NUMBER 83 1st ISSUE 1987

ICE

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

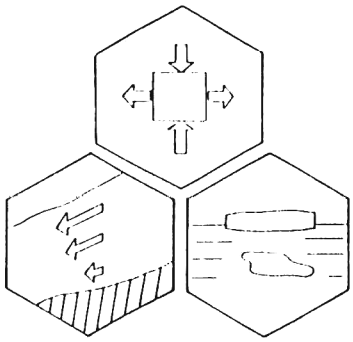
INTERNATIONAL GLACIOLOGICAL SOCIETY

SYMPOSIUM ON

ICE DYNAMICS

Hobart, Australia

14 - 20 February 1988



Pre-Symposium Science Tour of Hawaii 6–12 February

Post Symposium Glacier Tour of New Zealand 20–26 February

SECOND CIRCULAR

February 1987

Australia
1788-1988

An Australian Bicentennial Activity

CO-SPONSOR - Antarctic Division, Department of Science, Hobart

APPOINTED TRAVEL AGENT -
Traveller's World,
Marble Arch House,
66–68 Seymour Street,
London W1, U.K.
Tel: 01-4022371
Telex: 23177 G

OFFICIAL DOMESTIC CARRIER -
Australian Airlines

See pages 15–17 of this issue of *ICE* for extracts from the circular, which was mailed to members of the Society in February 1987.

ICE

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

NUMBER 83 1ST ISSUE 1987

CONTENTS

PHOTOGRAPHS. The Editor would like to revitalise the stock of photographs of ice crystals and unusual ice formations, to use as cover pictures for *ICE*. Any members with good black-and-white photographs, printed at the size of the cover picture on this issue of *ICE*, is encouraged to send them to her for consideration, with appropriate credit and caption information: Mrs H. Richardson, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK.

COVER PICTURE: Ice and water droplets on a spider's web and vegetation.
Photograph by E. Wengi, Swiss Federal Institute for Snow and Avalanche Research, Weissfluhjoch, Davos, Switzerland.

POLAND

KING GEORGE ISLAND SURVEY

From 30 October 1984 to 4 April 1986, seventeen members of the 9th Polar Expedition conducted research at the Antarctic Arctowski Station. Four American scientists and a West German one visited them. The research group dealt with:

(1) A study of polar ecosystems, in terms of their influence on the human body and the rational utilization of living resources and environmental protection;

(2) The geodynamics of the polar regions; study of the evolution of the lithosphere and of the formation of useful mineral deposits.

SPITSBERGEN SURVEY

The Institute of Geophysics (PAS) organized the 2nd Geodynamics Expedition under Prof. Guterch. It carried out geophysical studies (explosive seismology) on the structure of the Earth's crust in West and North Spitsbergen in July and August 1985. Simultaneous detailed geological investigations were also made.

NEW POLAR RESEARCH PROJECT

A new research project (CPBP No. 03.03) "Living resources, lithosphere and environmental protection in the Polar regions" has been devised for 1986-1990. The main study areas are the Antarctic Arktowski Station (King George Island) in Antarctica and Hornsund in Spitsbergen. Five expeditions to the Arctowski Station and two marine expedition on the r/v *Profesor Siedlecki* will be organized through this project.

UNIVERSITY EXPEDITIONS

Silesian University: A glaciological research programme was carried out by cooperating members of two expeditions to Spitsbergen:

1) An autumn (August-October) expedition with members from Poland, Spain and Cuba, and

2) The annual PAS expedition from July 1985 to July 1986.

The former investigated karst and glacial phenomena in Nordenskiöld Land, and fluctuations of the Hans, Werenskiöld and Torell glacier fronts in the Hornsund region, as part of the World Glacier Inventory.

Wroclaw University: The Geographical Institute expedition to Hornsund undertook permafrost and active layer studies, from July-September 1985.

Jagiellonian University: The Institute of Geography continued their work from June-September in Sörkappland, south Spitsbergen, on a comprehensive study of the environment.

N. Copernicus University of Torun: The Institute of Geography, organized an expedition to Kaffiöra, northwest Spitsbergen, from June-September 1985. The research programme included hydrological, geomorphological, periglacial and pedological studies.

A. Mickiewicz University of Poznan: The Quaternary Research Institute conducted research into the present-day denudation system of the Polar zone (a case study of Petuniabukta) in central Spitsbergen, from June-August 1985.

THE POLAR CLUB

The 12th Polar Symposium, 19-21 September, 1985, was held in Szczecin. Participants presented papers on geological, geophysical, biological and geomorphological problems of Spitsbergen and Antarctica and reported on some Polish expeditions to these regions. Altogether, 37 papers and reports were delivered and a poster session was held.

PUBLICATIONS

In 1985 the following publications were issued:

1. *Polish Polar Research*, Vol. 6, Nos. 1-2 with articles on the BIOMASS-SIBEX programme following the 1983-1984 expedition of the r/v *Professor Siedlecki* to the Antarctic; No. 3 reporting on the geomorphological, meteorological and hydrological problems of the Hornsund and Petuniabukta regions, Spitsbergen, as well as the topography and wind structure at the Dobrowolski Station, Bunger Oasis, Antarctica.

2. *Polar Studies of the Jagiellonian University Spitsbergen Epeditions 1980-82*, edited by Z. Czeppe, Prace Geograficzne 63, Kraków 1985, presenting the research results from Sörkappland, south Spitsbergen, concerning the environment of archaeological finds and settlement.

3. Abstracts of papers from the 12th Polar symposium (in Polish), Szczecin 1985.

SYMPOSIA AND SEMINARS

The First Polish-Soviet symposium on Antarctic Ecosystems with special reference to Krill (*Euphausia superba*) was held at the Antarctic Arctowski Station, King George Island, in December 1985. Thirteen Polish papers and 20 Soviet ones were presented.

A Seminar on Polar and Glacial Karst, 1 March 1986, was arranged within the frame-work of the 10th Speleological School by Prof. Pulina, of the Silesian University, in collaboration with Wroclaw University. Participants from Canada, Norway, Great Britain, Bulgaria, Czechoslovakia and Hungary attended the seminar. Stefan Kozarski

SWEDEN

GLACIAL HYDROLOGY AND ICE DYNAMICS, STORGLACIÄREN, KEBNE-KAISE REGION

(R.LeB. Hooke, G. Brand, GEOL/Minnesota, S. Miller, GEOL/Maine, P. Jansson, M. Kennett, GEOG//Stockholm, V. Pohjola, GEOG/Uppsala)

The most interesting results from the 1986 field season at Tarfala stem from a series of experiments in an overdeepening upglacier from a riegel that crosses the glacier near the middle of the ablation area. We now believe that a layer of deformable till exists between the glacier and the bedrock in this overdeepening.

The key experiments involved measurements in boreholes drilled to the bed in the overdeepening. Borehole deformation measurements were made in a 132 m hole about halfway between the centerline and the northern margin of the glacier and ~ 350 m upglacier from the riegel. Previous borehole-deformation studies have shown that during July and August the glacier is decoupled from the bed along the centerline for some distance upglacier from the riegel. The borehole this year was placed in a lateral position in an attempt to place limits on the width of this area of decoupling. Preliminary results suggest that the decoupling extends to this position.

The borehole-deformation measurements also provide evidence for a temporal change in the pattern of transverse flow at depth. Up to early August the flow is toward the north, which in this case is toward the nearest margin of the glacier, and is thus consistent with theory. This flow is strongest near the bed. The northward flow, however, is replaced by a southward flow in mid-August. We hypothesize that this is related to an increase in the resistance to flow over the riegel. By late August this southward flow, although still present, seems to have diminished. However, such flow at this time is consistent with contemporaneous tiltmeter measurements that indicate an uplift of the center of the glacier.

The borehole used for deformation measurements was one of 10 closely-spaced holes along a transverse profile. The holes were drilled in this pattern in order to make resistivity measurements using electrodes in contact with the substrate at the bottom of the holes. We found a quite low resistivity in the substrate and interpret this as indicating that there is a layer of till between the glacier and the bedrock. The close spacing of the boreholes allows an estimate of the thickness of this till layer: ~ 0.5 m. A sampler used to collect water from the base of one of the holes came up with a lump of compact clay attached to it, suggesting that this is the composition of the till.

