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Corporate donations fund Wadati Chair

To support teaching and research related to mounting global environmental concerns, eleven Japanese corporations have agreed to establish an academic chair at the Geophysical Institute, University of Alaska Fairbanks (UAF). Chair funds will support two professors whose work relates to the global environment.

The chair will be named in honor of Dr. Kyoo Wadati, a noted Japanese geophysicist who discovered earthquakes at depths greater than 300 kilometers, a pioneering contribution to the concept of plate tectonics. The belt of such "deep-focus earthquakes" is called the Wadati-Benioff zone. Dr. Wadati was awarded the Order of Culture in 1985. He is the former director general of the Japanese Meteorological Agency, president of the Japanese Academy, and is presently an Honorary Citizen of Tokyo, Japan.

The gift, valued at more than one million dollars over five years, was promoted by the Committee for Energy Policy Promotion of Japan (CEPP). The committee was established by four leading economic groups in Japan to address major Japanese energy problems and advise the government on overall energy promotion policy. They also work closely with their counterparts in other nations, such as the Atlantic Council of the United States.

An invitation by the CEPP secured participation of eleven major corporations in funding the Wadati Chair: Chubu Electric Power Company Incorporated, Electric Power Development Company Ltd., Hitachi Ltd., Mitsubishi Heavy Industries Ltd., Osaka Gas Company Limited, The Industrial Bank of Japan, Ltd., The Kansai Electric Power Company, Inc., The Tokyo Electric Power Company, Inc., Tokyo Gas Company Limited, Toshiba Corporation, and Toyota Motor Corporation.

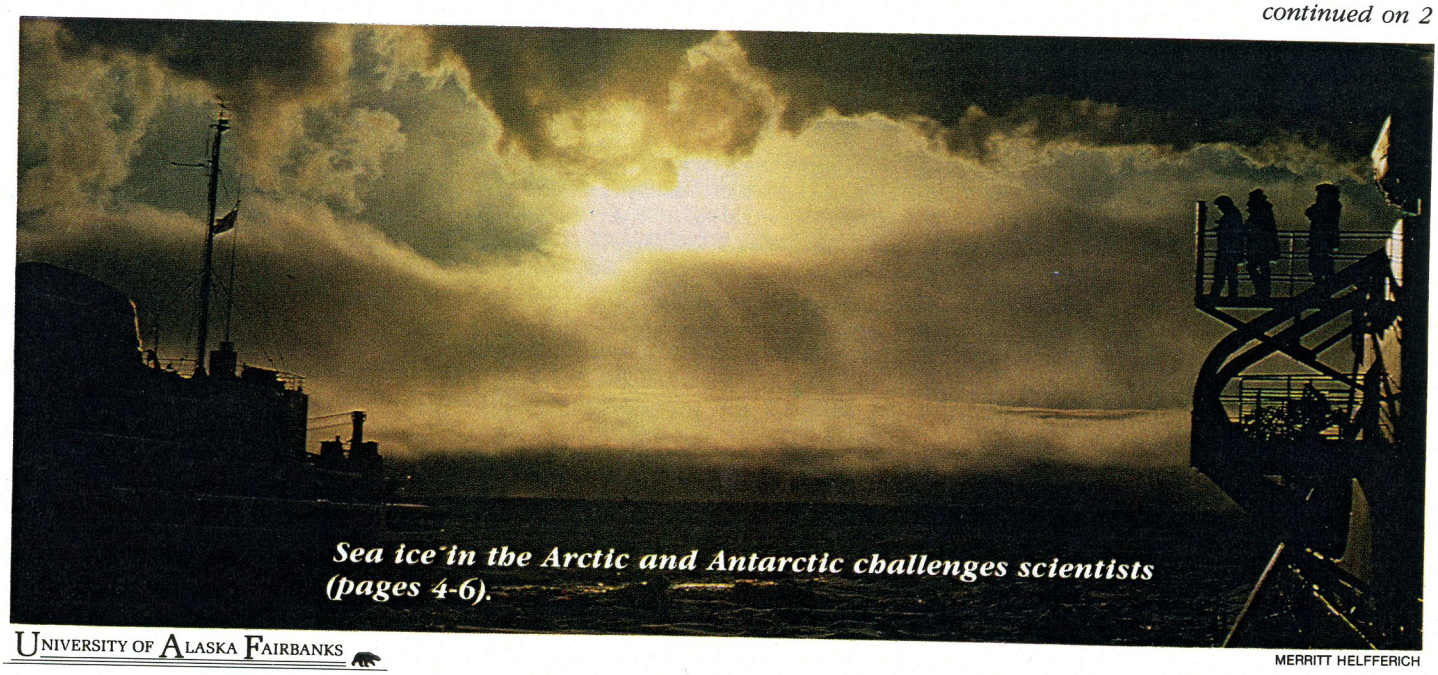
The work of scientists supported by the Wadati Chair will focus on climate change and other geophysical issues, and will enhance development of the Center for Global Change and Arctic System Research which was established at UAF this year.

