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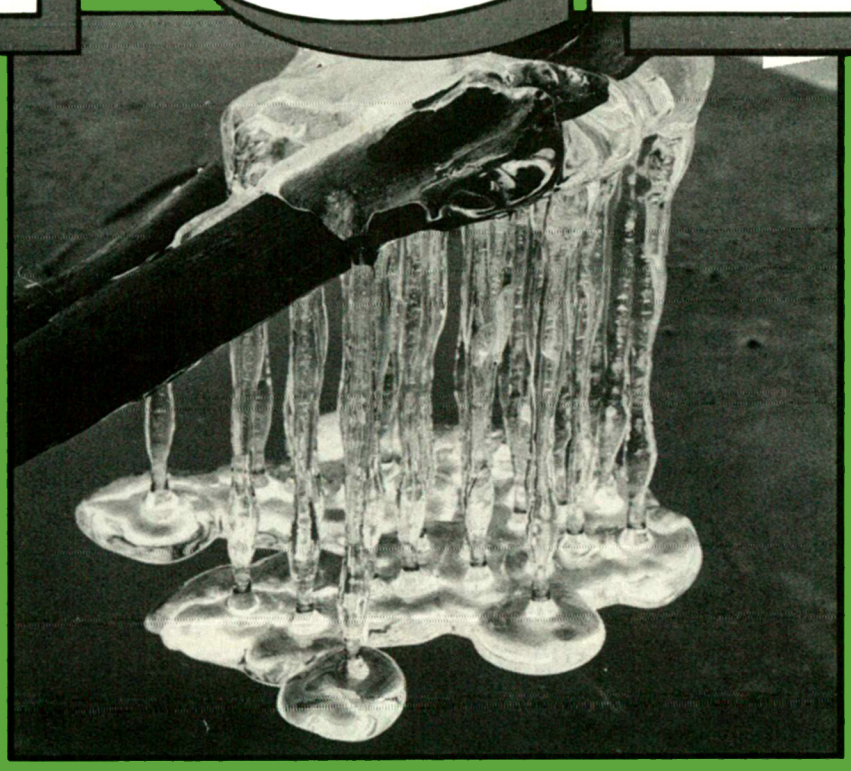

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

REMINDER

DEADLINE FOR ABSTRACT SUBMISSIONS

Changing Glaciers

Fjærland, Norway

15 January 1996

to: Ian M. Whillans, Byrd Polar Research Center, The Ohio State University,
108 Scott Hall, 1090 Carmack Road, Columbus, OH 43210-1002, U.S.A.

(Fax: +1 614 292-7688 E-mail: iwhillans@magnus.acs.ohio-state.edu)

Representation of the Cryosphere in Climate and Hydrological Models

Victoria, B.C., Canada

1 February 1996

to: Secretary General, International Glaciological Society, Lensfield Road
Cambridge CB2 1ER, UK

(Fax +44 1223 336-543 E-mail: 100751.1667@compuserve.com)

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NEWS BULLETIN OF THE
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CONTENTS

COVER PICTURE: Icicles above a water surface from *Snow of Japan* (photograph by Kihei Takahashi).

ICELAND

For abbreviations, see end of this report

Mapping bedrock and surface topography of ice caps

(Helgi Björnsson, Finnur Pálsson and Magnús T. Guðmundsson, SI)

Radio echo-sounding and precision-barometric-altimetry have been used for over 20 years to map glacier surfaces and bedrock topography of Icelandic glaciers. In 1991, surveying continued on Mýrdalsjökull and two southern outlets of Vatnajökull: Breiðamerkurjökull and Síðujökull. In 1993 and 1994 Skeiðararjökull, another southern outlet of Vatnajökull, was surveyed. Digital maps of the surface and bedrock have now been prepared for all of Vatnajökull, except the steepest eastern outlets. The surveying is carried out by the SI in collaboration with the NPC and IRA. The maps are used for studies of the geomorphology and volcanology of the subglacial part of the neo-volcanic zone in Iceland; subglacial reservoirs in geothermal areas; the triggering and subglacial routes of jökulhlaups; estimation of the area and location of water-drainage basins; and for modelling ice dynamics and estimates of glacial erosion (e.g. beneath Breiðamerkurjökull where a 20 km long and 2–4 km wide tunnel valley is located).

Topography of Katla caldera beneath Mýrdalsjökull, south Iceland

(Helgi Björnsson, Magnús T. Guðmundsson and Finnur Pálsson, SI)

The bedrock topography of Mýrdalsjökull has been mapped with radio-echo soundings. The ice cap is at the southern tip of the eastern volcanic zone in Iceland which is propagating southwards. It is underlain by a huge caldera which has erupted 20 times during the last 1100 years. The rim of the caldera encircles an area of 110 km^2; it is 600–750 m deep, its lowest elevation is 650 m a.s.l. and its highest rim is 1400 m. Three outlet glaciers have eroded 300–500 m deep breaches in the crater rim. The difference in morphology between the northern and southern caldera floors may reflect the level of subglacial volcanic activity. The northern is deeper and more level (an area of 25 km^2 below 800 m) whereas the southern is more rugged and elevated (subglacial ridges and mounts rise above 1100 m surrounded by depressions down to 750 m). A row of craters, trending NNW, is seen 2 km within the eastern rim of the caldera. The last eruption site (1918) is 1.5 km east of the northernmost of these craters, rising 150 m above the surrounding floor, beneath 400 m thick ice. A number of ridges radiate from the caldera, however, none southwards. One ridge strikes W towards the neighbouring volcano Eyjafjallajökull and a second ridge strikes E from the eastern rim of the caldera. Ridges also radiate towards the NW, N, and NE from the caldera. A linear depression, bounded by steep slopes, 150 m deep and 1.5 km wide, strikes NE towards the volcanic fissure Eldgjá which produced a lava flow of 14 km^3 in AD 930. Present geothermal activity is displayed by six small depressions in the glacier surface (1 km diameter). Meltwater accumulates beneath two or three of these cauldrons and frequently drains in small jökulhlaups. From an area of 70 km^2 within the caldera, meltwater drains to Mýrdalssandur (as did 18 of 20 recorded jökulhlaups in historical times); from 20 km^2 to Sólheimasandur (as did two of the jökulhlaups); the third route was taken by a jökulhaup in 1600 BP.

Mass balance, flow and meteorological observations on Vatnajökull

(Helgi Björnsson, Magnús T. Guðmundsson and Finnur Pálsson, SI; Hannes H. Haraldsson, NPC)

The mass balance and surface velocities of the western and northern outlets of Vatnajökull have been measured since 1991–92, and three automatic weather stations have operated since 1994, in a collaboration between the SI, NPC and IGS.

Surges of the outlet glaciers Síðujökull (1993–94) and Tungnaárjökull (1994–1995), SW and W Vatnajökull, were monitored with aerial photographs, seismic measurements, GPS velocity measurements and geodetic surveys. Samples were taken of sediment loads in rivers. Long-term changes in runoff from the surge-type glacier Tungnaárjökull were studied since its last surge in 1945.

Modelling the dynamics of Vatnajökull

(Helgi Björnsson, SI; Richard C.A. Hindmarsh, BAS).

Vatnajökull, the smallest large ice cap in the world, has a remarkable heterogeneity, possesses margins ranging from tidewater glaciers, surge lobes to valley glaciers, and, owing to its high accumulation rate, a very short time constant, an appreciable part of which is covered by historical records. These features make the ability to model Vatnajökull an important task. This collaborative work has been supported by ESF through EISMINT.

Interaction of surges and jökulhlaups

(Helgi Björnsson, Magnús T. Guðmundsson, and Finnur Pálsson, SI)

A surge of Skeiðararjökull, a southern outlet of Vatnajökull, began in March 1991. By late September almost the entire drainage basin (1000 km^2) was affected, 40 km upglacier and 4–5 km from the centre of the ice dam of the Grímsvötn lake. The front advanced about 500 m. During the surge, the water-drainage system of the glacier changed significantly. The discharge of Skeiðará, the largest river outlet, was 15–20% of normal flow from early May to mid July, whereas the flow of the second river, Sandgígjukvísl, was 3–4 times higher than normal. In late July, runoff from the river outlets returned to pre-surge conditions, but throughout the summer water issued from numerous small outlets along the glacier margin. Further, a jökulhlaup from the subglacial lake Grímsvötn, draining beneath the glacier outlet, started in late September. The jökulhlaup was cut off after draining only one quarter of the volume expected. Such a truncation of a jökulhlaup at an early stage has not been observed before. The subglacial channels may have been closed off due to increased creep of ice at the ice dam in response to tensile stresses generated by the surge. Moreover, expansion of conduits beneath the ice dam, due to melting by frictional heat, may have been hindered if the water was flowing beneath the ice dam in a distributed subglacial drainage system, considered to be present at the base of the surging glacier.

In November, when the upper part of the drainage basin had become quiescent, the remainder (three quarters) of the expected water volume drained from Grímsvötn.

During the first jökulhlaup event, about 0.35 km^3 of water drained from Grímsvötn, considerably faster out of the lake than from the glacier margin. At the time of peak outflow from Grímsvötn (12 days after the beginning of the flood), 0.2 km^3 of water had accumulated beneath the glacier, equalling a layer of 40 cm of water evenly distributed beneath 500 km^2 of the glacier and illustrating the storage capacity of the subglacial water system during a surge. This accumulation of water at the base of the glacier was not observed to reactivate the surge at the margin. However, a minor strain pulse in the upper part of the glacier may have gone undetected. The outflow of Grímsvötn receded in 6 days whereas water drained from the glacier margin in 3–4 weeks.

During the jökulhlaup proper, 1.1 km^3 of water drained from Grímsvötn. A significant phase lag was not apparent between water leaving the lake and water draining at the terminus. Thus, accumulation of water beneath the glacier was negligible compared to that of the former event. The flood peaked in about 25 days (reaching 2200 $m^3 s^{-1}$) and receded in 5–7 days. The shape of the hydrograph of this latter jökulhlaup was typical for drainage of Grímsvötn. Another example of the effect of a surge on jökulhlaups was observed on SW Vatnajökull. Jökulhlaups from the Skaftá-cauldrons, which normally drain to the river Skaftá, partly drained to a neighbouring river Hverfisfljót during the surge of Síðujökull.

Internal structure of glaciers studied by radio-echo sounding

(Helgi Björnson and Finnur Pálsson, SI; Yngvar Gjessing, IGUB; Svein-Erik Hamran, ESTP; Jon Ove Hagen and Björn Erlingsson, NPI).

(a) Continuous internal reflections have been mapped by radio-echo soundings over large areas on Vatnajökull. Four such reflecting planes are found in the Grímsvötn area, in the interior of the ice cap, at depths about 130 m, 150 m, 180 m and 200 m. These reflecting planes are interpreted as tephra layers from eruptions of the Grímsvötn volcano. These, presumably, date from AD 1934, 1922, 1903 and 1883, respectively. If so, the layers seem to have been buried at an average rate of 2.3–1.9 m a^{-1}. Location of these datable ash layers provides a strong constraint on glacier dynamics.

(b) Radio-echo sounding has been used effectively for mapping the thermal regime of polythermal glaciers on a regional scale in Svalbard. The thickness of the cold surface layer and the temperate basal-layer conduction meltwater has been mapped by multi-frequency synthetic pulse radar on three sub-polar glaciers (Austre Brøggerbre, Lovenbreen and Kongsvegen in the Kongsfjord area). Radar signals of 320–370 MHz penetrate ice at sub-freezing temperatures but are reflected from the top of layers of ice, which are at the melting point and contain water. Those at 5–20 MHz, on the other hand, see through both the cold and the temperate ice down to the glacier bed. Soundings at these frequencies have been used to investigate the thermal regime of four polythermal glaciers (Kongsvegen, Uversbreen, Midre Lovenbreen and Austre Brøggerbreen).

