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COVER PICTURE: Morainic berg off Viskikoi Island, South Sandwich Islands, Antarctica, taken from *Discovery II*, 2 March 1930. Photograph from National Institute of Oceanography.

CHINA

CLIMATIC AND ENVIRONMENTAL CHANGE

CLIMATIC CHANGE ON THE EFFECTS OF WATER RESOURCE IN NORTHWEST CHINA AND ESTIMATION OF ITS TREND

(Zhang Xiangsong and others)

The main areas of research are Tailan River, Yarkand River, Barkol Lake and Ebi Nor; analyses of regional data and enquiries into climatic change on effects of water resources (glaciers, lakes and river runoff etc.) in northwest China.

CLIMATIC AND ENVIRONMENTAL CHANGES OF THE QILIAN MOUNTAINS IN THE PAST 2000 YEARS FROM ICE CORES OF DUNDE ICE CAP

(Wu Xiaoling)

Analyses of 3585 ice samples were made, and papers and database on climatic and environmental changes prepared.

STUDIES ON CLIMATIC AND ENVIRONMENTAL CHANGES FROM ICE CORES IN QINGHAI-XIZANG PLATEAU

(Yao Tandong and others)

Glacier investigations in North Xizang region took place by selected location of drill holes. Ice thickness, ice temperature and accumulation were measured. Research continued on stratification of snow pits and water samples.

INTERNATIONAL COOPERATION STUDIES

SINO-USSR COOPERATIVE STUDIES ON THE GLACIATION AND EVOLUTION OF THE NATURAL ENVIRONMENT

(Xie Zichu and others)

Systematic data were collected on the development condition of glaciers, mass balance and thermal equilibrium, features of glacier physics and hydrology, glacial deposits and their changes, Quaternary glaciation and periglacial phenomena, and analyses on maritime-type glaciers and interactions with other spheres of Earth.

SINO-GERMAN GLACIOLOGICAL AND GEOMORPHOLOGICAL EXPEDITION TO THE SOUTH-EASTERN PART OF QINGHAI-XIZANG PLATEAU

(Xu Daoming)

^{14}C and thermoluminescence dating of sediments and drill cores was carried out. Dendrochronological analyses and investigation of glacial geomorphology in northern Europe were completed.

SINO-AMERICAN EXPEDITION ON CHEMICAL CHARACTERISTICS OF GLACIERS IN WESTERN CHINA

(Wang Ping and others)

Investigations were completed on nos 2–3 glaciers in the Shuiguan River and Gangnalou Glacier in Qilian Mountains, nos 3–4 glaciers on the pass of Kunlun Mountains and the glacier to the left of 105 maintenance squad in the Tanggula range. Water samples of snow cover in the accumulation areas were collected, systematic measurements of Be^2 and other ions of glaciated regions made, and supply conditions and chemical characteristics of glaciers determined.

SNOW COVER AND AVALANCHE

VARIATIONS AND REGIONAL DISPARITY OF SNOW COVER IN WEST CHINA

(Li Peiji and others)

Analyses were made of snow cover data of microwave remote sensing in 1978–87 and comparison with the data of surface meteorological stations. A database was established and time series of snow cover during the period 1957–87 were compared daily with snow-depth data during 1981-87 from 700 surface meteorological stations, and changing trends of snow cover and its qualities and the characteristics of regional disparity researched.

SNOW COVER IN THE HIGH MOUNTAIN REGION AT THE SOURCE OF URUMQI RIVER, TIEN SHAN

(Yang Daqing)

Radiation conditions in the free-ice cirque were observed, with analysis made of the data and exchange processes of energy on the snow cover surface.

FORMATION MECHANISMS AND PREVENTIVE PRINCIPLES OF AVALANCHE ALONG THE SICHUAN(SZECHWAN)–XIZANG HIGHWAY

(Wang Yanlong)

Physical properties of snow cover relating to avalanche formation, fabrics, structures and variations of snow layers were observed. Data on avalanche occurrence, movement and deposition, and meteorological data relating to the avalanches, investigation types, distribution and damage conditions of avalanche in the Medog (Meto) region were collected. A programme was developed to prevent snow disasters on Km 15–24 section of Medog Highway.

ANTARCTICA

ENVIRONMENTAL CHANGES OF HOLOCENE FROM ICE CORES NEAR GREAT WALL STATION, ANTARCTICA

(Han Jiankang)

The mass balance, ice formation, ice temperature, distribution features of O^{18}, and fabrics of surface ice of Collins Ice Cap were observed, and the geographical environment and weather conditions of the ice dam surrounding the region investigated.

GLACIOLOGICAL RESEARCH OF INTERNATIONAL TRANS-ANTARCTICA EXPEDITION (1989–91)

(Qin Dahe and others)

The trans-Antarctic crossing was completed. Data collected is being analysed together with stable isotope samples of shallow layer snow. The report and papers are in preparation. Glaciological studies at the Chinese Great Wall Station, Antarctica were also undertaken.

REMOTE SENSING

SATELLITE MONITORING OF SNOW COVER AND STUDIES OF SNOWMELT RUNOFF IN THE UPPER REACHES OF HUANG (YELLOW) RIVER

(Zeng Qunzhu and others)

Analysis of satellite images continued with CCT IB of AVHRR to remove cloud effects, enhanced precision to distinguish type and area of snow cover, and perfected ice and snow resource information system (ISRIS). This enhancement enabled the development of a forecast model for snowmelt runoff, and improved forecast precision during the first, second and last ten days of May. A distribution map of snow and ice resources in the upper reaches of the Huang River was published.

ICE PHYSICS

STUDIES ON THE GENESIS AND FABRIC OF SUBSURFACE ICE

(Cheng Guodong)

Research work was summarized and engineering equipment for a subsurface ice study secured.

TIEN SHAN GLACIOLOGICAL STATION

STUDIES ON MOUNTAIN GLACIOLOGY, HYDROLOGY, METEOROLOGY AND PERIGLACIAL PROCESSES IN THE TIEN SHAN GLACIOLOGICAL STATION

(Liu Chaohai and others)

A data set was collected of the accumulation, ablation and mass balance of glaciers in the source region of the Urumqi River. Surface movement of no. 1 glacier, terminal variations of some glaciers, and snow cover, river ice and hydro-meteorological factors observed. A snowmelt runoff experiment was completed and periglacial processes in the source region of Urumqi River and hydrological processes in free-ice cirque observed. A creep experiment in dirty ice has complemented radar exploration in an artificial ice cavern and research on the movement mechanism of continental-type glaciers in China. The boundary of the Quaternary glaciation in the region of the Tien Shan Glaciological Station was determined, and a topographical map of free-ice cirque compiled.

Submitted by Zhang Xiangsong




UK

CHEMISTRY OF MELTWATERS DRAINING THE UPPER AROLLA GLACIER, SWITZERLAND

(Giles Brown, M J Clark, A M Gurnell, M Tranter, University of Southampton, and Mike Sharp, University of Cambridge)

Meltwaters have been intensively sampled on a daily basis from May through August, 1989 and 1990. Full chemical analysis has been undertaken. Hydrograph and chemograph separation of bulk meltwater discharge and composition has revealed daily and seasonal variations in the composition of englacial and subglacial components.

CLIMATIC CHANGE OVER THE LAST 30 THOUSAND YEARS

(Geoffrey Boulton, Richard Hindmarsh, Tony Payne and David Sugden, Grant Institute of Geology, University of Edinburgh)

This is a large EEC-funded collaborative project with other northern European universities. The Edinburgh contribution is to carry out time dependent, three dimensional modelling of the Scandinavian ice sheet. The project has just started.

DEFORMABLE GLACIER BEDS: MEASUREMENT AND MODELLING

(Julian Dowdeswell and Tavi Murray, Scott Polar Research Institute, University of Cambridge)

A laboratory investigation into the factors affecting the rheology and yield strength of subglacial sediments has been undertaken looking at the effect of a number of parameters including water content, grain size distribution, mineralogy, pore-water ion content and particle arrangement.

The effect of deformation on sediments has also been investigated, looking at dilation and orientation effects within the sediments using SEM and optical microscopy techniques. The effect of particle orientation and dilation on water throughflow through an unlithified glacier bed has also been modelled.

DYE TRACER INVESTIGATIONS OF GLACIER HYDROLOGICAL SYSTEMS

(Wendy Lawson, Peter Nienon, Keith Richards, Mike Sharp and Ian Willis, Department of Geography, University of Cambridge)

The project aims to use dye-tracer investigations in order to infer the structure and seasonal evolution of the subglacial drainage system at the Haut Glacier d'Arolla, Switzerland. The information will be used to evaluate the implications of drainage system properties on basal water pressure and basal motion. During the year, time has been spent processing dye-tracing data which were collected during the 1989 field season and preparing for the 1990 field season. The latter successfully resulted in the collection of a large data set, including the results from over 200 dye-tracing experiments.

ENTRAINMENT OF FINE DEBRIS INTO GLACIER ICE ALONG CRYSTAL BOUNDARIES

(Peter Knight, Department of Geography, University of Keele)

We are designing a laboratory simulation to test hypotheses of inter-granular entrainment for fine debris aggregates in "clotted ice". The laboratory work has grown out of previous field study in Greenland and Iceland with Roland Souchez and co-workers from Belgium, and with a team from the University of Edinburgh including David Sugden. The laboratory element is in its initial stages.

