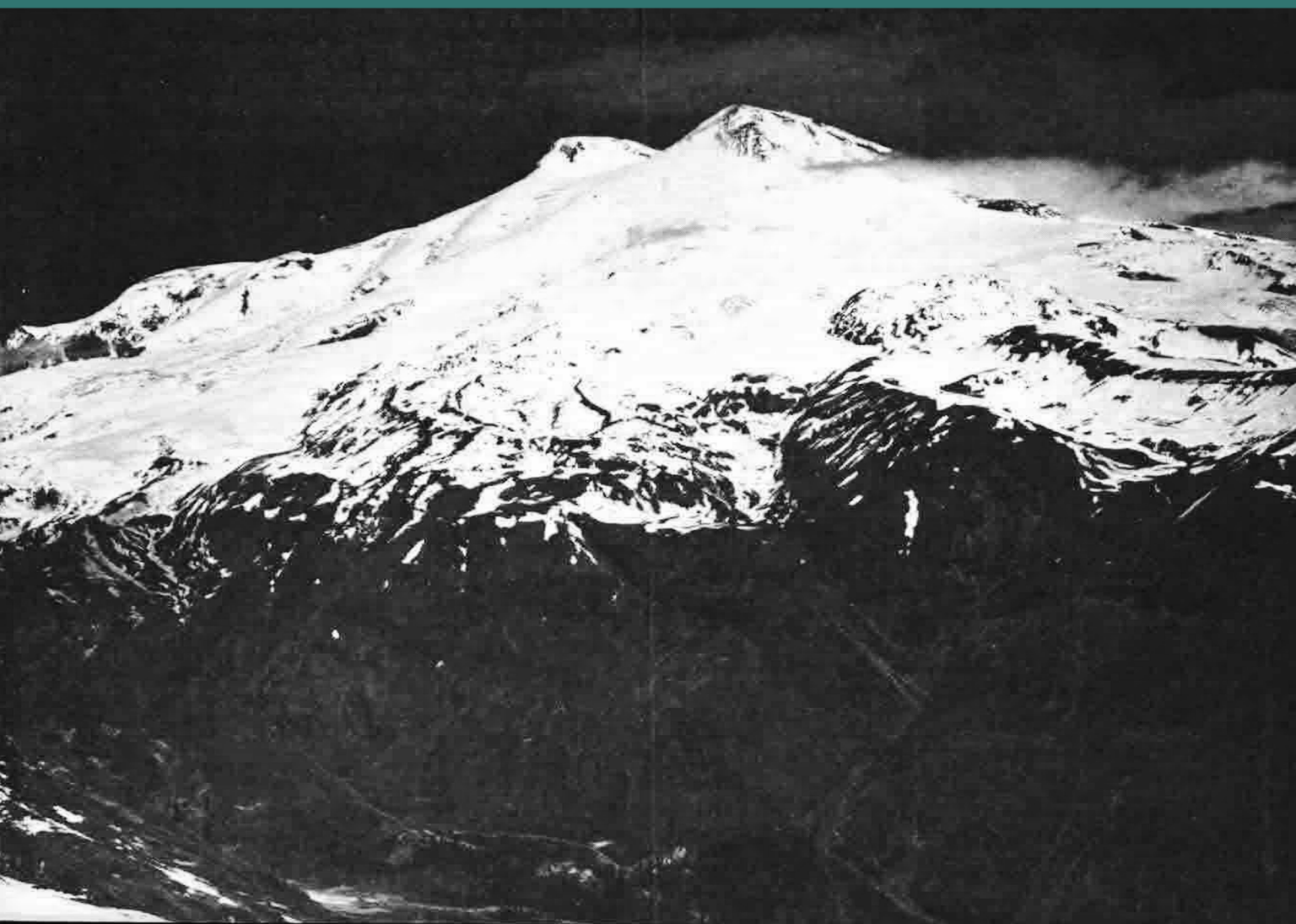
NUMBER 37

3rd ISSUE 1971

ICE



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ICE

NEWS BULLETIN OF THE GLACIOLOGICAL SOCIETY

3rd ISSUE 1971 NUMBER 37

CONTENTS

1972 ANNUAL CONFERENCE. Booking forms will be circulated to members early in 1972. If you intend to come to the Conference, please be sure to return the booking form quickly, so that we can reserve accommodation in good time.

INTERNATIONAL COMMISSION OF SNOW AND ICE. At the business meeting of the Commission held in Moscow during the XV General Assembly of IUGG, August 1971, the following officers were elected:

President	J. F. Nye
Vice-Presidents	V. M. Kotlyakov
	U. Radok
	N. Untersteiner
Secretary	F. Müller
Division Chairmen	E. R. LaChapelle (Snow cover and avalanches)
	W. F. Weeks (Sea, lake and river ice)
	N. A. Gravé (Ground ice)
	C. W. M. Swithinbank (Glaciers and ice sheets)

New statutes for the Commission were passed at the meeting, to replace the old and out-of-date ones. Information about the Commission may be obtained from its Secretary, Dr Fritz Müller, Geographisches Institut der E.T.H., 8006-Zürich, Sonneggstrasse 5, Switzerland.

COVER PICTURE. Mount El'brus, 5642 m, the highest peak in Europe, by Vaddim Gippenreiter. (Taken during the Glaciological Study Tour, held after the IUGG XV General Assembly in Moscow, August 1971.)

FIELD WORK

ITALY

The 1970-71 winter in the Italian Alps was a period of comparatively abundant snowfalls, although these were less heavy than in the previous year. At the Meteorological Station of Goillet (2526 m above sea level) in the Aosta Valley, 721 cm of snow fell, against 797 cm in 1969-70. While the quantity of snow was abundant, the frequency of falls was highly irregular and this hindered the formation of deep packed snow cover and made the winter snow supply poorer than normal. By 20 June the continuous snow cover had disappeared below 2600 m, even though enormous patches, fed by brief snowfalls, could be seen. These gave the mountains an almost winter appearance throughout June, although there was little depth or texture to the cover. In July the appearance changed: a succession of fairly hot days caused intense ablation and quickly melted the snow. The same conditions obtained in August. The mean monthly temperature for these two months at Goillet rose to 9°C, compared with a mean temperature over the previous decade of not more than 7°C. The fringes of residual snow around the glaciers gradually disappeared, and the snow line actually rose above 4000 m; this was also noted by Prof. Cerutti in the Mont Blanc massif. Snout areas often appeared extremely crevassed; huge séracs fell from the snouts, particularly from hanging glaciers. The melting of ice adhering to the walls of high cirques led to the accumulation of enormous cone-shaped masses of rocky detritus. Ablation continued in September and October, although the mean temperatures were lower. Throughout the ablation season, the differences between glaciers on slopes with different exposures were noted. Ablation was variable also between the Western and the Eastern Alps; the intensity was less in the Eastern Alps where cold north-east winds in the interior valleys reduced the mean temperatures.