Iceland Glaciological Society: *Jökull*

(Helgi Björnsson, SI)

The Iceland Glaciological Society was founded by 41 people on 22 November 1951 to further research and travel on glaciers in Iceland and to organise lectures about all aspects of glaciology. The first chairman of the Society, and its founder, was the meteorologist, Jón Eyþórsson, of the Meteorological Institute. (The 1995 IGS symposium in Iceland was dedicated to his memory on his 100th anniversary). After one year, membership had become 150 and now, in 1995, is 530 — volunteers from all professions: carpenters, blacksmiths, plumbers, drivers, mechanics, civil engineers, medical doctors and lawyers, teachers and journalists, farmers and pastors, librarians and geologists, hydrologists and a few that call themselves glaciologists — all having a common interest in travels on glaciers and willing to lend a helping hand when needed to organise and carry through an expedition. One group takes care of the weasels and another looks after food and supplies. A third group has spent their holidays for many years building huts around the glaciers.

This Society has been a great supporter of glaciological research in Iceland. Members of the society have measured glacier fluctuations since the 1930s. Without their help none of the Vatnajökull expeditions from 1950 to the late 1970s would have been possible. In 1951 they organised the French–Icelandic Expedition on Vatnajökull that did seismic shots in about 30 points all over the ice cap. In 1955 this French Icelandic collaboration continued on western Vatnajökull and Mýrdalsjökull. In 1960 gravity surveying was carried out in central Vatnajökull in collaboration with the NEA. Since 1953 expeditions have been sent to Vatnajökull every spring and sometimes in the autumn. All these expeditions went to Grímsvötn, measured the lake level and did snow-pit studies. Many were supported by the IRA because of their interest in the Grímsvötn jökulhlaups. Since 1976 the Society has assisted the SI and NPC in their radio-echo sounding on Vatnajökull. In 1972 members of the Society drilled a 415 m long ice core at Bárdarbunga in NW Vatnajökull in collaboration with the SI. During the winter 5–6 lectures are given in the Society on glaciological research and travel on glaciers.

Altogether the Iceland Glaciological Society has built ten huts: two are in Jökulheimar (675 m a.s.l.) at W Vatnajökull (5 km from the edge of Tungnaárjökull); three in Grímsvötn at 1720 m a.s.l.; on the nunatak Grímsfjall, at Kverkfjöll (1700 m a.s.l.); in N Vatnajökull, in Goðahnjúkar (1500 m a.s.l.); in E Vatnajökull, on the nunatak Esjufjöll; in Breiðamerkurjökull; and at Breiðá on Breiðamerkursandur. One other hut is situated at the eastern edge of Langjökull.

Since 1951 the Iceland Glaciological Society has published the journal *Jökull*, from 1977 as a joint publication with the Geoscience Society of Iceland. It is supported financially by the Ministry of Education. *Jökull* is an international forum for geoscience research in Iceland, presenting results of original scientific research. Specific areas of coverage include glaciology, glacial geology, physical geography, general geology, petrology, volcanology, geothermal research, geophysics, meteorology, hydrology, and oceanography. The specialisation of the journal is geographical rather than with regard to discipline. Readership covers a very broad spectrum including scientists in many disciplines, undergraduates, and many laymen interested in earth sciences.

Glacier variation monitoring

(Oddur Sigurðsson, NEA)

Meteorologist Jón Eyþórsson started monitoring front variations of Icelandic glaciers in 1930. A team of laymen, mostly farmers initially, has carried out these measurements of 40 different glaciers and outlet glaciers at about 55 locations to the present day. In 1951 the Iceland Glaciological Society assumed responsibility for this monitoring and has reported the results annually in *Jökull*. Reports have been sent at five-year intervals to the WGMS. All previous measurements are now being reviewed and revalued. The results will be published in *Jökull* within a year or two.

Stable-isotope measurements on glacier ice

(Árný E. Sveinbjörnsdóttir, SI; Sigfús J. Johnsen, SI and NBI)

Stable-isotope analyses of oxygen and hydrogen are performed on glacier ice using the Finnegan MAT 251 mass spectrometer (SI), mainly for paleoclimate research. Iceland is a member of the Greenland Ice-Core Project (GRIP), an international European joint effort organised by the European Science Foundation, that has drilled a 3029 m ice core at Summit, central Greenland. The continuous $\delta^{18}O$ profile gives detailed information on climate variations in Greenland and the North Atlantic over the last 250 000 yr. The stable-isotope results indicate climate instability was not confined to the last glaciation, but is also seen during the last interglacial (Eem) and during the previous Saale–Holstein glacial cycle. Our task is to measure both hydrogen and oxygen isotopes in specially chosen samples, especially when accurate measurements are needed, e.g. when the deuterium excess is studied and the annual cycles at some depth. Our contribution to the interpretation of the data are ice-flow modelling, studies of diffusion and interpretation of the stable-isotope profile.

During the summer of 1995, a 344 m core was drilled through the Hans Tavsen glacier, north Greenland, as part of the Nordic Environmental Program. The main objectives are to study the paleoclimate and glaciology of the north Greenland ice sheet. Our task is to measure the stable isotopes of hydrogen for deuterium excess.

Sensitivity of mass balance to climatic change

(Tómas Jóhannesson, ICMO; Oddur Sigurðsson, NEA)

The sensitivity of the mass balance of Icelandic glaciers to climate change has been studied using mass-balance measurements from Hofsjökull, degree-day mass-balance modelling and dynamic glacier modelling. The results were used to estimate the possible consequences of future climate warming on the mass balance of Hofsjökull and on the hydrology of glacier rivers in Iceland. The study is part of a Nordic research project on the hydrological consequences of future climate warming, with special emphasis on changes that are of importance for hydropower energy production.

Ice/volcano interaction in Vatnajökull and Mýrdalsjökull

(Magnús Tumi Guðmundsson and Helgi Björnsson, SI)

Several volcanoes exist beneath ice caps in Iceland, including the two that have been most active in historical times: Grímsvötn in Vatnajökull and Katla in Mýrdalsjökull. This project studies the effects of the ice cover on the mechanics of volcanic eruptions and how volcanic eruptions and associated geothermal activity have modified and changed the surface topography of these ice caps. The form and physical properties of subglacial ridges and mounds, created in subglacial eruptions, are studied with geophysical techniques such as radio-echo sounding, gravimetry and magnetics. An emphasis is placed on identifying subglacial bedrock formations created in historical eruptions and how these are related to ice thickness. Many hyaloclastite ridges and table mountains, found in the volcanic zones, formed in subglacial eruptions within the Pleistocene ice sheet. The project may provide a better understanding of the relationship between these formations and the thickness and extent of the ice sheet in Iceland during the Pleistocene.

Dating of ice by tephrochronology

(Guðrún Larsen, Magnús Tumi Guðmundsson and Helgi Björnsson, SI)

Tephra horizons cropping out in ablation areas of two outlet glaciers in W and N Vatnajökull are being studied. Tephra deposited onto the accumulation areas of glaciers are buried over time due to continued accumulation of snow and the descending flow of ice. The layers are preserved as distinct and coherent horizons in the ice (seen as internal reflections by radar) both in surging and non-surging glaciers. Correlated to eruptions of known age, they may prove to be a powerful tool for studies of glacier mass balance and dynamics. Of about 40 horizons in the ablation area of each glacier some 34 consist mostly of tephra (volcanic glass). Samples are extracted by shallow coring, to prevent contamination, and the glass is chemically analysed by EMPA for identification of source. The sequences, which include tephra from the 1362 eruption of the Öræfajökull volcano, represent a continuous record of more than 600 years of volcanism and ice accumulation and provide a valuable addition to the eruption history of subglacial volcanoes within Vatnajökull.

Glaciological monitoring at NEA

(Oddur Sigurðsson, NEA)

Mass-balance measurements are carried out by the NEA (Orkustofnun) on five glaciers and outlet glaciers in central and eastern Iceland. The results are published in local NEA reports and the main results in the WGMS Glacier Mass Balance Bulletin. NEA operates 61 water level gauges in 29 glacial rivers and monitors 5 glacial rivers for jökulhlaups. Accounts of jökulhlaups are published in *Jökull* every few years. 19 glacial rivers are sampled regularly at 22 places for suspended material.

Glacier inventory

(Oddur Sigurðsson, NEA)

A digital outline of glaciers is being established for Iceland for the year 1990. The inventory is based primarily on 1990 and 1991 Landsat images which were summers of high ablation, thus giving relatively snow-free images of the glacier edges. Where these are obscure the questionable places are checked on conventional aerial photographs or oblique stereographic photographs from hand-held cameras. No previous inventory for all Icelandic glaciers exists.

3-D image of surging-glacier speed

(Oddur Sigurðsson, NEA)

An almost complete vertical photograph coverage was made at three different instances during the 1994 surge of the 500 km^2 Síðujökull, SW Vatnajökull. These are being spliced together digitally into three different mosaics of the glacier surface. The parallax from differential movement between photo dates gives a stereographic image where the velocity of the glacier surface is the vertical component of the image. The three-dimensional velocity image can be plotted as isometric contours on the orthophotographic map of the glacier.

Climate monitoring and research

(Trausti Jónsson, ICMO)

The ICMO (Veðurstofa Íslands) has been responsible for the official meteorological service and monitoring in Iceland since its foundation in 1920. These activities are now distributed among four main branches (or departments): The weather service (mainly forecasts), a technical branch (station maintenance and chemical monitoring), a research and processing branch (DRP) and a geophysical branch (seismological monitoring, geophysical research). Climate monitoring and research is located in the DRP. There are at the present 17 positions, divided into a few main task groups which are: traditional climate monitoring and research, subdivided into, collection and quality monitoring of observations, database development and maintenance, information distribution, consultancy, and research; sea-ice monitoring and research; avalanche monitoring and research; and numerical modelling.

Avalanche Section, ICMO

(Magnús Mar Magnússon, ICMO)

The avalanche section is taking part in two European research projects, one in the third framework under the Human Capital and Mobility program (HCM), and the other in the fourth framework, under the Environment program. The HCM project involves constructing an avalanche-mapping system and linked database using GIS and a relational data base. Secondly, a project dealing with avalanche-risk modelling in Iceland (with C. Keylock and D. McClung, UBC, Canada). The Environment project has been given the acronym SAME (Snow Avalanche Mapping and warning in Europe). This project is ambitious and divided among the various participants. ICMO's responsibilities lie in the field of snow-avalanche databases and avalanche mapping. Thirdly, there is a joint project between NGI in Norway and Iceland, subdivided into four projects: avalanche warnings, avalanche modelling, hazard zoning and avalanche-defence structures. Work with the UI is attempting to model the return period of avalanches. A climatic study of past avalanche cycles is also underway. Work continues on the collection of historical records and avalanche reports There is a concerted effort to strengthen avalanche research and monitoring in Iceland due to recent catastrophic events.

Sea-ice research

(Þór Jakobsson, ICMO)

The Sea Ice Research Project (ICMO) is mainly concerned with sea-ice conditions in Icelandic waters, i.e. the Iceland Sea and the Denmark Strait. The work involves obtaining information by sea-ice reconnaissance in cooperation with the Icelandic Coast Guard, receiving observations from ships in the area and producing outlooks by the application of medium-range weather forecasts. All sea-ice data are stored and reports published. Research involves atmosphere/ocean interaction studies in the Iceland Sea as well as studies of fluctuations of sea-ice extent during this century and its relation to large-scale atmospheric general circulation. Work concerning experiments with sea-ice models and further use of remote sensing is in progress.

Local ice-cover deformation and mesoscale ice dynamics

(Björn Erlingsson, SI)

This project aims to: describe and model the processes involved in local ice deformation and to incorporate these into the governing equations of mesoscale ice dynamics; and identify a set of parameters which is adequate to describe an ice state and which can be derived from remote-sensing data and mesoscale modelling.