"The Wadati Chair represents an international partnership between private and public institutions that is vital to our effort to understand global change," said UAF Chancellor Patrick O'Rourke. "As we address these important scientific questions, it is appropriate to concentrate first on the sensitive polar regions, both the Arctic and Antarctic, for it is here that we expect to see the first and most drastic signs of such change, should it occur."

"It is significant that major Japanese corporations, rather than their government, took the international lead in contributing to the global warming research effort by recognizing that the solution to global change problems is an issue common to all mankind," said Syun-Ichi Akasofu, Geophysical Institute director. "The chair professors at the Geophysical Institute will play a pivotal role in integrating global change studies at UAF and they will contribute to the important questions we face about the earth as a system."

In recent years, attention has been drawn to questions of global change, a general term that refers to man-made changes in the earth's climate and environment. One example considered particularly serious is the expected global warming associated with observed increases in at-

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Sea ice in the Arctic and Antarctic challenges scientists (pages 4-6).

MERRITT HELFFERICH

Wadati *continued from 1*



Dr. Kyoo Wadati honored.

mospheric carbon dioxide from the burning of fossil fuel. Another is the breakdown of stratospheric ozone over the antarctic continent, resulting from the use of man-made chlorofluorocarbons, or CFCs.

"It is increasingly clear that human impacts on the earth can no longer be ignored, because they are beginning to jeopardize the habitability of the planet," said Akasofu. "At this juncture we must accurately assess the progress of environmental degradation and take measures necessary to minimize such effects in the future. Private corporate funding that supports research in this area and crosses national boundaries is significant. The project to establish the Wadati Chair may be the first of its kind."

A November 21 presentation ceremony will be attended by Dr. Wadati, Mr. Gaishi Hiraiwa, Chairman of the CEPP and of Tokyo Electric Power Company, Mr. Mamoru Sueda, Executive Director of CEPP, Dr. Akasofu, Dr. Gunter Weller, deputy director of the Geophysical Institute, Dr. Edward Malloy, counselor for scientific and technical affairs with the U.S. Embassy in Japan (representing Chancellor O'Rourke), and Mr. Kojiro Abe, far east representative, Alaska State Division of Tourism in Tokyo (representing Alaska Governor Steve Cowper). Dr. Frank Press, president of the National Academy of Sciences, and Dr. Robert Corell, assistant director for the Directorate for Geosciences, National Science Foundation are sending their congratulatory notes.

—Doreen Fitzgerald

Shared software aids tsunami warning center

Two software packages developed at the Geophysical Institute have been contributed to the Pacific Tsunami Warning Center in Ewa Beach, Hawaii, for acquiring and processing seismological data. Tsunamis, or giant sea waves, are a potential disaster associated with large earthquakes.

The software packages, JADE and Xpick, were developed by institute staff members Cole Sonafrank, computer system manager, and graphics specialist Mitch Robinson. Funded by the National Weather Service, Sonafrank traveled to the warning center in early July to install the software and taylor it to their needs.

"JADE, short for Just Another Detector of Events, is the central component of a system that collects data from a network of seismic instruments and automatically analyzes it for the location and time of earthquakes," said Sonafrank. "Xpick is a very portable X-windows based program that allows geophysicists to use a graphics workstation to easily and efficiently 'pick' pertinent information out of the digital seismic data."