ICE SHEET EROSION AT A REGIONAL SCALE

(Neil Glasser and David Sugden, Department of Geography, University of Edinburgh)

The aim is to map the distribution of landforms of glacial erosion under a former Scottish ice sheet. The field area is a transect from the centre to the margin of the ice sheet across northeast Scotland. The comparison of the distribution of landforms with models of former basal thermal regime suggests the thermal regime is a crucial factor determining ice-sheet erosion at this regional scale. The modelling of basal thermal regime has highlighted the importance of topography in determining areas where ice sheets may reach their pressure melting point and therefore facilitate maximum erosion. The major influence of topography is in determining ice thicknesses and patterns of convergence/divergence of ice flow beneath ice sheets. In the Scottish case this can be seen by comparing the predicted pattern of basal ice temperatures with the observed pattern of glacial erosion.

ICE SHEETS AS DYNAMICAL SYSTEMS

(Richard Hindmarsh, Grant Institute of Geology, University of Edinburgh – now at British Antarctic Survey)

The similarity solution for the slow viscous spreading of a body under its own weight has been obtained. Analytical solutions for spreading bodies with differing rheologies, and rate-factor variation in space, already exist. Perturbation expansions about these similarity solutions permit generalised Fourier decompositions of surface mass-balance functions, and semi-analytic computation of the dynamics of idealised ice sheets. Comparisons with numerical calculations suggest that the similarity solution strongly attracts other ice-sheet configurations, and that ice sheets operate as dynamical systems with fewer than a dozen degrees of freedom. Scaling analyses of ice sheets explain shear stress magnitudes in terms of thickness and accumulation rate, and predict basal molten zones at the margin of all but the smallest and most inactive ice sheets. A paper is being published in the "Cainozoic Ice Ages" Symposium volume of the Royal Society of Edinburgh.

OKSTINDAN GLACIER PROJECT

(Wilf Theakstone and He Yuanqing, Department of Geography, University of Manchester, with Tuis Knudsen and Jens Tyge Møller, University of Aarhus, Denmark)

As part of a regional study of water resources, long-term glacier changes are being investigated, in the context of variations of climatic parameters. Since 1976, the annual studies (which began in 1970) have included a programme of mass balance, surface deformation and glacier hydrological observations at Austre Okstindbreen, the largest glacier of the Okstindan area. Whilst some neighbouring glaciers have experienced periods of advance, Austre Okstindbreen has been in retreat throughout the last two decades; however, its net mass balance has been positive in four of the last five years. Annual changes of the glacier are documented by terrestrial photogrammetry. A portable radio-echo sounder developed at Aarhus University and field tested in 1989 was used successfully at Austre Okstindbreen in 1990. Routine sampling of glacier river water for isotopic and chemical analyses was continued. Accumulation area investigations in each of the three field seasons (May; July–August; September) concentrated on sampling at pits and cores (stable isotopes, chemistry). A large, hitherto-unknown supraglacial lake in the accumulation area of the glacier Oksfjellbreen was observed: water draining from the lake had excavated a substantial gorge in snow and firn before becoming englacial by way of a crevasse in underlying glacier ice.

RADIO TRACERS IN GLACIOLOGY

(Mike Kennett, NVE, Oslo, Norway, and Mike Walford, H H Wills Department of Physics, University of Bristol)

Radio transmitting devices promise to be very valuable in the exploration and study of englacial water bodies, rivers and streams, and subglacial systems. With surface based receivers we can monitor their position, and/or collect encoded data. Two sizes of disposable 27 MHz transmitters and receivers with visual and acoustic outputs have been built in Bristol and are being tested in Norway, in comparison with 150 MHz animal-tracking radio probe systems. The directionality of antennae at 150 MHz is advantageous but apparently scattering at this frequency is confusing.

SVARTISEN RESEARCH PROJECT

(Wilf Theakstone, Department of Geography, University of Manchester with Tvis Knudsen and Jens Tyge Møller, University of Aarhus, Denmark)

Studies of glacier change in relation to climate at Svartisen, northern Scandinavia's largest ice-covered area, are in their fourth decade. The two ice caps covering some 370 km^2, supply 60 glaciers. Whilst Engabreen, the largest glacier of West Svartisen, has been advancing since the mid-1960s, most of the other large glaciers which terminate on land have continued to retreat. General Circulation Models suggest that the region, which lies across the Arctic Circle, may be a sensitive indicator of climatic fluctuations over a much wider area. Many of the Svartisen glaciers were re-photographed in July 1990 from stations established 25–30 years ago. Most of the small glaciers lying at relatively high altitude now are more advanced than in the early 1960s. Since its catastrophic break-up in 1982, the tongue of Svartisen's largest glacier, Austerdalsisen, has retreated very rapidly as a result of calving into a proglacial lake; in 1990, much of its margin had reached the lake's northern shore, more than 1 km from its 1982 location. The behaviour of several other large glaciers is dominated by calving. A terrestrial photo-grammetric survey of Fingerbreen, East Svartisen's second largest glacier, was carried out in July 1990, for comparison with the results of similar surveys made in 1975, 1976 and 1981, and with the result of mapping from aerial photographs taken in 1945, 1968 and 1985.

THE PREDICTION OF GLACIAL LAKE FORMATION AND CATASTROPHIC DRAINAGE EVENTS AT SÓLHEIMAJÖKULL, SOUTHERN ICELAND

(Peter Knight and Fiona Tweed, Department of Geography, University of Keele)

The objectives of the project are: (1) to ascertain the conditions necessary for (a) the formation of an ice-dammed lake at Sólheimajökull, (b) the catastrophic drainage of such a lake at Sólheimajökull; (2) To provide criteria by which the conditions required for ice-dammed lake formation and catastrophic drainage can be assessed at other sites. Existing models of tunnel dynamics and catastrophic drainage have been applied to the Sólheimajökull site on the basis of fieldwork carried out during the summer. Calculations indicate that the ice tunnel currently maintained by the river is at a critical threshold whereby it may close during the winter and a lake may form. If a lake forms, flotation of the ice-dam is a likely mechanism for drainage.

Submitted by J.G. Paren

USA - WESTERN

POLAR ICE CAPS

ICE RADAR

(S. Hodge, Ice and Climate Project, US Geological Survey, Tacoma)

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(Ed Waddington and Al Rasmussen)

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MONITORING THE DYNAMICS OF THE ANTARCTIC COASTLINE WITH LANDSAT IMAGES
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(David Bahr, INSTAAR, University of Colorado, Boulder)

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(Richard Brandt and Stephen Warren, University of Washington)

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(Kristina B. Katsaros and Grant W. Petty, Dept. of Atmospheric Sciences, University of Washington)

ICE–VOLCANO INTERACTIONS

INTERACTION OF HOT ERUPTIVE PRODUCTS WITH SNOW AND ICE
(J.S. Walder and C.L. Driedger, U S Geological Survey/CVO)

OUTBURST FLOODS AND DEBRIS FLOWS AT MOUNT RAINIER NATIONAL PARK
(J.S. Walder and C.L. Driedger, U S Geological Survey/CVO)

MISCELLANEOUS

THE PHYSICS OF WATER ICE IN THE MARTIAN ENVIRONMENT
(Duwayne M. Anderson, Texas A& M University)

INTERFACIAL WATER IN HYDRATED SMECTITE SYSTEMS SUBJECTED TO FREEZE THAW TEMPERATURE CYCLES
(Duwayne M. Anderson, Texas A& M University)

COORDINATED EASTERN ARCTIC EXPERIMENT (CEAREX) DATA MANAGEMENT
(C.S. Hanson, NSIDC/CIRES, University of Colorado, Boulder)

SNOW AND ICE DATA MANAGEMENT
(Roger G. Barry, National Snow and Ice Data/World Data Center-A for Glaciology, CIRES, University of Colorado)

GREEN ICEBERGS
(Ian Allison and Vin Morgan, Australian Antarctic Division, Richard Brandt and Stephen Warren, University of Washington)

OPTICAL CONSTANTS OF CO_2-ICE
(Gary Hansen, Dept. of Geophysics, University of Washington)

Submitted by A. Fountain

Very full reports were received from contributors, to whom we send thanks. However, what we traditionally publish in *ICE* is a summary of each project. We do not have space for longer reports, due to budget considerations. We are therefore publishing above the titles of the projects and the names of those responsible for them, to whom enquiries should be addressed. – *Ed.*

International Glaciological Society

ANNUAL GENERAL MEETING 1990

MINUTES OF THE ANNUAL GENERAL MEETING OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY
30 August 1990 at Dartmouth College, Hanover, NH, USA

The President, Dr Sam Colbeck, was in the Chair. 33 members from 12 countries were present.

1. The Minutes of the 1989 Annual General Meeting, published in *ICE* 92, p. 25–26, were approved and signed by the President.

2. The President gave his report for 1989–90:

Since organizing meetings and publishing technical material is the "business" of the Society, I always feel that it is necessary to let you know what we are doing in these areas. We have a variety of successes, prospects and a few problems to attack.

The *Annals of Glaciology* continues to fulfill its objectives. It is a well established series which should continue to prosper as the record of our future meetings. The *Journal of Glaciology* needs a chief editor to help shape its future. We have been discussing this need, and have tried new ways of operating. We continue to talk to candidates who might take over responsibility for the *Journal. ICE* has a new format which makes it considerably more attractive. It is our medium for communicating the news of glaciology world-wide, and if you have any suggestions for how it might better serve your needs we would be happy to hear them.

The incoming president of the Society, Dr Garry Clarke, has been working on the first two volumes for a new series which we think of as "Source Books in Glaciology". These two volumes will be on the mechanics of glacier flow: the first a historical volume and the second a volume of more current interest. We see these as the first in a long series of such books and gratefully acknowledge a contribution from the Seligman family which makes it possible for us to get started in publishing this series. While I have mentioned this possibility before, we are now able to use our new software to reset the material which we cannot simply photocopy.