The project will be funded in 1996–98 through the EC Fourth Framework Programme; Marine Science and Technology, MAST–III. The consortium is constituted by the following institutes: Helsinki University of Technology, Ship Laboratory (HUT/SL), Finland; Nansen Environmental and Remote Sensing Centre (NERSC), Norway; Scott Polar Research Institute, University of Cambridge (UCAM-SPRI), UK; University of Helsinki, Department of Geophysics (UH/DG), Finland; and, University of Iceland, Engineering Research Institute; Halo Laboratory for Oceanic and Atmospheric Sciences (UI/ERI), Iceland.

HALO (UI/ERI) is responsible for mesoscale modelling, data and information management. The mesoscale modelling is based on a model scheme comprising the deformation patterns and internal stresses in the geophysical scale. The model provides relationships between small-scale ice deformation and parameters of mean ice-motion field. In relation to this, a framework for the constitutive relations for sea ice will be developed, based on mechanics, dynamics and kinematics of sea-ice and on ice-thickness redistribution function. It distinguishes two modes associated with rafting and ridging respectively. The parameters of the model will be measured as a subject of various experimental setups.

UI/ERI is responsible for the data and information management of the ICE STATE program. UI/ERI is responsible for a meta-database on all data that are collected or used for the program. This will contain information on the origin of the data, quality check attributes and description of its use and results it has been used to generate. All scientific data types will be stored according to de-facto standard generic self-describing file formats.

Glaciers and chemical weathering

(Sigurður R. Gíslason, SI)

Much of Iceland is covered with glacial sediments from the last glaciation. Thus it is difficult to assess the overall effect of glaciers on chemical weathering rates because there are no data available from areas with no glacial sediments. However, the effect of glacial cover can be studied. Glacial cover slows down the overall chemical denudation rates in SW Iceland. It increases the probability of high pH weathering solutions by excluding direct and indirect routes for the CO_2 from the atmosphere to the weathering site, and continuously exposing fresh rocks to the incoming solutions. High pH (8–10) makes the primary Ca silicates stable, the Mg silicates stable or less unstable, and increases the probability of deposition of

zeolites and smectites. Thus, the relative mobility and fluxes of Ca and Mg slow down during glacial cover, slowing down the permanent long-term consumption of atmospheric CO_2. This supports the theory of a negative feedback mechanism for the long-term stabilization of the Earth's surface temperature.

The increase in Fe and Mn fluxes with glacier cover in SW Iceland could be attributed to the enhanced solubility of metal oxides and hydroxides at high pH. Thus glacier cover of the land could result in enhanced fluxes of some metals to the oceans. This has implications for the short-term carbon cycle. Planktonic growth rates are determined, not only by nutrients, but by the level of a number of metabolically important metals such as iron, molybdenum, and copper.

CO_2 emission from glacierized volcanoes

(Sigurður R. Gíslason, SI)

To better understand processes that control sources of CO_2 in the carbon cycle, CO_2 emission from volcanoes is under study. The glacier-covered volcanoes of Iceland provide an opportunity for reliable measurements of total fluxes since all the water-soluble gases are trapped by glacial meltwaters. The ice-covered Eyjafjallajökull volcano, S Iceland provides an ideal opportunity to measure the CO_2 flux. The caldera is well-defined, with one outlet where the glacier calves into a lagoon drained by the river Jökulsa. Discharge and total-dissolved-carbon measurements in Jökulsa yield calculated fluxes of 100 to $> 800\ g\ CO_2\ s^{-1}$.

Jökulhlaup from Katla in 1918

(Haukur Tómasson, NEA)

Jökulhlaup records from the eruption of the subglacial volcano Katla in 1918 have been reviewed and ground control of the high-water marks set by the jökulhlaup surveyed in location and elevation. They show that the erupted material was 2500 million tons in roughly 20 days of eruption, more than half in the first 8 hours. This caused an enormous jökulhlaup. The volume was $7\ km^3$ and the maximum flow rate was over $300\,000\ m^3\ s^{-1}$ of water, ice and sediment. The latter was mainly erupted material.

Paleoclimate records in lake, near-shore and shelf sediments

(Aslaug Geirsdóttir, UI)

An Iceland/USA PALE initiative was developed in 1993 to construct long paleoclimate records from both lake and near-shore sedimentary environments in Iceland. PALE (Paleoclimate of Arctic Lakes and Estuaries) is the Arctic research component of Past Global Changes (PAGES), a core project of the IGBP. Its major goals are to reconstruct Arctic climatic variations over the past 200 000, 20 000 and 2000 years, and to understand the interactions of these variations with the global climate system.

The main objectives of PALE-research in Iceland is to clarify the time and spatial pattern of glaciation, deglaciation, and the post-glacial environmental changes here and in the North Atlantic, by studying lake and fjord sediments accumulated during the last 20 000 years. In 1993, the Canadian research vessel CSS *Hudson* carried out some preliminary coring of western Iceland and in 1994 and 1995 coring was carried out from the lake-ice surface of 5 lakes in S and W Iceland. Currently, studies on foraminifera and stable isotopic composition of benthic and planktic foraminifera are underway on the marine cores and detailed textural, rock magnetic, and palynological studies are underway on the lake sediments to provide correlations between the climate-related data.

An extension of this PALE research is planned for 1996. Beside coring several lakes on the NW peninsula of Iceland, the proposal aims at strengthening the estuarine/shelf element of the project by a cruise to core troughs off the peninsula. This will allow for direct land/ocean comparison from a region that is believed to reflect the changes in the strength and path of ocean currents in the Denmark Strait during the last glacial/deglacial cycle. This project would include research groups from Ui, SI, MRI, and INSTAAR (University of Colorado, Boulder) and the University of Tromsø, Norway.

Drainage system of a surge-type glacier, Brúarjökull, Vatnajökull

(Óskar Knudsen, ICMO)

The drainage system of the glacier has been studied over the last two surge cycles by aerial-photo reconnissance and a sedimentological study in the field. Esker systems at Brúarjökull form at the end of surges. They are stable and active during the quiescent phase. The esker tunnels are invaded by diamicton at the start of a surge. During the surge the eskers are deformed and redeposited and a new esker-system forms after the surge. This has the same configuration as the esker system formed during previous quiescent phase.

Proglacial formations, Tungnaárjökull, Vatnajökull

(Óskar Knudsen, ICMO)

The esker system of Tungnaárjökull, deposited during the quiescent phase (1945–94) has been studied in detail. River outlets at the termination of the 1994–95 surge were in the same location as eskers from the previous surge. A large ice-contact fan formed during the drainage of a subglacial lake. The glacier pushed up moraines along the glacier front. The relation of the push moraines to the lithology of the subglacial strata is being mapped.

Increased resolution of land-based glacial-geologic data and comparison with deep-sea and ice-core data on climatic changes

(Hreggviður Norðdahl, SI and Halldór G. Pitursson, IINH)

During the last decade an increased research effort has been aimed at studies of the Late-glacial deglaciation of Iceland and relative sea-level changes. Global climatic changes and changes in the North Atlantic Ocean circulation are reflected in the extent of the Icelandic ice sheet and a close relationship has been established between an increased extent of the inland ice sheet and simultaneous transgression of relative sea-level. Absolutely dated and climatically induced oscillations of Icelandic glaciers can be used to detect even small-scale variations in North Atlantic environmental conditions. Studies of Late-glacial history have enabled us to evaluate and better understand the terrestrial consequences of environmental changes deduced from studies of North Atlantic deep-sea sediment cores and Greenland ice cores.

The age of the Weichselian maximum glaciation, when

the inland ice sheet reached out onto the shelf around Iceland is yet unknown, but is assumed to have occurred at about 18 000 BP, concurrently with the NW European maximum glaciation. In coastal parts, the earliest Late Weichselian deglaciation in Iceland has been ^{14}C dated to about 12 700 BP and 12 500 BP in NE and W Iceland respectively. During a subsequent glacial advance relative sea level reached its highest position in NW, N and NE Iceland. During a succeeding deglaciation large areas in NE Iceland became ice free.

Two prominent climatic changes, observed in North Atlantic sediment cores and Greenland ice cores, have been dated to the Younger Dryas and early Preboreal Chronozones, respectively. Concurrent changes in the extent of the Icelandic inland ice sheet and elevation of relative sea level have now been widely recognised and dated to about 10 600 and 9700 BP, respectively. Recently we have gathered data indicating yet another glacial readvance that occurred in the period between the main Younger Dryas advance and the Preboreal advance of the Icelandic inland ice sheet. Stratigraphic studies and ^{14}C dates from different parts of the country indicate that this glacial readvance probably was climatically induced and culminated at about 10 100–10 200 BP.

Four-wheel-drive vehicles travelling on snow in highlands and on glaciers

(Friðrik Halldórsson and Hjalti Magnússon, 4X4)

Large areas of Iceland are inaccessible by conventional vehicles during the winter. In general snow depth exceeds 0.5 m and commonly grows to a few meters. The same goes for the glaciers in general at all times of the year. Therefore winter-travelling enthusiasts have redesigned four-wheel-drive vehicles for driving on deep snow and in bad weather conditions. Ordinary tires (29" diameter) are substituted by much larger ones (up to 44") for increased floating ability. The air pressure in the tires can be reduced from the usual 2–2.5 bar (28–35 p.s.i.) to 0.1–0.3 bar (1.5–4 p.s.i.). Thus the supporting area of the tire is increased greatly at much lower cost than acquisition of a snow track or comparable vehicles. This has increased travelling opportunities of the general public greatly, especially during the winter. Cars are now furnished with GPS navigation units, telecommunication like HF-radio, and mobile telephones for safety. Some Icelandic firms specialise in modification of four-wheel-drive cars for deep snow. Most of the designing effort now is to change the suspension system of the cars.

Until 1985 the glaciers of Iceland were all but inaccessible to the public. That year was the first time a car was driven to the Grímsfjall nunatak in the middle of Vatnajökull, about 50 km from the nearest road. The new type of vehicle has increased access to the glaciers in Iceland and thereby enhanced the opportunities for research in glacierized regions. However, the increased glacier travelling may be accompanied by more mishaps.

Abbreviations

BAS = British Antarctic Survey, Cambridge, UK
ESTP = Environmental Surveillance Technology Program, Lillestrøm, Norway
ICMO = Iceland Meteorological Office, Bústaðavegi 9, IS-150 Reykjavík
IGUB = Institute of Geophysics, University of Bergen, Norway
IINH = Icelandic Institute of Natural History, Hlemmi 3, IS-105 Reykjavík
IRA = Icelandic Road Authority
MRI = Marine Research Institute, Skúlagötu 4, IS-101 Reykjavík
NBI = The Niels Bohr Institute, Department of Geophysics, University of Copenhagen, Denmark
NEA = National Energy Authority, Grensásvegi 9, IS-108 Reykjavík
NPC = National Power Company, Háaleitisbraut 68, IS-103 Reykjavík
NPI = Norsk Polarinstitutt, Oslo, Norway
SI = Science Institute, University of Iceland, Dunhaga 5, IS-107 Reykjavík
UI = University of Iceland, Við Suðurgötu, IS-101 Reykjavík
WGMS = World Glacier Monitoring Service, Zürich, Switzerland
4X4 = Four-by-Four Travelling Club, Mörkinni 6, IS-108 Reykjavík

Submitted by Oddur Sigurðsson

News

DISASTER STRIKES SASE

On 4–5 September 1995 the worst floods on record struck the Manali district and totally destroyed the library of the Snow and Avalanche Research Establishment, built up over 25 years. Fortunately there were no casualties. Amongst the holdings lost were collections of the *Journal of Glaciology*, the *Annals of Glaciology* and *ICE*. The Director has issued a plea for assistance in replacing these and other lost items. Members willing and able to help can contact Major General K. C. Agrawal, Ph.D. at the following address:

Director SASE
c/- Directorate of Engineering
Kashmir House, Rajaji Marg
New Delhi 110011, India

International Glaciological Society

ANNUAL GENERAL MEETING 1995

MINUTES OF THE ANNUAL GENERAL MEETING OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

24 August 1995 in Reykjavík, Iceland

The President, Dr Bjørn Wold, was in the Chair. 35 members from 10 countries were present

1. The Minutes of the last Annual General Meeting, published in *ICE* 106, p. 18–19, were approved on a motion by K. Ricker, seconded by R. LeB. Hooke and signed by the President.