The 1971 summer therefore interrupted the comparatively colder series of spring-summer periods that has been a feature of the last ten years. 152 glaciers were measured; of these 85 (56%) were retreating, 26 (17%) advancing, and 41 (27%) uncertain, stationary or under snow. The high percentage of retreating glaciers would seem to be a reversal of the trend towards a period of glacial advance. It is important to note that the snout of a glacier may advance while the main part of the glacier is either stationary or retreating. Such an apparent advance is possibly the result of sliding of the tongue, with meltwater circulating inside the body of the glacier. For example, the general advance of the Mont Blanc glaciers, which rest on very steep slopes, during the summer of 1971 may perhaps be interpreted not as the effect of an increase in the glacier mass but rather as the result of pushing against the glacier tongue by the ice masses in the high cirques. When such a thrust acts on glaciers clinging to particularly smooth and steep walls, there is likely to be a sliding movement, with the result that the glacier tongue breaks off and crashes into the valley. These "landslide avalanches" or "débacles" have been observed on Mont Blanc on both the Italian and French sides in recent years. One occurred at Tour in France in 1949, and one at Freney in Val Veni in June 1946 due to intense ablation. Examples may be found in other alpine areas, such as the ice slide from the Montabel glacier in the Conca del Breuil in 1946. W. Monterin, during his 1971 glaciological survey, noted that on the Piode glacier in Valsesia a large block of ice had come away from the snout and had advanced 12 m. On direct measurement, therefore, compared with the marker placed in 1970, the snout showed an advance of 12 m—whereas in fact the whole glacier mass had shrunk as a result of the same intense ablation that had caused the block to move forward. These snout slides of the Valsesia glaciers were also observed many years ago by Umberto Monterin, so the phenomenon is not new.

We can therefore see that snout variations alone may be deceptive and that it is sometimes necessary to examine the whole glacier tongue in order to reach a valid conclusion about the advance or retreat of the glacier since the last measurement was made.

VARIATIONS IN ITALIAN GLACIERS IN 1971

	Advancing	Retreating	Uncertain, snow covered, stationary
Western Alps	10	17	15
Central Alps	13	60	24
Eastern Alps	3	8	2
Totals	26	85	41
Percentages	17%	56%	27%

For detailed results, please write to the Comitato Glaciologico Italiano, Palazzo Carignano, Torino, Italy.

M. Vanni

POLAND

During 1971, from 25 June to 26 September, a Polish Expedition was working in the Hornsund region of Vestspitsbergen, as in 1970. The 8 man expedition was organized again by the Geographical Institute of Wrocław University and led by Dr Stanisław Baranowski. As in 1970 the expedition was transported by the High Marine School's ship s/t "Jan Turlejski" (Gdynia). The Polish Station in Hornsund, Isbjörnhamna, was used as a base.

The programme was similar to that in 1970 and concerned glaciological and geomorphological problems, mainly in the area of Werenskioldbreen and Hansbreen. The investigations included the following studies:

1. Elements of radiation and heat balance of periglacial tundra based on continuous records.
2. Local climate at Werenskioldbreen.
3. Ablation on Werenskioldbreen and ablation water discharge.
4. Movement of ice and its strain rate on Werenskioldbreen and Hansbreen.
5. Ice temperature on Werenskioldbreen and Hansbreen.
6. Natural tremors of Hansbreen based on microseismographic records at three sites on the glacier.
7. Deformation and ablation of ice under the medial moraine of Werenskioldbreen.
8. Changes in ice thickness and morphology of several chosen sites of Werenskioldbreen termini and its moraines, based on terrestrial photogrammetry.
9. Solifluction, stone rings and stone stripes on slopes around Hornsund.
10. Movement of stones in polygonal nets due to changes in the water content of the ground.
11. Formation of "naledi" type of ice in front of some glaciers and the morphological implications.
12. Origin and development of ice-cored moraines.
13. Depth of summer melting of permafrost in front of Werenskioldbreen and on periglacial tundra.
14. Deformation in systems with reversed density gradient on periglacial tundra in the Hornsund region.

The expedition built a new hut (20 square metres) in the main glaciological camp, 1.5 km from the Werenskioldbreen snout, to be used during glaciological work on and near Werenskioldbreen.

S. Baranowski

SWITZERLAND

Field work was carried out in 1970 by the following Swiss institutions: Gletscherkommission der Schweizerischen Naturforschenden Gesellschaft (GK), Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie an der Eidgenössischen Technischen Hochschule Zürich (VAW), Eidgenössisches Institut für Schnee- und Lawinenforschung, Weissfluhjoch-Davos (SLF), Abteilung "Low Level Counting" des Physikalischen Institutes der Universität Bern (LLC), Geographisches Institut der Universität Basel (GBA).

ANNUAL SURVEY OF GLACIERS (VAW & GK)

Of 98 observed snouts 31 have advanced, 6 were approximately stationary and 61 have retreated. The mass balance studies on the 4 glaciers regularly under observation showed small changes in mass for 1969/70, except for Gries/Aegina where a loss of 519 kg/m^2 was obtained. (Kasser)

On the Jungfraujoch ice cap a small net accumulation of only 0.3 m was observed. At the snout of Steinlimmigletscher the mean bed slip velocity was 3.33 cm/day with an observed maximum from 2-7 July of 8 cm/day. Longitudinal strain rates amounted to 2.1%/year at 125 m and 6.0%/year at 25 m from the terminus. (Haefeli)

HYDROLOGICAL TEST BASIN DISCHMA (SLF)

The origin of the run-off in relation to altitude has been investigated by isotope studies (with LLC) and the hydrological effect of avalanches has been studied. (de Quervain, Martinec)

CONSULTANT WORK OF VAW

The observations on a number of steep glaciers were continued in relation to ice avalanche problems in the same manner as in previous years. When the press stirred up the public with rumours of an impending catastrophic avalanche of the glacier de Giétro into the storage lake of Mauvoisin it was possible to show that the fears were unfounded, based on periodic studies and the information obtained from the glacier-flow recorder (cryokinegraph) described previously.

The outbreak of an ice-dammed lake causing a flood in the town of Saas Balen was witnessed, and advice was given for the construction of an ice tunnel to prevent a repetition of the flood in 1971.

GLACIOLOGICAL INVESTIGATIONS OF LLC

The gas content of ice samples from Aletschgletscher was analyzed using a highly sensitive gas chromatograph (with He- detector). The O_2/N_2 and Ar/N_2 ratios were found to decrease from Jungfraujoch to the snout, indicating a loss of the more soluble gases Argon and O_2. The concentration of the highly soluble CO_2 however was largest at the snout. Isotope studies of the ice samples showed that contamination by rain water is practically absent. (Oeschger)

ROCK GLACIERS (GBA)

Rock glaciers in various parts of the Swiss Alps were mapped by air photography and field observations. Temperature measurements in small drill holes have been started. (Barsch)

H. Röthlisberger

UNITED KINGDOM

WORK ON SWISS GLACIERS

W. B. Whalley has been continuing work on the Feegletscher. This involved an examination of the structure of the lateral moraines and the calculation of debris supply rates relating to moraine building and glacial erosion. Investigations in the late winter involved examination of the push moraine and englacial debris content from a small tunnel in the snout. This glacier has been advancing since 1961 and in the last two years has thickened and steepened substantially at the snout. The push moraine and rockslide debris from 1954 are now being overridden. Observations of this process are continuing. Velocity measurements in the ablation area have been continued on a simple basis, though it is hoped to extend and intensify these later.

Dr S. Evans and J. L. Davis of the Scott Polar Research Institute, Cambridge, are developing a radio-echo sounder to measure the ice thickness of temperate glaciers. The first experiments were to be carried out using a pulse modulated radio-echo sounder with a carrier frequency of 60 MHz. It was hoped that at this frequency the attenuation due to inhomogeneities in the ice would not be great enough to obscure the bottom echo and yet the antenna could still have reasonable gain and be manageable on alpine glaciers.