In the past, we have noted frequently that water levels in holes drilled in the area extending from ~50 to ~300 m upglacier from the riegel dropped when the drill tip reached a level equivalent to 75% to 90% of the ice thickness. However, upon completion of the holes we found that the water level was only 20 to 25 m below the surface, and remained stable at that level, in one case even when water was flowing into the hole. In order to investigate this further we diverted surface streams into two of the holes drilled this year and poured salt into the streams. We then measured the conductivity of the water as a function of depth and time. In both cases the conductivity decreased rapidly with time in the upper part of the hole, but a residual column of highly conductive water remained immediately below the point where the drill tip was when the water level fell. We thus conclude that the holes were draining at this level and not higher. A further important conclusion is that there is waterflow into one of the holes from the bottom. This is suggested by the fact that the salt column does not extend all the way to the bottom, as would be expected from density considerations.

In contrast to previous experience, water levels in the boreholes drilled this year, midway between the centerline and the margin, varied with time, although remaining very close to the ice overburden pressure. This, in conjunction with the evidence that the holes made contact with the subglacial water system, suggests that decoupling of the glacier from the bed can be attributed to high water pressures. Furthermore, the fact that water levels do not seem to vary appreciably near the centerline, but do vary nearer the margins, suggests that changes in centerline velocity during the summer are controlled by variations in water pressure near the margins.

The tiltmeter measurements also showed a diurnal pattern superimposed on the rise mentioned earlier. We tentatively attribute this to water waves passing downglacier from a crevassed area just above the equilibrium line.

A dye-trace experiment, utilizing a stream flowing into a crevasse on the north side of the glacier above the equilibrium line as an input point, proved to be quite interesting. The dye took much longer to appear than expected, appeared during two distinct periods separated by 10 days with no output, and appeared in Nordjokk, the northerly of the two main streams draining the glacier. In contrast, in all previous experiments, utilizing moulins near the riegel as injection points, dye has come through in one continuous pulse that peaked within one to two hours of the injection time, and has been detected in

Sydjokk (South stream) only. The low water velocity through this area suggests that the subglacial till layer may be present over a large area of the overdeepening, thus inhibiting flow along the ice-bed interface.

We also (weather permitting) continued daily measurements on two 5-stake strain nets, and again found a sensitive response of the glacier to daily water input.

RIUKOJIETNA

(G. Rosqvist, P. Holmlund, GEOG/Stockholm)

Riukojietna (4.6 km^2), located 35 km NW of Kebnekaise, is the only ice cap in Sweden. Like all other Swedish glaciers it has diminished considerably during this century. Sediments from small proglacial lakes indicate that the glacier in postglacial time has been actively eroding the last 2500 years, while sediments from the proglacial area of a cirque glacier located 8 km farther north show continuous activity for the past 9000 years. In order to explain why these glaciers react so differently to climatic change, a mass balance study of Riukojietna was initiated in 1986. Moreover, radar sounding was used to determine the ice depths and this study also seems to suggest that the ice cap is cold-based in certain areas. As a result ice temperature measurements will be made during 1987.

AVALANCHE STUDIES, KEBNEKAISE REGION

(R. Kjessel, GEOG/Stockholm)

Mechanisms of avalanche release, particularly the dependence on the liquid water content of the snow, have been studied for both wet loose-snow avalanches and slush avalanches.

AVALANCHE FORECASTING

(M. Östling, GEOG/Stockholm)

Avalanche problems in Sweden have increased during recent years due to the increased popularity of cross-country and heli-skiing. Therefore a project concerned with devloping better methods for relevant meteorological and glaciological data collection as well as better methods for registration of released avalanches in the more popular areas has been initiated. At the end these data should be used in some sort of index of avalanche risk.

NIVATION AND MINI-GLACIERS, ABISKO REGION

(A. Rapp, R. Nyberg, L. Lindh, GEOG/Lund)

A series of snowfields has been selected for studies of nivation processes on gentle slopes. The processes of snow accumulaiton, melting, slope wash, geligluction, frost weathering and relation to frozen ground and thawing will be studied, from lower to high elevation (700-1200 m a.s.l.).

MASS BALANCE STUDIES, KEBNEKAISE REGION

(W. Karlen, P. Jansson, P. Holmlund, H. Grudd, GEOG/Stockholm, K. Rudensky, GEOL/Minnesota)

Glacier	Area (km^2)	Aspect	Mass balance data b_w (m)	b_s (m)	b_n (m)	ELA (m a.s.l.)
Rabots Glaciär	3.8	W	1.28	-1.47	-0.19	1385
Storglaciären	3.0	E	1.62	-1.68	-0.19	1485
Björlings Glaciär	1.4	S	1.39	-1.23	+0.16	1650
Sydöstra Kaskasatjåkkagl	0.5	SE	1.65	-1.56	+0.09	1600
Tarfalaglaciären	0.9	E	2.12	-2.09	+0.03	1510

The 1985/86 mass balance of Storglaciären was approximately zero and so was the result of 4 other glaciers in the region. While the two largest (valley glaciers) were slightly negative, the smaller ones (cirque glaciers) had slightly positive net balance.

Air photos from 1949, 1959, 1969 and 1980 have been used successively to produce photogrammetric maps of Storglaciären. These maps now give possibilities of studying exactly where on the glacier mass changes have taken place and they also verify our 41-year-long mass balance study of Storglaciären. The mass change between 1959 and 1980 as calculated from the corresponding maps only deviates 10% from the value derived from the mass balance study (-20.2 Mkg).

USA

WESTERN REGION

As of 1 September 1986, the Project Office-Glaciology (POG) of the U.S. Geological Survey has been merged with another office, the Cryospheric Interactions Project (CIP) to form a new office entitled Ice and Climate Project. The project chief is Dr W. Campbell and the new project members are Ed Josberger, Steve Hodge, Frank Danes, Nelly Mognard, and Charlie Ling from CIP and Al Rasmussen, Bob Krimmel, Andrew Fountain, Suzzane Brown, Austin Post, and Bruce Vaughn from POG. All correspondence with the former Project-Office Glaciology and the Cryospheric Interactions Project should be addressed to:

Ice and Climate Project
U.S. Geological Survey
University of Puget Sound
Tacoma, WA 98416, U.S.A.

On 4–5 December 1986, the annual meeting of Northwest Glaciologists was convened by Charlie Raymond (University of Washington, Department of Geophysics) at the Applied Physics Laboratory on the campus of the University of Washington, Seattle, WA. Fifty-eight people from the western U.S. and Canada attended the meeting and 37 papers were presented on 12 different topics (agenda follows). Steve Warren of the University of Washington, Department of Atmospheric Sciences, hosted a fine buffet gathering at his home on the first night of the meeting. The 1987 meeting will be hosted by the U.S. Geological Survey in Tacoma, WA.

Agenda for the Northwest Glaciologists' Meeting, 4–5 December 1986, held at the University of Washington, Seattle, WA. Meeting Chairman – Charlie Raymond

Day 1: 4 December 1986
Morning

SNOW

Ed Josberger, USGS-ICP: Satellite passive microwave observations of the Colorado river basin snowpack

Mathew Sturm (for Carl Benson) CRREL-F: Regional snowmelt on the Alaskan Arctic coast

Jon Rhodes, UW-F: Mode of ablation hollow formation controlled by dirt content of snow

WASHINGTON STATE GLACIERS

Ed Waddington, UW-GPHYS: Blue Glacier ice divide

Andrew Fountain, USGS-ICP: Subglacial hydrology of South Cascade Glacier

Carolyn Driedger, USGS-D: Outburst floods at Mt Rainier

NEPAL

George Wallerstein, UW-ASTRO: Ice ships and moraines on K2

ANTARCTICA

Steve Warren, UW-A: Optical properties of Antarctic snow

Pieter Grootes, UW-QRC: Inland ice/sea transition in the J-9 ice core, Ross Ice Shelf, Antarctica

Afternoon

BASAL WATER FLOW THEORY

Neil Humphrey, UW-GPHYS: Tesselated beds, a distributed subglacial flow system

ALASKAN TIDEWATER GLACIERS

Steve Porter, UW-QRC: Mean rates of advance and retreat of the Icy Bay glacier system during the Little Ice Age

Larry Mayo, USGS-CRHP: Hubbard glacier advance

Bob Krimmel, USGS-ICP: Columbia Glacier photogrammetry data set 1981-82 and 1984-85. Columbia Glacier short term velocity 1986

Roy Walters, USGS-TPP: Diurnal variations in glacier speed, Columbia Glacier

Al Rasmussen, USGS-ICP: Internally consistent set of flow and geometry data for the lower part of Columbia Glacier

ICE RADAR

Francis Jones, UBC-GPHYS: Portable impulse radar: results and numerical modeling of bed echo characteristics from Trapridge Glacier, Yukon

Bob Jacobel, SOC-PHY: A digital ice radar recording system – field tests and results from South Cascade Glacier

Day 2: 5 December 1986
Morning

TIDEWATER AND SURGE TYPE GLACIERS

Keith Echelmeyer, UA-GI: Stress and velocity along Jacobshavn Glacier – internal deformation or sliding?