2. The President gave the following report for 1994–95:

We have only one symposium this year — that which you have been attending here in Reykjavík — although we are collaborating with the European Science Foundation and will be publishing the proceedings of the EISMINT International Symposium on Ice Sheet Modelling taking place in Chamonix next month.

The IGS has worked closely with the Local Committee in organizing this International Symposium on Glacier Erosion and Sedimentation. I would like to thank all of them, and in particular the chairman Helgi Björnsson. I am sure you will agree that this has been a very interesting and stimulating meeting.

During the past year, we have continued to make progress towards reducing the backlog on papers and improving the production time in our Cambridge office. In the last 18 months, the average time of a paper in production has been substantially reduced, from a mean of approx. 480 days to just over 300 days. It is our hope to improve this still further, but a limiting factor will always be the three issues a year and the roughly 4 months between each issue. I am delighted to be able to tell you that the 2nd issue of this year, which was printed last week, clears all the papers which had been accepted up until the end of 1994. We hope that the final issue of 1995 will contain some papers accepted as late as June this year.

Improvements in production time have not only been realized with the *Journal*. Many of you will by now have received *Annals* 21, the proceedings of the International Symposium on the Role of the Cryosphere in Global Change held a year ago in Columbus. This was published in July. Although this is more than the 9 months we hoped for, it is quite an achievement when you consider that it was done with virtually no assistance from the production manager who was on an extended absence in Antarctica and Greenland throughout the production period.

To facilitate the dissemination of your work to a wider audience, we will be asking those of you who submit papers to us for publication to sign releases authorizing us to distribute them electronically or in any other appropriate medium. It is our intent to register our publications with the relevant clearance agencies and document delivery services.

Your Council met earlier this week and continues to be concerned about the cost of Society operations and our ability to meet them. As publication of the *Journal*, *Annals* and *ICE* are the principal activities of the Society our costs are very much affected by the price of printing. Many of you will have read of a worldwide shortage of paper that has driven up the price of many paper products. Printers are now paying as much as 50% more for paper and having to pass on the extra costs to their clients. By using a Dutch printer we are also hostage to variations in the exchange rate which is particularly bad at the moment. Recently the Secretary General contacted about a dozen UK printers for estimates on printing and distribution of the *Journal* and *Annals*. Lochem Prepress & Periodiekenservice have responded to our concerns by agreeing to fix the exchange rate at one more favourable to the pound and by reducing their costs so it will be possible to continue printing with them in the short term. However, rates offered by domestic UK printers were extremely favourable and we will be watching the situation in the coming year in case we feel it is necessary to change. In order to build a relationship with a domestic printer, we have decided to have one of the two *Annals* we will publish next year printed in the UK.

Last year I announced that Council had instructed the Secretary General to implement a credit card option for members' payments. This was put in place early a few months ago and has been very well received. However, as there is a cost to the Society for each transaction made this way we would prefer for members to pay in the traditional manner if that is convenient and feasible for them.

It is important that we all continue to make a concerted effort to increase membership to help counteract the loss of revenue from declining library subscriptions. It is very encouraging that there has been a growth in junior memberships over the last year. Those of you who teach glaciology might consider explaining to your students the benefits of membership and encourage them to join the Society if you don't do so already.

Last year, we also indicated we would try to provide you with E-mail access to the Cambridge office. Following a survey of the dozen or so companies in Cambridge that offer access to the Internet, we have recommended that we purchase an account with Compuserve. As the Secretary General has some concerns that once on-line he may have to spend most of his time answering mail, it would be appreciated if contact in the early stages be limited to urgent matters.

To consider the broader implications of electronic communication, we have set up an ad hoc working group, chaired by Christina Hulbe of the University of Chicago. Her group will report on the various options that may be available for delivering what we currently publish in *ICE*, for distributing information on the Society, and for assisting with production of our publications. She may contact some of you in the coming year, but if not, please feel free to contribute your ideas to her directly.

The acquisition of two new computers has meant we are moving to a greater degree of automation and integration of the administrative side of the Society's operations. We

now have the capability to store members' phone numbers, together with their addresses, and are in the final stages of inputting all membership information so the same data base can be used for regular correspondence as is used for our mailing labels. In due course, we plan to move to a broader-based data base that will enable us to integrate all aspects of the administration, including the financial and production sides. We are proceeding slowly to ensure that service to members is not interrupted by problems we might encounter.

Next year, the Society will organize the International Symposium on Representation of the Cryosphere in Climate and Hydrological Models, in Victoria, Canada from 12–15 August. Initial indications of interest have been very encouraging and planning is well underway. We expect the 2nd circular to be distributed in October, with an abstract and paper submission schedule similar to that for this meeting.

IGS will be co-sponsor of a workshop on the Structure and Dynamics of Valley Glaciers, to be held in Fjærland, Norway in June next year. A circular on this will be mailed to all members of the Society in October. Plans for the meeting on the Antarctic and Global Change in Hobart in 1997 are also moving along and we expect to have the first circular for that out shortly. In addition, we have accepted an invitation from French members, spearheaded by ANENA, to host a meeting on snow and avalanches in Chamonix in May of 1997. We are reviewing possible venues for meetings in 1998 and the Council was happy to accept an invitation from our members in Sweden to host a symposium in Kiruna, Sweden, in August 1998. The topic will be on interaction between ice sheets and landscapes. We would welcome proposals from any of you for future meetings. As I mentioned last year, we have handled more than one a year in the past and can do so in the future.

It always gives a President of the IGS great pleasure to be able to announce decisions made by Council on recommendations from our Awards Committee. This year, I am again fortunate to be able to announce two awards.

The first is that of the Seligman Crystal to Bill Budd.

He is an unique, original thinker with a far-ranging mind, a theoretician as well as a practical field scientist. He has made major scientific contributions in many glaciological areas, ranging from the ice caps of Mars, to sea ice, glaciers, and ice sheets of both polar regions on Earth. The presentation will take place in Victoria, Canada, next year.

The Council also decided to award Honorary Membership in the International Glaciological Society to Gorow Wakahama. He has been one of the leading scientists working on snow and ice in Japan for many years, and he has made major contributions within several fields. His contributions are not only limited to scientific research, but have expanded to international cooperation, as shown in his activities as a long-time Council member of IGS and later Vice President of the Society until 1994. He retired as professor from the Institute of Low Temperature Science, Hokkaido University in 1991, but is still very active in promoting the objects of our Society. He was recently elected president of the Japanese Society of Snow and Ice.

Council has now approved the incorporation of the Richardson Medal into the Society's awards system with the following terms of reference:

The Richardson Medal is awarded from time to time to one who has given outstanding service to glaciology.

For those of you attending your first IGS meeting, you may not appreciate that we are honoured to have present today the person after whom this award was named: Hilda Richardson, our previous Secretary General who served the Society so well for 40 years.

In reviewing the terms of reference for all the Society's awards it was decided to include the word "scientific" in those for the Seligman Crystal, respecting the original intent of this award. Thus we now have awards for both scientific and service contributions.

1995 marks the 100th Anniversary of the Comitato Glaciologico Italiano to whom we extend our heartiest congratulations. Our Secretary General will convey these wishes when he attends their special meeting in October.

On behalf of you all, I would like to express my thanks to our headquarters staff. To Simon Ommanney, our Secretary General, who has been working very hard on your behalf; to David Rootes our Production Manager and to Linda Gorman with whom most of you usually deal; as well as to Ray Adie, Sally Stonehouse, Brenda Varney, Sylva Gethin and Ken Moxham, who help maintain the high quality of our various publications. The quality of our *Journal* is sustained by a dedicated team of editors. To Doug MacAyeal, our Chief Scientific Editor, and his editorial board, we express our warmest thanks, as well as to those who have helped them during the year. I would also like to pay tribute to those who have been working on the papers for this meeting, particularly to David Collins and his team of editors, for maintaining the high standards we have come to expect of the *Annals of Glaciology*. Thanks, too, to the referees, many of them present here today, whose advice is so vital to the whole process.

T. H. Jacka proposed and H. Richardson seconded that the President's report by accepted. This was carried unanimously following a change in the reference to seasons in the Northern Hemisphere.

3. The Treasurer, Dr J. A. Heap, presented the following report with the audited Financial Statements for the year ended 31 December 1994.

"The state of the Society's finances is best summarised by considering the changes from 31 December 1993 to 31 December 1994 in the following funds:

Seligman Fund: increased from £1031 to £1047 as a consequence of interest accrual;

Accumulated Fund: increased from £13 877 to £16 493, consequent upon a transfer of £2616 from the General Income and Expenditure Account;

Contingencies Fund: increased from £8684 to £12 684, consequent upon a transfer of £4000 from the General Income and Expenditure Account;

Annals Fund: increased from £6531 to £24 484;

Publications Fund: increased from £7798 to £10 893.

In 1993 the Society published 734 pages in the *Journal of Glaciology* and 434 pages in *Annals of Glaciology*. In 1994 the figures were 596 for the *Journal* and 510 for the *Annals*. As I noted in my report for 1993, the Society's publications are becoming increasingly dependent upon the provision of page charges. This continues to be the case and I wish to register the Society's warm thanks to all those authors who have been both able and ready to support the Society in this way.

May I, again, make a plea to all members of the Society to do all in their power to increase the membership and to ensure that libraries in any institutions in which they have

influence either maintain their subscriptions or take out a subscription."

R. LeB. Hooke proposed and C. R. Bentley seconded that the Treasurer's report be accepted. This was carried unanimously.

4. Election of auditors for the 1995 accounts. J. A. Heap proposed and C. R. Bentley seconded that Messrs Peters, Elworthy and Moore of Cambridge be elected auditors for the 1995 accounts. This was carried unanimously.

5. Election to the Council 1995–98. 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:
Elective Members:
E. Akitaya
A. Iken
E. M. Morris
E. D. Waddington

6. Election of Treasurer. H. Röthlisberger proposed and R. LeB. Hooke seconded that J. A. Heap be reappointed Treasurer for 1995–98. This was carried unanimously.

The President thanked those members who had served on the previous Council and were now retiring.

SELIGMAN CRYSTAL AWARD 1995
To Dr Anthony Gow
22 August 1995, Reykjavik, Iceland

The Society's Council agreed unanimously in 1994 that a Seligman Crystal be awarded to Tony Gow. The Crystal was presented, in the presence of about 75 members and friends, by the President of the Society, Bjørn Wold, who introduced the recipient as follows:

"Tony Gow has worked for more than 35 years on an enormous range of problems relating to the great ice shelves and ice sheets of the polar regions as well as the internal structure and properties of the ice cover of rivers, lakes and seas. He is a world expert on crystal forms of ice — probably the leading authority on sea-ice fabric and its physical properties. His strength is underlined by the fact that although his Seligman Crystal is being awarded primarily for his contributions to glacier science, he was strongly supported for his contributions to sea-ice science. As an expert in both fresh-water and salt-water ice bodies, he links two communities that otherwise are largely separated. He is an experienced and devoted field worker as well as a laboratory experimentalist. His work, in particular his field observations, have influenced the studies of most present-day glaciologists, as well as polar oceanographers.