We have made the financial arrangements to publish the translation of a Russian monograph on sea ice and expect copyright permission to be received very soon. There are also very good possibilities for publishing other books which have either been finished or are being prepared. Thus we have a good chance of publishing several books over the next few years because of our ability to advertise and distribute to the glaciological community. We are always seeking other suggestions for extending either publications I just mentioned or getting into other areas where we can offer our services and take advantage of our unique capabilities.

We have a well established pattern of organizing successful meetings, the proceedings of which are published in the *Annals*. Our success in this area must be well known because we have an increasing number of prospects for organizing meetings and an impressive list of meetings now planned or which are strong possibilities. In 1991 we will be in China to discuss mountain glaciology; in 1992 we will be in Boulder to continue our remote sensing meetings and

in Japan to discuss snow; in 1993 we will publish the proceedings of the SCAR meeting in Cambridge as we did in Bremerhaven (1987) and Columbus, Ohio (1981), and we will have a meeting on ice engineering in Finland. In 1994 and 1995 we are looking at glacial erosion and sedimentation, inverse methods in glaciology and polar glaciology. The last is particularly exciting because of the ice core results that should be available about that time.

There is no recommendation to report from the Awards Committee regarding another Seligman Crystal and there are no slots available for Honorary Members. Thus, there will be no awards made during the next year.

The healthy list of meetings and the success of the publications which I have just mentioned are due in large part to the efforts of Hilda Richardson, Secretary General to the Society. In 1993 Hilda will have been with the Society for 40 years and is expecting to retire. This will obviously be a significant event in the history of the Society and we plan to mark it at the 1993 SCAR meeting in Cambridge. We are in the process of appointing a search committee in hopes that over the next few years we can find a qualified person to carry on the task of pushing the Society in the next century. You will read more about this in *ICE* in due course.

In my last week as president of the Society, I thank those who have done the actual work of running the Society. In particular I acknowledge the efforts of Hilda Richardson, John Heap, the office staff in Cambridge, Ray Adie, Bernard Stonehouse and the scientific editors of the *Annals* and the *Journal*, the hosts and sponsors of our meetings, the officers and members of Council, and the other members who enthusiastically support the Society at all levels. All of them contributed to what we have done and are necessary for what we hope to do in the future.

3. The Treasurer, Dr J.A. Heap, submitted a report with the audited accounts for 1989. He expressed his regret that he was unable to be present. The President highlighted some items and suggested that anyone wishing to know more details of the finances should ask the Secretary General.

The Treasurer emphasised in his report that the general finances remained good, with a surplus of £1 688 bringing the level of the Accumulated Fund up to just over £12,000. The Annals Fund increased by £3 000 to £11,228, which will give us some flexibility for updating our equipment in 1990–91.

G.K.C. Clarke proposed and R.P. Goldthwait seconded that the audited accounts for 1989 should be adopted. This was agreed unanimously.

4. Election of auditors for the 1990 accounts. L.W. Gold proposed and E. R. Ponder seconded that Messrs Peters, Elworthy and Moore of Cambridge be elected auditors for the 1990 accounts. This was carried unanimously.

5. Election to the Council 1990–93. After circulation to all members of the Society of the Council's suggested list of nominees, no further nominations were received, and the following people were therefore elected unanimously:

President:	G.K.C. Clarke
Vice-Presidents:	D.J. Drewry
	B. Wold
Elective Members:	H. Björnsson
	K.C. Jezek
	M.A. Lange
	A. Ohmura

G.K.C. Clarke thanked members for the confidence they had shown in him and said that he was enthusiastic about working for the Society during the next three years, especially with its publications.

. . . . . .

After the conclusion of the formal business of the meeting, an informal discussion took place. Suggestions were made about possible links with other organisations such as SCAR, IGBP, ICSI, particularly through news items and notices in each other's news bulletins. The proposal from the Council that IGS should offer to co-sponsor workshops was well received; a report should appear in *ICE*, or in a special section of the *Journal* if several workshops were held in any year.

BRANCH NEWS

BRITISH BRANCH

12-13 September 1990

The Annual Conference was held at the Mullard Space Science Laboratory (MSSL) at Holmbury St Mary in the depths of Surrey. It was the first occasion that the British Branch had met in a country setting, and the weather allowed the buffet meals to be taken on the verandah with extensive views southwards over rolling English countryside. David Mantripp, Branch Secretary, organized the meeting admirably. The Annual Dinner was held at a local golf club, and the branch meeting closed with a very up-market cheese and wine party on the verandah, hosted by the Remote Sensing Group of MSSL.

It was a pleasure to renew acquaintance with expatriot British glaciologists now working in the US and Denmark and to welcome Belgian, Swedish and Soviet scientists to the British Branch meeting.

A list of the papers presented is given below. If you are interested in these topics please communicate directly with the authors.

Remote sensing

Chris Rapley (MSSL)
Introduction to glaciology-related remote sensing at MSSL.

Seymour Laxon (MSSL)
Sea ice monitoring using radar altimetry and passive microwave.

Jeff Ridley and Wyn Cudlip (MSSL)
Monitoring the Larsen Ice Shelf by radar altimetry.
Jonathan Bamber (MSSL)
Altimeter waveform retracking – an update.
John Reynolds and A.R. Wooler (Polytechnic South West)
Glaciological factors affecting seismic reflection surveys in the Canadian Arctic.
Mark Drinkwater (NASA/Jet Propulsion Laboratory, California, USA)
SAR observations of the Greenland Ice Sheet.
Philippa Berry (MSSL)
Geoid determination in ice-covered ocean.
Jan Askne (Chalmers University of Technology, Gothenburg, Sweden)
Ice investigations in the Gulf of Bothnia by means of SAR.

Hydrology and chemistry
Giles Brown (University of Southampton)
Hydrograph and Chemograph separation of bulk meltwaters draining the Upper Arolla Glacier, Valais, Switzerland.
Wendy Lawson (University of Cambridge)
The structure and hydraulics of the basal hydrological system of the Upper Arolla Glacier.
Heidi Mader (University of Bristol)
The thermal behaviour of the water vein system in polycrystalline ice.
Peter Knight and Fiona Tweed (University of Keele)
Formation and catastrophic drainage of ice dammed lakes.
Eric Wolff and Ed Suttie (British Antarctic Survey)
Heavy metals in Antarctic snow during the 20th Century.
John Moore (British Antarctic Survey)
Ice drilling in Greenland (GRIP 90).

Climate
Chris Doake (British Antarctic Survey)
Breakup of Wordie Ice Shelf, Antarctica.
Roger Braithwaite (Geological Survey of Greenland, Copenhagen, Denmark)
Monitoring the changes of the Greenland Ice Sheet caused by climatic change.
A.N. Krenke (Moscow Academy of Sciences, Moscow, USSR)
Relations between global climate and glaciers.

Ice dynamics
Gordon Hamilton (Scott Polar Research Institute, University of Cambridge)
Glacial investigations on a late quiescent surge type glacier, Svalbard.
Richard Hindmarsh and Geoffrey Boulton (University of Edinburgh)
Coupled ice sheet and deformable beds.
Rick Frolich (British Antarctic Survey)
A time-dependent model of Rutford Ice Stream and its catchment area.
David Vaughan (British Antarctic Survey)
The distribution of surface crevassing with relation to measured strainrates.
Adrian Jenkins (British Antarctic Survey)
Gravity currents beneath ice shelves.

Geophysics/geomorphology
David Collins (University of Manchester)
Annual variability of sediment transport in a glacier-fed stream.
Judith Hart (University of Southampton)
Till discontinuities.
Geoffrey Boulton and K. Dobbie (University of Edinburgh)
Glacier footprints.
Charles Warren (University of Edinburgh)
Non-climatic controls on the recent fluctuations of 72 West Greenland glaciers.
Matthew Bennett (University of Edinburgh)
The deglaciation of the North West Highlands.
Neil Glasser (University of Edinburgh)
Basal thermal regime and erosion under former ice sheets.
Tavi Murray (Scott Polar Research Institute)
Factors affecting the rheology of sedimentary glacier beds.

The 1991 British Branch Meeting will be held at the Old College of Edinburgh University on 19–20 September. Contributions are welcome on all aspects of glaciology, in particular glacial geology, present day observation and ice sheet dynamics. All UK members will be notified. If you have interest from abroad please contact David Mantripp, Mullard Space Science Laboratory, University College London, Holmbury St Mary, Dorking, Surrey RH5 6NT, U.K.

SELIGMAN CRYSTAL AWARDS 1990

28 August 1990. Hanover, NH, USA

The Society's Council agreed unanimously in 1988 that Seligman Crystals were to be awarded to Charles R. Bentley and Akira Higashi for their notable contributions in two fields of glaciological research. The Crystals were presented by the President of the Society, Sam Colbeck, in the presence of 90 members and visitors.

In his introduction the President said:

"Welcome to the 1990 Seligman Crystal presentations of the International Glaciological Society. Thank you for coming and sharing with me the presentation of two Seligman Crystals. Presentation of one of these crystals is one of the great rewards of being President of the Society and this evening I have the pleasure of presenting two.

I take particular pleasure in being the first to present a Crystal in recognition of work done outside of North America or Europe. In preparing my remarks for the presentation of a crystal to Dr Akira Higashi, I have not had any trouble in finding lots of international support. Dr Victor Pentrenko, presently a visitor here at Dartmouth, told me several days ago that Dr Higashi has contributed more to our knowledge of lattice defects in ice than anyone else.

Dr Higashi has clarified the structure of lattice defects in ice as well as the dynamical behavior of dislocations. To do this, it was necessary for him to develop the X-ray techniques that were needed and to grow the types of ice that would produce meaningful results. Ice is a very difficult material on which to use X-ray techniques but his results are better than those for other materials. His biggest contributions were to our experimental knowledge of dislocation structure in ice, anisotropy of ice plasticity, multiplications of dislocations, and interactions between dislocations and point defects. This knowledge is of fundamental interest to anyone interested in the mechanical or electrical properties of ice.