Ted Clarke, UA-GI: Jakobshavn Glacier, Greenland: Ice production, terminus fluctuations, topography, and temperature with some comments on velocity

Barclay Kamb, CIT-GEO: Minisurge activity in Variegated Glacier subsequent to the 1982-3 surge

Mark Fahnestock, CIT-GEO: A longitudinal radar profile on upper Variegated Glacier

Michael Balise, UW-GPHYS: Velocity inversion for Variegated Glacier minisurges

Mindy Brugman, ETH-VAW: Water flow at the base of a surging glacier: Variegated Glacier dye tracing results

Bill Mathews, UBC-GEO: Submarine evidence for ice streams along the Canadian west coast during former glaciation

Afternoon

Tad Pfeffer, UW-GPHYS: Structures in the terminus region of Variegated Glacier

BASAL PROCESSES

Joe Walder, UW-QRC: Penetration of ice into till

Neal Iverson, UM-GEO: Ice flow around abrading rock fragments

Neil Humphrey, UW-GPHYS: Closure of conduits in stressed ice

Mindy Brugman, ETH-VAW: Basal ice at Findelen Glacier

Roger Hooke, UM-GEO: Deformable till layer in overdeepening beneath Storglaciaren

AIR MOTION IN SNOW

Jerry Johnson, CRREL-F: Thermal convection in snow

Garry Clarke, UBC-GPHYS: Wind pumping as a potential heat source in polar ice sheets

ALASKA RANGE GLACIERS

Mathew Sturm (for Will Harrison), CRREL-F: Fels Glacier project

Keith Echelmeyer, UA-GI: Peters Glacier surge

Ted Clarke, UA-GI: Susitna Glacier potential surge

CLIMATE AND GLACIERS

Gerry Holdsworth, EC: Correlation of acidity bands and volcanism from Mt Logan ice cores

Charlie Raymond, UW-GPHYS: Time scales for the advance and retreat of glaciers

ABBREVIATION KEY

CRREL-F: Cold Regions Research and Engineering Laboratory, Fairbanks, AK

EC: Environment Canada, Saskatoon Sask

ETH: Eidgenossischen Technischen Hochschule, Zürich; VAW – Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie

CIT: California Institute of Technology, Pasadena, CA; GEO – Geology

SOC: Saint Olaf College, Northfield, MN; PHY – Physics

UA: University of Alaska, Fairbanks, AK; GI – Geophysical Institute

UBC: University of British Columbia, Vancouver, BC; GPHYS – Geology and Astronomy; GEO – Geology

UM: University of Minnesota, Minneapolis, MN; GEO – Geology and Geophysics

UW: University of Washington, Seattle, WA; ASTRO – Astronomy; ATMO – Atmospheric Sciences; F – Forestry; GPHYS – Geophysics; QRC – Quaternary Research Center

USGS: United States Geological Survey; CRHP – Cold Regions Hydrology Project, Fairbanks, AK; D – District Office, Tacoma, WA; ICP – Ice and Climate Project, Tacoma, WA; TPP – Transport Processes Project, Tacoma, WA

Andrew G. Fountain

MONTANA STATE UNIVERSITY

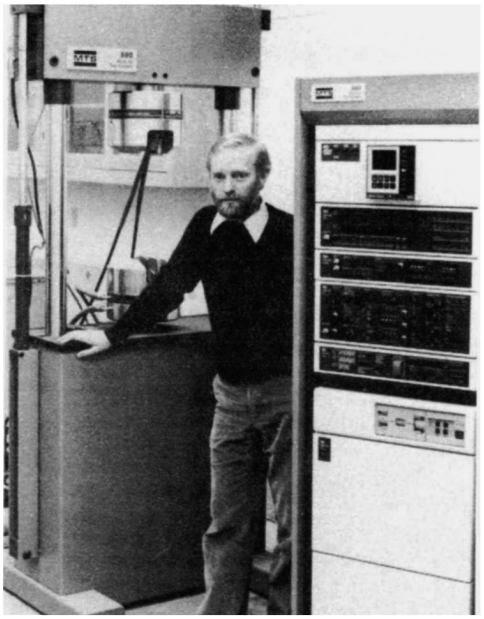
Department of Civil and Agricultural Engineering, Bozeman, MT 59717.

MECHANICAL PROPERTIES OF SNOW
(R.L. Brown)

Under sponsorship of the Army Research Office, the multiaxial, high rate properties of snow are being investigated. The stress-strain equations are based on the material microstructure, which includes mean values of grain size, bond diameter, neck length, bonds/grain, and pore size. Laboratory tests are now being conducted to test the stress-strain relations, and surface sections are being used in conjunction with an image analysis system to evaluate the change in microstructure due to deformation.

BINDER STRENGTHENED SNOW
(R.L. Brown)

In this NSF grant funded jointly to MSU and Michigan Technological University, various materials such as sawdust and polystyrene beads are being investigated to find optimum materials for improving snow roadways and landing strips in the Antarctic. Laboratory studies at Montana State University have shown that swawdust appears to be an optimum binder material when mixed with snow in the proper proportions. This season field tests using sawdust will be tried at the McMurdo and South Pole stations. Dr Sung Lee at Michigan Technological University is the principal investigator for this project.



Bob Brown and high strain rate testing machine - environmental chamber not shown

BLOWING SNOW
(R.L. Brown)
In conjunction with a winter weather modification program in the Bridger Mountains near Bozeman, Montana, a field investigation is being undertaken to determine the effect of cloud seeding on snow deposition patterns, crystal habit, and snow cover stratigraphy. A computer-based physical model will also be developed to predict changes in snow deposition patterns caused by cloud seeding. Observations will also be made on avalanche activity.

MECHANICAL PROPERTIES OF SEA ICE
The mechanical properties of columnar sea ice are being investigated to develop a multiaxial constitutive relation in terms of microstructural processes (dislocation climb and crack damage). Currently only a one-dimensional formulation has been considered, but generalization to three dimensions is currently underway.

AVALANCHE DYNAMICS
(Jimmie D. Dent)
An attempt is being made to derive a flow law for dry-snow avalanches based upon recent advances in the theory of rapid shear of granular materials. Modeling snow as an assemblage of discrete particles which interact through contact, normal forces (impact) and friction forces, kinetic theory type arguments are used to determine the dynamic friction coefficient as a function of shear rate, pressure, and the material properties of the snow (such as grain diameter and coefficient of restitution). Computer modeling of systems of particles and experiments involving simple shearing of glass beads or sand, confirm most of the derived results. However, for very pressures kinetic theory arguments break-down due to sustained contact between particles. In this regime computer modeling can be used to determine how the dynamic friction responds to shear rate and pressure. Although shear rate is a fundamental variable in granular fluid theory, it is flow speed that is of primary interest in describing avalanches. In order to convert from speed to shear rate or vice versa, it is necessary to know the depth over which shearing is taking place. Experimental investigation indicates that this depth is at most a few centimeters for snow flowing on a smooth slope. An analytic relationship between the thickness of the shear layer and the speed, pressure, and material properties is the current focus of investigation. With this information in hand an analytic flow law for dry snow avalanches on smooth surfaces would be readily available, at least within the confines of granular flow theory.