Our knowledge of almost every aspect of the solid portion of the hydrological cycle has benefitted from Tony Gow's attention. His contributions to the snow and ice literature are numerous and of a consistently high quality. He has made significant contributions to our understanding of ice in essentially all its natural states and settings. On the land-ice side these have included: the stratigraphic analysis of ice cores; the internal structure of ice sheets and ice shelves; the use of isotopes in core and ice-sheet studies; and, grain-growth processes in snow and firn. On the floating-ice side he is noted for his work on the physical and mechanical properties of lake, river and sea ice; salinity variations in sea ice; crystal alignments in sea and lake ice; characteristics of sea and lake ice at microwave frequencies; morphology of pressure ridges; fractionation of brines in Antarctic ice shelves, and, properties of brackish and model (urea) ice. He has also done significant work on the effects of freezing and thawing on the properties of soils, and has been highly innovative in applying modern laboratory techniques and procedures to studies of ice properties, in the laboratory, as well as in the field.

He was the scientific "honcho" on the USA's deep borehole though the West Antarctic ice sheet at Byrd Station.

On topic after topic he has provided the observations and analyses on which others (as well as he himself) could build.

Tony Gow was born in New Zealand. He obtained undergraduate degrees in chemistry and geology from Victoria University, Wellington, and then completed his Master in Geology there. In the summer of 1957 he was employed as a lecturer and demonstrator in the Geology Department. His subsequent achievements were recognized when the University awarded him a D.Sc in Geology in 1973. Tony became a naturalized US citizen in 1976.

In September 1957 he joined the Arctic Institute of North America as a project glaciologist and participated in the 308 m core drilling at Byrd Station in the Antarctic. For the next four years he was involved in the coring program at Little America, Antarctica, and borehole measurements at site 2, Greenland. When he was not in the field he worked on core analysis as well as the physical and mechanical properties of Antarctic snow and glacier ice at the Snow, Ice and Permafrost Research Establishment in Wilmette, Illinois.

In the fall of 1961 he joined the Cold Regions Research

and Engineering Laboratory of the U.S. Army Corps of Engineers, which had recently been renamed and moved to Hanover, New Hampshire from Wilmette, and he has been at CRREL to this day.

The latter years of the 1960s saw Tony continuing his analyses of the Byrd core and investigating other local problems. In addition to papers on the core, on its preliminary analysis, on bubble pressures, and densification, he reported on the snow, both at Byrd and the South Pole, describing its accumulation and stratigraphy, age hardening, isotopic composition and electrolytic conductivity. The early short core at Byrd had been followed by a longer, 2164 m, one, permitting and requiring a wide range of analyses with which Tony became involved into the early 1970s. Meanwhile he continued studies of snow accumulation and properties in the region.

It was about this time that he began his work on lake and sea ice. He investigated the crystal structure of river ice, the strength, growth characteristics and crystalline properties of lake ice, and the structure and movement of sea ice in the Beaufort Sea, Alaska near Prudhoe Bay. Thus by the late 1970s his work encompassed continuing analyses:

- in the Antarctic: of the Byrd core, of snow and firn, of the McMurdo Ice Shelf, and of the sea ice in McMurdo Sound and the Weddell Sea;
- in Alaska: of sea ice and lake ice;
- and back in Hanover: the first work on the urea ice sheets used for modelling experiments in the CRREL test basin.

By the mid 1980s the range of his interests and the number of collaborators had increased further. The next phase was very much concentrated on floating ice. Reports included ones on the: chemical, physical, structural and dynamic properties of sea ice; optical characterization of real and simulated sea-ice, pressure-ridge morphology; and on brackish ice from the Bay of Bothnia.

In a way the pendulum has now swung back. With the successful acquisition of the GISP2 ice core, much of the focus of Tony's work has returned to the subject areas in which he started, although it is now Greenland and the Arctic rather than Antarctica that provides the data. In fact he was in the central Arctic Ocean participating in a joint U.S./Canada Arctic Ocean project last summer when we tried to reach him, telling that he had been selected for this award.

The 1990s have seen many papers on different aspects of the analysis and interpretation of the GISP2 core: measurements of the GISP2 and GRIP cores and reports on them; snow accumulation; crystalline structure and *c*-axis fabrics; the depth/age scale; p-wave velocity profiles; environmental history; electrical conductivity; the record of volcanism; grain-scale processes; and most recently, the origin of basal debris in the GISP2 and Byrd ice cores and its relevance to bed processes presented here in Reykjavik.

His hard work ethic and complete willingness to share data and insights has made him a favourite among the many diversified collaborators on these programs.

Tony Gow is the quintessential field glaciologist, the ultimate ice man. A person who invariably produces new insights into whatever aspects of glaciology he is investigating. He may not be a theoretician, but he makes honest people of them! If you want insights into the realities of snow and ice in the natural setting, he is definitely your man.

Tony, it is a great pleasure and honour for me to present to you the Seligman Crystal."

After the presentation of the Crystal, Tony Gow made the following reply:

"Thank you Bjørn for your kind words of introduction. I am still utterly surprised, in fact flabbergasted, at my having been selected to receive this award, knowing that there are others probably more deserving. To be named to join such a distinguished group is indeed an honor for which I am profoundly grateful. I have known all previous awardees, with the exception of Gerald Seligman, and have been closely associated professionally with a number of them. Among the first people I met when I arrived at SIPRE in 1958 were Henri Bader, Lyle Hansen, Willy Weeks, Hans Weertman and Hans Rõthlisberger. All were subsequently to be honored with the Seligman Crystal. This, at the outset of my career in glaciology when I was an absolute novice in this game! I was certainly an advantaged individual to find myself enjoying the expertise and company of such exceptional people.

In so far as the news of the award was totally unexpected, so was the manner in which I received it. At the time I was travelling north aboard the icebreaker *Polar Sea* making its way across the Arctic Ocean towards the North Pole. Early one morning, I believe it was 11 August 1994, my colleague from CRREL Terry Tucker (we were engaged in examining sea-ice characteristics at the time) handed me an E-mail message from Dr Wold announcing the award of a Seligman Crystal. It took Terry some time to convince me this was the genuine article and I am still having a hard time believing it! On sombre reflection however I know that whatever small contribution I might have made none of it would have been possible without the help and collaboration of many colleagues at CRREL and around the world. In this instance I truly view the award of the Seligman as much an honor to them as it is to me. Today is the 22 August 1995. It seems almost coincidence that exactly one year ago, nearly to the hour in fact, the *Polar Sea* nudged her bow across the North Pole.

Perhaps it would be opportune now to give you a little history of how I got my start in glaciology. It was a most unusual one, and not one I had even contemplated in the deepest recesses of my mind. It all began in 1957 with Dr Dick Goldthwait, of this Society. He was visiting New Zealand on a Fullbright Scholarship at the time and contacted Dr Bob Clark, Chairman of the Geology Department at Victoria University of Wellington with the news that the Americans had assembled a team to do some drilling in Antarctica. They were looking for an applicant from the British Commonwealth to join the project. After all this was the IGY and adding a foreigner to the drilling team would have provided international flavor. Professor Clark contacted me by phone while I was attending a New Zealand University sports tournament suggesting I apply for the position. At the time I was finishing up a Masters degree on studies of a recently active volcano, just the sort of training to benefit one unsuspectingly about to enter the field of glaciology. The problem was that through some misunderstanding initially we thought the object of drilling was to penetrate through thin ice in order to examine the hardrock geology. After being notified by Bill Marshall, the project leader at SIPRE, that I had been accepted for the expedition, I was then brought to earth literally on being informed that we would be drilling for and analysing ice cores only. What was one to do? Living near the coast of New Zealand where it never snowed I didn't even know what a snowflake looked like and about my only experience with ice was that which formed on

roadside puddles during the occasional frosty evenings in winter and which we gleefully broke with our boots while walking to school. Little did I imagine that 40 years later I would begin a project examining the flexural strength of floating ice covers! However, with the aplomb of the casual Kiwi, I adopted to the time-honored tradition of geologists of ignoring what you don't understand and to simply press on regardless. I have been doing this ever since.

To cut a long story short, I joined the SIPRE team in New Zealand, travelled south to Byrd Station, West Antarctica where we drilled an ice core to 308 m depth. In those days it was called deep ice-core drilling, today it would simply be another shallow core. At that time, it was the deepest core drilled in Antarctica. It represented about an order of magnitude increase in drilling depth over that obtainable with the SIPRE coring auger (about 30 m using a tripod). It is interesting to note that less than a decade later we drilled nearly 2200 m of ice to bedrock at Byrd Station and just two years ago a U.S. team, of which I was a member, succeeded in penetrating the bottom of the Greenland ice sheet at 3053 m, almost exactly an order of magnitude deeper than the 1957–58 drilling at Byrd.

I spent 4 years at SIPRE (1958–61) under an AINA contract which included core drilling to the bottom of the Ross Ice Shelf (258 m) at Little America, Antarctica. This represented the first successful penetration of an Antarctic glacier. In 1961 SIPRE transferred to new facilities in Hanover, NH where it combined with another group from Massachusetts to form CRREL. I was offered an appointment and CRREL has been my work location for the last 34 years.

My abiding interest has been in the physical and structural properties of ice cores. In this regard I have been most fortunate in being able to take part in drilling projects that reached the bottom of both the Antarctic and Greenland ice sheets. These cores have yielded a wealth of paleoclimate information we could hardly have envisaged 40 years ago. The cores recently obtained to 300 m depth at the summit of the Greenland ice sheet, spanning possibly 200 000 years or more, have produced a paleoclimate record unequalled in its detail. However, the same cores have, in their deeper parts, revealed disturbing evidence of significant stratigraphic distortion that cautions us to be aware of the importance of dynamic factors in evaluating the depth–age relationships of the ice at the very summit of the Greenland ice sheet where we might have expected minimal disturbance.

My situation at CRREL has also allowed me the freedom to pursue a more diverse range of glaciological topics that seems possible for anyone entering the field today. Much of this work has largely involved the application of thin section techniques to the study of a variety of ice types, including lake, river and sea ice. All represent aggregations of crystals in one form or another that are readily amenable to analysis by thin-section techniques. The importance of the structural element of ice at the crystalline level cannot be underemphasised since it is the make-up of crystals of ice that exert a major control on the physical, mechanical and electromagnetic properties of ice. The intrinsic colorful beauty of thin sections, as revealed by the simple expedient of viewing them between crossed polarizers, is an additional attraction. Given their extraordinarily varied and colorful aspect, it often makes thin section examination an exhilarating experience in the area of optical art!

If diversity has been a trademark of my work then I must ascribe this to a combination of circumstances that have allowed me the freedom to do the things I like to do and continue to do.

1. To begin with, the mere fact that I was in the right place at the right time was a major factor in determining the course of my career in glaciology. At the time the field was wide open allowing us to diversify into many different aspects of glaciology. The creation of the IGY in 1957 was a boon since we were on the threshold of an expanding scientific base that involved us in applying new techniques to the study of glaciers. This application of new technical approaches blossomed during the 1960–1970s and resulted in a number of significant breakthroughs, an example which I personally experienced occurred at the end of January 1968. Just as we succeeded in reaching the bedrock interface at Byrd a plane fitted with radar-sensing gear operated by a bunch of people from BAS flew overhead and communicated to us the ice thickness in the immediate vicinity of the drill site. The estimate was within a few meters of what we had measured downhole. Their radar signals also indicated isolated areas of bottom melting which we verified was actually occurring at the drill site. This simultaneous success in accessing the bottom of a thick polar ice sheet both directly and remotely is, I believe, one of the singular crowning achievements in glaciology which helped to revolutionize the way we look at the role of polar ice sheets in global climate.

2. A second major factor was funding which, in the US at least, was liberally subscribed to science in the 1960 and 1970s, including glaciology of the polar regions. If there is one program that the U.S. Government has done consistently right it has been to fund R&D. Unfortunately, these days appear to have passed us by. We see signs of a turning away from this commitment to basic research. Recent action by the government indicates that resources for basic science will be much harder to come by in the future.

