of Unteraargletscher were melted in a

stainless steel container under vacuum and  $CO_2$ , Ar<sup>39</sup> and Si<sup>32</sup> were extracted for dating purposes. The gas content was too small (4-12 litre per 1000 kg of ice) for  $CO_2$ - or Ar<sup>39</sup>-dating, but dating with filtered organic carbon and Si<sup>32</sup> may work. Tritium analyses on samples from the snout showed negligible contamination by recent surface water (in spite of a high water content). Large variations of the O<sup>18</sup>/O<sup>16</sup> ratio were observed, so that a complete homogenization is absent.

# GLACIER FLOW MEASUREMENTS BY AUTOMATIC CAMERA

A high precision set-up with an automatically operated Hasselblad camera has been developed and installed at the border of Unteraargletscher by A. Flotron. A continuous record for 30 months with a lapse of 4 days between pictures was obtained (with less than 20% failure owing to adverse weather). Analysis in the stereo plotter for 1970/71 has shown not only a large seasonal velocity variation, but also a systematic change of the vertical component of motion with velocity.

H. Röthlisberger

#### UNITED KINGDOM

# CAMBRIDGE ARCTIC NORWAY EXPEDITION

During July and August 1973, hydrological investigations, both of the subglacial drainage and of the characteristics of the outwash streams, were carried out on Strupbreen, Lyngen Peninsula, Troms. A survey of the surface topography of the lower part of the glacier was completed, and meteorological and ablation records were kept.

Investigations into the subglacial drainage were carried out using dye tracers, which were entered into moulins and deep crevasses. Travel times and exit points of specific bodies of water were recorded and many interesting observations made particularly in connexion with the relationship between the ice-dammed lakes and the overall drainage pattern. Strupvatnet, the largest of these, appears to have remained at a constant level since the observations made by the Cambridge expedition in 1971, and there was no evidence of a catastrophic burst since that time. Daily ablation and meteorological observations were recorded for the lower part of the glacier, and a continuous record of the discharge of the outflow was kept.

Suspended solids in the outwash streams were continuously recorded, and samples collected for laboratory analysis in Great Britain, as well as sediment samples for scanning electron microscope analysis.

The Expedition consisted of 11 members, from Cambridge and Southampton Universities and from North East London Polytechnic, and was led by D. W. Matthews.

S. C. Wrenn

#### U.S.S.R.

In 1972 Soviet glaciological expeditions carried out investigations in the mountains of the Caucasus, Central Asia, Altay, Polar Urals, Kamchatka, Khibiny and Antarctica.

#### CAUCASUS

The Department of Glaciology, Institute of Geography, USSR Academy of Sciences continued investigations of glacier climate. For this purpose, and to study the dependence of properties of air masses upon the underlying surface and upon the distance from slopes surrounding the firn area, field work was carried out on the transverse profile of Lednik Marukh. The vertical temperature profile and wind profile near the surface of the glacier were investigated. Surveys of albedo as well as mapping of types of surface were carried out regularly. Meteorological surveys and the measurements of heat balance were continued. Methods of calculating climatic factors affecting glacier heat balance were worked out. Global radiation and heat reserves of melting of Lednik Marukh Glacier surface were calculated for the period of 1947-1970, according to the data on weather type frequencies, obtained at the glacier weather station Arkhiz. The variations of heat balance of this glacier were estimated for the first time. They turned out to be small (mean square root error was 10%).

Investigations of the formation of water balance were continued. The internal feeding, filtration and infiltration of melt waters into the firn sequence of Marukh Glacier were investigated for this purpose. New methods were worked out; the quantitative data on vertical migration of waters and on intraglacial run-off into the firn sequence of a temperate glacier were obtained. Water discharges were measured by the "ionic flood" method. The measurements of conductivity of ice and firn, and the measurements of water velocity by the "salt method" were started. A new electric conductivity guage proved to be very effective for estimating water velocity in firn voids, water discharge and conductivity in layers of firn sequences.

Investigations of the glacier bed were carried out on Lednik Dzhankuat, using data on the velocity of melt waters under ice. The velocity was measured by the "salt method".

Field work on the Kolka and Maili surging glaciers made it possible to prepare extendedperiod forecasts of glacier behaviour. Some investigations were carried out for the first time due to the improved accessibility of these glaciers. Thermo-probing to the depth of 15 m showed that at the bottom of these glaciers the temperature is 0°C. The data obtained completely reject the hypothesis that freezing-thawing plays an important role in surges. The mass balance of the Kolka and Maili glaciers was calculated according to the measurements of accumulation and ablation. The ice-water balance showed that the advanced lobe of the glacier will not melt away for another 15-20 years.

The estimate of the danger of glacial hazards in northern Ossetiya was given. The investigations of mountain valleys made it possible to group them as extremely dangerous, dangerous and practically safe valleys. The following conclusions were made concerning glacier surges: a glacier surge is preceded as a rule by a slow advance of the glacier; the velocities of a glacier during the surge vary essentially, up to a complete stopage; the movement of the advanced part of the glacier still continues after the surge; hollows in the glacier, originated by the surge, rapidly close up during the relaxation that follows.

The Laboratory on the Problems of Snow Avalanches, and Mudflows, Moscow University,

continued the investigations of Lednik Dzhankuat. The following work was carried out: snow surveys (April, June, August), ablation observations by means of the vast network of stakes and pits, run-off observations on the two profiles and the run-off plot, meteorological observations, measurements of ice-temperature at different depths in the ablation area, measuring of ice thickness by way of thermodrilling, the study of water flow within the glacier by the 'salt method'' observations of the phenological phases of vegetation and of the rate of its spreading in the zones below the end of the glacier.

The glaciological year 1971-72 was characterized by a negative glacier mass-balance. The water balance in the catchment area was characterized by a pronounced excess of the output items of the balance over its input items (about 5%). A water-bearing horizon similar to the water-bearing horizons in karst areas was found at a depth of 40 m. The velocity of melt water in the glacier and under the glacier is approximately the same as in open channels. The temperature of ice below the active layer in the ablation area is several tenths of a degree lower than the pressure melting point.

The studies of snow avalanches in the Caucasus were continued. The laboratory estimated the danger of snow avalanches in the west Caucasus. Five periods of the greatest avalanche activity in the El'brus region were singled out. The laboratory studied the parameters of a moving avalanche, triggered by an artificial explosion. The wave impact upon an obstacle was measured.

The Institute of Geography, Georgia, continued glaciological investigations on the glaciers of the southern slope of the Central Caucasus. A phototheodolite survey of the fronts of three glaciers was made. The velocities of the glacier surface, their vectors, ablation and deformation values and the positions of glacier ends were determined. Studies of the regime of ablation and observations of surficial run-off were carried out.

Kharkov University investigated present-day and former glaciation of the Caucasus. The present position of Lednik Dykhsu was determined and the tongue of Lednik Suatisy was investigated. The data determining the paleogeography of the northern slope of the Central and the East Caucasus were obtained. Dendroclimatic investigations made it possible to reconstruct meteorological conditions in the Teberda basin during the period of tree growth (XVIII-XX centuries) and to reveal the relationship of the annual tree growth with cycles of solar activity and meteorological conditions.