T.E. Lang
Acting Department Head

ENERGY BALANCE OF AN ARTIFICIAL ICE ISLAND
(S.T. Connolly, Arctic Applications, Inc.)
Instrumentation was installed to measure energy balance at an artificial spray ice island grounded in 10 m of water in the Beaufort Sea of Alaska. Radiative and sensible heat fluxes were measured as well as heat conducted through the surface of the island. The monitoring program began at the end of island construction and terminated at the onset of the ablation season. A numerical model was developed to simulate the heat flow and melting of the ice island through the ablation season. The model was run with climatological data from local meteorological stations. The model will be used for design parameters and survival probabilities of ice islands in various locations and water depths.

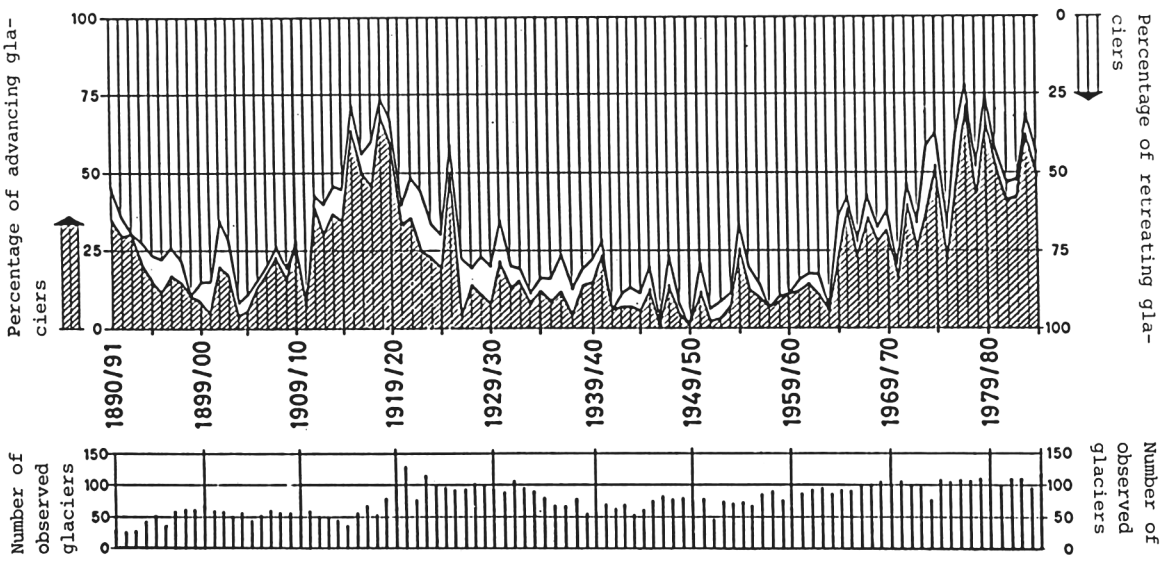
NOTE
The following names should have been included in *ICE* **81**, p.10, after RECENT WORK – UNITED KINGDOM, OKSFJORDOKUL – NORWAY: W.B. Whalley, J.E. Gordon, A.F. Gellatly, J.D. Hansom.

GLACIOLOGY AT VAW/ETH, ZÜRICH

The long history of glaciological activities in Switzerland includes scientific research as well as practical applications. During the 19th century, the most important tasks consisted of dealing with hazards related to glacier advances, glacier floods and ice avalanches, of developing the fundamental ideas of past Ice Ages, of carrying out the first inter-disciplinary and experimental glacier studies, and of starting long-term national and international glacier monitoring. The 20th century then saw the intensive development of hydroelectric power schemes in heavily glacierized areas, leading to a strong interaction between glaciology and hydraulic engineering. As a result, the Section of Glaciology within the Laboratory for Hydraulics, Hydrology and Glaciology (VAW) of the Federal Institute of Technology (ETH) in Zürich was established. In recent years, concern for the quality of the environment has resulted in involvement in many fields of pure and applied ice research. Glaciology at the VAW is inter-disciplinary in its approach, and places an emphasis on deriving results of practical importance as well as on the investigation of theoretical aspects. The following overview should illustrate some of the main fields of current activity.

Glacier fluctuations

Since 1893, carrying out annual observations of the fluctuations of glaciers in the Swiss Alps has been the central task of the Swiss Glacier Commision within the Swiss Academy of Sciences (Fig. 1). This task is carried out with the active participation of federal departments, cantonal forestry services, power companies and private persons. The Section of Glaciology at the VAW contributes to the observations, organizes the measurements, collects the results and edits the annual reports. Long-term variations of glacier length are observed within a net of 120 glaciers at present. The corresponding record reaches as far back as 1880. The general tendency of glacier shrinkage shows a maximum around 1950, being interrupted only shortly by minor readvances around 1890, 1920 and 1980 (Fig. 2). On average, the observed glaciers have become shorter by almost 1 kilometer since the start of regular measurements. Mass balance measurements using glaciological methods are carried out on the glaciers Silvretta, Gries and Limmern/ Plattalva, whereas a hydrological model is applied to calculate balances of Aletschgletscher, the largest glacier in the Alps. All mass balance measurements are



Variation in length of glaciers in the Swiss Alps. Percentages of advancing and retreating glaciers in the years 1890/91-1894/85 (above) and total number of observed glaciers (below).

checked periodically by photogrammetrical mapping. On a number of glaciers (e.g. Aletsch, Giétro, Corbassière, Unteraar), surface velocities and thickness changes are measured annually at selected cross profiles. The records reach back several decades.

On a global scale, the International Commission on Snow and Ice (ICSI/IAHS) carries out two programmes for collecting standardized information about the distribution of and the variation in the land ice cover of the earth: a temporary programme to compile a World Glacier Inventory and a permanent programme for monitoring the Fluctuations of Glaciers. The two programmes are now combined as the "World Glacier Monitoring Service (WGMS)" at the VAW. In close cooperation with the United Nations Environment Programme (UNEP/GEMS), the Federation of Astronomical and Geophysical Services (FAGS/ICSU) and UNESCO, a publication on the World Glacier Inventory and Vol. V of the "Fluctuations of Glaciers" (1980-1985) are presently being prepared. Publication is planned for 1988 in both cases. At the same time, steps are being undertaken to publish mass balance data of selcted reference glaciers more frequently, to attain global coverage by applying satellite observations in remote areas, and to improve the possibilities of interpreting the numerous length variation data by updating and analyzing old records. In fact, for the first time in history, it is now possible to observe the reactions of various glaciers to recent and well documented changes in their mass balance history - a fascinating situation which will certainly furnish important empirical information on climate/glacier relationships.

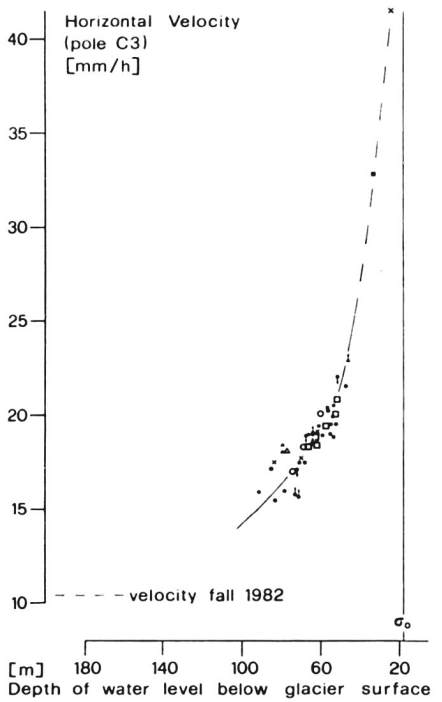
Advancing snout of northern Feegletscher (Saas Fee, Valais) in 1982. The advance since 1956 amounts to about 500 m.

Hot-water drill in operation on Findelengletscher in winter: water basin, tripod with drill hose, heating unit and pump, and Matterhorn (background)

Glacier hydraulics and basal sliding

A major research field involves glacier hydraulics and its interaction with basal sliding. Important theoretical accomplishments have been the development of theories of englacial channel flow for steady state and transient conditions. In order to enable specific field investigations on the basal conditions of glaciers to be made, a hot-water drill (open system) was constructed in 1972. This drill permits the efficient drilling of vertical holes to the glacier bed (Fig. 3). A variety of applications has resulted: measurements of englacial temperatures, subglacial water pressures, vertical straining of the ice to analyze glacier uplift, borehole inclinometry, borehole geoelectrics, sampling of basal water during tracer experiments, and depth control in conjunction with radio-echo sounding.