"A rapid response to earthquake activity is a fundamental operational criterion," said Gordon Burton in a recent letter of appreciation to institute director Syun-Ichi Akasofu. Burton is geophysicist-in-charge at the warning center.

"The software ... provides a significant enhancement of PTWC's capabilities and saves a time-consuming effort for in-house development. It also provides a higher level of technical capability than would have been achievable at PTWC."

The letter of appreciation accompanied a plaque recognizing the institute's contribution to center operations.

"What pleases us the most is that software developed to meet our own institute needs has become the basis for an exciting new cooperative relationship with the warning center," Sonafrank said, "and we expect it to be mutually beneficial."

The PTWC, part of the National Oceanic and Atmospheric Administration, has regional, national, and international responsibilities for issuing warnings of potential tsunamis.



International agreements signed by institute

Two international exchange agreements have been signed recently by the Geophysical Institute with universities in the Soviet Union and Japan.

Scientific cooperation in the field of auroral physics, geomagnetic, and ionospheric research will continue under a new agreement between GI and the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN), Academy of Sciences of the USSR. The arrangement includes the exchange of faculty members, post-graduate and other students, the organization of joint meetings and seminars, and other information exchange. The agreement was completed and signed on September 21.

Among scientific topics of mutual interest are geomagnetic variations at high latitudes, geomagnetic activity indices and forecasting, energetics of the magnetosphere, and software development. Also of interest is the response of the ionosphere to the precipitation of energetic particles, field-aligned currents, and Joule heating; and, the use of radio techniques to study high-latitude sources, coupling mechanisms, and propagation of atmospheric gravity wave and traveling ionospheric disturbance phenomena. The institute plans to invite Professor V.N. Oraevsky to visit next year.

An academic exchange agreement with the Solar-Terrestrial Environment Laboratory at Nagoya University in Japan calls for the development of exchange and cooperation in the field of atmospheric sciences, magnetospheric physics, and solar-terrestrial physics. Cooperative work may include joint ground-based observation programs, joint data analysis and theoretical work, exchange of scientists, and exchange of scientific materials, publications, and information.

Institute director Syun Akasofu visited the newly established laboratory on July 16 and signed the agreement with Dr. Takasi Oguti, laboratory director. As first projects, their balloon group plans to conduct a joint observation of ozone with the GI atmospheric sciences group. Researchers Kiyohami Yumoto and John Olson plan to establish a meridian chain of magnetometers across the Pacific Ocean.

Selected Project Briefs

STRATOSPHERIC OZONE—Knut Stamnes, Roger Smith, and Glenn Shaw received a NSF grant for an experimental and theoretical investigation of stratospheric ozone and ozone-related trace gasses in the Arctic. After measuring ultraviolet and visible radiation at the ground, they will infer column abundances of atmospheric ozone and other trace gases important in ozone chemistry, such as oxides of nitrogen and chlorine. Measurements of intensity ratios for wavelength pairs in the ultraviolet part of the spectrum will be used to derive column ozone content; visible absorption spectroscopy will be used to infer column abundances of stratospheric nitrogen oxides. The $157,300, one-year grant may be extended a second year to total $236,100.

CLOUD MICROPHYSICS—Knut Stamnes has received a $74,000 grant from the U.S. Department of Energy to study the effect of cloud microphysics on climate sensitivity. Stamnes plans to develop cloud radiative parameters based on liquid water content and cloud drop size distribution. This information will be used to produce a radiative-convective model. The model will be used to assess how potential cloud microphysics changes associated with greenhouse warming may effect cloud/radiation feedback. The grant supports research for one year. The project may be extended up to three years to total $230,800.

GEOLOGICAL RESEARCH IN ANWR—The Tectonics and Sedimentation Research Group has received grants totaling $355,000 from twelve petroleum companies for its 1990 geological research program in the Arctic National Wildlife Refuge. The funds will support this year's work by Wesley Wallace, Keith Watts, Keith Crowder, and their graduate students. The group has been working on a long-term study of the geology of the northeastern Brooks Range since 1985. The work includes studies of the structural geology and the carbonate and clastic stratigraphy and sedimentology of the region. The research aims to discover the regional geologic history, provide examples of geologic processes applicable to other regions, and provide a regional geologic framework for resource evaluation of the ANWR coastal plain.