The Rostov-on-Don Hydrometeorological Observatory carried out investigations of 15 glaciers of the northern slope of the Greater Caucasus. The studies under the I.H.D. programme were carried out on Lednik Marukh. The investigations included meteorological, hydrological and heat balance surveys, observations of ablation and accumulation. On the majority of the glaciers investigated, the variations of their snouts were established. The studies showed that nearly all the glaciers of this part of the Caucasus have retreated, and only two of them have advanced.

Hydrometeorological Service, Georgia, and the Transcaucasian Hydrometeorological Institute investigated 6 glaciers on Mount Kazbek and 4 glaciers of the southern slope of the main Caucasus range. The most complete programme was carried out on Lednik Gergety. It included measurements of ablation, a survey of glacier velocities at two transverse profiles, route snow surveys, measurements of solid and liquid precipitation with the help of eight totalizers, observations of the snout variations and of the run-off regime of the Chkhery river, taking its source from the glacier. Measurements of ablation and of ice velocity, levelling and surveys of glacier fronts were carried out on the other glaciers.

The summer and winter months of 1971-72 were characterized by heavy snowfalls and low temperatures of air, which caused the growth of glaciers. The thickness of glaciers on the northern slope of the Caucasus range increased by 1.2-2.9 m, and on the southern slope the increase was 1.2-2.0 m. The velocity of all glaciers continues to grow and in 1972 it was above the norm.

#### **CENTRAL ASIA**

The section of Physical Geography of the Academy of Sciences, Kazakhskaya SSR continued glaciological investigations in the Zailiyskiy Alatau, the Dzhungarskiy Alatau and Kungey Alatau field work was carried out on 14 glaciers, in the river basins of Malaya Almatinka, Sredniy Talgar, Chilik and Bolshaya Almatinka. In the Dzhungarskiy Alatau field studies were carried out on 13 glaciers in the river basins of the Sarkan, Maliy Baskan and Kora-Karatal'skaya.

Investigations included quantitative evaluation of precipitation and their accumulation on the glaciers and extraglacial surfaces, the measurements of the velocities of ice and of the levels of glacier surfaces (levelling at fixed profiles); observations of the position of the glacier ends, measurements of the temperature of ice, firn and snow by means of thermo-probing and glacial run-off. Phototheodolite and tacheometric surveys, and meteorological, actinometric, gradient and hydrometric studies were completed. The thickness of ice was determined by ice drilling. Surveys of the mechanism of glacier variations were started. In the Dzhungarskiy Alatau, Lednik Shumskogo, the network of glaciological stakes was enlarged (29 profiles), covering now practically all the glacier. Albedo and moraine surveys of glacier surface were carried out.

The glaciological year 1971-72 was characterized by a precipitation deficit in autumn and winter. In spring the precipitation increased, but even so by the time of maximum snow storage the quantity in the accumulation area did not exceed  $35-50 \text{ g/cm}^2$ . The summer was very cold with daily snow or hail precipitation, and ice melting was not intensive. According to preliminary estimates, the 1972 mass balance of the Kazakhstan glaciers was positive.

The Department of Glaciology, Central Asia Hvdrometeorological Institute, carried out multidisciplinary studies on Lednik Abramov under the I.H.D. programme. Radio echo sounding by different types of devices was applied at 420 points along transverse profiles and profiles in elevation with a total length of 50 km. The data obtained made it possible to compile a detailed map of glacier thickness. An experimental device for radio echo sounding of glaciers from helicopters was worked out. A method of determining internal glacier feeding was developed: it involves the measurement of quantitative changes in water storage in deep pits. Experiments in high-speed thermodrilling of ice were successful down to 110 m; cores were obtained from all depths.

New methods were developed for snow-cover investigations. They included determination of snow storage, for hydrological forecasts in river basins, on the basis of route surveys and the data obtained from stakes and satellites. It was established that up to now the data from weather stations and totalizers are the most reliable. The relationship between thickness, density and water content of snow to altitude has been obtained.

Observations of avalanches were continued, and improvements made in the methods of forecasting different types of avalanches. A study was made of the relationship between the strength of fresh snow and avalanching to meteorological conditions in the west Tien-Shan. A large-scale map of avalanche hazards of the Uzbekistan highland terrain has been compiled.

The Tien-Shan physico-geographic station investigated the Karabatkak and Korolkov glaciers. The main aim of the investigations was to study the constituents of heat and mass balances, and the variations in glacier dimensions. Snow storage was measured regularly in the cold season, and surveys of the elevation of the surfaces of the glacier tongues were made along several profiles. The data obtained made it possible to differentiate the material accumulated at the glacier tongue from precipitation and that derived from the firn area.

The climatic conditions of 1971-72 (and of the summer season in particular) were favourable for the glaciers of the Central Tien-Shan. The temperature of the air during the ablation period was 1.5-2.0°C lower than average; the total ablation appeared to be lower than normal.

The natural pollution of glacier surfaces was determined on Kok-Shaal Khrebet. Despite its considerable value (200 g of æolian silt per 1 m<sup>2</sup>) the dusting effect is weaker than in Terskey Alatau.

Hydrometeorological Service, the Kirahiz Republic, carried out multidisciplinary studies of Lednik Golubin, situated on the northern slope of the Kirghiz range. The investigations included meteorological, heat balance, and hydrologic surveys, observations of ablation and accumulation, ice movement, variations of the level of glacier ends. Surveys of tongue variations and surface changes of three glaciers were carried out on the northern slope of Kungey Alatau and on the northern slope of Talass range. The surveys showed a certain activisation of glaciers. In 1972 three of the investigated glaciers were stationary, one advanced 200 m and only one continued to retreat at a speed of 16 m per year.

The Laboratory of Glaciology, Institute of Geology and Geophysics, Uzbek Academy of Science, continued investigations in the Chatkal river basin of the role of glaciers in river run-off. Meteorological observations, measurements of ice and snow melting, surveys of debris cover, and collection of geological and water samples were made. The relationship between the temperature of the mid-troposphere (the layer of 4-7 km) and the value of melting on glaciers has been established. The value of melting on slopes of crevasses and icefalls was calculated: its addition to the general value was about 20%.

The Department of Glaciology, Institute of Geography, USSR Academy of Sciences investigated the conditions of melting and heat-balance of glaciers in the extreme conditions of the high Vostochnyy Pamir. The empirical relations of melting to meteorological data were obtained, as well as the dependance of these data on the altitudinal and latitudinal position of the glacier.

The observations of the Medvezhiy surging glacier were continued: about 50 stakes were surveyed from fixed points; phototheodolite surveys and observations of the debris cover of the surface and ablation were made, as well as meteorological observations on three plots. A survey of the albedo of all the ablation area was carried out twice. Observations of ice dynamics and morphological changes in the surface of Lednik Medvezhiy testify to the outburst in its activity, which evidently precedes a new surge.

Together with the Tadzhik Hydrometeorological Service, observations of the glaciers in the Vanch and Gunt river basins were carried out in connection with the compilation of the Pamirs Glacier Inventory. Expeditions to the southern piedmonts in the Fergana valley and to the high areas of the Tien Shan and Pamirs were devoted to the problems of paleoglaciology. The expedition studied key sections of Holocene and Late Pleistocene sediments with some sampling for radio-carbon and paleobotanical analysis.