Recently, the interaction of subglacial water pressure and basal sliding has become a focal point of research activities; the relationship between wter pressure and sliding velocity has been studied in detail at Findelengletscher (Fig. 4) in an area with an obviously non-deforming bed and extensive cavity formation. The relationship differs substantially from that observed earlier at the nearby Gornergletscher, where the cavity network appears to be poorly developed; it is also different from conditions encountered at Grubengletscher, a partially cold glacier resting on unconsolidated fine-grained sediments of considerable thickness.



Velocity of a survey marker near the centre line of Findelengletscher versus depth of water level in boreholes connected with the subglacial drainage system. Different symbols refer to various periods in May and June 1982 and June 1980.

Gornergletscher with the white ice of its main stream (Grenzgletscher). This ice is formed in the altitudinal belt of cold infiltration and infiltration-recrystallisation above about 4000 m a.s.l. and remains at subzero temperatures even within the tongue at low altitude. Arrows mark deep boreholes with englacial temperature measurements.

Cold ice and permafrost

In the drier parts of the Alps where the equilibrium line on glaciers rises far above the lower boundary of permafrost distribution, considerable amounts of cold firn and ice can be found. One of the most spectacular phenomena in this respect is the brilliantly white (air bubble-rich) ice of Grenzgletscher which, during its descent from the highest peaks of the Monte Rosa, does not completely warm up to form a temperate glacier but remains at temperatures around -3 °C even in its flat and slowly moving tongue (Fig. 5). The presence of such polar-type cold firn and ice in the Alps was the basis for starting, in 1976, a long-term core drilling project on Colle Gnifetti, Monte Rosa, 4450 m a.s.l., where the 10m-temperature is around -14 °C. Among the main goals of this project, which is being carried out in close co-operation with the Physics Institute of the University of Bern and other scientists inside and outside Switzerland, are, (1) the reconstruction of the history of the atmosphere in a heavily industrialized region, and (2) the investigation of glaciological parameters (temperature, density, distribution and history of accumulation) at high altitudes in connection with the problem of ice avalanching.

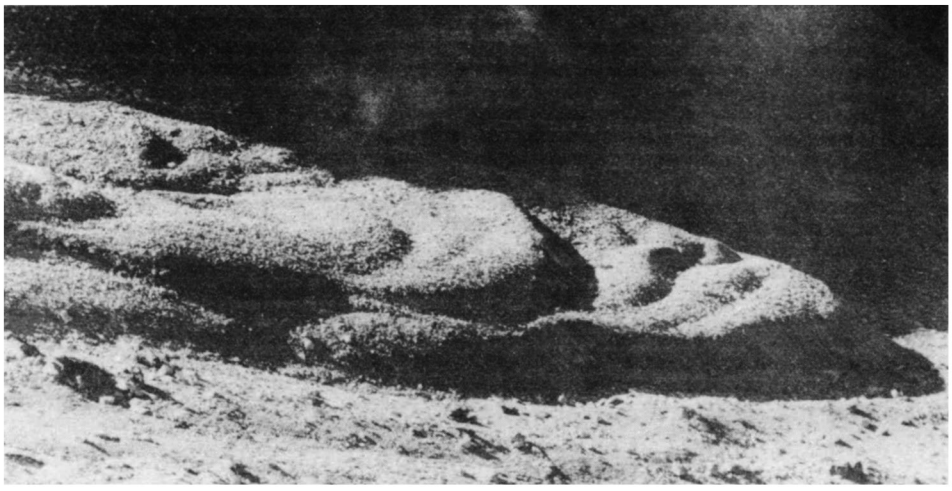
Systematic investigations are also being carried out on rock glaciers (Fig. 6), the most striking and widespread phenomena of high-mountain permafrost creep. Many investigatory techniques (shallow core drilling, permafrost mapping using geothermal methods, seismic, geoelectric and radio-echo soundings, high precision surveys of short-term and photogrammetric monitoring of long-term flow behaviour) have shown rock glacier flow to be a natural large-scale experiment on the steady-state creep and sliding of supersaturated ice/rock-mixtures under nearly constant temperatures, stresses and strain rates.

Core drilling through an active rock glacier in the Grison Alps is planned for the near future and a survey net for long-term monitoring of rock glacier-permafrost is presently being established.

Theoretical glaciology

Emphasis is on activities concerning the constitutive behaviour of temperate ice, computational glacier and ice sheet dynamics, and the dynamics of snow avalanches.

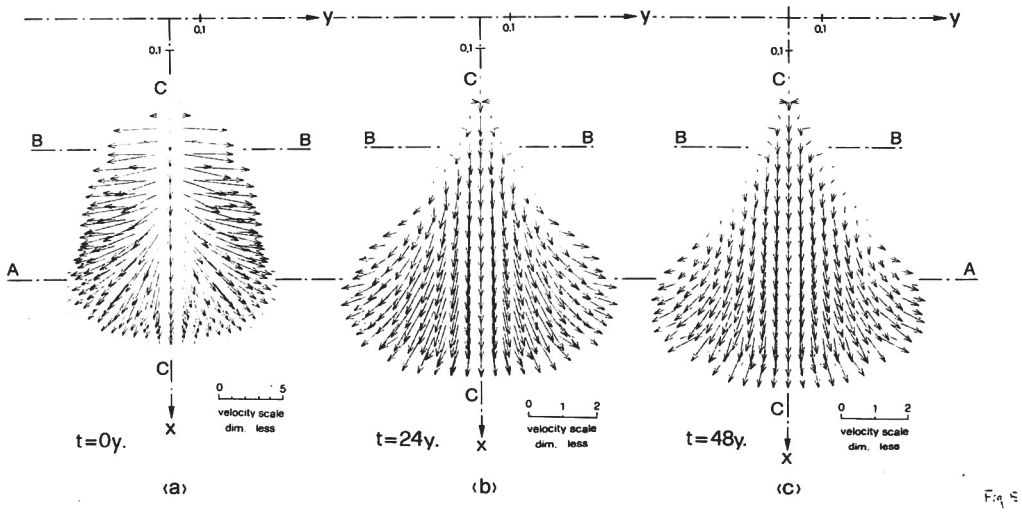
Basic to the existence of temperate ice is the fact that ice and water co-exist in a proportion that depends on the thermodynamic state of the ice specimen. A first step in



Active rock glacier in the Val Muragl, Engadin, Grisons, where long term monitoring using aerial photogrammetry was begun recently.

deducing material properties for "wet" ice therefore consists of understanding the melting and freezing processes along a phase-change surface, which may be the boundary of the vein system or the surfaces of grains. Analysis of this micromechanical problem has lead to the recognition of an interesting dependence of the melting and freezing processes on the curvature properties of the phase-change surface. The second step in the deduction of material properties consists of averaging thermodynamic characteristics over a large number of grains.

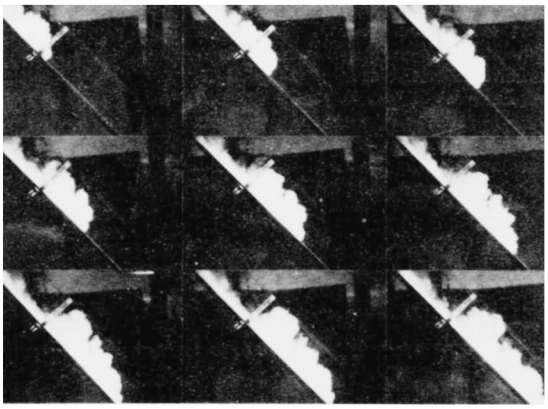
It is well known among glaciologists that computational ice flow is a highly fashionable subject these days: topics being modelled are surges, fast flow in the outlet glaciers of ice sheets, marine ice sheets; even global ice cap



Flow of a piedmont-type glacier as obtained from a non-steady computational model.

flows are being simulated by computational techniques. Generally, the underlying models do not have the structure of a true dynamic system, in other words the models are stripped from an interplay with the climatological input. They may not permit true modelling of ice sheet growth and decay, or may neglect temperature effects. Attempts are being made to formulate a dynamic model which permits simultaneous determination of ice sheet geometry, flow and temperature (if necessary), with conditions in the atmosphere and geosphere being described in space and time. Several configurations have already been put into a finite difference code (Fig. 7).