It is fitting that Dr Higashi has produced a number of students with whom he worked and who are now full-fledged scientists in their own right. Dr Higashi and his group have published a widely-acclaimed book on lattice defects in ice. In fact, ice is the only material for which such a book now exists. In his review of this book Dr Robert Whitworth said that it reveals the beauty of ice to us. He said: "It should be an essential volume in any collection that aims to show what ice is like, and is a fine memorial to the contributions that Akira Higashi and colleagues have made to glaciology."

Let the Seligman Crystal also be a memorial to his work."

After the presentation of the Crystal, Akira Higashi made the following reply:

"It is a great honor and pleasure for me to receive the Seligman Crystal this year with Charles. Also I am honored to be the first Japanese recipient. When I got a telephone call on the award last year, I first remembered the late Professor Nakaya. He was a pioneer on the research of snow crystals, and the founder of the Institute of Low Temperature Science, which is known as one of the major centers of glaciological research in the world. If he had lived a few years longer, I believe he would have been one of the early recipients of the Seligman Crystal. The first award was instituted in 1963, just the year after Nakaya died at the age of 62.

When I began to study physics as a student of Hokkaido University in Sapporo, we were already in the midst of World War II. The course of quantum mechanics was replaced by that of electron physics, because of the immediate interests in war-related research. In the summer of 1944, some students of physics were mobilized to help a project on the fog dissipation of airfields in the eastern part of Hokkaido. The project was lead by Professor Nakaya, and that summer's work ignited my interests in a particular field of meteorology, which has since been called Cloud Physics. My senior thesis was related to counter measures for frost heaving of runways in winter. The war ended just before I received my Bachelor's degree in 1945.

Desperate and poor in a war-defeated country, I became a graduate student under Nakaya's supervision, supported only by a government scholarship, which could hardly catch up with the severe postwar inflation in Japan. However, Professor Nakaya made an effort to support and encourage researchers and graduate students, establishing some projects related to the economic restoration of Japan. You should know that the postwar policy of the Allied Powers to Japan was such that "Japan will be permitted to have only light industry, not heavy industry, and she will survive as an agricultural country like Switzerland". So, Nakaya's group tried to develop agricultural techniques based on physical and meteorological principles. The most successful project was the hastening of the melting of accumulated snow on the ground in Hokkaido in early spring. I investigated the areal distribution of seasonal frozen ground in Hokkaido, as well as its maximum depth.

After writing my Ph.D. thesis on the thermal conductivity of frozen soils, I was appointed a lecturer of physics of Hokkaido University. My subjects of study in the early 1950s were still diverse, cloud physics, frost heaving and snow hydrology.

However, I began to recognize that one of the main streams of physics was solid state, and I thought about how it related to the ice crystal itself. Immediate motivation for such conversion was provided by Nakaya's beautiful work on the internal melt figures in, and bending creep tests of, the ice single crystal, both carried out in the SIPRE from 1952 to 1954. As a visiting scientist, he not only conducted these experiments, but also greatly influenced young scientists who had initiated glaciological research in this new institute. As you know, SIPRE was the former body of CRREL, here in Hanover.

After Professor Nakaya came back to Sapporo, in 1955 I joined the SIPRE as a contract scientist. That was my first experience abroad. In my two and a half years' stay, I was first asked to carry out laboratory experiments on frost heaving. Simultaneously, I collaborated with Arturo Corte from Argentina, on the experimental study of the desiccation cracking of soil by the suggestion of Dr Bader, the chief scientist. This was memorable work for me at SIPRE, because the work was appreciated by Professor Washburn as an essential contribution to the study of the periglacial phenomena. In the last half year or so in SIPRE, I carried out some experiments on the plastic deformation of ice, which was the first step towards my real involvement in the solid state studies of ice.

In SIPRE, I made many friends, who later became experts in various fields of glaciology. Dr Henry Bader, the chief scientist, was already an expert on deposited snow, and he received the Seligman Crystal in 1967 for his leadership in SIPRE. Among young American scientists in those days, Chet Langway is still very active as an expert on deep ice-core studies. Afterwards in the 1970s, through his kind assistance, I had the good fortune to receive several Byrd Station deep ice-core samples from the NSF storage. After our extensive experimental work on the mechanical properties of the ice core, exchange of researchers and ice cores had begun between Buffalo and Sapporo. The exchange is still continuing and expanding.

In April 1958, I came back to Sapporo and began to study the ice crystal as a subject of solid state physics. The first thing to do was to obtain single crystals of ice. Nakaya had the privilege of using large amounts of natural large single crystals of ice collected by a SIPRE team at the Mendenhall Glacier, Alaska. At that time, it was believed that the most efficient way to obtain single crystals of ice was to collect natural large ones in Alaska, which was relatively easy to access from Japan. So I organized

an expedition to the Mendenhall Glacier among scientists in Hokkaido University.

The expedition in the summer of 1960 successfully collected about 500 kg of good quality, single crystals of ice on the terminus lake of the Mendenhall Glacier. The ice was taken back to Hokkaido from Juneau by a fishery training ship of the University. Possession of large amounts of single crystals of ice made it possible to conduct extensive experiments on the mechanical properties of ice, such as the creep and the stress–strain tests in our cold laboratory of the Physics Department of Hokkaido University. These mechanical tests continued for several years, under various conditions of temperature, stress, and strain rate. We exhausted the single crystals in those experiments, and went again to Alaska to collect nearly one ton of single crystals of ice in 1964.

In the same year, I was appointed as a professor of the newly established Department of Applied Physics. Since the expansion and development of Japanese industry led to the restoration of its heavy industry, engineering schools of her national universities were expanding. The importance of applied physics has been recognized ever since. It was just at this time that we seriously felt the need to consider research on dislocations in ice. I decided to purchase a newly manufactured apparatus for X-ray topography, with special funding from the government for this new department.

I remember with the new apparatus in our early days, it took about 20 hours exposure time to take one topograph with our ordinary X-ray generator of 0.3 mA current. Fortunately, the method has improved very rapidly, due mainly to the increase of the electric current of the generator (for example, the use of a rotary target permits large current such as 200 mA up to 1A). Exposure time is now shortened to the order of several minutes. At first, dislocation configurations were examined, and it was proven that the Mendenhall single crystals were comparatively perfect, contrary to our fear that they might contain too many dislocations to be distinguishable.

Because of the comparatively low absorption coefficient for X-rays in ice, we can examine thick specimens of ice, on the order of nearly 10 mm. This is the greatest advantage for the use of X-ray topography for ice, because we can see the behavior of dislocations in the same specimen subjected to mechanical stress or heat treatment by interleaving X-ray examinations during these tests. For our precise investigations of dynamic behavior of dislocations, ice crystals of lower dislocation density than the natural ones were needed. Parallel to the work with the Mendenhall ice single crystals, we attempted to grow artificially good quality single crystals in our laboratory. The X-ray topography was used in order to assess crystal perfections as well as to clarify the mechanism of the entrainment and multiplication of dislocations during crystal growth.

Studies carried out in the past 20 years include, determination of Burger's vectors of dislocations in ice, measurements of dislocation velocity under various stress and temperature, generation and multiplication processes of dislocations, stacking faults and their interactions with point defects, and structures of large-angle grain boundaries. They have all contributed from time to time to our understanding of the microscopic processes underlying the mechanical properties of ice. For example, our results of dislocation velocity gave a much lower value than that theoretically predicted by Dr Glen and his colleague. So, later they modified their value and finally took a new approach for evaluating the dislocation velocity.

When I retired from Hokkaido University in 1985, I proposed to my colleagues, who had worked with me for a long time, making a book of collected topographs compiled in files over 20 years.

It took about two years for me to edit the book, collecting and reproducing topographs and writing the text, including the various subjects mentioned previously. The book, entitled *Lattice defects in ice crystals, X-ray topographic observations* was published by the Hokkaido University Press in early 1988. I hope that the work described in this book is a valuable contribution to glaciology and worthy of the award presented.

On this occasion, I should like to thank many associates and past students who helped me with their enthusiastic efforts, especially the co-authors of the book: Akeharyu Fukuda, Mitsugu Oguro, Takeo Hondoh, Hitoshi Shoji and Kumiko Azuma. The subject of ice physics is now principally passed on to these people. I am also very glad to see that the X-ray topographic studies of ice have been extended worldwide. Of special mention is Dr Whitworth's group in Birmingham, England, which has recently provided beautiful topographs taken with synchrotron radiation as a source of X-rays. In America, Dr Itagaki here in CRREL observed oscillatory movements of dislocations in ice in X-ray topographs.

In the past decade, I have also been associated with Antarctic glaciological research. I have managed the East Queen Maud Land Glaciological Project as the project leader from 1982 to 1986. Last year, I was asked to participate the workshop of Sea Level Rise of the IPCC held in England. Discussions on the effects of anticipated global climatic change (due to warming gas in the atmosphere) to glaciers and ice sheets in the world have made me consider seriously the problem of global environments. At my new affiliation in Tokyo, the International Christian University, I am now supervising senior students on integrated studies in natural science, with the topic of "Global environment". It is my pleasure that I can study this subject, not only in my own interests, but with the cooperation of young students. They are the real supporters of the "sustainable development", an idea for the 21st century. That idea was once unthinkable among the Japanese scientists and engineers who made the concentrated effort necessary for postwar industrial restoration."

Charles Bentley and Akira Higashi

The President continued:

"We now turn from the molecular scale to that of the Antarctic Ice Sheet.