The Tadzhik Hydrometeorological Service continued investigations of Lednik Skogach (Darvazskiv Khrebet). Meteorological surveys, observations of ablation on the tongue, measurements of ice dynamics on three transverse and one longitudinal profiles were conducted. The Meteorological Service also observed the run-off of the river flowing from the glacier and changes in the position of the glacier terminus. At the beginning and end of the ablation period, snow surveys were carried out in the firn area of the glacier. The information obtained made it possible to specify formulae, previously calculated, to determine mean values of day temperature of the air in glacier areas, according to the data from the nearest weather stations. The previously discovered relationship between the run-off of the river flowing from the glacier and ablation, and between the latter and mean day temperatures of the air were confirmed.

Theodolite surveys of the snouts of Zerafshan, Rama and Tro (Zerafshan river basin) glaciers were carried out. The surveys covered also Lednik Garmo and Lednik Mazarskiy (Obikhingou river basin); Lednik Akbaytal and Lednik Maliy Oktyabrsky (Karakhull river basin); Lednik Bakchiggir (Gunt river basin) and Lednik Mushketov (Muksu river basin). It was established that Maliy Oktyabrsky, Garmo and Mazarskiy glaciers were stationary Ahbaytal and Mushketov glaciers had considerably advanced, Tro glacier had made a small advance, while Zarafshansky, Rama and Bakchiggir glaciers continued to retreat.

The Laboratory on the Problems of Snow Avalanches and Mudflows, Moscow University, investigated the estimation of avalanche hazards in the mountain areas of the Tien Shan and Pamirs, which made more precise the map of avalanche hazards of the USSR, published in 1971.

The Department of Geography, Leningrad University, worked on Lednik Abramov. Meteorological and geomorphological observations were carried out. Radio echo sounding enabled the researchers to determine the structure of this glacier.

#### THE ALTAY

**Tomsk University** continued observations in the selected glacier basin of the Aktru river. They included meteorological, actinometric, gradient (at the altitudes 2300-2550 m a.s.l.), aerial and hydrometric observations, surveys of ablation, aufeis and other processes on the slopes. Glacier movement velocities and snow surveys were carried out on the Aktru glaciers.

The summer season in 1972 was cool. The mean temperature of July was 7.9°. It turned out to be the coldest July of the 16-year records. The precipitation of three summer months equalled 177 mm. The volume of the run-off during the season was 25 mil.m<sup>3</sup>, i.e. was nearly normal.

Superadiabatic gradients of temperature (below 2° at the height of 100 m) were discovered in the higher areas of the Aktru valley. The gradients obtained characterize the temperature field, humidity of air and wind in enclosed glacier basins, with great differences between absolute altitudes. Weather-balloon observations proved that this field is related to the external circulation.

Observations of snow accumulation at the heights of 900-3100 m were carried out for the first time in the Altay. They were made in the Multa river basin and lasted through the winter. It was found that the biggest snow storage (up to 100 g/cm<sup>2</sup>) was located in the sub-Alpine belt and near the rear slopes of cirques (up to 50 g/cm<sup>2</sup>).

In the Multa headwaters the winter avalanching was recorded. The relationship of avalanching to the intensity and length of snow drifts was established. At the end of May aerial observations of the avalanche source area were carried out in the Katun Range. The data obtained were used to compile avalanche maps of these ranges.

Meteorological and hydrometric observations, and surveys of ablation and ice velocity were carried out on Lednik Maashey (the Bish-Irdu mountains). The studies of the glacier included also general glacio-geomorphological research. Complete agreement between meteorological regimes of the upper areas of the Aktru valley and those of the Maashey valley was established. However, the retreat of Lednik Maashey is much slower (below 5 m/per year) than the retreat of other Altay glaciers.

#### SAYANY

The Institute of Geography of Siberia and the Far East, USSR Academy of Sciences, carried out investigations of aufeis. It was determined that aufeis coverage is extremely high on the Khamar-Daban and Vostochnyy Sayan ranges. In some areas the latter amounts to 1.5%. The thickness of aufeis is about 12 m, the zone of spreading is above 1 mil.m<sup>2</sup>. In some areas the aufeis spreads for 50-70 km, reaching up to the water divides.

The traces of former glaciation were studied in the Zopodnyy Sayan. The valleys of the river Ak-Such, to the west of the range and to the east along the route Kyzyl-Abakan were investigated. It was determined that the former glaciers had been 25-28 km long. Three lines of terminal moraines and other features were described. Sampling to determine the absolute age of the terminal moraines was carried out.

#### POLAR URALS

The Department of Glaciology, Institute of Geography, USSR Academy of Sciences, continued observations of the water balance in the I.H.D. selected basin of the Bol'shaya Khadata river. Together with systematic balance observations a series of ablation measurements under moraine of different thickness (up to 1 m) was carried out.

Surveys of glacier variations were continued. The maps of Lednik IGAN and Lednik Obruchev were drawn according to aerial stereophotogrammetric resurveys in 1971. The resurveys also made it possible to determine changes of their volume during the previous periods. The relationship between the variations of external and internal mass-exchange on the one hand, and changes in its geometry on the other was established on the basis of 7-year velocity record from Lednik Obruchev.

#### KHIBINY

The "Apatit" mine service investigated with the help of transmitters avalanche impact under natural conditions, and also carried out statistical presentation of perennial instrumental observations of snow drifts. It was proved that every tenth snow drift produces avalanching. Mean figures of the "avalanche" snow drifts are several times higher than those of "non-avalanche" snowdrifts. This can serve a good reference for the exposure of an avalanche-prone situation.

The qualities and regularities of snow transport and avalanches were also studied by the Novosibirsk Institute of Railway Transport.

#### КАМСНАТКА

The Institute of Volcanology, USSR Academy of Sciences, started investigations of the interaction between recent glaciation and volcanism. In order to choose glaciers for the investigation, the Institute studied Lednik Koselsky (Avacha group of volcanoes), Lednik Erman (Kluchyevskaya group) and Lednik Mutnov (Mutnov volcano). Meteorological surveys were carried out and the thickness and density of ice-firn sequence measured. The data on snow and ice ablation, ice velocity and run-off from the glacier were determined.

#### ANTARCTICA

Investigations under the International Antarctic Glaciological Project were started in 1972. In January-March the 17th Soviet Antarctic **Expedition** carried out an inland glaciological traverse from Mirny to "Vostock" station. The traverse was the first step in the realization of the Soviet studies under IAGP. Glaciological investigations were made on the profile up to a distance of 170 km from the coast. The heights of 193 stakes were measured, and 123 new stakes established. The expedition investigated snow sequence in 9 pits, studied the core and measured temperatures in two boreholes about 50 m deep. At the distance of 57 and 153 km from the coast the expedition established polygons, on which it carried out detailed glaciological and geographic investigations. These works were aimed at determining the dynamics of the ice sheet during future measurements in the same areas.

The thermodrilling of the deep bore-hole was continued at "Vostok" station. Ice cores to the depth of 955 m were obtained. The Institute of Geography, USSR Academy of Sciences and Geography Department of Moscow University tested the method of  $O^{16}/O^{18}$  analysis of snow and ice samples, and began investigations of snow and ice cores, obtained from the deep borehole at "Vostok" station.