New conceptional models treating flow avalanches as a granular continuum and powder snow avalanches as turbulent two-phase flows have been deduced and adapted to compute chute flows of such continua that are typical for avalanche flows. Such models are of limited value if they are not checked against observations. Experiments are therefore being conducted in the laboratory both for flow and powder snow avalanches (Fig. 8). Particle velocities and densities of the clouds are measured using an ultrasonic Doppler technique. Transposition of the dynamical quantities to the prototype scale makes use of the laws of similitude and enables the estimation of real-scale velocities, pressures, densities etc. to be made.



A sequence of shots of a laboratory powder snow avalanche consisting of water-borne plastic particles moving down a submerged chute.

Consulting work

From the very beginning, consulting work has been an aspect of fundamental importance in glaciology at the VAW. Glacio-hydrological aspects have clearly predominated during the design and construction stages of hydro-electric power plants at high altitudes. A variety of problems have been encountered through the years, including questions of run-off regime, probability of glacier advances, performance of subglacial water intakes, the magnitude of waves in reservoirs caused by calving and ice avalanches or the extent of glacier retreat to be expected when the terminus becomes submerged behind a new dam. Since the late 1960s, safety aspects in connection with hydroelectric power and tourist installations have become more and more important. Because much of the constructional activity of the 20th century had followed the course taken by the retreating glacier tongues, the recent readvance of glaciers has automatically brought along a number of conflicts. Forecasting glacier advances and assessing risks of ice avalanches and glacier floods are now standard aspects of the glaciological consulting work at the VAW. High altitude construction work at sites like Jungfraujoch, Klein Matterhorn or Titlis requires information about permafrost conditions and, during winter, problems of the bearing capacity of lake ice at low altitudes have frequently to be treated in relation with recreational activities.

Teaching

Glaciology courses are given by members of the VAW within the framework of the curricula in various disciplines, and include an introduction to glaciology, theoretical glaciology, applied glaciology, glacier mechanics, measurement techniques in glaciology, permafrost, and glacial geomorphology/paleoglaciology. An additional course on snow and avalanches is given at the ETH by colleagues from the Weissfluhjoch Institute, Davos. Diploma and Ph.D. research work on glaciological topics is being done by students from various disciplines, primarily civil engineers, physicists, physical geographers and geophysicists.

Markus Aellen
Wilfried Haeberli
Kolumban Hutter
Almut Iken
Hans Röthlisberger

INTERNATIONAL GLACIOLOGICAL SOCIETY

JOURNAL OF GLACIOLOGY

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

R. Gabison:
A thermodynamic model of the formation, growth, and decay of first-year sea ice.

R.S. Bradley & M.C. Serreze:
Mass balance of two High Arctic plateau ice caps.

K. Echelmeyer & Wang Zhongxiang:
Direct observation of basal sliding and deformation of basal drift at sub-freezing temperatures.

Huang Maohuan & Wang Zhongixian:
Research on the tunnel excavated in Urumqi Glacier No. 1, Tianshan Glaciological Station, China.

B. Kamb & H. Engelhardt:
Waves of accelerated motion in a glacier approaching surge: the mini-surges of Variegated Glacier, Alaska, USA.

J.A. Dowdeswell & N.F. McIntyre:
The surface topography of large ice masses from Landsat imagery.

R.W. Davison & S.K. Davison:
Characteristics of two full-depth slab avalanches on Meall Uaine, Glen Shee, Scotland.

G.D. McKenzie & R.G. Goodwin:
Development of collapsed glacial topography in the Adams Inlet area, Alaska, USA.

J-L. Tison & R.D. Lorrain,
A mechanism of basal ice-layer formation involving major ice-fabrice changes.

I. Muszynski & G.E. Birchfield:
A coupled marine ice-stream–ice-shelf model.

J.J. Rhodes, R.L. Armstrong & S.G. Warren:
Mode of formation of "ablation hollows" controlled by dirt content of snow.

J.S. Gardner:
Evidence for headwall weathering zones, Boundary Glacier, Canadian Rocky Mountains.

B. Hanson & R.E. Dickinson:
A transient temperature solution for bore-hole model testing.

D.J.A. Evans & T.G. Fisher:
Evidence of a periodic ice-cliff avalanche on north-west Ellesmere Island, NWT, Canadian High Arctic.

R.C. Hooke, P. Holmlund & N.R. Iverson:
Extrusion flow demonstrated by bore-hole deformation measurements over a viegel, Storglaciären, Sweden.

S. Hasternrath:
Continued decrease of ice-flow velocity at Lewis Glacier, Mount Kenya, East Africa.

M. Kuhn:
Micro-meteorological conditions for snow melt.

O. Nasello, L. Levi & F. Prodi:
Crystal structure of ice accreted on an ice substrate.

S.C. Colbeck:
History of snow-cover research.

G. Wendler & Y. Nagashima:
Inter-relations between the Arctic sea ice and the general circulation of the atmosphere.

L.W. Gold:
Fifty years of progress in ice engineering.

L. Reynaud:
The November 1986 survey of the Grand Moulin on the Mer de Glace, Mont Blanc Massif, France. [Letter]

J.W. Glen:
Fifty years of progress in ice physics.

J. Weertman:
Basal water and high-pressure basal ice. [Letter]

INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON ICE DYNAMICS

The Society will hold a symposium on ice dynamics in Hobart, Tasmania, Australia in 1988. Registration will take place on Sunday 14 February and sessions will be from Monday 15 February to Friday 19 February in the University of Tasmania. Tours to Hawaii and New Zealand will take place in association with this event.

PARTICIPATION

This circular includes a booking form, which should be sent to the Secretary General before 1 October 1987. Payments should be made in £ sterling, as indicated on the booking form, to I.G.S. in Cambridge, England. (Australian participants may make payments to the I.G.S. bank account in Melbourne, as indicated on the booking form.)

***Participants'* registration fees cover accommodation and breakfast at Jane Franklin Hall, lunch at the Conference Centre, organization costs, distribution of preprints of summaries, Icebreaker, Banquet, day tour, and a copy of the Proceedings Volume.**
***Accompanying persons'* registration fees include accommodation and breakfast at Jane Franklin Hall, organization costs, Icebreaker, Banquet, and day tour.**
* There is an administration surcharge for participants who are not members of I.G.S.

Registration Fees:

Participant £185

*Participant (who is not a member of I.G.S.) £235

Junior Member (under 26 years of age) £160

Accompanying person aged 18 or over £120

There is no fee for those under the age of 18, unless they wish to attend the Banquet. Tickets for them may be purchased upon registration on 14 February.

TOPICS

The symposium will be concerned with the following topics:

1. Derivation of flow law parameters from field and laboratory studies.
2. Results of field survey of ice sheets and glacier dynamics.
3. Modelling of the dynamics of ice masses.
4. The stability of marine ice sheets.
5. The flow of ice shelves.
6. Interaction of ice shelves and icebergs with the ocean.
7. The dynamics of sea ice and ocean/atmosphere interactions.

PROGRAMME

A detailed programme will be given in the **Third Circular**. Various local tours and visits will be available for accompanying persons, and may be booked when registering on Sunday 14 February.

ACCOMMODATION

We have made a block booking of rooms in Jane Franklin Hall, one of three residential colleges in the University of Tasmania. It is situated on a hill 20 minutes' walk from the Conference Centre and has spacious landscaped gardens and extensive views of the surrounding area. There are 150 single bedrooms, with shared facilities including kitchenettes with tea- and snack-making facilities, automatic laundries.
We have selected the bed and breakfast tariff, as participants will be taking lunch down at the Conference Centre, and accompanying persons will be able to get lunch during their various tours and visits. Evening dinner can be obtained at restaurants in Hobart, with transport arranged as required.
On the day of arrival, 14 February an Icebreaker buffet/barbecue will be held at Jane Franklin Hall (in the gardens if weather permits).
On Wednesday 17 February, a full-day tour to the interior of Tasmania will be held. The cost of this (transport, lunch, and craybake/barbeque at a waterside restaurant in the evening) is included in the registration fee.
On Thursday 18 February, a banquet will be held at the Wrest Point Casino. The cost of this is also included in the registration fee.
– You will thus only have to make your own arrangements for dinner on 3 evenings (Monday, Tuesday and Friday).