Dr Charles Bentley's work on the Antarctic Ice Sheet spans the period of time from the IGY in 1957, when we knew rather little about even the geometry of the world's dominant fresh water reservoir, to the present when he is still a key figure in developing knowledge about the very processes that control the flow of the ice sheet. It is timely to present a Seligman Crystal to Charles Bentley because he was one of the pioneers who laid the foundations for current work on the ice sheet, work that is now even more widely recognized because of our sudden interest in the Earth's climate.

In his early work he pioneered the use of geophysical techniques in Antarctica including the study of wave propagation in glacier ice and other heterogeneous media. While he has taken the lead in developing geophysical sensing techniques for the ice sheet, his work has also included flow and mass balance studies, icebergs, ice shelves, subglacial till, and even subglacial crustal structure.

As is appropriate for someone of Dr Bentley's knowledge and vigor, his contributions have been made in part through a group of students. Thus he has given us a group of professionals who are now contributing on their own, at this meeting for example. In recent years this group has revolutionized our ideas about the very flow of glaciers and ice sheets.

As is befitting an Antarctic glaciologist, Dr Bentley has been very active in international organizations and has served the international community of scientists through a number of those. Not being an Antarctic glaciologist myself, I have not had the opportunity to work with Dr Bentley in the field, but I have served on the Board of Editors of the Antarctic Research Series which he chairs. He has invigorated that Series with his enthusiasm for Antarctic science with the same dedication to the subject that has allowed him to complete so much research, on such a difficult subject, in such an inaccessible place. For the great depth and breadth of this work, we are pleased to present the Seligman Crystal to Dr Charles Bentley."

Following the presentation of the Crystal, Charles R. Bentley replied:

"As you can well imagine, it is truly a pleasure to be standing in front of you tonight. I was flabbergasted when I received the phone call from Sam Colbeck last summer. At first he said he was calling only to find out if I was enjoying my Sunday afternoon. When he then told me the real reason, I was thrilled and deeply complimented. There is no other society whose recognition I would value as much as I do this one's. I also applaud the emphasis made in Sam Colbeck's remarks on the research group at Wisconsin whose efforts I have profoundly appreciated — without them I could have done very little.

Like most glaciologists, I didn't start out my career thinking of myself as one. For many years I considered myself to be a geophysicist working on ice. Then in the '70s I started teaching a course in glaciology. As any teacher knows, teaching is the way really to learn a subject, and it was the route through which I started regarding myself primarily as a glaciologist. Now the Society has associated me with the superb glaciologists, Akira Higashi most deservedly now among them, who already hold the Seligman award, and I am extremely gratified as well as grateful.

But at one time I wasn't even going to be a geophysicist. When I graduated from college I enrolled in law school, even though I had been a physics major. If I had not had an unexpected opportunity to work with Maurice Ewing's group at Columbia that summer, I would now be a lawyer. But after two months on the research vessel *Atlantis* I never thought of the law again.

Thus by 1954 I thought I was a marine geophysicist. A graduate student working with Doc Ewing was expected to go to sea and I did, but I didn't know what my dissertation work was going to be. Then one day Frank Press, at that time an assistant professor at Columbia and a member of the IGY committee planning the Antarctic oversnow traverse program, asked if any of us graduate students would like to spend a year and a half in Antarctica. The other students were married, so were having none of it, but I wasn't, so I signed on.

That led me to my dissertation project in Greenland in 1955 with the new prototype broadband seismograph system designed for the Antarctic program. We made seismic measurements around Site 2, working during the "night" to get access to weasels. At Tuto, just off the ice cap, we had been issued only gloves for our hands, which were enough protection there but not at Site 2, particularly at night. I was so naïve then that I supposed that if we were issued only gloves, gloves were all our hands should need and it was my fault my hands were stiff from cold all the time. We also did some shooting in Blue Ice Valley where I first met Mark Meier. He was studying crevasses and taught me a lesson I've never forgotten — that one could be confident in walking across the unbroken surface because "there're no crevasses heeeeere."

We were back in Greenland to continue the work the next summer, when the Antarctic-glaciologists-in-training were also there at a school under the direction of Henri Bader. They were learning how to dig pits, so at that time I didn't even *want* to be a glaciologist!

For a young geophysicist going to the Antarctic at the beginning of the IGY, Bert Crary was the demigod and Gordon Robin the oracle. Crary, whose Arctic exploits were legendary, was our on-the-spot boss. Preprints of Robin's *magnum opus* from the Norwegian-British-Swedish Expedition, provided to us on the horrible thermal-copier paper of the day, were the textbooks. Crary also taught me an unforgettable lesson — that one can be confident in walking up to the very edge of the ice shelf because "there's no calving heeeere."

Also in the Antarctic during the first years were Hugh Bennett and Ed Robinson, who became my first students at the University of Wisconsin, although it was Crary who actually directed their thesis research in the field. Bennett, a geophysicist, distinguished himself by pulling out of a crevasse a glaciologist who had taken Mark Meier's advice too literally. We cowardly geophysicists normally adhered to the Crary dictum that the only way to get

along with crevasses was to stay away from them.

After returning to Wisconsin, I soon had the opportunity to attend my first International (then British) Glaciological Society meeting. I gave a messy paper comparing surface slopes to ice thicknesses measured by the poor-man's tool – gravity. I was going to prove John Nye wrong! He was very kind and gentlemanly, as always — I didn't even notice the skewer until two days later. It did eventually turn out that surface slopes indeed change by much more than is needed to keep the stress constant on the bed, but it was Robin who figured it out. I didn't even know what a longitudinal stress was in those days.

It wasn't long before I started hearing about Bud Waite's use of radio altimeters to sound the ice at Little America and south of Wilkes Station. Waite, an electronics engineer, was anxious to help geophysicists use his tool, so George Jiracek took it south. He worked on Skelton Inlet and Roosevelt Island and got the first sounding on the inland plateau, at Pole Station, but only by orienting his antennas perpendicular to each other. That depolarization has never been explained — in fact, the potential utility of polarization measurements for studying the ice sheet and its bed remains largely unrealized to the present day.

Meanwhile, Stan Evans and the SPRI group were developing the radio-echo sounder that revolutionized ice-sheet sounding. Bud Waite organized the ICFEGS (International Cooperative Field Experiment in Glacier Sounding) in Greenland where he and Evans proved the superiority of the radar technique to any of us geophysicists who might still have been skeptical. John Clough took over the radar program for the Wisconsin group, leading, among other things, to the soundings with John Beitzel on the East Antarctic plateau traverses. Later on, early in our Ross Ice Shelf studies, Clough jury-rigged antennas under the wings of a Twin Otter, starting the airborne sounding program that he, and later Ken Jezek and Sion Shabtaie, carried on so effectively over the ice shelf and the adjacent Siple Coast.

The most personally rewarding outcome of the radar work for me, however, was the opportunity to meet and work with the late Vitaly Bogorodsky in Leningrad. Bogorodsky was the outstanding scientist who had invented radar sounding in the Soviet Union and developed radioglaciology to a level in some ways exceeding that in the west. He was also a charming and totally enjoyable man whose hospitality was boundless.

The 5-year Ross Ice Shelf Geophysical and Glaciological Survey brought Jamie Robertson, Larry Greischar, Don Albert, Larry Whiting and Joe Kirchner into the program, along with Jezek and Shabtaie. Jezek, by the way, went directly into the field without bothering to come home after spending the winter at McMurdo being bombarded by cosmic rays. I think the irradiation affected his judgment, but I suppose I'm no one to talk, having once wintered two years in a row. Clough started with us on RIGGS, then went to join Lyle Hansen in the effort to drill an access hole through the ice shelf, a project that turned out to be a real burner!

In the late '70s a luxurious camp was built at Dome C, initially not for the benefit of science, but for Lockheed engineers who had the unenviable task of recovering three C-130s that had crashed there, one by the remarkable method of shooting itself down with its own JATO bottle. This camp provided the opportunity for a glaciological program around that site, including the famous core hole drilled by Claude Lorius and his group. Don Blankenship, Roger Gassett and Ken Taylor joined Albert in the Wisconsin geophysical effort there.

It is Dick Cameron who deserves the credit for getting the Siple Coast Project going. He pushed it for years while he was NSF's program manager for glaciology. I think his eventual success was aided in no small measure by Hans Weertman's recognition of the dynamics of the West Antarctic marine ice sheet as "glaciology's grand unsolved problem". Another of Cameron's accomplishments was to get Barclay Kamb into the Antarctic program by luring him south as a Distinguished Visitor. Of course, once Kamb saw the Antarctic he was hooked. It *is* irresistible.

We at Wisconsin started our Siple Coast Project field work in 1983, and I hardly need to elaborate on the exploits of Richard Alley, Sean Rooney, and Blankenship on Ice Stream B. Suffice it to say that, together with Shabtaie's surveys and Craig Lingle's numerical analyses of ice stream dynamics, those exploits were instrumental in bringing about this award tonight. Alley, incidentally, originally came to Wisconsin only after I agreed (I would have agreed to anything to get him) that he would not have to go to Antarctica again. Well, he was just as hooked as anyone else, so that was a promise I never had to live up to.

The Antarctic is indeed irresistible, as I well know. After all, I too am hooked. But in my case there is another reason for my repeated trips that was stated succinctly at Crary's IGY 25th aniversary party. Someone asked why Bentley keeps going back, and a wag responded: "He has to keep going till he gets it right!" That may well be true, and with the inspiration that the Seligman Crystal provides maybe we finally will get it right! So for me, and all those who are part of the Wisconsin team, I say once again, thank you."