Investigations of the morphology of Antarctic glacier coasts proved that the boundaries of the Antarctic continent should be drawn along the external edge of ice shelves. In the course of investigations dealing with the water balance of the Earth, information on accumulation and ablation in the Antarctic was collected. The Institute of Geography, USSR Academy of Sciences, together with the Arctic and Antarctic Institute, compiled a new accumulation map of the Antarctic Ice Sheet.

The Laboratory on the Problems of Snow Avalanches and Mudflows, Moscow University compiled maps at a scale of 1:10 000 of the Sayce, Albrecht-Penck, Alberikh, Meserve, Rhone and Taylor glaciers, and of the Wright and Taylor valleys. On the basis of these maps, the laboratory started to determine the ice velocities during the cold and warm seasons. It was proved that the influence of vertical movement on the glaciation in the Dry Valleys was much more important than previously supposed. A hypothesis about neotectonic control over the dimensions of glaciation was put forward.

The following results in glaciology from 1972 should be considered the most important:

1. For the first time it proved possible to use the data of stereophotogrammetric resurveys from spacecraft for the determination of the height of the snow-line, the position of glacier snouts and other glaciological objects. It was also found possible to use T.V. photos taken from satellites to estimate the migration of the seasonal snow-line in the mountains and on polar ice sheets.

2. A new notion of "potential ablation" was introduced. The notion characterizes the ice-mass which can melt away at any point of ice-free ground under given climatic conditions. The map of this value was drawn for the whole territory of the USSR. The map can be used for engineering, glaciological and palaeoglaciological work. The boundary was drawn to the north of which it is possible to create perennial artificial icemasses without thermoisolation.

3. A new method of temperature measurement on a temperate glacier was suggested. It involves the measurement of the diameter of a bore-hole immediately after drilling and a few hours later, when the new ice appears on the walls of the hole. The temperature is calculated according to the volume of the new ice. By means of this method, it became possible to measure negative and close to 0°C temperatures to a high precision, without using special highly accurate devices.

4. On the basis of long-term studies of rheological properties of polycrystalline ice and its monocrystals, the vector nature of the process of ice deformation was established. The studies also showed some regularities in the changes of parameters of these properties connected with the process itself. The coupling equation between the strain rate and stress temperature of polycrystalline ice was set up. The equation remains true in all the variation range of these parameters under natural conditions of the Earth's surface.

5. The simplest mathematical model of threedimensional unstationary anisothermic glacier consisting of homogeneous isotropic ice was constructed. The range of application of this model and the ways of its development, with all the necessary initial data available, were formulated. The calculation methods of the fields of absolute and relative velocities and velocity vectors of rotation of isochronal and physical glacier surfaces were worked out. On the basis of repeated observations, there were also worked out methods of calculation of transfer function, vectors of velocity and rotation of ice, tensors of strain rate and stress of ice, and vectorgradient of the model of ice velocity vector on the glacier surface.

6. The relationship between the variations of external and internal mass-exchange on the one hand and changes in its geometry on the other was established on the basis of 7-year velocity record. Significant regularities in the velocity of internal mass-exchange were found. New notions and terms were introduced. For the first time researchers obtained concrete instructions for field observation data processing in the studies of mechanism and causes of glacier variations.

7. Theoretical investigations of unsteady states of large ice-sheets were accomplished. These works are necessary for the analysis of mechanism and causes of the former continental glaciations. The correlation between the data on glacioeustatic records and existing concept of the lce Ages was made. The sequence of glacial and non-glacial intervals was formulated in this concept. Regularity of transitions from interglacial to glacial conditions and vice-versa was pointed out. A new explanation of the mechanism of formation of glacial erratics and ice-thrust features was put forward. The latter supports the concept of glaciation in West Siberia.

V. M. Kotlyakov

#### **BRANCH NEWS**

#### WESTERN ALPINE BRANCH

The 1973 Annual Meeting of the Branch, originally named "French Branch", was held in Zermatt, Switzerland, 7-9 September. 29 members and 28 friends enjoyed a lively time in and around this attractive town.

On the first day, everyone met at the railway station in Brigue and, armed with special badges and files of papers, went by train to Randa, a small village in the St. Niklaus Valley at the foot of the east face of the Weisshorn. The Bies glacier perches on the slopes above the village, which is thereby threatened by falls of séracs, sometimes involving a mass of ice 10 million m<sup>3</sup> in size. A. Bezinge and H. Röthlisberger described the history and recent events: since 1972 measurements by laser from the opposite side of the valley had shown that the mass of ice had accelerated from 10 cm/day to 60-80 cm/day at the time of the break in August 1973. A Flotron demonstrated the use of the laser equipment, which has an accuracy of  $\pm$  1 cm at a distance of 5.5 km. After drinking wine offered by the local municipality, we resumed our journey to Zermatt, which was basking in warm sunshine. Tempted though we were by the weather and scenery, we spent the afternoon indoors, and were rewarded with several interesting lectures.

Frederic Röthlisberger:

History of alpine cols in the Zermatt region, from Roman times, in relation to the climate. Corrado Lesca:

Documentation and photographic archives of the Comitato Glaciologico Italiano. High precision topographic methods for determining surface velocities.

John W. Glen:

The role of a specialised glaciological journal and in particular of the Journal of Glaciology.

André Roch:

Hanging glaciers.

Climbing on the rock and ice of Swiss, Alaskan and Himalayan mountains.

Film: Cloud formations round the Matterhorn (1936) with simulation by laboratory experiments.

M. Caillemer:

First panoramic photographs of the Alps by French geodesists, 1900.

After dinner, we visited the Alpine Museum at the kind invitation of K. Lehner, the Warden.

The next day dawned clear and sunny, and we set out in fine spirits for an excursion to the Gorner glacier. The mountain railway afforded spectacular views of the valleys and of everchanging aspects of the snow fields and mountains. From the summit of the Gornergrat, at 3100 m, exceptionally clear conditions allowed the photographers to take many shots of the Moute Rosa massif and of the Matterhorn, frequently with Louis Willoud as the incomparable foreground-blowing his alpenhorn or throwing a Swiss flag in a complex series of patterns. Talks were given by A. Bezinge on the topography and climate of the region and on results of research on the glacial lake; by F. Röthlisberger on several features of historical interest and the use of dendro-chronology techniques on tree-trunks from moraines; and by O. Schmidt on the geological structure of the massif. After a picnic lunch, the return journey was made on foot through the magnificent gorges of the Gorner valley.

The Annual General Meeting of the Branch was held at 7 p.m. in the hotel and the following officers were elected for 1973-74: President— Albert Bezinge, Vice-President—Corrado Lesca, Secretary—Treasurer—François Valla.

At 8 p.m. the Banquet was held, and we were honoured with the presence of M. Roger Bouvin, President of Switzerland, who gave one of the speeches. Later, a group of folk dancers and musicians performed for us, and the evening ended with the braver members of the Branch venturing on to the floor to demonstrate their agility.