CONTINUATION FUNDING—Since July 1, 1990, funding has been received for the continuation of several major research projects, including: Determination of the Mechanisms of Rapid Flow in **Jakobshavns Glacier**, Greenland by borehole measurements, additional $116,214 granted by NSF to Keith Echelmeyer and Will Harrison; Measurement and Simulation of the Profile Properties of Undeformed First Year **Sea Ice**, additional $95,100 granted by NSF to Willy Weeks and Lew Shapiro; Numerical Modeling of **Magnetospheric Dynamics**, additional $54,900 granted by NSF to Dan Swift; Numerical Modeling of **Substorm Processes**, additional $57,700 granted by NSF to Dan Swift; Boundary Layer Measurements in **Eastern Antarctica**, additional $86,000 granted by NSF to Gerd Wendler; Study of the Magnetic Field **Annihilation Process in the Magnetosphere** and some geotechnical applications, additional $140,000 granted by the Department of Energy to Lou-Chuang Lee; **Plasma Experiments** from CRESS, additional $37,000 granted by the National Aeronautics and Space Administration to Eugene Wescott and Hans Stenbaek-Nielsen.

ALASKA VOLCANO OBSERVATORY—AVO is a cooperative project with the U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys to monitor primarily the Cook Inlet volcanoes. Funding from the Department of Interior includes $250,000 that supports AVO operations at the institute. In addition, Interior has provided $1.03 million to fund 16 individual projects directed at ongoing monitoring and research on Redoubt Volcano. Working on AVO operations or specific research projects are John Davies, Juergen Kienle, Doug Christensen, David Stone, Hans Pulpan, Chris Nye, Dan Jaffe, Ken Dean, Kristina Ahlnaes, Keith Echelmeyer, James Beget, Sam Swanson, and Hiroshi Tanaka.

ALASKA'S TECTONIC STRUCTURE—Doug Christensen received a $50,000 grant from the National Science Foundation (NSF) to study the crustal and upper mantle velocity structure along the trans-Alaska crustal transect (TACT). Inversion of teleseismic receiver functions are being used to determine the velocity structure at points along the TACT reflection/refraction profile. In early June 1990, data was gathered in the Brooks Range using temporary, three-component, intermediate-band seismic stations. In late August the four stations were relocated at sites between Valdez and Fairbanks for the winter months. Results derived from the data will improve knowledge of the deep crustal and upper mantle structure along the north-south profile. The information will shed light on the detailed tectonic picture of the conglomerations of accreted terranes which make up Alaska.

REDOUBT VOLCANO—Juergen Kienle received $20,000 from NSF for close-range observation of eruptive processes at Redoubt Volcano. The grant funds deployment of a helicopter-portable volcano observatory equipped with a slow-scan, solar-powered, low-light television imaging system to document and film eruptive processes. The observatory was used on October 27, 1990 ten kilometers north of the active vent. The video camera, now undergoing cold-temperature testing, has full-tilt, pan, and zoom capability for real-time tracking of rising eruptive columns, ash-flows, mud flows, and floods on the north flank of the volcano. This data can be radio-telemetered live to Fairbanks, where it will be useful for interpreting the great variety of seismic signals being recorded daily at the Fairbanks laboratory of the Alaska Volcano Observatory.

POKER FLAT RESEARCH RANGE—The National Aeronautics and Space Administration (NASA) has funded seven contract modifications for the planning and design phase of the Poker Flat Upgrade Program. The award is being used for engineering and architectural design of facilities and range infrastructure. These funds supplement the Range operations and maintenance budget of approximately $1.3 million, which is also funded by NASA. During the next four to five years, the upgrade program will spend $30 million to develop the Range as a world-class facility for research on atmospheric phenomena via rocket-borne experimentation packages and ground-based observations.

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New pack ice study

Questions of global change and the potential consequences of climate warming have heightened interest in sea ice structure and processes such as growth and melting. In the Arctic and Antarctic, great volumes of sea ice are found in both seasonal and multiyear forms, but the ice of these regions is not the same. The less-known antarctic pack ice is the subject of a two-year study that has been funded at the Geophysical Institute by the National Science Foundation.