SYMPOSIUM ON ICE–OCEAN DYNAMICS AND MECHANICS

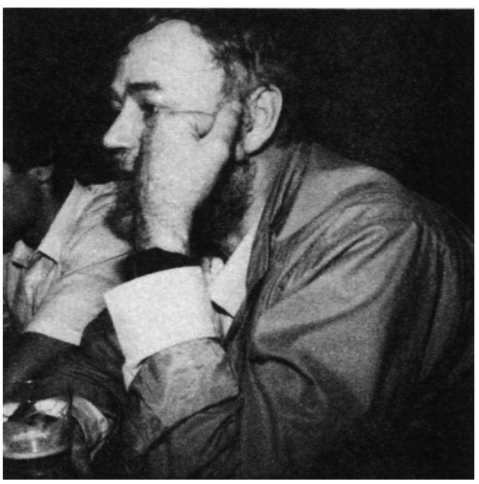
Hanover, NH, USA, 27–31 August 1990

The symposium was held in the Thayer School of Engineering, Dartmouth College, and was attended by 70 participants. The Local Arrangements Committee, under the chairmanship of Erland Schulson, and with the help of willing volunteers, laid on interesting events. The Chief Editor of the proceedings volume, Kolumban Hutter, kept associate editors and authors working hard, though none worked quite such long hours as he did himself.

An icebreaker was held on the first evening, a cruise on Lake Winnipesaukee in mid-week, and a banquet later in the week.

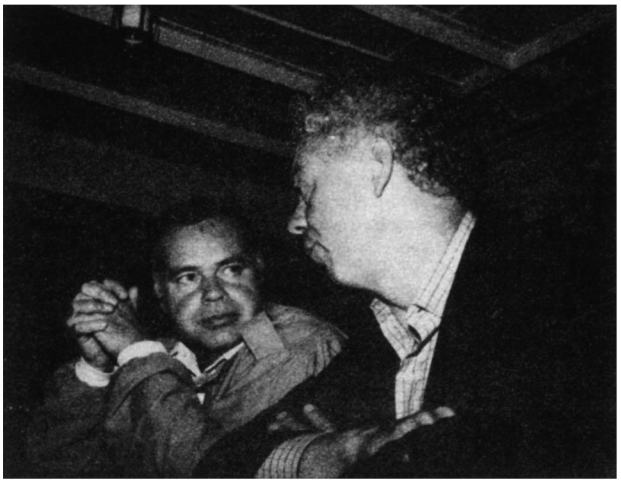
Evening cruise on Lake Winnipesaukee

Dick Goldthwait expounds on the landscape

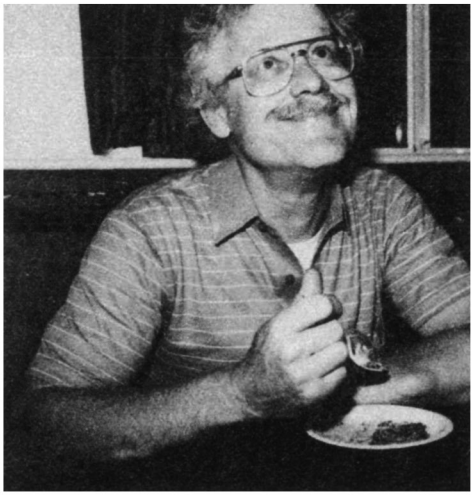


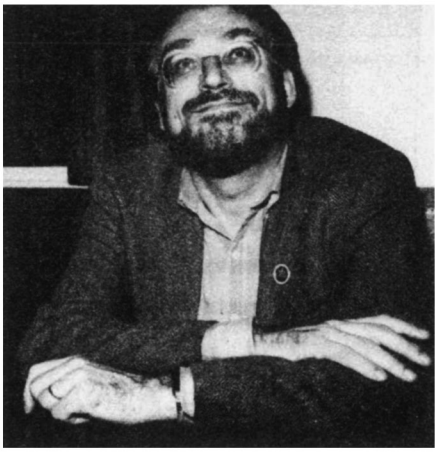
Bill Budd listens intently

while Willy Weeks
remembers
hilarious adventures
in hilly New Hampshire



Stig Jonsson and Garry Clarke
ponder serious matters –





Sam Colbeck and Koli Hutter
wonder what these might be

Photos by Koni Steffen




INTERNATIONAL SYMPOSIUM ON REMOTE SENSING OF SNOW AND ICE

A CONTRIBUTION TO THE GLOBAL CHANGE PROGRAMME
Boulder, Colorado, USA 17 – 22 May 1992

The Second Circular is now available from The Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England.

INTERNATIONAL GLACIOLOGICAL SOCIETY
INTERNATIONAL SYMPOSIUM ON APPLIED ICE & SNOW RESEARCH

Rovaniemi, Finland 18 – 23 April 1993

CO-SPONSORED by
Ministry of Education, Finland Arctic Centre
University of Lappland, City of Rovaniemi

FIRST CIRCULAR

The Society will hold an international symposium on Applied Ice and Snow Research in 1993. Registration will take place on Sunday 18 April and sessions will be from Monday 19 to Friday 23 April in Rovaniemi, Finland.

TOPICS: The suggested topics include: (a) measurement of ice and snow properties, (b) modelling of ice growth and decay, (c) seasonal snow cover, (d) snow thermodynamics (e) fracture and creep of ice, (f) friction and adhesion of ice and snow, (g) ice and snow as construction material.

SESSIONS: Sessions will be held on four full days and one half-day. An excursion will be held on one half-day. We plan to provide ample opportunity for poster displays. In the Second Circular we will ask you to indicate, when submitting your summary, if you wish to participate in the poster sessions.

PUBLICATION: The Proceedings of the symposium will be published by the Society in the *Annals of Glaciology*. Papers will be refereed and edited according to the Society's usual standards before being accepted for publication.

ACCOMMODATION: Details will be given in the Second Circular.

TOUR: A post-symposium tour to the Gulf of Bothnia and Finnish Lappland will be held. Details will be given in the Second Circular.

FURTHER INFORMATION: You are invited to attend the symposium. Please return the attached form as soon as possible. The Second Circular will give information about accommodation, general programme, preparation of summaries and final papers, and tour. Requests for copies of the Second Circular* should be addressed to the Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, U.K.
*Note: Members of the International Glaciological Society will automatically receive a copy.

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INTERNATIONAL GLACIOLOGICAL SOCIETY SYMPOSIUM ON
APPLIED ICE & SNOW RESEARCH

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I hope to participate in the symposium in April 1993 [ ]
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Charity Commission Reference 231043

JOURNAL OF GLACIOLOGY

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

A E TAYLOR
Holocene paleoenvironmental reconstruction from deep ground temperatures.

A LETRÉGUILLY, P HUYBRECHTS, N REEH
Steady-state characteristics of the Greenland ice sheet under different climates.

A M SMITH
The use of tiltmeters to study the dynamics of Antarctic ice-shelf grounding lines.

H BLATTER, K HUTTER
Polythermal conditions in Arctic glaciers.

W HAEBERLI, M FUNK
Borehole temperatures at the Colle Gnifetti core-drilling site (Monte Rosa, Swiss Alps).

M TRANTER, R RAISWELL
The composition of the englacial and subglacial component in bulk meltwaters draining the Gornergletscher, Switzerland.

T A GOSINK, J J KELLY, B R KOCI, T W BURTON, M A TUMEO
Butyl acetate, an alternative drilling fluid for deep ice-coring projects.

N R IVERSON
Potential effects of subglacial water-pressure fluctuations on quarrying.

M LOWSON, M E R WALFORD, D M HARGREAVES, S STUART-SMITH
Freezing of water drops on a cold surface.

E MOSLEY-THOMPSON, J DAI, L G THOMPSON, P M GROOTES, J K ARBOGAST, J F PASKIEVITCH
Glaciological studies at Siple Station (Antarctica): potential ice-core paleoclimatic record.

W A EDELSTEIN, E M SCHULSON
NMR imaging of salt-water ice.

A OHMURA, N REEH
New precipitation and accumulation maps for Greenland.

N HUMPHREY
Estimating ice temperature from short records in thermally disturbed boreholes.

R B ALLEY
Deforming-bed origin for southern Laurentide till sheets?

Glaciological Diary

** IGS Symposia
* Co-sponsored by IGS

1991

28 May-1 June
AGU–MSU Spring Meeting, Baltimore, MD, U.S.A. (Christine N. Hooke, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, DC 20009, U.S.A.)

3-6 June
* Symposium on the Tropospheric Chemistry of the Antarctic Region, Boulder, Colorado (Barry A. Bodhaine, NOAA-CMDL R/E/CG1, 325 Broadway, Boulder, CO 80303, U.S.A.)

3-7 June
WATERSCAPES '91: International Conference on Water Management for a sustainable environment, Saskatoon, Canada (WATERSCAPES '91, #3-3002 Louise Street, Saskatoon, Saskatchewan, Canada S7J 3L8)

23-28 June
OMAE 1991. 10th International Conference on Offshore Mechanics and Arctic Engineering: Arctic/Polar Symposium (including ice mechanics and properties of ice, and remote sensing), Stavanger Forum, Stavanger, Norway (Nirmal K. Sinha, Member, Executive Committee, Offshore Mechanics and Arctic Engineering Division (OMAE/ASME), Division of Mechanical Engineering, National Research Council of Canada, Ottawa, Ontario, Canada K1A 0R6)

2-9 August
XIII INQUA Congress, Beijing, China (Chinese Academy of Sciences, 52 Sanlike, Beijing 100864, China)

11-15 August
ISOPE-91. First (1991) International Offshore and Polar Engineering Conference, Heriot-Watt University, Edinburgh, U.K. (ISOPE-91 Edinburgh Secretariat, 4 Frederick Sanger Road, Surrey Research Park, Guildford, Surrey GU2 5YJ, U.K.)