Dr H. Röthlisberger, of the E.T.H. in Zürich, offered logistic support and in March a thorough radio-echo sounding survey of the Aletschgletscher was completed. Bottom echoes were only received where the ice-bedrock slopes were steep; for example near the valley sides and to the east of Ober Mönchjoch and then only to a maximum depth of about 200 metres. Otherwise the records were mainly of 'clutter' echoes from within the ice. The results from the radio-echo sounding on the Griesgletscher were similar.

Using these results and other results obtained on temperate glaciers in Norway at 480 MHz, 150 MHz and 35 MHz, it was decided to experiment with frequencies below 30 MHz. Equipment was made for tests which were carried out on the Aletschgletscher in July. The results confirmed earlier predictions that a low radio frequency is necessary if the scattering in temperate ice is to be sufficiently reduced. A new radio-echo sounder is being developed and tested at S.P.R.I. and it is hoped that field tests will take place in 1972.

U.S.A.

CURRENT AVALANCHE RESEARCH IN NORTH AMERICA

Increasing utilization of land subject to avalanches has resulted in expanded efforts during recent years to understand and predict the occurrence of avalanches. In the United States avalanche research is carried out primarily by the US Forest Service, the University of Colorado, the University of Washington, and Montana State University.

The US Forest Service, with activity centered at Fort Collins, Colorado, has systematically supported avalanche research for many years, and is currently continuing to enlarge and improve a West-wide Avalanche Data Network. This network is designed to produce a flow of data relating to snow, weather, and avalanche conditions from the principal ski areas on national forest land throughout the Western United States. Data from these areas are augmented by information from such additional sources as mountain highways and mines. Work is now underway to design a data processing and analysis system to handle this flow of data. The ultimate objective will be to establish criteria for avalanche forecasting on a statistical basis. The broad background for this project is based on the expectation that avalanche warning systems, initially local and eventually

regional, will be evolved within the next decade. Additional Forest Service avalanche work is being conducted at the Alta Avalanche Center in Utah. The principal work at present is the further development of theoretical models for slab fracturing and avalanche release, and the preparation of training materials for the evolving Forest Service Avalanche and Winter Sports Training Program. As part of this program, a national avalanche school was planned for the week of 2-6 December 1971 at Reno, Nevada.

In the Spring of 1971 the Institute of Arctic and Alpine Research at the University of Colorado entered into a three year research contract with the Bureau of Reclamation to investigate avalanche conditions in the San Juan Mountains of south-west Colorado. This research is part of a larger study of cloud seeding, intended to augment run-off in the Colorado River Basin. The San Juan Mountains are the primary pilot study area of this Colorado Basin project. The avalanche investigation is aimed first at developing effective methods of forecasting the natural occurrence of avalanches, and second at investigating the possibility that increased precipitation resulting from the cloud seeding program may enhance avalanche activity in this region. A team of scientists and observers has taken up residence in Silverton, Colorado, which will serve as the headquarters for this study during the next three years. High altitude observation stations, each with a full complement of meteorological and snow observation equipment, have been established in the vicinity of Red Mountain Pass. Supplementary research is being conducted on the applications of nuclear profiling snow gauges to avalanche forecasting, and on the use of automated remote weather stations as an additional tool for such forecasting.

The University of Washington is engaged in a three year program to evaluate avalanche problems in the Cascade Mountains of Western Washington and to develop appropriate control procedures, especially in connexion with the new North Cascades Highway which traverses some 70 miles of rugged mountain terrain in northern Washington State. Preliminary efforts were concentrated on analyzing potential avalanche problems on the North Cascades Highway and on the production of a comprehensive avalanche atlas for the region. At present, work is underway to define the character of deformation and glide in a snow cover under conditions of climate, terrain, and vegetation cover characteristic of the Western Cascades. Complementary studies are also being conducted on the properties of newly fallen snow and the mechanical characteristics of slab avalanche formation. A new research facility, the Cascade Field Station, has recently been established by the University of Washington at Mount Baker, Washington. This high altitude station, located in a region of heavy snow fall, is designed primarily for investigation of phenomena of winter snow and avalanches. Initial facilities include housing and a limited amount of shop space.

Avalanche research is being pursued at the Bridger Bowl area near Bozeman, Montana, under the auspices of Montana State University. Investigations here include continued work on cornice formation and exploratory work on the basic characteristics of avalanche fracture and slab mechanics.

Avalanche research in British Columbia, under the direction of the Canadian National Research Council, has continued at Rogers Pass. Emphasis is on investigation of engineering problems relating to avalanche defence structures. Experiments to define impact forces and the behaviour of sliding avalanches are underway. In addition, a formal avalanche training course for observers and forecasters is being offered for the first time at the Rogers Pass site.

E. R. LaChapelle
G. Maykut

PLANS FOR THE 1972 AIDJEX PILOT STUDY

During the spring of 1972, the Arctic Ice Dynamics Joint Experiment (AIDJEX) will conduct the third in a series of pilot studies preceding the main experiment in 1974-75. Among the primary purposes of this pilot study are to: i) calculate mesoscale and macroscale ice strains in the sea ice, and to relate them to measured stresses; ii) determine to what extent surface pressure and geostrophic flow in the atmosphere can be used to derive regional values of wind stress at the top of the ice; iii) relate flow in the oceanic boundary layer and in the deep ocean to water stress at the underside of the ice; and iv) test the applicability and performance of various remote sensing devices (side-looking radar, microwave imagers, laser profilers, &c.) over Arctic sea ice. An array of manned and unmanned stations will be established on the ice pack about 400 km north of Point Barrow, Alaska. Some

300 tons of equipment and 80 scientific and support personnel will be airlifted to the site of the main camp in late February 1972. This will be one of the largest scientific operations ever attempted in the Arctic, including some 23 separate research projects, and investigators from 14 organizations in the United States, Canada and Japan.

The experimental array consists of: i) three manned stations set in an approximate equilateral triangle with 100 km sides; ii) five automatic data buoys deployed on the perimeter of a circle of about 400 km radius, centered on the main camp; and iii) an array of 12 to 16 ranging targets positioned around the main camp at distances of up to 15 km. Approximately 70 people will be housed at the base station, while a crew of 4-5 people will operate each of the satellite stations. Routine weather observations, deep oceanographic measurements, and position determinations will be performed at all manned stations. In addition to these measurements, the observational program at the main station will include air and water stress, ice acceleration and tilt, microscale and mesoscale strain, radiation, and heat budget.

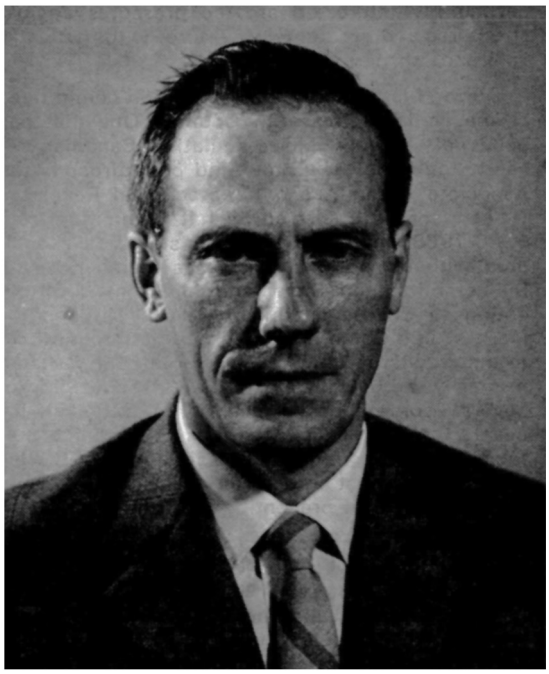
Of particular importance in the 1972 Pilot Study is the determination of strain on a number of different scales. Positioning of the manned stations will be accomplished with the Navy Navigation Satellite System which offers relative position accuracies of better than 50 m. Accuracies of 1 m may be possible between satellite fixes using an acoustic bottom referencing system. A test of such a system will be conducted at the main station this spring. Mesoscale strains will be derived from the movements of the ranging targets; distances will be measured both with pulsed laser (accurate to 1 m) and with continuous wave laser (accurate to 1 mm), while angles between the targets will be measured with a theodolite. On the microscale, strains will be obtained from bonded strain gages placed within a 1 km polygon. Stresses and deformational events within the polygon will be monitored. Comparison of these data should indicate the degree of correlation between strains over a wide range of scales within the pack.