In December 1990 and 1991, principal investigators Martin Jeffries and Willy Weeks will travel from Australia to McMurdo Station near the Ross Ice Shelf and then on to Chile, sampling the ice pack and making observations while at sea and also while working at McMurdo. Weeks is a professor of geophysics and scientific director of the Alaska SAR Facility (ASF); Jeffries is a research associate professor at ASF, the satellite radar data station at the institute.

"Most of our knowledge and understanding of sea ice is based upon studies in the Arctic," Jeffries said. "Antarctic sea ice research activity has increased in recent years, but there is still much work to be done."

"Thanks to satellite studies, we know there is greater seasonal variation in the extent of antarctic pack ice than in the Arctic Ocean pack ice," said Weeks. "The greatest variability occurs in the Weddell Sea and the Ross Sea, where winds play a key role in sea ice dynamics and thermodynamics. To date, most of the systematic studies have been in the Weddell Sea, although some research has been done off Enderby Land. In the Ross Sea region where we will be working, sea ice studies to date have been limited to the fast ice in McMurdo Sound."

The objective of the Ross Sea study is to characterize the basic physical properties and structural characteristics of pack ice floes, including their thickness, salinity, temperature, brine volumes, stable isotopic composition, and crystallography.

"By studying these parameters, we can identify processes and conditions of ice growth and decay and improve our understanding of sea ice-ocean-atmosphere interactions," Jeffries said.

The researchers will sample the ice pack floes to find the amount of various ice types and differences in salinity of ice type components. They also want to determine whether salinity variations are related to ice structure and stratigraphy. They will document grain size and morphology variations in frazil and platelet ice, asking how this relates to ice salinity. They hope to understand how and where brine and other materials are included and subsequently lost from the ice by studying the substructure of frazil and platelet ice.

"In the Weddell Sea, the sea ice is thinner, more saline, and has a greater structural-stratigraphic variability than arctic sea ice," said Jeffries. "Most arctic sea ice has a columnar structure of vertical ice crystals that are oriented parallel to the direction of ice growth by heat conduction through the ice. Columnar or congelation ice is also found in the Antarctic, but there are also significantly greater amounts of frazil and platelet ice than in the Arctic. These types of ice create a layered structure in the floes and indicate greater variation in antarctic sea ice growth conditions and processes."

Frazil ice initially comprises many very small, needle-like crystals, which nucleate in turbulent, supercooled water. They accumulate at the water surface in a spongy or slushy mass, which often assumes small, pancake-shaped forms before eventually congealing into a solid ice cover.

"This is now commonly called the pancake cycle," said Jeffries. "It is a means by which the sea surface can become covered with sea ice almost overnight."

Platelet ice may also form in supercooled water and has been found in many Weddell Sea ice floes, but its origin, significance, and basic properties are less well understood than they are in either congelation or frazil ice.

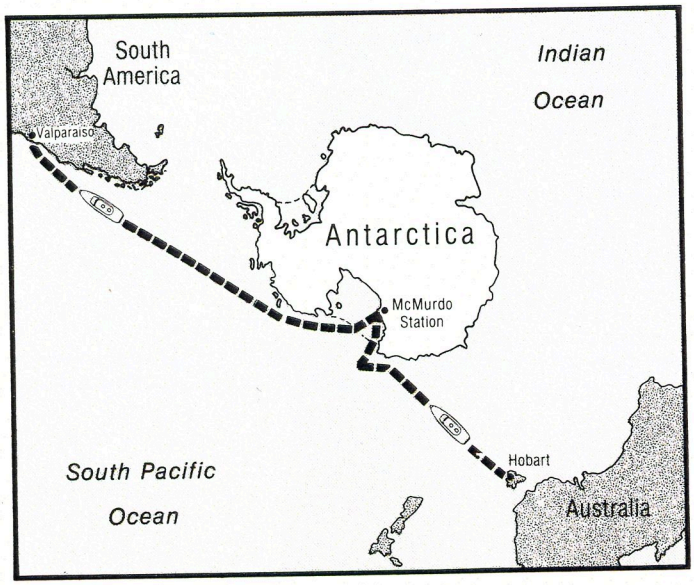
"It appears that frazil and platelet ice play a key role in the complex Southern Ocean regime, yet their formation, growth, and behavior, in both the horizontal and vertical dimensions, are among the least understood components of the system," Jeffries said.