11-24 August
20th General Assembly of the International Union of Geodesy and Geophysics, Vienna, Austria.

26-30 August
** IGS Symposium on Mountain Glaciology relating to Human Activities, Lanzhou, China (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, U.K.)

September
6th International Symposium on Ground Freezing, Beijing, China (Hans Jessberger, Ruhr-University Bochum, P.O. Box 102148, D-4630 Bochum 1, Germany)

1-6 September
Symposium on the Physics and Chemistry of Ice, Sapporo, Japan (Norikazu Maeno, Institute of Low Temperature Science, Hokkaido University, Sapporo 060, Japan)

16-20 September
VAW/ETHZ International workshop on Permafrost and Periglacial Environments in Mountain Areas, Interlaken, Switzerland (W. Haeberli, Head, Section of Glaciology, Laboratory of Hydraulics, Hydrology and Glaciology, ETH-Zentrum, CH-8092 Zürich, Switzerland)

18-21 September
Geotechnica: International Trade Fair and Congress for Geo-sciences and Technology, Cologne: Conservation of Planet Earth — Challenge to Science and Technology (Alfred-Wegener-Stiftung zur Förderung der Geowis-

senschaften, Wissenschaftszentrum, Ahrstrasse 45, Postfach 20 14 48, D-5300 Bonn 2, Germany)

23-27 September
SCAR International Conference on Antarctic Science — Global Concerns, Bremen, Germany (Dr G. Hempel, Convenor, Antarctic Science – Global Concerns, Alfred-Wegener-Institut, P.O. Box 12 01 61, D-2850 Bremerhaven, Germany)

24-28 September
POAC '91. 11th International Conference on Port and Ocean Engineering Under Arctic Conditions, St. John's, Newfoundland (Hanny Muggeridge, Ocean Engineering Research Centre, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X5)

12-15 December
2nd meeting on Environmental Change in Iceland, München, Germany (Johann Stötter, Institut für Geographie der Universität München, Luisenstr. 37, 8000 München 2, Germany)

1992

6-10 April
XVII General Assembly of the European Geophysical Society, Edinburgh, Scotland (EGS Office, Postfach 49, 3411 Katlenburg-Lindau, Germany)

17-22 May
** Symposium on Remote Sensing of Snow and Ice, Boulder, CO, U.S.A. (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, U.K.)

29 June-3 July
Interpraevent 1992: Protection of Habitat against Floods, Debris Flows and Avalanches, Berne, Switzerland (Interpraevent 1992, c/o Bundesamt für Wasserwirtschaft, Postfach, CH-3001 Berne, Switzerland)

14-18 September
** Symposium on Snow and Snow-related Problems (as part of an International Forum on Snow Areas), Nagaoka, Japan. Co-sponsored by the Japanese Society of Snow and Ice and the City of Nagaoka (Secretary General, IGS, Lensfield Road, Cambridge CB2 1ER, U.K.)

1993

5-9 July
6th International Conference on Permafrost, Beijing, China (Cheng Guodong, Lanzhou Institute of Glaciology and Geocryology, Academia Sinica, Lanzhou, 730 000, China)

News

AWARDS

Professor Maynard Miller was awarded an honorary doctorate degree at the University of Alaska Southeast at Juneau, on 4 May 1990. Miller is being awarded the degree for his work on the Juneau Icefield Research Program. Miller is considered one of the world's foremost experts on icefield conditions, and his research has documented changes in the global climate.

Charles Bentley and **Jeff Dozier** were elected Fellows of the American Geophysical Union at the meeting held in San Francisco in 1990.

Robert Jacobel, professor of physics at St. Olaf College, presented the prestigious Melby Lecture at St. Olaf College on 15 November 1990. The lecture series honours contributions to education and to St. Olaf College, and Dr Jacobel was asked to present this lecture because of his active participation in research on ice radar, and his inclusion of undergraduate students in research. Several of his students have been a co-author on various journal articles and symposium presentations. The lecture was titled "A Geophysical Perspective on Global Change".

Charles Swithinbank, an Associate in Glaciology at Scott Polar Research Institute, has been awarded the Mungo Park medal of the Scottish Geographical Society. The citation stresses Dr Swithinbank's contributions to international cooperative research and his demonstration of inter-relationships between pure and applied research in glaciology.

Peter Wadhams, Director of the Scott Polar Research Institute, received an Italgas Prize for Environmental Sciences in October 1990. The prize aims to 'offer recognition and stimulus to those working on research for civil and social development in Italy and other EEC countries'. Dr Wadhams' most recent work, involving measurements of Arctic ice thickness from submarines, suggests that a significant thinning of ice has occurred over the last decade.

John Heap, head of the Polar Regions Section of the Foreign and Commonwealth Office, London, became a Companion of the the Most Noble Order of St Michael and St George (CMG) in the New Year Honours List. Dr Heap has acted as our Treasurer for 11 years, and given much valuable advice to the Society.

On 23 November 1990, a happy meeting was held in Genoble, France in honour of **Louis Lliboutry's** retirement. In addition to colleagues at the Laboratoire de Glaciologie, which he founded in 1958, and others in Grenoble, several European glaciologists were invited to present papers on glacier mechanics and interaction between glaciers and climate: Hans Röthlisberger, Almut Iken, Hans Oeschger, Kolumban Hutter, John Nye, Walter Ambach, Niels Reeh, André Berger, Geoffrey Boulton. A successful day concluded with the presentation, to loud applause, of the premier medal of the Université Joseph Fourier, to mark Professor Lliboutry's remarkable career.

New members

Igor L.Appel, Arctic and Antarctic Research Institute, Bering Street 38, 199226 Leningrad, U.S.S.R.

Oleg P. Chizhov, Zelenograd 440, Kv. 105, 103498 Moscow, U.S.S.R.

Robert E. Davis, US Army CRREL, 72 Lyme Road, Hanover, NH 03755-1290, U.S.A.

Andrei Glazovskiy, Institute of Geography, Academy of Sciences USSR, Staromonetny 29, Moscow 109017, U.S.S.R.

Gleb Y. Glazyrin, Department of Hydrology, Geographical Faculty, Tashkent State University, TashGU, VUZ Gorodok, 700000 Tashkent, U.S.S.R.

J. Wouter Greuell, Geographisches Institut ETH, Winterhurerstrasse 190, CH-8057 Zürich, Switzerland.

Norio Hayakawa, Nagaoka University of Technology, Kami-tomioka-cho 1603-1, Nagaoka 940-21, Japan.

Vladimir G. Khodakov, Institute of Geography, Academy of Sciences USSR, Staromonetnyy Street 29, 109017 Moscow, U.S.S.R.

Yaroslav D. Muravyev, Institute of Vulcanology, Academy of Sciences USSR, Piip Boulvar 9, 683006 Petropavlovsk-Kamchatskiy, U.S.S.R.

Petr A. Plekhanov, Kazakh Pedagogical Institute, Sovetakaya Street 30, 480100 Alma-Ata, U.S.S.R

Ross D. Powell, Department of Geology, Northern Illinois University, Dekalb, IL 60115, U.S.A.

Qin Dahe, Lanzhou Institute of Glaciology and Geocryology, Academia Sinica, Lanzhou 730000, Gansu, People's Republic of China.

Brice R. Rea, School of Geosciences, The Queen's University of Belfast, Belfast BT7 1NN, Northern Ireland, U.K.

Albert A. Romanov, Arctic and Antarctic Research Institute, Bering Street 38, 199226 Leningrad, U.S.S.R.

Jo Scheur, 9 chausée St. Martin, L-6989 Hostert, Luxembourg.

Daniel B. Stone, Department of Geophysics and Astronomy, University of British Columbia, Vancouver, British Columbia V6T 1W5, Canada.

David V. Thiel, Radio Science Laboratory, Division of Science and Technology, Griffith University, Nathan, Queensland 4111, Australia.

Ganibek A. Tokmagambetov, Institute of Geography, Academy of Sciences of the Kazakh SSR, Pushkin Street 99, 480100 Alma-Ata, U.S.S.R.

Roderik van de Wal, IMOU, Princetonplein 5, 3584 CC Utrecht, Netherlands.

International Association of Hydrological Sciences

The International Association of Hydrological Sciences has published many proceedings of symposia organized or sponsored by the Commission on Snow and Ice. Some recent titles are:

AVALANCHE FORMATION, MOVEMENT AND EFFECTS

edited by Bruno Salm & Hansueli Gubler

This publication contains over 60 papers selected from those accepted for the symposium organized by the Federal Institute for Snow and Avalanche Research, Davos, Switzerland, and held there in September 1986. The papers present recent work on: snow as a material, its structure and its metamorphosis, the chemical, mechanical and electromagnetic properties; snow pack characteristics, including stability, gliding and wind effects, as well as the climate and meteorological conditions leading to unstability of a snow cover; movement of avalanches, particularly slush avalanches; forecasting methods; avalanche risk analysis.

Publ. no. 162 (1987), price $50 (US) *ISBN 0-947571-96-5*

LARGE SCALE EFFECTS OF SEASONAL SNOW COVER

edited by B. E. Goodison, R. G. Barry & J. Dozier

This publication contains 35 papers from the symposium held at Vancouver, August 1987. The papers are divided into three themes: ***role of snow cover in climate dynamics (polar and mid-latitude regions); large scale hydrological effects of snow cover; remote sensing of snow cover.*** Aspects of particular interest for snow-climate interactions include snow cover as a climate indicator and for climate system monitoring, and snow cover parameterization for climate modelling. For hydrological effects, the focus is on inter-relationships between snow cover, snowmelt, flooding, spring soil moisture and runoff in large basins (>2500 km^2), as well as the effect of spatial variability of inputs and model parameters and the appropriate scale of modelling. In remote sensing, the emphasis is on properties measurable by remote sensing, the mapping of snow cover in polar, mid-latitude and mountain regions, the use of remotely sensed data in hydrological/climatological models, and the integration of remotely sensed and ground based snow measurements.