Another objective of the field program will be to test the possibility of deriving regional values of wind stress from the synoptic pressure field. Pressure measurements, taken at the three manned stations, at the five data buoys, and at existing shore stations surrounding the Arctic Ocean, will be used to construct atmospheric pressure maps and to obtain geostrophic winds. Techniques are being developed to relate geostrophic winds to surface winds and thereby to surface stresses. Local wind stresses will be determined at the surface by both the profile and eddy correlation methods. Vertical profiles of wind velocity and temperature will be taken in the lower few hundred meters of the atmospheric boundary layer using the boundary profile system of the National Center for Atmospheric Research. Heat budget and radiation work will include measurements of net longwave and shortwave radiation, turbulent heat fluxes, ice temperature profilers, albedos over a variety of arctic surfaces, concentrations of ice-crystal aerosols, and atmospheric turbidity.

Oceanographic investigations will be concerned with three basic questions: i) the relationship of form drag to skin drag at the underside of the ice, ii) determination of water stress from velocity profiles in the Ekman layer, and iii) the degree to which flow in the Arctic Ocean approaches geostrophy. An array of ninety specially designed current probes, mounted in orthogonal triplets on four masts, will be employed for the measurement of the velocity and Reynolds stress fields in the turbulent boundary layer in the vicinity of a typical pressure ridge. In addition, velocities will be measured with conventional current meters at ten levels between 2 m and 100 m, providing water stress estimates by the profile method. To relate the deeper currents to those in the boundary layer and to determine the horizontal coherence of flow on a 100 km scale, current measurements below the Ekman layer will be carried out at all manned stations. Data from a STD recorder and Nansen bottles with reversing thermometers will provide the information necessary to calculate the mass field.

In conjunction with the ground-based observations, remote sensing data will be obtained during the experimental period from overflights of the test area with a NASA Convair 990 and a US Navy NC-121K. Instrumentation on board the aircraft will include aerial mapping cameras, side-looking radar, laser profilers, infrared scanners, and passive microwave imaging devices. Detailed ground truth measurements will support the airborne observations. Sequential images of the test area will provide information on the development of deformational features such as leads and pressure ridges, which will then be correlated with measured strains. Another important aspect of the remote sensing program is to test potential instruments and techniques which may be capable of remote determinations of ice thickness; the passive microwave sensors appear to be particularly promising in this respect.

The program for the 1973 Pilot Study, although dependent upon results from this year's experiment, will be much more modest, and will concentrate on solving any remaining problems with equipment or experiment design. Further information regarding the AIDJEX program may be obtained from the AIDJEX Coordinating Office, Division of Marine Resources, University of Washington, Seattle, Washington 98105, USA.



LORNE GOLD

Lorne Gold was born in Saskatoon, Saskatchewan, in 1928 and grew up on the prairies. Students of regional characteristics might well guess that he comes from that part of Canada, for his quietly relaxed, friendly and uncomplicated approach to life is typical of many prairie people.

He attended the University of Saskatchewan between 1946 and 1950 and obtained a degree in engineering physics. Up to this time he had had no contact with snow and ice research, nor any interest in it. It was a result of his taking an appointment in Ottawa with the National Research Council of Canada that the opportunities to study deformation and behaviour in ice stimulated his interest in glaciology. This work had been initiated in the NRC's Division of Building Research by Dr Robert F. Legget, Director of the Division, who saw very clearly the need for glaciological research in Canada. One of the first reports that Lorne studied provided welcome guidance. It was a report on snow and ice problems in Canada prepared by Dr Marcel de Quervain, who had spent a year working in the Division at Dr Legget's invitation. Lorne was granted leave of absence in 1951 to take a M.Sc. in physics at McGill University in Montreal. In his study of the characteristics of natural snow crystals, he was able to show the same relationship between temperature and shape that Dr Ukichiro Nakaya had recently obtained in laboratory work. This year at McGill was the beginning of a long and pleasant association with the University. The revived interest in ice physics at McGill, under Dr Elton Pounder, was of great help in the development of glaciological research at NRC.

In 1953, the Division of Building Research hired a second man to study ice problems, and gradually the Snow and Ice Section grew to an 8-man unit, with Gold as its head. The main concern of the section has been the engineering aspects of glaciology, but no opportunity has been lost to investigate other interesting and challenging problems. Much work has been done

on the deformation behaviour of ice, formation of ice in lakes and rivers, avalanches, heat exchange at natural surfaces, bearing capacity of ice covers, snow removal and ice control on roads, and ice pressures against structures. Lorne Gold's own special interests have been the deformation and strength behaviour of ice, the influence of snow cover on the ground thermal regime, and the bearing capacity of ice covers. His Ph.D. thesis in 1970 dealt with the failure behaviour of ice, a work based in part on his experimental research at DRB. The residence requirement at McGill University meant that during the academic year he had to "commute" weekly between Ottawa and Montreal. Only in this way could he keep in close touch with his family and maintain some contact with his work and colleagues at the Division.

There cannot have been much time in that winter for the usual family outings on skis—trips on which Lorne admits that he now has to concentrate on cross-country skiing because his four children, aged between 19 and 13, can outclass him on the hills. (A milestone that must be familiar in the life of many a glaciologist . . . .)

In 1969, the groups doing research on soils, permafrost, ice and snow in DRB were brought together to form a Geotechnical Section, with Gold as Section Head. In addition to snow and ice research, the Section studies soil stability, design of foundations, frost action, problems in permafrost areas such as the factors affecting the distribution and stability of permafrost, acceptable design, construction and operational methods for such regions, and the strength and deformation behaviour of frozen and thawed ground. It is not surprising that, with all this activity in the Section, Lorne has been heard complaining ruefully in his quiet voice that he is now too involved with paper work. The two subjects in which he is particularly interested are ice pressures against structures and ground temperature, with particular reference to permafrost.

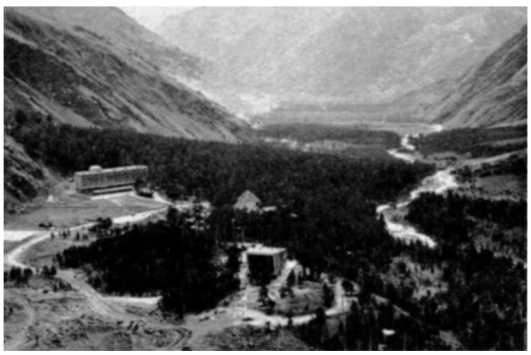
During his career he has served on committees at the National Research Council. One that has been very effective in stimulating Canadian research on soils, ice, snow and permafrost is the Associate Committee on Geotechnical Research. Dr Legget was Chairman of that Committee from 1946-1968, and members of his staff were associated with its work. Lorne was a member of the Subcommittee on Snow and Ice from 1955-68, acting as Chairman from 1958-68. Through the work of this Committee he was able to contribute to the growth of snow and ice research in Canada, primarily through the Committee's sponsorship of several conferences: "Bearing capacity of ice covers", "Heat exchange at snow and ice surfaces", "Snow removal and ice control", "Ice pressures against structures", "Use of air bubbling systems for preventing ice formation".