3. From 1957–72 I rotated annually, for months at a time, between Antarctica and Greenland, in the process, leaving my wife Marge alone to take care of the home and to rear the family. These responsibilities, thrust on her by the nature of my work, she undertook without complaint. I can truly say that of all the factors that have contributed to my career none have been more important than the love and unending devotion she has given me over the past 36 years. She has been the wind under my wings and without her love, consideration and support I could not have accomplished things for which the Society is honoring me tonight.

4. Very few of us are given the opportunity to consistently do the things we love to do. In this regard I deem myself extremely fortunate to have been associated with CRREL where I have been afforded undisturbed freedom to pursue my glaciological interests in earnest. My 34 years at CRREL (and 4 years at SIPRE) have been an exceptional experience both in terms of the vitality of the institution and in the extent of support I have received from my colleagues at all levels in CRREL. Institutions are only as good as the people within their walls; it is the people that have made CRREL the internationally reputed organization that it is and I am extremely proud to be counted among them. I believe the awarding of three previous Seligman Crystals to members of the SIPRE and CRREL staffs is further evidence of the high standing that CRREL enjoys within the international glaciological community.

Another aspect of glaciology that I have enjoyed is the professional associations we develop among ourselves and

the lasting friendships they promote. I can think of no other society in which these relationships are better expressed than in the IGS. During my career I have seen the Society grow into an organization of the highest international repute of which we can all be proud. Much of this growth derives from the inspirational and dedicated work of the lady we know as Hilda. We all owe her a great debt of gratitude.

My speech tonight would not be complete or proper without some reference to my many associates. At CRREL those with whom I have been most closely associated include Terry Tucker, Deb Meese, Willy Weeks, Steve Ackley, Steve Mock, Don Perovich, Austin Kovacs and Steve Arcone. Others outside CRREL include Bob Sharp, Dick Goldthwait, Sam Epstein, Charlie Bentley, Dick Cameron and Richard Alley. To many colleagues from overseas I offer my heartfelt thanks. They know who they are, but more important, I know who they are and what their contributions have meant to me.

In conclusion let me say the path of glaciology has taken me to many points of destination but none more satisfying than the point of destination that brings me here to Iceland tonight. I am indeed the luckiest man in the world. Thank you all so much."

ANNALS OF GLACIOLOGY STANDARDS

The *Annals of Glaciology* came into existence in 1980 as a vehicle for publishing research contributions presented at scientific symposia of the International Glaciological Society. Prior to 1980, symposium papers were published as special volumes of the *Journal of Glaciology*. In the course of editing these special volumes it became apparent that differences in the theme, organization, and geographical setting of each symposium imposed unique demands on the *Journal of Glaciology*. To facilitate a flexible response to these demands, the Society launched the *Annals of Glaciology*. While flexibility remains an important characteristic of the *Annals*, this should not be at the expense of scientific or editorial quality. The following statement of Standards for the *Annals of Glaciology* was approved by the Council of the Society at its recent meeting in Iceland.

Statement of Standards

1. The purpose of the *Annals of Glaciology* is to provide rapid publication of work presented at thematic symposia of relevance to members of the International Glaciological Society. The *Annals* should be published no more than nine months after the symposium.

2. In order to contain the cost of publications and to facilitate rapid publication of symposium papers, editorial procedures for the *Annals* differ from those of the *Journal of Glaciology*. The *Annals* are edited on a tight schedule, allowing for only one revision, with clear deadlines for receipt of both original and final manuscripts.

3. Papers are limited in length to 5 published pages. This translates to about 5500 words, less space for figures and tables. Exceptions will be made only when *the editors*, having reviewed the manuscript, believe that the content of the paper cannot adequately be presented within 5 pages. The editors will then determine how many extra pages can be allowed for an article. The author will be assessed page charges for pages in excess of 5.

4. For each sub-topic of the symposium the chief editor may invite a review or overview paper. These papers may be permitted more space: 8 pages (8800 words less figures).

5. Although the *Annals* provide a forum for symposium papers, they are not a proceedings in that papers are refereed, and papers presented at the symposium will not necessarily be accepted for publication in the associated issue of the *Annals*. Each paper is to be reviewed by at least two scientists.

6. Papers in the *Annals* must be of good scientific quality. Given that papers are subject to a page limit, they will not necessarily meet the same exacting standard of scientific importance as those appearing in the *Journal of Glaciology*. Scientific relevance, page for page, is expected to be comparable to that for any scientific journal.

Papers for the *Annals* must demonstrate one or more of the following:
- interesting and new quantitative results
- new theoretical development or analysis
- new interpretations of existing or new observations or results
- new qualitative ideas for processes, developed in an informative way to some conclusion [thought pieces]
- preliminary results with interpretation, even if more comprehensive results will be published later
- review articles

The following types of papers are not acceptable:
- field or data reports
- descriptions of work in progress without any preliminary results and conclusions
- descriptions of models or theory without any results
- descriptions of planned research or outlines of future projects
- preliminary results without any interpretation

Informational articles or letters on recent or planned projects or field experiments or on promotional, organizational, or educational activities should be submitted to *ICE*, the Society's newsletter.

7. In spite of the aim of rapid publication, the *Annals* have the same standard of English as that for any scientific journal. Articles must be well thought out, well organized, and written with care. Given the page limit, they must be concise. They must be free from errors in grammar, spelling, and punctuation. They must contain complete references including journal volume, issue number, and page numbers. [For non-English or lesser-known journals a copy of cover pages will assist *Annals* editors.] Figures and tables must be necessary to the purpose of the paper and have useful captions and table titles. Final copy editing is performed by the Society.

ANNALS OF GLACIOLOGY

The following papers have been accepted for publication in *Annals of Glaciology* Vol. 23, the Proceedings of EISMINT, the International Symposium on Ice Sheet Modelling, held in Chamonix Mont-Blanc, France, 18–22 September 1995 and edited by K. Hutter.

M R ALBERT
Modeling heat, mass and species transport in polar firn

N AZUMA AND K GOTO-AZUMA
An anisotropic flow law for ice-sheet ice and its implications

J L BAMBER AND P HUYBRECHTS
Geometric boundary conditions for modelling the velocity field of the Antarctic ice sheet

R J BRAITHWAITE
Models of ice–atmosphere interactions for the Greenland ice sheet

L BRISSET AND F RÉMY
Antarctic topography and kilometre-scale roughness derived from ERS-1 altimetry

M R van den BROEKE
Characteristics of the lower ablation zone of the West Greenland ice sheet for energy-balance modelling

W F BUDD AND R C WARNER
A computer scheme for rapid calculations of balance-flux distributions

C E BØGGILD, H OERTER AND T TUKIAINEN
Increased ablation of Wisconsin ice in eastern north Greenland: observations and modelling

O CASTELNAU, T THORSTEINSSON, S KIPFSTUHL AND P DUVAL
Modelling fabric development along the GRIP ice core, central Greenland

V A CHUGUNOV AND A V WILCHINSKY
Modelling of a marine glacier and ice-sheet — ice-shelf transition zone based on asymptotic analysis

A C FOWLER AND C JOHNSON
Ice-sheet surging and ice-stream formation

R GREVE AND D R MacAYEAL
Dynamic/thermodynamic simulations of Laurentide ice-sheet instability

I HANSEN AND R GREVE
Polythermal modelling of steady states of the Antarctic ice sheet in comparison with the real world

R C A HINDMARSH
Stability of ice rises and uncoupled marine ice sheets

R C A HINDMARSH
Stochastic perturbation of divide position

R C A HINDMARSH AND A J PAYNE
Time-step limits for stable solutions of the ice-sheet equation

P HUYBRECHTS
Basal temperature conditions of the Greenland ice sheet during the glacial cycles

P HUYBRECHTS, T PAYNE AND EISMINT INTERCOMPARISON GROUP
The EISMINT benchmarks for testing ice-sheet models

C S HVIDBERG
Steady-state thermomechanical modelling of ice flow near the centre of large ice sheets with the finite-element technique

A KERR AND A GILCHRIST
Glaciation, erosion and the evolution of the Transantarctic Mountains

W H KNAP, J OERLEMANS AND M CADÉE
Climate sensitivity of the ice cap of King George Island, South Shetland Islands, Antarctica

J K-W LAM AND J A DOWDESWELL
An adaptive-grid finite-volume model of glacier-terminus fluctuations

W LAWSON
The relative strengths of debris-laden basal ice and clean glacier ice: some evidence from Taylor Glacier, Antarctica

E LE MEUR
Isostatic postglacial rebound over Fennoscandia with a self-gravitating spherical visco-elastic Earth model

E LE MEUR AND P HUYBRECHTS
A comparison of different ways of dealing with isostasy: examples from modelling the Antarctic ice sheet during the last glacial cycle

LI JUN, T H JACKA AND W F BUDD
Deformation rates in combined compression and shear for ice which is initially isotropic and after the development of strong anisotropy

D R MacAYEAL, V ROMMELAERE, P HUYBRECHTS, C L HULBE, J DETERMANN AND C RITZ
An ice-shelf model test based on the Ross Ice Shelf

B A MARMO AND J DAWSON
Movement and structural features observed in ice masses, Framnes Mountains, MacRobertsons Land, East Antarctica

S J MARSHALL AND G K C CLARKE
Sensitivity tests of coupled ice-sheet/ice-stream dynamics in the EISMINT experimental ice block

I MARSIAT
Ice sheets' surface mass-balance evaluation in the UGAMP GCM: the climate of Antarctica

J MEYSSONNIER AND A PHILIP
A model for the tangent viscous behaviour of anisotropic polar ice

A OHMURA, M WILD AND L BENGTSSON
Present and future mass balance of the ice sheets simulated with GCM

F PATTYN
Numerical modelling of a fast flowing outlet glacier: experiments with different basal conditions

A PAUL
A seasonal energy-balance climate model for coupling to ice-sheet models

F RÉMY, C RITZ AND L BRISSET
Ice-sheet flow features and rheological parameters derived from precise altimetric topography

E RIGNOT, R FORSTER AND B ISACKS
Mapping of glacial motion and surface topography of Hielo Patagónico Norte, Chile, using satellite SAR L-band interferometry data

M A RIST, P R SAMMONDS, S A F MURRELL, G MEREDITH, H OERTER AND C S M DOAKE
Experimental fracture and mechanical properties of Antarctic ice: preliminary results

V ROMMELAERE AND C RITZ
A thermomechanical model for ice-shelf flow

R J M ROWDEN-RICH AND C J L WILSON
Models for strain localization in Law Dome, Antarctica

A N SALAMATIN AND C RITZ
A simplified multi-scale model for predicting climatic variations of the ice-sheet surface elevation in central Antarctica

B SALTZMAN AND M Y VERBITSKY
Heinrich-scale oscillations as an internal property of ice sheets

M J SIEGERT AND W FJELDSKAAR
Isostatic uplift in the Late Weichselian Barents Sea: implications for ice-sheet growth
M J SMITHSON, A V ROBINSON AND R A FLATHER
Ocean tides under the Filchner–Ronne Ice Shelf, Antarctica
B SVENDSEN AND K HUTTER
A continuum approach to model-induced anisotropy in glaciers and ice sheets
F G M van TATENHOVE, A FABRE, R GREVE AND P HUYBRECHTS
Modelled ice-sheet margins of three Greenland ice-sheet models compared with a geological record from ice-marginal deposits in central West Greenland
C J VAN DER VEEN AND I M WHILLANS
Model experiments on the evolution and stability of ice streams
R S W van de WAL
Mass-balance modelling of the Greenland ice sheet: a comparison of an energy-balance model and a degree-day model
R S W van de WAL AND S EKHOLM
On elevation models as input for mass-balance calculations of the Greenland ice sheet
M WEIS, K HUTTER AND R CALOV
250 000 years in history of Greenland's ice sheet
C J L WILSON AND Y ZHANG
Development of microstructure in the high-temperature deformation of ice
T WU, K JÖHNK, B SVENDSEN AND K HUTTER
On the gravity-driven shear flow of an ice–till mixture