PAPERS

(i) SUBMISSION OF PAPERS

Those participants who would like to contribute to the Symposium should first submit a summary of their proposed paper in English; this summary should contain sufficient detail to enable the Papers Committee to form a judgement on the likely merit of the proposed paper, but should not exceed two pages of typescript, on international size paper A4 (210 × 297 mm). References and illustrations are not required at this stage. Summaries should be sent to:

Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

LAST DATE FOR SUBMISSION OF SUMMARIES - 1 MAY 1987

(ii) SELECTION OF PAPERS

Each summary will be assessed by the members of the Papers Committee, acting independently of each other, taking into account scientific quality and relevance to the topics of the Symposium. The Papers Committee will then invite a strictly limited number of papers for presentation and thorough discussion at the Symposium (not necessarily confining themselves to authors who have submitted summaries). It is hoped to notify authors of papers during August 1987.

(iii) DISTRIBUTION OF SUMMARIES

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

(iv) SUBMISSION OF FINAL PAPERS AND PUBLICATION

Papers presented at the Symposium will be considered for publication in the proceedings volume. Final typescripts of these papers should be submitted to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England, by 1 November 1987. They should be written in English and prepared in accordance with the instructions that will be sent to authors when they are notified about acceptance of papers for the Symposium. Authors will be told the maximum length for their papers when they receive notice of acceptance of their summaries. The papers will be refereed according to the usual standards of the Society before being accepted for publication. Speedy publication of the proceedings will depend upon strict adherence to deadlines.

Acceptance of a summary implies that the paper based on that summary will be submitted to the proceedings volume, which will form volume 12 of the Annals of Glaciology.

LAST DATE FOR SUBMISSION OF FINAL PAPERS: 1 NOVEMBER 1987

SOCIAL EVENTS

Various events will be arranged and details will be given in the Third Circular.

The Banquet will be held on Thursday 18 February. In addition to being the main social event of the Symposium, it will also be the Annual Banquet of the International Glaciological Society. The registration fees include the cost of the Banquet.

TRAVEL FROM EUROPE, NORTH AMERICA AND JAPAN

The Council has authorized Traveller's World, London, to arrange group travel; this is the company that handled our Japan and China events in 1984. Their brochure will be mailed to you during March.

Travel from Europe will be based on Round The World (RTW) tickets, with stop-overs in Los Angeles, Hawaii, Hobart (Australia), New Zealand and SE Asia – a westward progression. RTW ticketing allows much flexibility, so return arrangements may be made to suit individual wishes.

Travel from North America will be based on group travel out of Los Angeles, to Hawaii, Hobart (Australia), New Zealand, with the return journey back over the Pacific to Los Angeles.

Participants from Japan will join the group in Hawaii, then go to Australia and New Zealand on the group arrangement.

People who prefer to make their own travel arrangements, and do not wish to join the tours in Hawaii and/or New Zealand, need only pay the registration fee, which includes all arrangements (except evening dinners) in Hobart.

When you receive the Traveller's World brochure, please write to them about your travel requirements. It is to the benefit of the Society and you to use the services of our official travel agent, so we urge you to book with them. Please register with I.G.S. for the Symposium, using the registration form at the end of this circular.

REGISTRATION, PACKAGE TOURS, ACCOMMODATION

SYMPOSIUM ON ICE DYNAMICS

14 – 20 February 1988

Mail to: Secretary General, International Glaciological Society, Cambridge CB2 1ER, England - **BEFORE** 1 November 1987. See reverse of this form for methods of making payment.

A. REGISTRATION (please type or print in black ink)
Name of participant:

....
(family name) (initials)

Address .....

.....

.....

Accompanied by (indicate age if under 18)

Name ..... Name .....

I send registration fees as follows:

(i) Participant (£185 each) £ .....

(ii) Participant (not IGS member) (£235 each) £ .....

(iii) Junior member (£160 each) £ .....

(iv) Accompanying person (£120 each) £ .....

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

TOTAL REGISTRATION FEE/S = £.....

B. PACKAGE TOURS

I/We wish to join package tour *A, B, C, D from *London/*Los Angeles/*Tokyo and have sent the booking forms and deposits to Traveller's World.

METHODS OF MAKING PAYMENT FOR REGISTRATION FEES

Payments should be made in £ sterling

- by sterling cheque payable to: International Glaciological Society and sent to the Secretary General at the Society's address;
- by sterling Bank transfer to: International Glaciological Society, Account No. 08102112 and sent to the National Westminster Bank plc. 56 St. Andrew's Street, Cambridge CB2 1ER, England.

For people resident in Australia, by equivalent payment in A$ to: International Glaciological Society and sent to T.H. Jacka, Antarctic Division Glaciology Section, University of Melbourne, Parkville, Victoria 3052, Australia, for the IGS bank account in Melbourne.

GLACIOLOGICAL DIARY

** IGS Symposia
* Co-sponsored by IGS

1987

30 March - 4 April
** Symposium on Ice-core analysis. Bern, Switzerland. (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, U.K.)

30 March - 3 April
Symposium on the Use of isotope techniques in water resources development. Vienna, Austria. (International Atomic Energy Agency, IAEA-SM-299, Vienna International Centre, P.O.Box 100, A 14400 Vienna, Austria.)

1-5 June
Symposium on Glacier fluctuations and climatic change. Amsterdam, Netherlands. (J. Oerlemans, Princetonplein 5, 3508 TA Utrecht, The Netherlands)

4-6 June
International Symposium on Cold regions heat transfer. Edmonton, Alberta, Canada. (V.J. Lunardini, CRREL, 72 Lyme Road, Hanover, NH 03755, U.S.A., *or* K.C. Cheng, Dept. Mechanical Engineering, University of Alberta, Edmonton, Alberta, Canada T6G 2G8, *or* N. Seki, Dept. Mechanical Engineering, Hokkaido University, Sapporo 060, Japan)

31 July - 9 August
12th Congress of the International Union for Quaternary Research. Ottawa, Ontario, Canada. (L. Baignée, Secretariat, XII INQUA Congress, c/o National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada)

31 July - 9 August
Holocene glacier fluctuations, 12th INQUA Congress. Ottawa, Ontario, Canada. (P.T. Davis, Dept. Geology, Mount Holyoke College, South Hadley, MA 01075, U.S.A. *or* G. Osborn, Dept. Geology, University of Calgary, Calgary, Alberta, T2N 1N4, Canada)

9-22 August
Symposium on the Physical bases of ice-sheet modelling. IUGG General Assembly. Vancouver, BC, Canada. (E. Waddington, Geophysics Program AK-50, University of Washington, Seattle, WA 98195, U.S.A.)

9-22 August
Symposium on Marginal ice zone processes. IUGG General Assembly. Vancouver, BC, Canada. (R.D. Muench, Science Applications Inc., 13400 B Northrup Way, Suite 36, Bellevue, Washington 98005, USA *or* K. Davidson, Dept. Meteorology, Naval Postgraduate School. Monterey, CA, U.S.A.)