The growth of glaciological research in Canada gained impetus when the Government recognized the importance of water in all its forms. Lorne has gladly shared his knowledge and experience with those organizing water research in other Canadian agencies, and has had the satisfaction of seeing a great increase of activity in the last decade. His present position as Head of the Geotechnical Section in DRB is a tribute not only to his scientific ability but to his capacity for leadership and for liaison between the various disciplines involved in his work. He enjoys the challenge of glaciology: to maintain, in the face of rapid growth of knowledge, its character as a freely associating interdisciplinary group, providing sister disciplines with the co-operation and assistance they require.

GLACIOLOGICAL STUDY TOUR OF THE CAUCASUS, August 1971

Organized for participants in the XV General Assembly of IUGG (Moscow), by the Academy of Sciences of the USSR.

The tour, well organized locally by A. Bazhev, took us to the republics of Kabardino-Balkaria, Ossetiya and Georgia.



We stayed for five days in the Terskol valley,

visiting the Research Institute of the Faculty of Geography of Moscow State University—where the Director, Dr Plam, made us very welcome.

We walked through the valleys near El'brus—

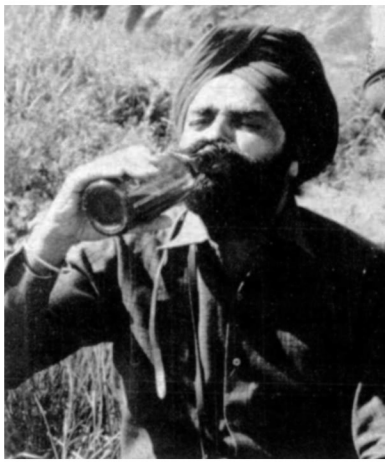
some people tried the tough mountain horses

(even the Secretary was taken for a ride)—

and we listened to Prof. Tushinskiy's unique illustrated talks.

We ate and drank very well, sometimes in typical Caucasian barbecue style (even a heavy downpour of rain could not spoil our appreciation of this feast, the gift of the Academy of Sciences USSR)—

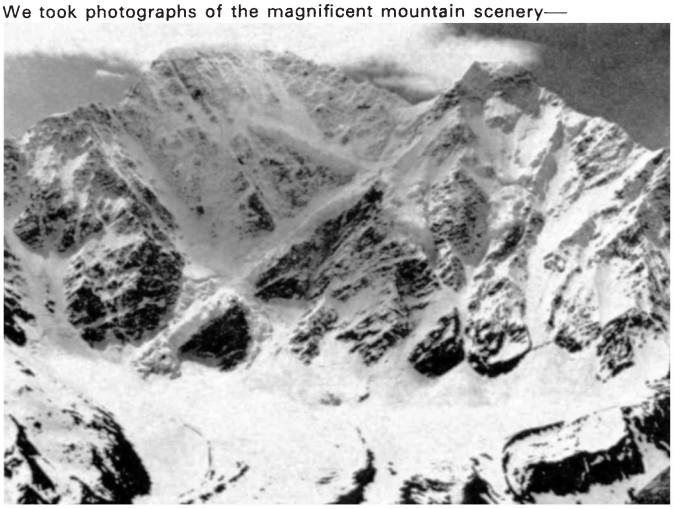
and sometimes more simply—



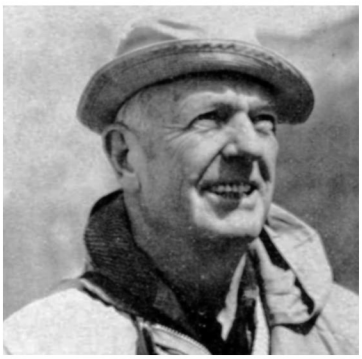
Many careful notes were taken . . . . . .

. . . except when the truck drivers were too enthusiastic

We took photographs of the magnificent mountain scenery—



and of each other.



The last part of the tour, through Ossetiya and Georgia, included some archaeology as well as glacial geology and geomorphology.

The hot sunny weather let us enjoy everything to the full.

The tour ended in Tbilisi, with a visit to the Georgian Hydrometeorological Institute.

Photographs by:
Mary Field
V. Gippenreiter
H. C. Hoinkes
G. Østrem
Hilda Richardson
V. Schytt
C. W. M. Swithinbank

GLACIOLOGICAL SOCIETY

MEETINGS

BRITAIN 1971

21 OCTOBER, Reading University, Department of Geography—"Centuries of world history in the polar ice sheets" by J. G. Paren.

FUTURE MEETINGS

1972

20 & 21 April, Scott Polar Research Institute, Lensfield Road, Cambridge, England (by kind permission of the Director)—Annual Conference. The sessions will begin at 0915 and 1415 each day. The afternoon sessions will end at approximately 1715.

20 April, 1730—Annual General Meeting.

1930 for 2000—Annual Dinner, at which the presentation of Seligman Crystals to Lyle Hansen and John Glen will take place.

21 April, 1900—Party (informal).

A circular, with booking forms for accommodation and for the Dinner and Party, will be sent to all members in February 1972.

THE LIBRARY

We thank authors or donors of books, reprints, maps and other publications for their gifts to the library.

Glaciological works, with their complete references, will be reviewed or listed in "Glaciological literature" at the end of the *Journal of Glaciology*.

Recent books acquired include the following:

R. J. Chorley *and* B. A. Kennedy. *Physical geography: a systems approach.* London, Prentice-Hall International Inc., [c1971]. xxi, 370p. Paperback £2.00; cloth £4.25.
[". . . represents an unreserved attempt to show how the phenomena of physical geography can be rationalized and perhaps made to assume new significance and coherence when treated in terms of systems theory, statistical analysis, cybernetics, and other modern inter-disciplinary approaches to the features of the real world."]

Comitato Glaciologico Italiano. *Archivo Fotografico. Catalogo Generale.* unpub. [Torino, Comitato Glaciologico Italiano, 1970.] [95] leaves.
[First part of the general catalogue of the photographic archives of the Comitato Glaciologico Italiano, listing particulars of photographs of Italian glaciers.]

E. R. LaChapelle. *Field guide to snow crystals.* Seattle and London, University of Washington Press, [c1969]. vii, 101p. Paperback $2.95; cloth $6.50.
[Reviewed in *Journal of Glaciology*, Vol. 10, No. 60, 1971.]

J. MacDowell *and* C. J. Callahan, *comp. International Hydrological Decade. International Field Year for the Great Lakes (Lake Ontario basin 1 April, 1972 – 31 March, 1973). The proceedings of the second international IFYGL workshop at McMaster University, Hamilton, Ontario, Canada. 7 – 9 July, 1971.* Burlington, Ontario, Canada, Centre for Inland Waters, IFYGL Centre, 1971. 288p. [Papers, reports, discussions.]

Pitty, A. F. *Introduction to geomorphology.* London, Methuen, [c1971]. xvi, 526p. Paperback £2.50; boards £5.00.
[Sections deal with: definitions, nature and basic postulates; landforms and structure; physical, chemical and biological basis of geomorphological processes; inter-relationships between processes and landforms; landforms and time; appendix on some simple methods of field measurement.]

Jahn, A. *Lód i zlodowacenia [Ice and glaciations].* Warszawa, Panstwowe Wydawnictwo Naukowe, [c1971]. 316p.
[Sections deal with glaciers, ground ice and floating ice (river, lake and sea).]