The third day saw a slightly tired but happy group travelling by train, landrover and on foot to Hohwang, at 2400 m, at the foot of the north face of the Matterhorn. H. Schnyder reported the results of studies on the mass balance of the Hohwang glacier; A Bezinge spoke of the relationship between the Z'Mutt glacier and local climate, and A. Roch described the surrounding climbs, in particular the ascent of the north face of the Matterhorn. Lower down the valley, near the pumping station, the Director of Grande Dixence, R. Masson, gave an interesting talk on the functions and work of the Company, and M. Dayer demonstrated in the pumping station the methods of forecasting outflow from the glaciers using meteorological parameters and computer processina.

Members were then entertained to lunch by Grande Dixence—an open-air occasion, with plenty of local wine and 'raclette'' (melted cheese with potatoes and salad). Even the onset of rain did not dim the enthusiasm, and the Branch Meeting closed in the hotel that evening with thanks to the organisers and hopes for an equally successful Meeting in September 1974 in Courmayeur, Italy.

## NORDIC BRANCH 1973 MEETING

Greenland 8-18 June

- 1 En masse (minus the photographer, Valter Schytt)
- 2 By the side of Tunugdliarfik (Eriks Fjord), near Narssarssuag
- 3 Lunchtime at Brattahlid, in front of bronze sculptures
- 4 Kiagtût sermiat, a glacier near Narssarssuaq, watched over by Anker Weidick
  - Photographs by Valter Schytt and Edvigs Kanavin



## WESTERN ALPINE BRANCH 1973 MEETING









- 1 Zermatt and the summit of the Matterhorn.
- 2 Participants in silhouette.
- 3 M. R. Masson, Director of Grande Dixence, telling us about their installations.
- 4 The President of Switzerland (at right) came to the Banquet.

3

5 The office of the Branch is ready for business.



4

5



View of Tweedsmuir glacier snout near critical bluff. Distance to ice from base of bluff  $70 \pm 10$  m (Austin Post, Sept. 11, 1973). See report on page 23.



The Fuchs Medal. See report on page 22.



#### BRANCH NEWS (continued)

#### BRITISH BRANCH

The International Glaciological Society usually has a conference in Cambridge in the Spring in association with the Annual General Meeting. This year, however, the Annual General Meeting is taking place during the Symposium on Remote Sensing in Glaciology in September, and the International Commission of Snow and Ice is holding a Symposium on Snow Mechanics in early April, and, so as not to compete with this, the Society is not having an International Conference this Spring. However, one useful function of this conference has been providing the opportunity for researchers in Britain to give informed reports on progress of their work and to meet and discuss their problems with each other.

In order not to leave a gap between these get togethers, there will be a one-day meeting of the British Branch in the Physics Department, University of Birmingham on 26 March 1974. To allow people time to get here from the nearer universities, the meeting will start at 1030. Further information may be obtained from Dr J. W. Glen, Department of Physics, University of Birmingham, P.O. Box 363, Birmingham B15 2TT.

#### JOURNAL OF GLACIOLOGY

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

- G. T. Jarvis & G. K. C. Clarke:
  - Thermal effects of crevassing on Steele Glacier, Yukon Territory, Canada.
- J. C. Rogers & E. R. LaChapelle: Instruments & methods: The measurement of vertical strain in glacier bore holes.
- M. F. Meier, W. B. Kamb, C. R. Allen & R. P. Sharp:

Flow of Blue Glacier, Olympic Mts., Washington, USA.

W. D. Hibler, W. F. Weeks, A. Kovacs & S. F. Acklev:

Differential sea ice drift I — Spatial and temporal variations in mesoscale strain in sea ice.

W. D. Hibler:

Differential sea ice drift II — Comparison of mesoscale strain measurements to linear drift theory predictions.

- G. D. Ashton: Froude criterion for ice block stability.
- G. Wendler & N. Ishikawa: The effect of slope, exposure and mountain screening on the solar radiation of McCall Glacier, Alaska.
- G. Wendler & N. Ishikawa: The combined heat-, ice and water-balance of McCall Glacier, Brooks Range, Alaska.
- P. Worsley: Recent "annual" moraine ridges at Austre Okstindbreen, Okstindan, North Norway.
- N. Ahmad & N. H. Hashimi: Glacial history of Kolahoi Glacier, Kashmir, India.
- R. J. Small & M. J. Clark: The medial moraines of the lower Glacier de Tsidjiore Nouve, Valais, Switzerland.

#### THE LIBRARY

#### **BOOKS RECEIVED:**

Bogorodskiy, V. V. and Gavrilo, V. P., ed. Fizika I'da. Obzor dokladov mezhdunarodnogo simpoziuma po fizike I'da, sostoyavshegosya 9-14 sentyabrya 1968 g. v g. Myunkhene [Physics of ice. Survey of reports of the International Symposium on the Physics of Ice held in Munich, 9-14 September 1968]. Leningrad, Gidrometeoizdat, 1973. 156p., illus.

[Shortened papers from N. Riehl and others, ed., Physics of ice. Proceedings . . . New York, Plenum Press, 1969.]

Danilans, I. Ya., ed. Lednikovyy morfogenez [Glacial morphogenesis]. Riga, Izdatel'stvo ''Zinatnye'', 1972. 115p. [Nine articles.]

Dyunin, A. K. and Krasnosel'skiy, E. B., eds. Inzhenernaya glyatsiologiya. Trudy 1 vsesoyuznogo koordinatsionnogo soveshchaniya po inzhenernoy glyatsiologii (6-9 aprelya 1970g., g. Kirovsk) [Engineering glaciology. Transaction 1 of the coordinating conference on engineering glaciology (6-9 April, 1970, Kirovsk)]. Apatity, Kol'skiy Filial Akademii Nauk SSSR, 1973. 234p.

[44 papers.]

Jochum, Oskar. *Glazialhydrologische Untersuchungen mit der Farbstoffverdünnungsmethode.* Innsbruck, Leopold-Franzens-Universität, 1973. xii, 272 leaves, illus.

[Thesis. Measurement of discharge from glaciers by dye dilution method.]

Maksimov, Ye. V. Problemy oledeneniya zemli i ritmy v prirode [Problems of glaciation of the earth and rhythms in nature]. Leningrad, lzdatel'stvo ''Nauka'', 1972. 296p.

[Response of glaciers to cyclic climatic change.]

Marcinek, Joachim and Nitz, Bernhard. Das Tiefland der Deutschen Demokratischen Republik. Leitlinien seiner Oberflächengestaltung. Gotha/Leipzig, Hermann Haack, 1973. 288p., illus. 23.5 cm.

[Includes glacial geology and periglacial features.]

- Miller, Maynard M. *Taku Glacier evaluation study*. State of Alaska Dept. of Highways in cooperation with the U.S. Dept. of Commerce Bureau of Public Roads, 1963. variously paged.
- Østrem, G. and others. Atlas over breer i Nord-Skandinavia. Glacier atlas of northern Scandinavia. By G. Østrem, N. Haakensen and O. Melander. Norges Vassdrags- og Elektrisitet-svesen. Meddelelse fra Hydrologisk Avdeling, Nr. 22, Stockholms Universitet. Meddelande från Naturgeografiska Institutionen, Nr. 46, 1973, 315p. + 2 maps in end pocket.

[English summary, p. 269-82.]