9-22 August
Symposium on Large-scale effects of snow cover. IUGG General Assembly, Vancouver. BC, Canada. (B.E. Goodison, Atmos. Environ. Service, Environment Canada, 4905 Dufferin St., Downsview, Ontario M3H 5T4, Canada)

9-22 August
Workshop on River ice. IUGG General Assembly. Vancouver, BC, Canada. (K.S. Davar, Dept. Civil Eng., Univ. New Brunswick, Fredericton, NB E3B 5A3, Canada)

7-12 September
* Fourth SCAR International Symposium on antarctic glaciology. Bremerhaven, FRG. (H. Kohnen, Alfred-Wegener Inst. for Polar Research, Columbus Center, D-2580 Bremerhaven, Fed. Rep. Germany)

1988

14-19 February
** Symposium on Ice dynamics. Hobart. Australia. (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, UK)

4-8 July
Sixth International Congress on Protection of habitat from floods, debris flows and avalanches. Graz, Styria, Austria. (INTERPRAEVENT 1988, Postfach 43, A-8010 Graz, Austria)

2-5 August
Fifth International Conference on Permafrost. Trondheim, Norway. (Kaare Flaate (chairman), Norwegian Road Research Laboratory, P.O. Box 6390 Etterstad, N-0604 Oslo 6, Norway)

4-9 September
** Symposium on Snow and glacier research relating to human living conditions. Lom, Norway. (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, UK)

1989

21-25 August
23rd IAHR Biennial Congress. Ottawa, Ontario, Canada. (T.M. Dick, NWRI, CCIW, P.O.Box 5050, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6, Canada)

late August
** Symposium on Ice and climate. Seattle, Washington, U.S.A. (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, UK)

NEWS

APPOINTMENTS

W.F. Weeks has become a professor of geophysics and chief scientist of the Alaskan Synthetic Aperture Radar (SAR) Facility at the Geophysical Institute of the University of Alaska, Fairbanks. Willy, President of IGS 1972-75, had been on the staff of the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, N.H., for 24 years.

Craig S. Lingle recently became Program Manager for Glaciology in the Division of Polar Programs of the National Science Foundation (NSF). Previously, he had been a research associate at the Cooperative Institute for Research in the Environmental Sciences at the University of Colorado, Boulder.

David J. Drewry, currently Director of the Scott Polar Research Institute, Cambridge, will take over the position of Director of the British Antarctic Survey from Richard Laws on 1 May 1987.

Elizabeth M. Morris has taken over the Ice and Climate Division at the British Antarctic Survey, following the reorganization of the Earth Sciences Division on the retirement of Charles Swithinbank on 17 November 1986.

NEW MEMBERS

E.L. Andreas, 3375 Cripple Creek Trail, Boulder, CO 80303, USA.

K.-H. Bässler, Kirschweg 2, 500 Köln 90, Federal Republic of Germany.

G. Casassa, Institute of Low Temperature Science, Hokkaido University, Sapporo, 060, Japan.

S. Fujita, Department of Applied Physics, Faculty of Engineering, Hokkaido University, Sapporo, 060 Japan.

M. Funk, V.A.W., ETH-Zentrum, CH-8092 Zürich, Switzerland.

N.C. Gough, 2 Brookway, Blackheath, London SE3 9BJ, UK.

W. Graf, Dachauer Strasse 419, D-800 München 90, Federal Republic of Germany.

M.E. Källström, Department of Meteorology, University of Stockholm, Arrhenius Laboratory, Fack, S-01405 Stockholm, Sweden.

T. Kameda, Department of Applied Physics, Faculty of Engineering, Hokkaido University, Sapporo, 060 Japan.

C. Lüdecke, MAN, Technologie, EDP-2, Dachauer Strasse 667, D-800 München 50, Federal Republic of Germany.

A.S. McLaren, 1310 College Avenue, Suite 1104, Boulder, CO 80302, USA.

R. Meister, Dischmastrasse 51, CH-7260 Davos-Dorf, Switzerland.

H.D. Mooers, Department of Geology, University of Minnesota, Minneapolis, MN 55455, USA.

S. Murakami, Institute of Low Temperature Science, Hokkaido University, Sapporo, 060 Japan.

S.A.F. Murrell, Department of Geological Sciences, University College London, Gower Street, London WC1E 6BT, UK.

H. von der Osten, Offenbachstrasse 56, D-8011 Baldham, Federal Republic of Germany.

H. Ozawa, Institute of Low Temperature Science, Hokkaido University, Sapporo, 060 Japan.

P. Ramu, Civil Engineering Office, 3792 Saanen, Switzerland.

J. Schug, Burgsiedlung 7, D-8972 Sonthofen, Federal Republic of Germany.

D.G. Smith, Department of Geography, University College London, 26 Bedford Way, London, WC1H OAP, UK.

T. Umemura, Department of Mechanical Engineering, Technological University of Nagaoka, Kamitomioka-Machi, Nagaoka-shi, 940-21 Japan.

I.C. Willis, Emmanuel College, Cambridge CB2 3AP, UK.

E. H. Wishman, Archaeological Museum in Stavanger, P.O. Box 478, N-4001, Stavanger, Norway.

REVIEW

We have received a review of *A Visitor's Guide to Mount Rainer's Glaciers*, by Carolyn Driedger. This will appear in the next issue of *ICE*.

INTERNATIONAL GLACIOLOGICAL SOCIETY

Founded by G. Seligman

c/o SCOTT POLAR RESEARCH INSTITUTE, University of Cambridge, Lensfield Road, Cambridge CB2 1ER, England

Secretary General: H. Richardson

COUNCIL MEMBERS 1986 – 1989

			Date first elected to the Council (in present term of office)
PRESIDENT	H. Röthlisberger	1984-87	1978
VICE-PRESIDENTS	S.C. Colbeck	1984-87	1984
	H. Kohnen	1985-88	1984
	P. Schwerdtfeger	1984-87	1984
IMMEDIATE PAST PRESIDENT	C.W.M. Swithinbank	1984-87	1975
TREASURER	J.A. Heap	1987-90	1980
ELECTIVE MEMBERS	* B. Hallet	1984-87	1984
	* D. Raynaud	1984-87	1984
	R.S. Williams	1984-87	1983
	* G. Young	1984-87	1984
	* K. Higuchi	1985-88	1985
	* C. Jaccard	1985-88	1985
	* Shi Yafeng	1985-88	1985
	* B. Wold	1985-88	1985
	* R. Hooke	1986-89	1986
	* N. Maeno	1986-89	1986
	* R. Perla	1986-89	1986
	* D. Sugden	1986-89	1986
CO-OPTED	I. Allison	1986-87	1985
	H. Oescher	1986-87	1985

* first term of service on the Council

CORRESPONDENTS

AUSTRALIA	N. Young	JAPAN	N. Maeno
AUSTRIA	M. Kuhn	NEW ZEALAND	T. Chinn
BELGIUM	R.A. Souchez	NORWAY	H. Norem
CANADA	J.-P. Nadreau	POLAND	S. Kozarksi
CHINA	Xie Zichu	SWEDEN	S. Jonssoni
DENMARK	A. Weidick	SWITZERLAND	W. Haeberli
FINLAND	M. Seppälä	U.S.S.R.	V.M. Kotlyakov
FRANCE	P. Duval	U.K.	J.G. Paren
GERMANY	O. Reinwarth	U.S.A. (Eastern)	
ICELAND	H. Björnsson	U.S.A. (Western	A. Fountain
ITALY		U.S.A. (Alaska)	L. Mayo

SELIGMAN CRYSTAL AWARD RECIPIENTS

1963	G. Seligman	1976	W. Dansgaard
1967	H. Bader	1977	W. Kamb
1969	J.F. Nye	1982	M. de Quervain
1972	J.W. Glen	1983	W.O. Field
1972	B.L. Hansen	1983	J. Weertman
1974	S. Evans	1985	M.F. Meier
		1986	G. de Q. Robin

HONORARY MEMBERS

A.P. Crary	M.F. Meier
W.O. Filed	M. de Quervain
R.P. Goldthwait	H. Richardson
P. Kasser	R.P. Sharp
R.F. Legget	A.L. Washburn
L. Lliboutry	Z. Yoshida

The Society is registered as a charity in the United Kingdom with the Charity Comissioners – number 231043

INTERNATIONAL GLACIOLOGICAL SOCIETY

Lensfield Road, 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 General. No proposer or seconder is required.

ANNUAL PAYMENTS 1987

Private members	Sterling £25.00
Junior members	Sterling £12.50
Institutions, libraries	Sterling £70.00 for Volume 33 (Nos.113,114,115)

Annals of Glaciology – prices vary according to size of volume. For further information, apply to the Secretary General.

Note: Payments from countries other than Britain should be calculated at the exchange rate in force at the time of payment. Please ensure that sufficient money is included to cover the bank charges. The Society needs the full payment, so bank charges should be paid by you. Thank you.

ICE

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

Annual cost for libraries, etc., and for individuals who are not members of the Society:

Sterling £9.00

All enquiries about the International Glaciological Society should be addressed to the Secretary General of the International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.