JOURNAL OF GLACIOLOGY

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

Articles—

S. G. Collins:
Survey of the Rusty Glacier area, Yukon Territory, Canada, 1967-70.

R. E. Dugdale:
A statistical analysis of some measures of a glacier's health.

A. J. Gow, F. de Blander, G. Crozaz and E. Picciotto:
Snow accumulation at "Byrd" station, Antarctica.

I. Hawkes and M. Mellor:
Deformation and fracture of ice under uniaxial stress.

W. D. Harrison:
Temperature of a temperate glacier.

A. Iken:
Measurements of water pressure in moulins as part of a movement study of White Glacier, Axel Heiberg Island, NWT, Canada.

J. B. Lyons, R. H. Ragle and A. J. Tamburi:
Growth and grounding of the Ellesmere Island ice rises.

L. R. Mayo, M. F. Meier and W. V. Tangborn:
A system to combine stratigraphical and annual mass-balance systems: a contribution to the International Hydrological Decade.

A. C. Palmer:
A kinematic wave model of glacier surges.

A. Post:
Periodic surge origin of folded medial moraines on Bering Piedmont Glacier, Alaska.

B. M. E. Smith and S. Evans:
Radio echo sounding: absorption and scattering by water inclusion and ice lenses.

Short note—

A. C. Pinchak:
Electronic detection of sérac avalanches and glacier noise at Vaughan Lewis Icefall, Alaska.

MEETINGS

IUGG XV GENERAL ASSEMBLY, MOSCOW 1971

SYMPOSIUM ON ENERGY FLUXES OVER POLAR SURFACES

(IAMAP/IASH/IAPSO/SCAR)

Session 1: Detailed energy fluxes over land surfaces

Chairman: H. C. Hoinkes

B. Holmgren: Energy exchange on a sub-polar ice cap in summer.

B. Barge: The influence of fog on the radiation budget of an ice cap.

M. Kuhn: Spectral energy distribution in short-wave fluxes over the East Antarctic Plateau.

G. Wendler: Some measurements of the heat balance in Central Alaska.

Session 2: Wind studies and detailed energy fluxes over sea ice

Chairman: E. R. Pounder

U. Radok: On the energetics of surface winds over the Antarctic Ice Cap.

T. E. Vinje: On the turbulent fluxes over an Antarctic Ice Shelf during the transition from stable to unstable stratification.

W. J. Campbell and L. A. Rasmussen: A numerical model for sea ice dynamics incorporating three alternative ice constitutive laws.

I. F. Allison: A sample study of the energy fluxes preceding, accompanying, and following the formation of Antarctic sea ice.

M. P. Langleben: The decay of a cover of sea ice.

Session 3: Large scale energy fluxes, regional studies

Chairman: N. Untersteiner

A. E. Basharinov, A. A. Kurskaya and L. T. Tushkov: Microwave radiation of ice cover on the Kara Sea.

M. P. Langleben: Albedo of ice-infested waters in the channels of the Canadian Archipelago.

E. Vowinckel and S. Orvig: Synoptic energy budgets from the Beaufort Sea.

R. M. Koerner: Ice accumulation and ablation in and ice export from the Arctic Ocean.

D. C. Thompson: Surface heat balance and climate in an ice-free area of Antarctica.

A. E. Basharinov, A. S. Gurvich, A. A. Kurskaya and D. T. Matveyev: Some results of measurements of microwave energy flow in the Antarctic zone.

Session 4: Large scale energy fluxes, global studies

Chairman: M. J. Rubin

M. I. Budyko: Energetic balance of polar areas and climate change.

J. O. Fletcher, Y. Mintz, A. Arakawa and T. Fox: Numerical simulation of the influence of Arctic sea ice on climate.

Ye. P. Borisenkov and M. Sh. Chernukhin: Estimation of the energy balance elements for the atmosphere of the polar zone of the Northern Hemisphere (northward of 50°N).

Kh. P. Pogosyan: The effect of large scale tropospheric processes upon the geopotential field variations and the stratospheric air circulation.

Session 5: Interaction between ocean and atmosphere

Chairman: A. F. Treshnikov

D. L. Laykhtman, K. L. Yegorov, A. G. Palagin, N. M. Lifshits and V. M. Radikevich: Dynamic and thermal processes of ice-cover as a link in the interaction between ocean and atmosphere.

S. D. Smith: Wind stress and turbulence over a smooth ice flow.

W. J. Seifert and M. P. Langleben: Air drag coefficients and roughness lengths of a cover of sea ice.

E. R. Pounder and O. M. Johannessen: Ice movement in the Gulf of St. Lawrence.

V. V. Bogorodski, B. Ya. Gaytskhoki and V. I. Trepolnikov: Methods of remote measurements of drifting sea-ice thickness and a photometric model of snow/ice cover.

Session 6: Needs and plans for future work in polar meteorology

Chairman: N. P. Rusin

Ye. P. Borisenkov: The Soviet programme of Polar Experiment.

N. Untersteiner: The AIDJEX programme.

FUTURE MEETINGS

INSTITUTE OF BRITISH GEOGRAPHERS
POLAR GEOMORPHOLOGY SYMPOSIUM

The following papers have been accepted for the meetings on 4 and 5 January 1972, in Aberdeen, Scotland, and will be published by the Institute of British Geographers:

Derbyshire, E.
Tors, rock weathering and climate in southern Victoria Land, Antarctica.

LeMasurier, W. E.
Volcanic record of Antarctic ice cap history and implications with regard to Cainozoic sea levels.

Ingle Smith, D.
The solutional erosion of limestone in an arctic environment.

Harris, C.
Soil movement in turf-banked solifluction lobes, Okstindan, Norway.

John, B. S.
Glacial history of West Antarctica.

Haynes, V.
Outlet troughs of the Sukkertopen ice cap, West Greenland.

Howarth, P. J. and Bones, J. G.
Process and form on high arctic debris slopes, Devon Island.

Cogley, J. C.
Fluvial activity and solutional processes in an arctic limestone terrain.

Funder, S.
Deglaciation history in the fjords of Scoresby Sund region, East Greenland.

Gill, D.
Modification of levée morphology by erosion in the Mackenzie River delta, N.W.T.

McCann, S. B. and Carlisle, -
The nature of ice foot on the beaches of Radstock Bay, S. W. Devon Island.

Kennedy, B. and Melton, M.
Slope forms in a permafrost area of the N.W.T., Canada.

Drewry, D. J.
Radio echo sounding in the investigation of Cainozoic tectonics and glaciation in Antarctica.

Boulton, G. S.
Role of thermal regime in glacial sedimentation—a general theory.

Lister, H.
Rock wear by sliding ice.

SECOND INTERNATIONAL CONFERENCE ON PERMAFROST

Yakutsk, USSR, 16—28 July 1973

The Soviet Academy of Science's new Scientific Committee for Cryology of the Earth (Nauchnyy Sovet po Kriologii Zemli) has issued an Information Bulletin, No 1, giving preliminary information about this conference.

The themes of the main session are to be:

1. Thermal and physical basis of problems in the formation and development of frozen ground.
2. Regional permafrost studies.
3. Genesis, composition and structure of frozen ground and subsoil ice.
4. Physics, physical chemistry and mechanics of frozen ground and ice.
5. Subsoil water in frozen ground.
6. Survey and forecasting of frozen ground.
7. Principles governing building on permafrost.