#### HANS RÖTHLISBERGER

Hans (or John as he is called in German speaking countries) Röthlisberger was born on 1 February 1923 in the Canton of Berne in the Emmenthal, famous for its cheese and dark forests. It is a hilly area and close enough to real mountains to make climbing attractive, and the tops of the hills offer magnificent views of the high peaks; there are, however, no glacierseven during the Würm glaciation it was an icefree area. His school days were spent in this Canton, with the Bernese Oberland as the scene of summer vacations. Glaciers did not at this time particularly interest Hans, although he was impressed by the thundering ice avalanches around Grindelwald and Wengen and the deep gorges carved by glacial streams. Later on he became more and more interested in climbing, and was close to becoming an incurable "Alpinomaniac". Rocks meant much more to him than ice or snow, and when, as an earth science student at the Federal Institute of Technology (ETH) in Zürich, 1943-47, Prof. Paul Niggli gave him the choice between laboratory work at Weissfluhjoch or petrological field work for the diploma thesis, he chose the latter. He had no inclination to become a glaciologist-partly because he hated the cold.

In 1947, Hans became an Assistant at the Institute of Geophysics, ETH, and investigated the elasticity of rocks, the seismic and petrological properties of molassic rocks, and grain size determination in sections—subjects which became his doctoral thesis under Prof. F. Gassmann. He stayed at the Geophysics Institute until 1954, and it was during this period that through sheer coincidence he became more closely acquainted with glaciers. This occurred when he had a chance to join the first Arctic Institute of North America (Baird) Expedition to the River Clyde area of central Baffin Island in the spring of 1950 as a mountaineer (as well as pack horse and sledge dog). Watching Bill Ward drilling holes into the ice, Svenn Orvig fighting blizzards on top of Barnes Ice Cap and Pat Baird digging snow pits, gave him his first lasting impression of the challenge of glaciological research. This impression was enhanced three years later when he met Ben Battle, as well as old acquaintances, during the second AINA expedition to Baffin Island, again led by Pat Baird, this time to make seismic soundings on the glaciers of Penny Highland. After that it was but a small step to make a living out of glaciology, and in 1954 he joined Peter Kasser's group at the Hydrology Branch of the Laboratory of Hydraulic Research and Soil Mechanics, ETH. In the next three years he came to know Robert Haefeli, Marcel de Quervain and the few other Swiss glaciologists.

He married Doris, who soon became part of the glaciological community and shared Hans' urge to go to foreign countries-an urge that had been one of his main reasons for choosing earth sciences during his studies. They spent the years 1957-61 in the United States, where Hans was a contract scientist at the Snow, Ice and Permafrost Research Establishment (SIPRE) in Wilmette, Illinois (which later moved to Hanover, New Hampshire, and changed its name to CRREL). Through working at one of the large centres of glaciological activity they got to know practically everybody with a name in this field, and had what they describe as a marvellous time. Their return to Zürich in 1961 was brought about by family reasons more than anything else, paired with the longing to be close to good climbing and skiing after four years in the Chicago area.

Since his return to the Hydrology Branch, Hans has been engaged in problems of applied glaciology and in particular with dangerous glaciers such as the Giéto glacier, Gruben glacier and the recent menace of an ice field on Randa. He was in the public eye when he had to test the bearing capacity of the frozen lake of Zürich in 1963: after he had given the green light, thousands of people surged on to the lake—and stayed dry. He and Doris and their two daughters spend as much time as they can in their modern chalet, its seven levels clinging to a steep mountain slope in the Canton of Valais. Here, far above the busy traffic of the Rhone Valley, they look southwards to the snowclad peaks, and often share the view with their many visitors—for they have a great ease in making friends.

Hans says that his attitude towards glaciers has not changed: it has never been a love affair and the loss of Ben Battle's life, as well as a number of anxious hours connected with nearfatal other accidents, have not helped him to consider large ice masses as the best thing earth can offer. Not being fond of the cold, he has always felt happier at the snout of a glacier than in the accumulation areas, so his interest in meltwater seems directly motivated. It is almost symptomatic that in recent years he has become more and more involved in glacier catastrophes, so that he has to fight negative aspects of glaciers, like lake bursts and ice avalanches.

Fortunately he considers that glaciers are one of the most interesting adversaries one can imagine, and that belonging to the glaciological community is fully rewarding in itself—rewarding enough to stand the cold once in a while ...



# **RECENT MEETINGS (of other organizations)**

## SYMPOSIUM ON PHYSICAL METHODS OF ICE AND SNOW STUDIES Leningrad, 1-5 October 1973

The Symposium on Physical Methods of Ice and Snow Studies, sponsored by the Arctic and Antarctic Research Institute and Joint Commission on Antarctic Research under the Earth Science Section of the Presidium of the Academy of Sciences of the USSR, was held in Leningrad, 1-5 October 1973.

46 papers were presented and discussed at the Symposium. About 200 scientists, from USSR and eight other countries, attended the Symposium. The papers revealed the results of recent studies of:

1. Electromagnetic methods of snow and ice studies. Active and passive radio sounding of ice and snow cover.

2. Optical methods of snow, ice and water studies.

3. Dynamic and statical methods of studies of ice and snow mechanical properties.

The Symposium was a logical continuation of a number of joint conferences and seminars on the use of radiophysical methods in oceanographic and ice investigations, which were organized by the Arctic and Antarctic Research Institute in 1964, 1966 and 1968. In this respect the Symposium notes a co-ordinating role of the AARI both in studies of snow and natural ice physical properties and formulation of new problems relating to ice and snow physics which can be solved at present only by using modern physical methods.

The Symposium notes the following:

Considerable achievements have been made in the Soviet Union and other countries in the use of radio sounding methods for the study of ice sheets, sea and freshwater ice. As a result of extensive studies of physical properties of various types of ice and their electromagnetic characteristics in a wide frequency range, the problem of remote measurements of relatively thin sea ice is solved in principal (AARI, Institute of Civil Aviation Engineers in Riga).

New experimental data on optical properties of ice have been obtained. Further studies of optical characteristics which determine conditions of radiation transfer through the snow and ice are necessary. These studies will make it possible to use optical and especially holographic interferometrical methods (AARI, All-Union Institute of Optical and Physical Studies).

Extensive use of isotope methods (first of all, tritium and deuterium molecular varieties of water as natural indicators) for studies of ice and snow formation processes and their physical properties is noted to be desirable (The Institute of Water Problems). For the estimation of large water equivalents of snow cover the method based on evaluation of cosmic ray flow absorbtion by snow and ice is considered to be advantageous. We ask the Main Administration of the Hydrometeorological Service and the Institute of Applied Geophysics to increase efforts in modification and development of this method and recording instruments.

The considerable part of papers was devoted to the results obtained and methods used for the study of mechanical and acoustic properties of snow and ice. The speakers have shown the importance of further studies concerning determination of inner friction characteristics, the absorbtion coefficient, viscosity, velocity of wave propagation, reflecting and scattering properties in the wide range of deformation amplitudes and elastic and elastic-viscous fluctuation frequencies (seismic, low infrared, sound and ultrasonic ranges from  $10^{-2}$  to  $10^{6}$  Hz).

For investigation of the dynamic phenomena and tension state of the ice cover in various water bodies the seismoacoustic methods currently used in the AARI for ice studies and the methods based on the use of optical quantum oscillators are recommended.