JOURNAL OF GLACIOLOGY

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

L LLIBOUTRY
Temperate ice permeability, stability of water veins and percolation of internal meltwater
GUOGUANG ZHENG AND R LIST
Thermal conductivity of porous ice in hailstone shells
G S HAMILTON AND J A DOWDESWELL
Controls on glacier surging in Svalbard
T S CLARKE AND K ECHELMEYER
Seismic reflection evidence for a deep subglacial trough beneath Jakobshavns Isbræ, Greenland
A IKEN, K FABRI AND M FUNK
Water storage and subglacial drainage conditions inferred from borehole measurements on Gornergletscher, Valais, Switzerland
A AMES AND S HASTENRATH
Diagnosing the imbalance of the Santa Rosa Glacier, Cordillera Raura, Peru

INTERNATIONAL SYMPOSIUM ON ANTARCTICA AND GLOBAL CHANGE

Hobart, Tasmania, Australia 13–18 July 1997

CO-SPONSORED BY

SCAR–GLOCHANT (Scientific Committee for Antarctic Research — Global Change in Antarctica)
AMOS (Australian Meteorological and Oceanographic Society)
IGS (International Glaciological Society)

FIRST CIRCULAR

The Cooperative Research Centre for the Antarctic and Southern Ocean Environment (Antarctic CRC) cordially invites your participation in the International Symposium on Antarctica and Global Change, to be held in Hobart, Tasmania, Australia on 13–18 July 1997. Those interested in attending the symposium are requested to return the attached form as soon as possible. The second announcement, which will include detailed information on accommodation, preparation of summaries and final papers, etc. will be circulated in June 1996.

The Antarctic CRC examines the processes in Antarctica and the Southern Ocean which affect climate and global change. Research is focussing on the oceanic and atmospheric circulations of the region, their interaction with sea ice and the continental ice sheet, and their relation to global environmental change and biological productivity. CRC participants include the University of Tasmania, the Australian Antarctic Division, CSIRO Division of Oceanography, the Australian Bureau of Meteorology and the Australian Geological Survey Organisation.

TOPICS The Symposium has a broad title in order to bring together researchers from a large range of physical and earth sciences. Papers should address global change through studies related to Antarctica or the Southern Ocean. These studies may be based on field measurements, remote sensing, computer modelling, etc. Examples (although this list is not exhaustive) of topics covered might include:

ice-sheet mass budget
palaeoenvironmental records from ice, land and ocean sediments
sea ice
ice/ocean/atmosphere/lithosphere interaction
sea-level change
climate monitoring and detection of change
biogeochemical cycles.

PAPERS Abstracts will be available at the symposium. Papers presented to the symposium will be considered for publication in *Annals of Glaciology*. Papers will be refereed according to the usual standards of the International Glaciological Society before being accepted for publication. Details concerning submission of abstracts for presentation to the symposium and of papers for publication in the proceedings volume will be given in the second circular.

CHIEF SCIENTIFIC EDITOR W. F. Budd

VENUE AND ACCOMMODATION Wrest Point Convention Centre, the venue we have chosen for the symposium, is close to shops, restaurants and accommodation. A variety of accommodation has been booked at conference rates, including college accommodation, colonial bed and breakfast or a five star hotel, etc., all within walking distance of Wrest Point.

TASMANIA About twice the land area of Switzerland, but with a population of less than half a million, the island State of Tasmania has been described as a land of great diversity. Tasmania is separated from the Australian mainland by the 200 km wide Bass Strait. Two hours drive in almost any direction takes one through a wide range of scenery, ranging from lush farmland, snowy peaks and rain forests inland, to pristine beaches lining much of the coast. For a little longer drive or perhaps a scenic flight, you can experience the ruggedness of the southwest, a renowned World Heritage area. In fact, more than 30% of the land area in Tasmania is designated as World Heritage. The host city of Hobart is steeped in history, with its graceful old buildings and gardens, and picturesque harbour. Hobart offers a wide range of fine restaurants and you may choose to dine on Tasmanian food and wine or opt for an international flavour. Just ninety minutes to the south of Hobart you will find the famous convict ruins of Port Arthur, with many stories to tell of a bygone era.

CLIMATE Hobart in July will be cool and crisp, with day-time maximum temperatures ranging from 7°C to 14°C (44°F to 58°F). While you should be prepared for rain, clear sunny days are common.

LOCAL ORGANISING COMMITTEE Jo Jacka (Antarctic CRC, Symposium Chairman), Rod Cameron-Tucker (Antarctic CRC), Lorraine Nielsen (Antarctic CRC), Ian Goodwin (SCAR–GLOCHANT), Beth Pocock (Mures Conventions), Trudi Dwyer (Mures Conventions)

FURTHER INFORMATION The next announcement of the symposium, together with a formal call for papers, will be circulated to all respondents to this circular. Members of the International Glaciological Society will automatically receive a copy. Abstracts will be due at the end of December 1996.
Information regarding the symposium scientific content may be obtained from the Secretary General, International Glaciological Society, tel: +44 1223 355974; fax: +44 1223 336543; E-mail: 100751.1667@compuserve.com

MANAGEMENT Symposium management facilities are provided by Mures Convention Management, Hobart: Antarctica and Global Change, Mures Convention Management, Victoria Dock, Hobart, Tasmania 7000, Australia. tel: +61 02 34 1424, fax: +61 02 34 4464; e-mail: mures@hba.trumpet.com.au.

INTERNATIONAL SYMPOSIUM ON ANTARCTICA AND GLOBAL CHANGE

Hobart, Tasmania, Australia 13–18 July 1997

Surname . . . . . .First Name/s . . . . . .

Title . . . . . Organisation . . . . . .

Address . . . . . .

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Tel: . . . . . .Fax: . . . . . .E-mail: . . . . . .

Please send me the 2nd circular, with a Call for Papers and Registration Form [ ]

I am interested in being an exhibitor [ ]

I will require child care [ ]

Please send to:
Antarctica and Global Change, Mures Convention Management, Victoria Dock, Hobart, Tasmania 7000, Australia.

IGS AWARDS

Following the recent Council meeting in Iceland, the International Glaciological Society now has three different ways of recognizing contributions to the science of glaciology and to its objectives. These are:

SELIGMAN CRYSTAL

"... shall be awarded from time to time to one who has made an outstanding scientific contribution to glaciology so that the subject is now enriched."

HONORARY MEMBERSHIP

"Honorary Members shall be elected by the Council in recognition of eminent contributions to the objects of the Society, and shall not exceed twelve in number."

RICHARDSON MEDAL

"... is awarded from time to time to one who has given outstanding service to glaciology."

Members are invited to recognize their colleagues by submitting nominations either to the Chairman of the Awards Committee or to the Secretary General.

Recent meetings (of other organizations)

100 YEARS OF GLACIER RESEARCH IN ITALY

It is 100 years since the Comitato Glaciologico Italiano was established by the Italian Alpine Club in 1895. Representatives from the IGS, ICSI and WGMS joined agency representatives and Italian glaciologists to celebrate the occasion at a two-day meeting in Torino (19–20 October 1995), hosted by Professor Augusto Biancotti, President of the Comitato.

Research on Italian glaciers is undertaken by field observers with widely differing backgrounds, from academic scientists to technicians from firms for which glaciers constitute a resource to those from many different local authorities and enthusiastic amateurs; all of whom were well represented at the meeting.

Glacier researchers in Italy report to both the Comitato Glaciologico Italiano and the Italian Alpine Club. These two groups are linked by those who are members of both, thus ensuring a common purpose and methodology and consistent international relations.

Some 45 papers were presented that described the development of monitoring and research activities throughout this century, work that even in the early days was as rich, diversified and far-reaching as today. These papers will be published in a special issue of *Geografia Fisica e Dinamica Quaternaria*, a title adopted in 1978 for the third series of the *Bollettino del Comitato Glaciologico Italiano* which was first published in 1914.

A highlight of the meeting was the launch of a multimedia CD-ROM containing the results of the third inventory of Italian glaciers which has just been completed. Undertaken for the Ministry of the Environment, it includes an account of the state-of-the-art of research on Italy's principal glacier-clad mountains: Ortles-Cevedale, Mont Blanc, Monte Rosa and the Gran Sasso. Prepared with the general public in mind, it will be on sale at newsagents throughout Italy. The first Italian inventory was undertaken for the International Geophysical Year (1957–58), and the second as a contribution to the World Glacier Inventory during the 1980s.

At a time when the international community is looking for larger data sets on variations and mass balance of mountain glaciers, the extent of the past and present network in Italy, and the amount of data being provided to national and international agencies, give the Comitato Glaciologico Italiano and Italian Alpine Club good reason to feel proud of their accomplishments over the last 100 years.

Books received

Delmas, R.J., *Ed.* 1995. *Ice core studies of global biogeochemical cycles*. NATO ASI Series I: Global Environmental Change 30, NATO Advanced Studies Institutes, ISBN 3-540-59274-1, DM 298,00. Berlin, etc, Springer-Verlag, 475 pp.

Griselin, M., *Ed.* 1995. *Actes du 3e symposium international, Cavités glaciaires et cryokarst en régions polaires et de haute montagne, 1-6 novembre 1994, Chamonix, France*. Annales littéraires de l'université de Besançon 561, Série Géographie 34. 100,00 FF + 25,00 FF postage. Paris, Les Belles Lettres, 138 pp.

Donner, J. 1995. *The Quaternary history of Scandinavia*. First edition, World and Regional Geology 7, ISBN 0 521 41730 9, $60/US$99.95. Cambridge, New York, Melbourne, Cambridge University Press, 200 pp.

Haakensen, N. 1995. Glasiologiske undersøkelser i Norge 1992 og 1993. *Norges Vassdrags-og Energiverk, Vassdragsdirektoratet, Oslo, Norway, Publikasjon*, Hydrologisk Avdeling 08, 139 pp. + map.

The proceedings of the Festschrift held to honour Bill Field have just been published in the first two issues of *Physical Geography* for 1995. Members may be interested in the following papers:

Morrison, M. William O. Field and the American Geographical Society: the early years. **16**(1), 9–14.

Post, A. Annual aerial photography of glaciers in northwest North America: how it all began and its golden age. **16**(1), 15–26.

Hall, D. K., C. S. Benson and W. O. Field. Changes of glaciers in Glacier Bay, Alaska, using ground and satellite measurements. **16**(1), 27–41.

Sturm, M. Short-period velocity fluctuations of two glaciers on Mt. Wrangell, Alaska. **16**(1), 42–58.

Post, A. and R. J. Motyka. Taku and LeConte Glaciers, Alaska: calving-speed control of Late-Holocene asynchronous advances and retreats. **16**(1), 59–82.

Molnia, B. F. and A. Post. Holocene history of Bering Glacier, Alaska: a prelude to the 1993–94 surge. **16**(2), 87–117.

Heusser, C. J. Late-Quaternary vegetation response to climatic-glacial forcing in North Pacific America. **16**(2), 118–149.

Marcus, M. G., F. B. Chambers, M. M. Miller and M. Lang. Recent trends in the Lemon Creek Glacier, Alaska. **16**(2), 150–161.

Future meetings (of other organizations)

GLACIERS OF THE SOUTHERN HEMISPHERE

Melbourne, Australia, a 2–3 day symposium in the week of 1–9 July 1997

The International Snow and Ice Commission is convening a symposium on Glaciers of the Southern Hemisphere. Firm dates are not yet set, but it will take place during the week of 1–9 July 1997, in conjunction with the IAPSO and IAMAS meetings in Melbourne, and will complement the IGS symposium being held in Hobart the following week. The theme of the ICSI symposium is glacier response to a changing climate and will highlight the programs and results of studies on alpine glaciers in the Southern Hemisphere, including the tropics. The organisers will encourage papers that address the topics of glacier mass changes, water flow from glaciers, and evolving glacier hazards, calving glaciers, and glacier contributions to changes of global sea level. They will also welcome papers that provide a long-term perspective based on glacial geologic studies and modelling efforts.