Those wishing to submit papers are asked to send three copies of a 500 word summary in Russian and English early in 1972 to the Scientific Committee for Cryology of the Earth, Ul. Fersmana, Dom 2, podyezd 4, Moscow 117312, USSR. Topics should be original, based on data of the last ten years, and concerned with the most interesting theoretical and practical questions.

The organizing committee (Chairman, P. I. Mel'nikov) will select the papers it wants from among the summaries received, and will notify authors, who should submit their papers by 1 June 1972. These should be about 3000 words, and will be published before the conference.

Field trips are planned after the conference. Details and cost will be given in the next number of the *Information Bulletin.* The registration fee for the conference is 30 roubles, and should be sent to Yakutsk Branch of Gosbank, Account No. 6112308 (Institut Merzlotovedeniya), Yakutsk, USSR.

GLACIOLOGICAL DIARY

1972

2-4 February
Canadian Pipeline Research Conference, Ottawa (I. C. MacFarlane, National Research Council of Canada, Ottawa, Ontario K1A OR6, Canada.)

20-21 April
Glaciological Society Annual Conference, Cambridge, England. (Mrs H. Richardson, Glaciological Society, Cambridge CB2 1ER, England.)

10-17 August
International Geographical Union, 22nd Congress, Montreal, Canada. (Secretariat, 22nd International Geographical Congress, P.O. Box 1972, Ottawa, Canada.)

14-18 August
Symposium on the physics and chemistry of ice. Royal Society of Canada. (M. K. Ward, National Research Council of Canada, Montreal Road, Ottawa 7, Canada.)

21-30 August
International Geological Congress, 24th Session, Montreal, Canada. (Secretary-General, 24th International Geological Congress, 601 Booth Street, Ottawa 4, Canada.)

6-20 September
Symposia on the role of snow and ice in hydrology. Banff, School of Fine Arts, Banff, Alberta, Canada. (Dr I. C. Brown, Secretary, Canadian National Committee for IHD, No 8 Building, Carling Avenue, Ottawa 1, Canada.)

26-29 September
Symposium on Ice and its action on hydraulic structures, I.A.H.R. Leningrad, USSR. (Mr B. P. Lebedev, committee for USSR participation in international power conferences, Sovmek, 11 Gorky Street, Moscow K-9, USSR.)

18-25 October
Radiocarbon Conference, Royal Society of New Zealand. (Mr G. W. Markham, Royal Society of New Zealand, P.O. Box 196, Wellington, New Zealand.)

1973

16-28 July
Conference on Permafrost, USSR Academy of Sciences, Yakutsk. (Institut Merzlotovedeniya, Yakutsk, USSR.)

2-10 December
International Union for Quaternary Research, congress, New Zealand. (Dr Jane M. Soons, Secretary-General, Dept. of Geography, Univ. of Canterbury, Christchurch, New Zealand.)

WORLD DATA CENTER A—GLACIOLOGY OPENS IN TACOMA, WASHINGTON, USA

by M. F. Meier

After 10 months of preparation, World Data Center A—Glaciology has opened its new facilities in Tacoma, Washington. The collection is now housed in an office suite adjacent to the Glaciology Project Office of the U.S. Geological Survey. It is not altogether inappropriate that the view from the windows of the new suite includes a panorama of the Cascade Mo ntains with the glacier-covered peaks of Mounts Rainier and Adams. The new location includes enough stack and file space for more then doubling the holdings of the center in addition to a separate map and photo room. A room is also provided for visiting researchers and conferences, while another contains facilities for copying material, including journal articles and parts of books. This room also serves as a preparatory area for the publication of *Glaciological Notes,* the quarterly bibliographic publication of the library. Three issues of this publication have been released since the Data Center was moved from its previous location in New York and the fourth will be issued in February 1972. Efforts have been made to improve the format and content of the publication with special attention given to expanding the subject and regional listings.

Current operations of the Data Center include reorganizing the collection in order to house it more efficiently and increasing the scope of the collection. Revision of the *CIG Guide to Data Centers* has been proposed and it is hoped that in this way the center can assume a more active role in the glaciological field. Attempts are being made to involve the Data Center with other, similar operations in both the areas of data storage and retrieval and data collection in order to keep up to date on new developments and increase the quality and quantity of services offered to our users.

In conjunction with Data Centers B and C [Moscow and Cambridge respectively] a system of international data exchange exists. At present this system is not untilized to its fullest, and Data Center A hopes to encourage and expand use of this international cooperative agreement.

In the information science field, as in most others, the trend towards computerization is inevitable. The Data Center is not neglecting this aspect and is studying ways in which computer technology could increase the value of the services offered. With this in mind, a plan for adding keyword subject access to the already existing Scott Polar Research Institute cataloguing scheme is being put into operation. These additional points of access to the collection would make specific subject searches by computer possible as well as increasing the subject access through the more traditional existing card cataloguing system.

A new and exciting acquisition to the Data Center is the complete collection of glacier aerial photographs taken by Austin Post of the Glaciology Project Office. The Data Center's existing collection, made excellent through the efforts of Dr W. O. Field of the American Geographical Society when it was under his direction, is greatly enhanced by this addition, containing as it does records of North American glacier changes from 1960 to the present. These photographs will be made available by the Data Center. Eventually, these photographs will be fully catalogued and indexed.

World Data Center A—Glaciology operates under guidance of the World Data Center A Coordination Office, National Academy of Sciences, and is supported in Tacoma by the U.S. Geological Survey. The staff includes: Dr Mark F. Meier, Director; Elizabeth A. Schwartz, Librarian; and Terri A. Hurdlow, Clerk.

The Data Center welcomes telephone and mail inquiries but hopes that use of the collection will not be limited to these. We are offering excellent working conditions to those who wish to research the collection personally and we would gladly welcome such use. We would also welcome additions to the mailing list for complimentary copies of the quarterly *Glaciological Notes.* Please address requests and inquiries to: World Data Center A—Glaciology, U.S. Geological Survey, 1305 Tacoma Avenue South, Rm. 304, Tacoma, Washington 98402, U.S.A. (Phone: 206-383-2861 ext. 276)

Icefield Ranges Research Project, Scientific Results. (Vivian C. Bushnell and Richard H. Ragle, editors; foreword and introduction by Walter A. Wood). American Geographical Society, New York, and Arctic Institute of North America, Montreal. Vol. 1 (1969), xv, 224 p., illus., maps. $6.00.* Vol. 2 (1970), ix, 138 p., illus. $6.00.*

Starting in 1961, the American Geographical Society and the Arctic Institute of North America have jointly sponsored the Icefield Ranges Research Project with the objective to study the environment of the St. Elias Mountains at the Alaska-Yukon border, which represent one of the large mountain complexes of the earth. The backbone of the St. Elias Mountains is formed by the Icefield Ranges, from where emerge some of the largest glaciers outside the polar areas, such as the Hubbard with a length of 120 km, or the Kaskawulsh measuring 72 km. The profile studied follows the latter and includes part of the Hubbard and Seward and culminates at the Kaskawulsh-Hubbard divide at an altitude of about 2630 m.

Although the scope of the project is geographical in nature, the participants have from the beginning represented a large variety of scientific fields, including meteorology, climatology, glaciology, glacial geology and biology.

Volume 1 of the scientific reports is a collection of 19 different papers covering the activity in the physical and earth sciences of the first few years of the project (mainly 1963—1965). The majority of the papers, 14 by number, have also been published elsewhere in scientific journals or institutional reports. The more important articles have thus been available to the scientific community before, though from 11 different sources! To obtain them bound together in one volume is not only practical, but gives a comprehensive view of the project activity. The main benefit of the publication is that it draws the attention of the reader of one article to all the others, thereby bringing other problems of the high mountain environment—possibly related to his own interests—to the reader's attention. Furthermore the volume is equipped with a three-colour contour map at the scale of 1:500,000, and it is illustrated with impressive landscape photographs which are not part of the previously published papers.