Considerable progress has been made in studies of the physics of icing and ice adhesion to various construction materials (AARI and the Leningrad Polytechnical Institute).

The experience gained by the scientists of the Leningrad Mining Institute, who have recently obtained important experimental data on greatly mineralized ice destruction under the influence of electromagnetic field of high tension, is of a special interest.

The study made by Dr. V. Petera from the Czechoslovakian Academy of Sciences dealing with the process of charge appearance at the interface of freezing aqueous solution phases is of importance in the physics of ice.

It was generally felt that the papers discussed at the Symposium reflect new and rather interesting findings which significantly contribute to the physics of ice. These results make it possible to approach the solution of the most important physical and technical problems connected with an active impact on ice and snow (destruction), estimation of tension in the ice cover by laser and seismoacoustic methods, remote sensing of the structure and state of glaciers, sea and freshwater ice (active and passive radio sounding).

> V. Bogorodskiy Vice-Chairman, Organizing Committee V. P. Gavrilo Secretary

## ICE CORE DRILLING SYMPOSIUM

#### University of Nebraska-Lincoln, Lincoln, Nebraska, U.S.A. Tentative Dates: 28-30 August 1974

In response to suggestions that an attempt be made to bring together the scientists and engineers from the several nations who are currently involved in ice and ice-core drilling in the polar regions, the Ross Ice Shelf Project Office at the University of Nebraska proposes to host an Ice Drilling Symposium preceding the XIII SCAR Meeting. This three day symposium would focus on technological developments and the accomplishments of these various ice core drilling projects. A frank discussion of failures as well as successes is encouraged. Formal sessions and working sessions which will allow maximum exchange of information are contemplated.

It is proposed that the papers presented be compiled and published in a single volume. Manuscripts and illustrations should be available at the time of the symposium.

This preliminary announcement should be considered a call for a show of interest by those who might participate in this symposium. Since the number of people involved is fairly limited, the success of the symposium will be directly related to the willingness of these people to participate in the symposium.

We would appreciate a prompt response to this preliminary announcement. Please indicate if you or your colleagues are interested and will or will not be able to participate in this symposium. Please send your response to:

Dr. Robert H. Rutford, RISP Management Office, 135 Bancroft Hall, University of Nebraska-Lincoln, Lincoln, Nebraska 68508, U.S.A.

# **GLACIOLOGICAL DIARY**

#### 1974

- 1-5 April Symposium on Snow Mechanics. Grindelwald, Switzerland. (Int. Commission of Snow and Ice, IAHS, Dr F. Müller, Secretary, Geog. Inst. der ETH, Sonneggstrasse 5, Zürich 8006, Switzerland.)
- 15-19 April

Symposium on Remote Sensing of Environment, The University of Michigan, USA. (Mr Jerald J. Cook, The Center for Remote Sensing Information and Analysis, Willow Run Laboratories, Environmental Research Institute of Michigan, P.O. Box 618, Ann Arbor, MI 48107, USA.)

20-24 April

1st Symposium on the Geological action of drift ice, Québec, Canada. (Jean-Claude Dionne, Environment Canada, C.P. 3800, Sainte-Foy, Québec, Canada.)

6-11 May Polar Oceans Conference. SCOR/SCAR and Arctic Institute of North America and McGill University, Montreal, Canada. (M. J. Dunbar, Atlantic Oceanographic Laboratory, Marine Sciences Directorate, Bedford Institute of Oceanography, Dartmouth, N.S., Canada.) 25 May

Symposium on Quaternary Environments, York University, Toronto, Canada. (Dr. W. C. Mahaney, York University, Atkinson College, Geography Department, 4700 Keele Street, Toronto, Canada).

9-12 September

Celebration of Tercentenary of Scientific Hydrology and Symposia to mark end of I.H.D.; Effects of man on the interface of the hydrological cycle with the physical environment. Flash floods—measurement and warning, (Director, Division of Hydrology Unesco, 7 place de Fonternoy, 75700 Paris, France.)

- 15-21 September Symposium on Remote sensing in glaciology, Cambridge, England. International Glaciological Society. (Mrs. H. Richardson, Secretary, Cambridge CB2 1ER, England.)
- 23-27 September
  Conference on Properties of water and steam, Giens, France. (Dr. S. Beitler, Dept. of Mechanical Engineering, Ohio State University, 206 W 18th Avenue, Columbus, Ohio 43210, USA.)

## 1975

8-10 April

Symposium on the thermal regime of glaciers and ice caps. National Research Council of Canada, Simon Fraser University, Vancouver, Canada. (Dr R. B. Sagar, Dept. of Geography, Simon Fraser University, Burnaby, B.C., Canada.)

Symposium on Isotopes and Impurities in Snow and Ice, International Commission of Snow and Ice, Grenoble, France, during the 1975 General Assembly of IUGG. (Dr Fritz Müller, Secretary ICSI, Geog. Inst. der ETH, Sonneggstrasse 5, Zurich 8006, Switzerland.)

18-20 August

International Symposium on the Geochemistry of Natural Waters. Canada Centre for Inland Waters, Burlington, Ontario, Canada. Sponsors: Working Group on Geochemistry and Cosmochemistry, the International Association of Hydrological Sciences and Canada Centre for Inland Waters. (Mary E. Thompson, Chairman, Canada Centre for Inland Waters, Burlington, Ontario, Canada.)

## REVIEW

Icefield Ranges Research Project, Scientific Results. (Vivian C. Bushnell and Richard H. Ragle, editors). American Geographical Society, New York, and Arctic Institute of North America, Montreal, Vol. 3 (1972), ix, 261 p., illus., maps. \$ 7.00 (25% discount to fellows of AGS and members of AINA).

Volume 3 of the scientific reports is a continuation of a collection of papers dealing with the project work similar to the two previous volumes reviewed in ICE No. 37 (1971). The ratio of original to reprinted articles is considerably higher than before. Of a total of 26 papers, 14 are of a glaciological nature. The majority of the latter (9) are devoted to the surging Steele glacier and to the Rusty glacier, which is believed to be in a presurge phase. Part of the papers on the Steele surge have already been published in Vol. 6 (No. 4) of the Canadian Journal of Earth Sciences (1968; Symposia of St. Hilaire and Banff), but the richly illustrated historical review 1935-68 by W. A. Wood is new. Also the "movement observations on the terminus area of the Steele glacier" (S. Thomson) in the boundary area of the active and stagnant ice are worth mentioning, in spite of the very short period of observations of nine days limiting the value of the conclusions. Reports on the

18-21 August

International Association of Hydraulic Research Committee on Ice Problems and US Army Cold Regions Research and Engineering Laboratory—Symposium to include ice management and engineering as related to extended season navigation of inland waterways, ice jam control, and effects of sea ice on marine structures.

## 1976

15-25 August

The 25th International Geological Congress, Sydney, Australia. (Secretary-General, 25th International Geological Congress, P.O. Box 1892, Canberra City, General, 25th International Geological ACT 2601, Australia.)

August 23rd Interna

23rd International Geographical Congress, Moscow, USSR. (V. Annenkov Institute of Geography, Academy of Sciences USSR, Staromonetny 29, Moscow 109017, USSR.)