Publ. no. 166 (1987), price $42 (US) *ISBN 0-947571-16-7*

THE PHYSICAL BASIS OF ICE SHEET MODELLING

edited by Edwin D. Waddington & Joseph S. Walder

The Physical Basis of Ice Sheet Modelling was one of the five IAHS symposia convened at the XIXth IUGG Assembly in Vancouver, August 1987. The proceedings contain over 30 papers and a number of abstracts, which focus on the physical descriptions which go into computers, rather than on the numerical algorithms which come out of computers. Models are necessary for the study of ice sheets because of their large spatial and temporal scales. The first group of papers is on the constitutive laws for ice; the second group covers conditions at the bed; the third group encompasses mass and energy exchange at the surface and bed conditions (atmospheric temperature and fluxes, geothermal flux); the fourth group is on interactions with long time constraints; the group on ice data from ice cores shows that isotopic sampling yields extremely useful palaeoclimate information and information about changes in ice sheets. The final group of papers presents useful data to constrain or test ice sheet models.

Publ. no. 170 (1987), price $40 (US) *ISBN 0-947571-36-1*

SNOW COVER AND GLACIER VARIATIONS

edited by S. C. Colbeck

The 13 papers in this publication centre on the current interest in world-wide changes in snow and ice masses. These contributions were selected for presentation at the Symposium on Snow Cover and Glacier Variations held during the Third Scientific Assembly of IAHS at Baltimore, Maryland, in May 1989. They are arranged under the topics: ***snow and ice; mountain glaciers and runoff;*** and ***climate and glacier variations.*** Several papers provide particularly useful information about glacial and snow cover variations in China: one gives snow cover records for 30 years and another presents conclusions from 178 glaciers. These papers are complemented by palaeoglacier studies in the Tien Shan of the USSR and Mt Logan of Canada. Twenty years of data are analysed for glaciers from the American northwest and for two particular sites in China. In addition, 22 glaciers in China are classified according to their climatic influences. Although concentrating on the bigger picture, this volume also includes papers that deal with smaller scale problems like water flow through snow, mass balance and water runoff.

Publ. no. 183 (1989), price $30 (US) *ISBN 0-947571-07-8*

HYDROLOGY OF MOUNTAINOUS AREAS

edited by L. Molnár

This publication contains a selection of contributions to the international workshop held at Štrbské Pleso in the High Tatras of Slovakia in June 1988. The workshop itself was a contribution to IHP project 4.8. The papers have been divided into five sections: ***keynote papers; integral data networks, hydrometeorological data collection and processing in mountainous areas; hydrological balance as a basis for water resources assessment and water management in mountainous regions; surface water and groundwater interactions in mountainous regions; modelling of hydrological processes and of man's activity impacts in mountainous areas.*** The importance of mountain hydrology cannot be overestimated. While the tropical regions are the main source of atmospheric moisture, the mountainous regions control much of its distribution over the continents. Mountain ranges are the source areas of all the large river systems of the world and their temperature regime is a key factor for the seasonal distribution of their streamflow.

Publ. no. 190 (1990), price $45 (US) *ISBN 0-947571-42-6*

HYDROLOGY IN MOUNTAINOUS REGIONS – I

edited by H. Lang & A. Musy

This large publication contains 37 papers accepted for presentation at the Symposium on Improved Methods of Hydrological Measurements in Mountain Areas (S1), and 58 papers accepted for the Symposium on Quantitative and Qualitative Water Cycle Aspects in Heterogeneous Basins (S2). Both symposia were held at Lausanne, Switzerland, August-September 1990 as part of the International Conference on Water Resources in Mountainous Regions jointly convened by IAHS and the International Association of Hydrogeologists. The papers for S1 are grouped under four topics: ***reliability of precipitation measurements; methods of direct estimation of evaporation; assessment of snow and glaciers as water balance and river flow components; improved methods of measuring discharge in mountain rivers, including problems of bed load.*** The papers for S2 are divided into six topics: ***quantitative space-time water variability; qualitative space-time water variability; hydrological modelling in regions of rugged relief; interaction between acid rain and pedological and geological basin characteristics; assessment of the utilization potential of surface water resources; general paper.***

Publ. no. 193 (1990), price $70 (US) *ISBN 0-947571-57-4*

HYDROLOGY IN MOUNTAINOUS REGIONS – II

edited by Richard O. Sinneger & Michel Monbaron

Hydrology in Mountainous Regions — II contains 29 papers accepted for presentation at the Symposium on the Impact of Artificial Reservoirs on Hydrological Equilibrium (S3), and 26 papers accepted for the Symposium on the Role of Water in the Morphological Evolution of Slopes (S4). Both symposia were held at Lausanne, Switzerland, August-September 1990 as part of the International Conference on Water Resources in Mountainous Regions jointly convened by IAHS and the International Association of Hydrogeologists. The papers for S3 are arranged under five topics: ***flood control by artificial reservoirs; sediment transport prediction, sediment deposit formation and problems related to flushing; consequences of modified flow regime downstream of reservoirs; ecological effects and fishery problems related to reservoirs; general papers.*** The papers for S4 are arranged under four topics: ***runoff processes and slope development; extreme floods and their geomorphological effects; influence of anthropogenic hydrological modifications; assessment and mapping of flood and landslide hazards with respect to land-use planning***

Publ. no. 194 (1990), price $50 (US) *ISBN 0-947571-62-0*

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INTERNATIONAL GLACIOLOGICAL SOCIETY

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	*A. Ohmura	1990-93	1990
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*first term of service on the Council

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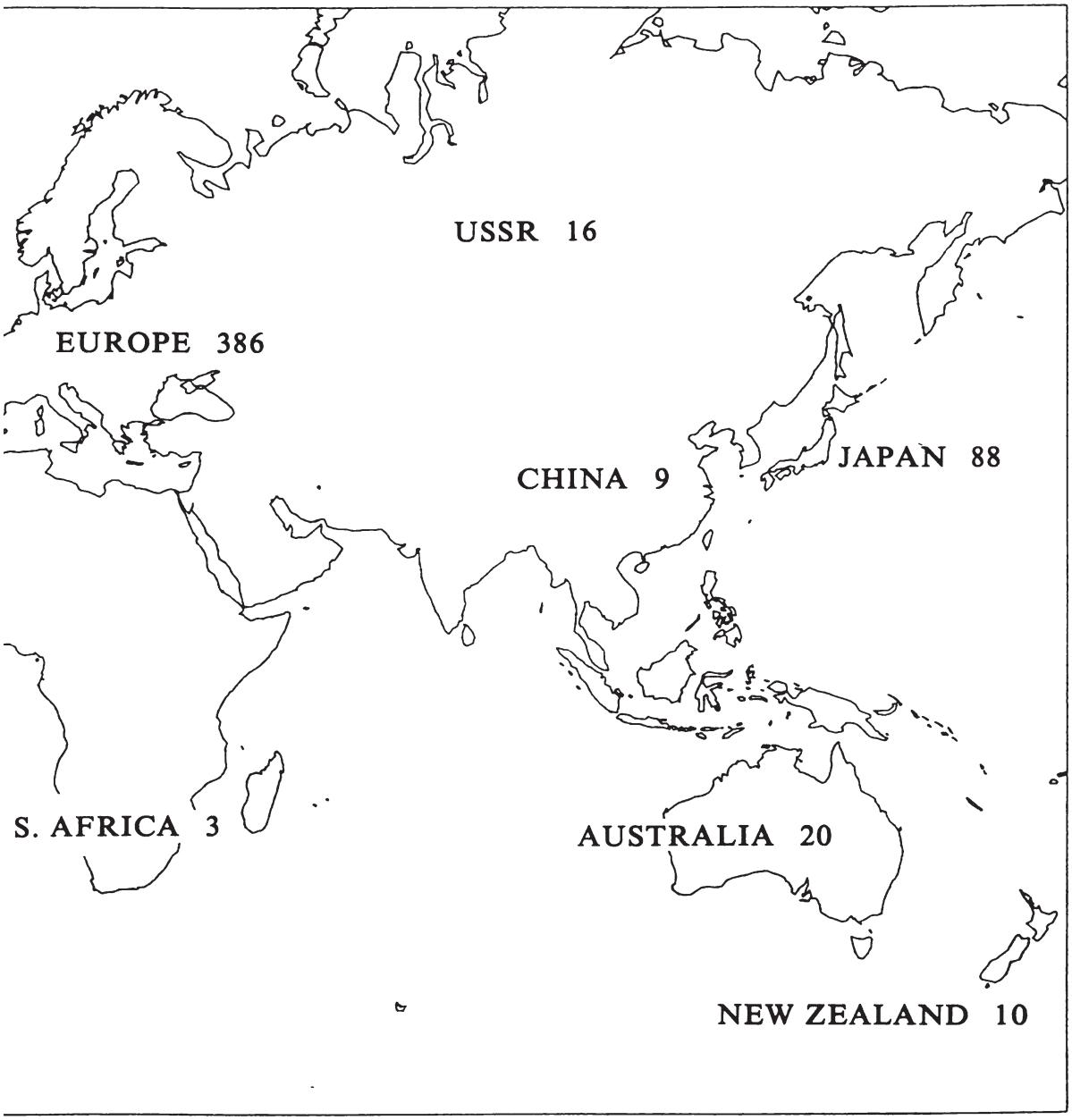
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ICE

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