Three papers deal with meteorology and climatology (Havens and Saarela; Marcus; Taylor-Barge). The main emphasis is placed on the question to what extent the St. Elias Mountains form a climatic barrier and in what relation the climatic divide stands to the topographic one. Studies include various climatic elements and it has been attempted to separate regional from local effects, for instance by comparing twin stations, one at the glacier surface and one on bare ground. Although one or two seasons seem short for climatological studies, the observations from the mountains can be combined with the results of the more permanent weather stations on both sides of the St. Elias Mountains, Yakutat and Whitehorse, by which way more general conclusions are possible. The four following papers deal with the snow cover and its physical conditions including O_{16}/O_{18} ratios (Wagner; Macpherson and Krouse; Grew and Mellor). Because of the limited time scale the snow studies have the character of reconnaissance work leaving many questions open. From the distribution of the saturation and percolation facies it seems nevertheless possible to arrive at the conclusion that Kaskawulsh glacier is neither typically temperate nor entirely subpolar. A next group of four articles covers geophysical investigations and glacier mechanics. In a remarkably concise paper Clarke presents gravimetric and seismic soundings on the Kaskawulsh and Hubbard glaciers including interesting details on technique and relating the results to flow studies. One finding of some general interest is that the topographic and flow divide coincide, while there is no corresponding bedrock divide. A short note on radio-echo sounding (Nelsen) states that the technique was applicable in the divide region between the Kaskawulsh and Hubbard glaciers. From recent experience in the Alps this implies that these glaciers are not truly temperate, confirming the interpretation of the snow studies. An extensive analysis of observational data on the formation of transverse crevasses in relation to strain rates is given by Holdsworth, and flow velocities are discussed by Brecher (there does not seem to be any significant seasonal change in the accumulation area). Two "letters to the editor" of the *Journal of Glaciology* on moulins and a water-spout follow (Dewart; Ewing, Loomis and Lougeay). The remaining six articles cover the field of glacial geology, morphology and chronology. The changes of level of Kluane Lake and a drainage reversal are discussed by Bostock in view of the glacial history of the area. Fahnestock describes the river morphology of one of the large outlet streams of Kaskawulsh glacier. Two papers (Denton and Stuiver; Borns and Goldthwait) deal with the retreat of the Kaskawulsh glacier at the end of the ice age and the later re-advances and present a number of important C^{14} datings. Further stratigraphic and more chronological information extending the time scale

* $4.00 to fellows and associates of AGS and AINA.

further back is contained in a second paper by Denton and Stuiver. Finally the age of a conspicuous layer of volcanic ash is discussed in a short note (Stuiver, Borns and Denton).

Volume 2 contains 15 papers, all previously published elsewhere (one in the *Journal of Glaciology).* They cover project activities of 1965—1968. Of the 10 papers dealing with the physical and earth sciences, 8 are glaciological; the 5 remaining short articles are concerned with the biological sciences.

A first series of reports refers to the meteorological and climatological aspects in a similar way as in Volume 1, further enhancing the role of the St. Elias Mountains as a climatic barrier. In this context the upper-air wind patterns have been studied (Benjey): considerable deviations from simple air-flow models have been found. On the local scale a 10-day microclimatological study over a flat snow field has been carried out (Lougeay), and the ablation rates on a medial moraine of the Kaskawulsh glacier have been observed in relation to till thickness and the resulting topographical features (Loomis). Four papers deal with snow accumulation and snow properties (Keeler; Alford and Keeler; Mellor; Alford): the precipitation pattern with altitude and distance from the coast, snow density and temperature distribution, and optical properties are given. Two major articles are concerned with glacier physics at the confluence of the two major arms of the Kaskawulsh glacier. One deals with ice deformation (surface movements and strain rates), surface structures and petrofabrics (Anderton), the other with microseismic noise and its sources, seismic velocity inhomogeneity and anisotropy, and bedrock topography obtained by seismic soundings (Dewart). A short geomorphological paper (Price) refers to solifluction lobes and blockfields.

Some substantial results have come out of the Icefield Ranges Research Project, and studying the reports contained in the two volumes published so far is well worth the effort. This is particularly true for those working in other mountain areas such as the Alps. With a lower equilibrium line (firn line) as compared to peaks, valleys and passes, the St. Elias Mountains are to-day much more extensively covered by glaciers than the Alps and can thus be viewed as a model of the latter ones at some ice-age stages. Some insight into the behaviour of the large Alpine valley glaciers can be expected from the present-day glaciological studies of the Icefield Research Ranges Project.

H. Röthlisberger

Research in the Antarctic (L. O. Quam and H. D. Porter, editors), American Association for the Advancement of Science, Washington, D.C., Publication No. 93, 768 p., 1971.

Research in the Antarctic is the product of a symposium presented at the December 1968 meeting of the American Association for the Advancement of Science. The symposium was organized by the staff of the United States Antarctic Research Program (USARP) under the general editorship of Dr. L. O. Quam and is effectively a "show and tell" for a selected portion of their program. Because the USARP program has always been diverse, one would expect the present book to range over a wide variety of subjects, and it does. The main sections of the book are concerned with biology (8 papers), glaciology (4), cold poles and heat balances (3), conjugate phenomena (6), ocean dynamics (4) and Gondwanaland (5). Also included are brief histories of the Antarctic Treaty and the Scientific Committee on Antarctic Research as well as a historical note on the work of James Eights.

Of particular interest to glaciologists are the long review papers by Nicols on the "Glacial geology of the Wright Valley" and by Bull on "Snow accumulation in Antarctica". Shorter papers by Crary and by Langway, Gow and Hansen review studies of the "Thickness of ice and isostatic adjustments . . ." and the "Deep drilling into polar ice sheets . . ." respectively. Other papers of interest discuss the ". . . Climate of interior Antarctica" (Dalrymple and Frostman), "Antarctic . . . as a test tube for meteorological theories" (Lettau), ". . . Oceanographic studies of Antarctic waters" (Gordon), "Antarctic deep water . . ." (Warren), and "The formation of Antarctic bottom water" (Elder and Seabrooke). Although the length and the depth of the papers vary widely, the general quality of the contributions is good with each contributor addressing his particular speciality. The book is also well edited and the quality of the printing is high.

In fact the book has only two slight drawbacks: (1) the delay of over two years between conference and publication has already made some of the contributions a bit dated; and (2) it is expensive relative to the total amount of glaciological information. If one's enthusiasm is not dampened by these two items, the book can be highly recommended to those who wish to obtain an overview of the varied and impressive USARP program.

W. F. Weeks

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THE GLACIOLOGICAL SOCIETY

Cambridge CB2 1ER, England

DETAILS OF MEMBERSHIP

Membership is open to all who have scientific, practical or general interest in any aspect of snow and ice study. Members receive the Journal of Glaciology free. Forms for enrolment can be obtained from the Secretary. No proposer or seconder is required. Annual subscription rates 1972:

Private members—	Sterling:	£5.00
Junior members (under 25)	Sterling:	£2.00
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. (For example, the U.S. dollar rate was $2.60 to the £1 in December 1971, but may change again in the next few months.) 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: Mrs. H. Richardson

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

Annual subscription for libraries, &c, and for individuals who are not members of the Glaciological Society:

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