#### September

Symposium on Problems of applied glaciology, Cambridge, England. (International Glaciological Society, Mrs. H. Richardson, Secretary, Cambridge CB2 1ER, England.)

field work of the 1968 and 1969 seasons on Rusty glacier contain results of mass-balance studies (T. Brewer), hydrological investigations indicative of a presurge regimen as compared to adjacent glaciers (T. Faber), a gravity survey and ice temperatures (D. J. Crossley and G. K. C. Clarke). Their analysis shows a possibility for the existence of areas at the pressure melting point at the bed of the subpolar (-5° C) Rusty glacier. Valuable information on deep drilling in cold ice is also given. The other glaciological articles deal with  $0_{16}/0_{18}$  ratios (K. E. West and H. R. Krouse), the distribution of snow accumulation across the Icefield Ranges and accumulation variations over a number of years (M. G. Marcus and R. H. Ragle), dielectric properties of snow and ice samples in relation to radio wave propagation (T. Yoshino), supraglacial meltstreams (K. J. Ewing) and infrared radiometric temperatures in relation to the feasibility of thermal remote sensing (R. Lougeay). The remaining papers cover various fields of the earth sciences and biology and are more or less related to the presence of glaciers and frozen ground phenomena. The relict nature of part of the flora for instance has a direct bearing on the glacial history of the Shakwak Trench area.

H. Röthlisberger

#### AWARDS

Sir Vivian Fuchs, who was President of the Glaciological Society 1963-66, retired in September 1973 as Director of the British Antarctic Survey.

At the annual BAS conference in Cambridge he was presented with the Survey's first Fuchs Medal. Making the presentation, the new director, Dr Richard Laws, said: "On the retirement of a colleague it is customary to make a presentation, but this is felt to be totally inadequate in your case. For this is no ordinary retirement - it marks the end of an era. To convey our thanks for all you have done for us, individually, and severally; in recognition of the outstandingly successful influence you have had on the development of the Survey --- indeed it would not be too extravagant to say on its survival; in acknowledgement of your services to Antarctic exploration and science generally; and as a means of perpetuating your name so that it will be in the thoughts of future generations of Fids, who will not have had the privilege of serving under you; it has been decided, with acclamation, to institute a "Fuchs Medal". The overwhelmingly generous response to our request for contributions to the medal fund shows how widely your achievements are respected, and in what affection you are held by your past and present colleagues and friends.

The Fuchs Medal depicts on the obverse the excellent head and shoulders bas relief of Sir Vivian and his name. On the reverse the words BRITISH ANTARCTIC SURVEY lie around the periphery, the middle space being left blank so that the individual recipient's name and a short citation can be engraved there. (See photograph on page 14). The intention is to present one medal (or more if merited) annually, to men or women who have, in the opinion of a Medal Committee, made outstanding personal contri-

butions to the work of the Survey — beyond what is normally expected.

Although the Polar Medal recognizes those who have made notable contributions to the exploration and to knowledge of polar regions, and although there are other honours bestowed by the Queen, or by learned Societies, from time to time, many who contribute to the work of the Survey cannot appropriately be proposed for these awards. It is for these people — whether field workers, support personnel at the bases or office staff, scientists or technicians — that the Fuchs Medal is primarily intended. Thus it will reflect the concern of Sir Vivian for the well-being of all members of the organization, and his interest in their activities, whatever part they play.

A Committee has been formed, and this committee will review nominations annually. It is now my pleasant duty to invite you, Sir Vivian, to become its first Chairman.

However, in the expectation of some difficulty with our Chairman over the choice of the first recipient, we have taken it upon ourselves to settle this problem, and it is my final, very pleasant duty today, on behalf of all your friends and colleagues, to present you with the very first Fuchs Medal for outstanding, dedicated service to the Survey, far beyond what is normally expected, even of a Director, over a period of 26 years. Again no ordinary citation will suffice, and the inscription on the reverse reads '..... there has never been any intention of turning back .....' Although a statement which many of us will recognize from the days of the Trans-Antarctic Expedition, it is a commentary indicative of Sir Vivian's whole life. In passing may I suggest it is also a good motto for the Survey and for us all."

## SURGE OF TWEEDSMUIR GLACIER, BRITISH COLUMBIA, CANADA

Tweedsmuir Glacier (59° 50' N; 138° W), largest glacier in British Columbia, was photographed on 11 September 1973 by Austin Post of the U. S. Geological Survey. At that time, the 70 km long glacier was found to be surging.

The advance of the glacier threatens to block the Alsek River which flows from the Yukon Territory out to Dry Bay, Alaska. The consequences of this: (a) the formation of an icedammed lake, and (b) the subsequent generation of a flood wave, are both being examined.

In September 1972, Post's photographs show the glacier to be still in the quiescent stage, after last having suffered a surge in 1952-54. Recent enquiry has disclosed the fact that on 7 August 1973, a Geological Survey of Canada reconnaissance party that flew past the glacier considered by its appearance that it might be surging, but they did not report this observation until much later. On 14 and 15 October, G. Holdsworth and M. Alford flew into the glacier, established a baseline and took photographs using the Wild P-30 phototheodolite. They found the frontal advance to be confined to the northern third of the frontal lobe, and established the September-October advance rate. The southern part, characterised by heavy moraine and medial loops, is blocked by an extensive rock sill which protects the river. A line of cairns was established in front of the glacier to enable advance rates to be determined at future dates.

On 8 and 9 November Holdsworth and Alford revisited the glacier, repeated the photography, and remeasured the position of the snout. As a result of the ice front hitting a critically located bluff, the river (flow 890 cusecs; 8 November) had backed up 1--1.5 km, and was diverted through a higher channel on the east side of the bluff. (See photograph on page 13.)

From these data it has been established (using a surge response curve) that (1) the surge is a relatively weak one, (2) it began in April or May 1973, accelerating up to July-August (peaking at 6 m per day), (3) it is now in the deceleration stage ( $2.4 \pm 0.3$  m per day) and could grind to a halt as early as September 1974 or as late as February 1975, depending on the erosional effects of the river.

If the glacier proceeds as predicted, then the present spillway could be overwhelmed by August or September 1974. But the erosional capability of the Alsek River on the ice front has not been fully accounted for; the peak flow, estimated to be in excess of 20,000 cusecs in August, may prevent closure. However, if there is damming it is likely to occur only once, and the lake could be breached the following spring or summer (1975). Observations, including the interpretation of ERTS imagery, are being continued.

G. Holdsworth

## THE REMOTE SENSING SOCIETY

Following a series of meetings in the United Kingdom, the Remote Sensing Society is to be formed. The initiative for this has come from a body of scientists, technologists, and administrators deeply interested in methods of measuring and managing the Earth's resources and environment. The Society is to be supported by members from the earth sciences (geography, geology, botany, etc.) as well as by members from the technological sciences (physics, engineering, computer science, photo-interpretation, etc.).

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## POSTSCRIPT

Have you returned your booking form for the Remote Sensing in Glaciology Symposium? Cambridge, 15-21 September 1974 (see Glaciological Diary).

# 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 1974:

Private members	Sterling: £5.00
Junior members	Sterling: £2.00 (under 25)
Institutions, libraries	Sterling: £10.00

**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  $\underline{f}0.50p$  per cheque. Thank you.

## ICE

#### Editor: Mrs Hilda Richardson

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