Organizing Committee:

Andrew G. Fountain (Chairman)
U.S. Geological Survey, P.O. Box 25046 MS-412, Denver, CO 80225, USA (Tel: +1 303 236 5025; Fax: +1 303 236 5034; andrew@usgs.gov)

Georg Kaser
Institut fur Geographie, Innrain 52, A-6020 Innsbruck, Austria (Tel: +43 512 507 5407; Fax: +43 512 507 2895; georg.kaser@uibk.ac.at)

Juan Carlos Leiva
IANIGLA, CC330, 5500 Mendoza, Argentina (Tel: +54 61 287 370; Fax: +54 61 287 370; ntcricyt@criba.edu.ar)

Glaciological Diary

GLACIOLOGICAL DIARY

1996

18-22 March

18th International Polar Meeting, German Society for Polar Research, Potsdam (Deutsche Gesellschaft für Polarforschung, Alfred-Wegener-Institüt, Telegrafenberg A43, D-14473 Potsdam, Germany)

16-18 April

64th Annual Western Snow Conference, Bend, OR, USA (K. C. Jones, NRCS Water and Climate Center, 101 SW Main Str., Portland, OR 97204-3225, USA Fax: +1 503 414 3101; a16kjones@attmail.com)

17-19 April

Glaciation and Hydrogeology: Workshop on the Impact of Glaciations on Rock Stresses, Groundwater Flow and Hydrochemistry Past, Present and Future, Sweden (L. King-Clayton, Intera Information Technologies Ltd., 47 Burton Street, Melton Mowbray, Leics, LE13 1AF, UK Fax: +44 1664 411402)

10 May

Peyto Glacier Workshop (in conjunction with the Canadian Geophysical Meeting 5-10 May) Banff, Canada. Topics include historical background, atmosphere and climatology, changes in area and volume, the liquid phase. (Gordon Young, Wilfrid Laurier University, Waterloo, Ont., N2L 3C5, Canada Tel: +1 519 884 1070; Fax: +1 519 884 885)

26-31 May

6th International Offshore and Polar Engineering Conference, Los Angeles, USA (ISOPE, P.O. Box 1107, Golden, CO 80402 1107, USA Fax: +1 303 420 3760)

2-6 June

7th International Workshop on Atmospheric Icing of Structures, Chicoutimi, Canada (IWAIS '96, M. Farzaneh, Dept. of Applied Sciences, Université du Québec à Chicoutimi, 555 boulevard de l'Université, Chicoutimi (Québec), G7H 2B1, Canada; Fax: +1 418 545 5012)

16-20 June

OMAE 1996, 15th International Conference on Offshore Mechanics and Arctic Engineering, Florence, Italy (OMAE'96 Conference Secretariat, via Trieste 230, I-48100 Ravenna, Italy Tel: +39 544 518014; Fax: +39 544 518015)

17-20 June

International Conference on Quaternary Glaciation and Paleoclimate in the Andes Mountains, IVIC, near Caracas, Venezuela (M..Bezada, Departamento de Ciencias de la Tierra, Universidad Pedagogica Experimental Libertador, Ave. Paez el Paraiso, Caracas, Venezuela Fax: +58 2 872 1443)

17-21 June

2nd International Scientific Conference on the Global Energy and Water Cycle (Ocean–atmosphere–ice exchanges), Washington, DC (International GEWEX Project Office, 409 Third Str. SW, Suite 203, Washington, DC 20024, USA Tel: +1 202 863 0012; Fax: +1 202 488 5364; gewex@cais.com)

24-26 June

* Changing Glaciers: Revisiting Themes and Field Sites of Classical Glaciology, Norwegian Glacier Museum, Fjaerland, Norway (E. Isaksson, Norwegian Polar Institute, P.O. Box 5072, Maj., N-0301 Oslo, Norway Tel: +47 22 95 96 34; Fax: +47 22 85 95 01; elli@npolar.no)

24-28 June

Interpraevent 1996: Protection of Habitat against Floods, Debris Flows and Avalanches, Garmisch-Partenkirchen, Germany (Interpraevent 1996, c/-Bayerisches Landesamt für Wasserwirtschaft, Lazarettstr. 67, D-80636 Munich, Germany)

8-16 July

High Arctic Joint Field Meeting, IPA Working Group on Periglacial Processes and Environments and International Geographical Union Commission on Frost Action Environments (A. Lewkowicz, Dept. Geography, Univ. of Ottawa, Ottawa, Ont., K1N 6N5, Canada Tel: +1 613 564 2244: Fax: +1 613 564 3304: alewkowi@acadvm1.uottawa.ca)

12-15 August

** International Symposium on Representation of the Cryosphere in Climate and Hydrological Models, Victoria, B.C. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK)

12-17 August

ASCE 8th International Specialty Conference on Cold Regions Engineering, Fairbanks, Alaska (L. Bennett, School of Engineering, University of Alaska Fairbanks, P.O. Box 755900, AK 99775-5900, USA Tel: +1 907 474 6121; Fax: +1 907 474 6087; fyasce@aurora.alaska.edu)

13-15 August

19th Nordic Hydrological Conference (NHK-96), Akureyri, Iceland (NHK-96, Orkustofnun, Grensásvegi 9, IS-108 Reykjavík, Iceland Tel: +354 569 6040/6042; Fax: +354 568 8896; ke@os.is or asn@os.is)

27-31 August

* IXth International Symposium on the Physics and Chemistry of Ice, Dartmouth College, Hanover, USA (V. Petrenko, 8000 Cummings Hall, Dartmouth College, Hanover, NH 03755-8000, USA)

1-7 September

4th International Symposium on Glacier Caves and Cryokarst in Polar and High Mountain Regions (H. Slupetzky, Institut für Geographie, Universität Salzburg, Hellbrunnerstrasse 34/III, A-5020 Salzburg, Austria Fax: +43 662 8044 525; slupetzky@edvz.sbg.ac.at)

2-6 September
Avalanches and Related Subjects: the Contribution of Theory and Practice to Avalanche Safety, Kirovsk, Murmansk region, Russia (Centre of Avalanche Safety, 33 a, 50 years of October st., 184230 Kirovsk, Murmansk region, Russia Fax: +7 477 891 4124: master@apatit.murmansk.su)

6-10 October
ISSW96, International Snow Science Workshop, Banff, Alberta (Banff Centre for Conferences, P.O. Box 1020, Stn.15, Banff, Alta, T0L 0C0, Canada Tel: +1 403 762 6308; Fax: +1 403762 7502)

October/November
Northwest Glaciological Meeting, University of British Columbia, Vancouver, Canada (Garry Clarke, clarke@geop.ubc.ca)

23-24 November
** IGS Nordic Branch Meeting, Denmark (C. Hammer, Department of Geophysics, The Niels Bohr Institute, University of Copenhagen, DK-2200 Copenhagen N, Denmark)

15-19 December
AGU Fall Meeting, San Francisco, USA (see *EOS* for full details)

1997

25-29 May
** International Symposium on Symposium on Snow and Avalanches. Chamonix, France (Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK)

10-12 June
International Symposium on Physics, Chemistry, and Ecology of Seasonally Frozen Soils, Fairbanks, Alaska, U.S.A. (P. Groenvelt, Department of Land Resource Science, University of Guelph, Guelph, Ont., N1G 2W1, Canada Fax:+1 519 824 5730)

1-9 July
Glaciers of the Southern Hemisphere, Melbourne, Australia (A. G. Fountain, U.S. Geological Survey, P.O. Box 25046 MS-412, Denver, CO 80225, USA Tel: +1 303 236 5025; Fax: +1 303 236 5034; andrew@usgs.gov)

13-18 July
** International Symposium on Antarctica and Global Change, University of Tasmania, Hobart, Australia (Secretary General, International Glaciological Society, Lensfield Rd, Cambridge, CB2 1ER, UK)

1998

23-27 June
7th International Conference on Permafrost, Yellowknife, N.W.T., Canada (J. A. Heginbottom, Terrain Sciences Division, Geological Survey of Canada, 601 Booth Street, Ottawa, Ont., K1A 0E8, Canada Tel: +1 613 992 7813; Fax: +1 613 992 2468; heginbottom@gsc.emr.ca)

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New members

Robert E. Gagnon, Institute of Marine Dynamics, National Research Council of Canada, P.O. Box 12093 Station A, St. John's, Newfoundland, A1B 3T5, Canada (Tel: +1 709 772 5524; Fax: +1 709 772 2462; E-mail: rgagnon@minnie.imd.nrc.ca)

Anne M. Hiatt, School of Geography, University of Leeds, Leeds, LS2 9JT, U.K. (Tel: +44 113 233 6638; Fax: +44 113 233 3308; E-mail: geoamh@west-01.novell.leeds.ac.uk)

Hester Jiskoot, School of Geography, University of Leeds, Leeds, LS2 9JT, U.K. (Tel: +44 113 233 6638; Fax: +44 113 233 3308; E-mail: pghj@geog.leeds.ac.uk)

Jiancheng Kang, Glaciology Division, Polar Research Institute of China, 451 Jinqiao Road, Pudong, 200129 Shanghai, P.R. China (Tel: +86 21 8711801; Fax: +86 21 8711663)

Per Klingbjer, Emmylundsvägen 3, S-171 60 Solna, Sweden (Tel: +46 8 16 48 63)

Richard A. Marston, Department of Geography, University of Wyoming, Laramie, WY 82071-3371 U.S.A. (Tel: +1 307 766 3311; Fax: +1 307 766 2697; E-mail: marston@uwyd.edu)

Jens-Ove Näslund, Naturgeografiska institutionen, Stockholms universitet, S-106 91 Stockholm, Sweden (Tel: +46 8 16 49 60; Fax: +46 8 16 48 18; E-mail: jens@natgeo.su.se)Halldor Pétursson, Hvannavellir 8, IS-600 Akureyri, Iceland (Tel: +354 462 2983; Fax: +354 461 1296)

Ursula Ryan, Antarctic C.R.C., University of Tasmania, GPO Box 252C, 7001 Hobart, Tasmania, Australia (Tel: +61 02 20 7683; Fax: +61 02 20 2902; E-mail: u.s.ryan@antcrc.utas.edu.au)

Peter R. Sammonds, Department of Geological Sciences, University College London, Gower Street, London WC1E 6BT, U.K. (Tel: +44 171 387 7050; Fax: +44 171 387 1612; E-mail: p.sammonds@ucl.ac.uk)

Flosi Sigurdsson, VST Limited, Consulting Engineers, Armúli 4, IS-108 Reykjavík, Iceland (Tel: +354 569 5000; Fax: +354 569 5010; E-mail: vstfs@skima.is)

Eric Steig, Dept. of Geological Sciences, University of Washington, P.O. Box 351310, Seattle, WA 98195-1310, U.S.A. (Tel: +1 206 543 4571; Fax: +1 206 543 3836; E-mail: esteig@geophys.washington.edu)

Petru Urdea, Department of Geography, University of Timisoara, Sbr. Pestalozzi Nr.16, RO-1900 Timisoara, Romania (Tel: +40 56 124316; Fax: +40 56 190377)

Milorad Vasic, 18 Law Street, Rochdale, Lancashire, OL11 4PT, U.K. (Tel: +44 161 275 3674; Fax: +44 161 275 4407; E-mail: mfvpgmv@fsi.go.man.ac.uk)

Stefan Winkler, Geographisches Institut, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany (Tel: +49 931 8885587; Fax: +49 931 8885544; E-mail: geog079@rzbox.ini-wuerzburg.de)

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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.
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