The scientists have planned their field work to take advantage of the annual sealift and resupply of McMurdo Station by icebreaker.

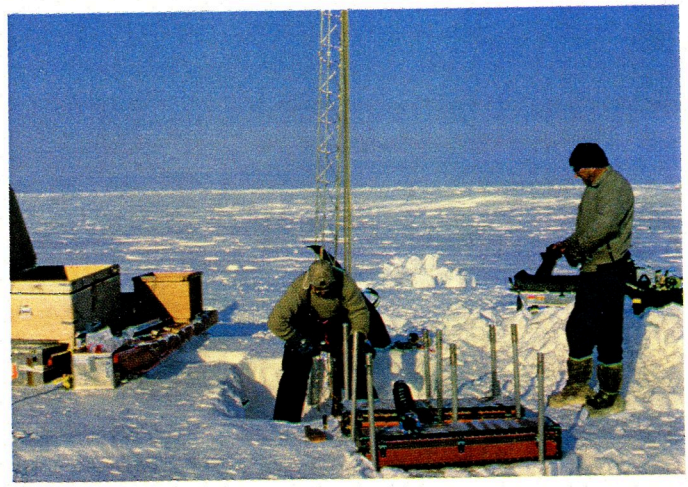
"This logistical approach provides a practical and economical means of making observations and measurements," said Weeks. "We will gain access to the ice floes either directly from the icebreaker or by helicopter.

"On the inbound journey, we'll take ice cores from floes at the pack ice edge and along the coast of Victoria Land where sea ice is found year-round," said Weeks. "On the outbound journey from McMurdo

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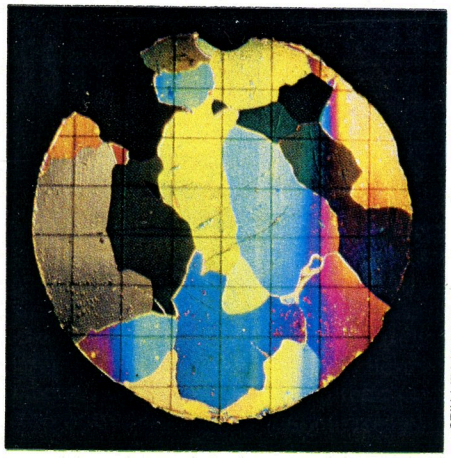


For the Antarctic project, researchers will travel by icebreaker from Australia to the Ross Sea to Chile.



Martin Jeffries photographed colleagues Harold Serson of Canada and Olli-Pekka Nordlund of Finland as they drilled ice cores at Hobson's Choice Ice Island, floating near Axel Heiberg Island in spring 1986. The ice core section on page 5, from Hobson's Choice, was photographed in crossed polarizers to reveal ice crystal structure.

Sampling the ice



MARTIN JEFFRIES

Ice, the dense substance formed by the freezing of water to the solid state, usually occurs in the form of hexagonal crystals, but there's much more to ice than its common crystalline structure. In the sea, on glaciers and ice sheets, in rivers and lakes, ice grows or accumulates by different processes and under somewhat different conditions. Consequently, its physical-mechanical properties and structural characteristics differ considerably.

The common approach to investigations of these ice types is to drill ice cores for subsequent laboratory analysis. The cores are extracted with an ice coring auger. A hollow barrel with cutters at one end, the auger is drilled into the ice to extract cylindrical ice samples. Individual ice core sections may be as much as two meters long. Ice cores are typically 70 to 150 millimeters in diameter.

For shallow coring, from as little as a few centimeters to perhaps 50 meters deep, it is common to drill by hand using a lightweight auger and a tripod for raising and lowering the drill. For ice cores at depths exceeding 50 meters to as much as 2 or 3 kilometers, the only practical method is using a large, electrically powered auger.

At the University of Alaska Fairbanks, the Polar Ice Coring Office of the National Science Foundation designs, builds, and operates ice coring augers of all sizes, particularly the large ones for obtaining deep ice cores from the Greenland and Antarctic ice sheets for studies of paleoclimate.

Several Geophysical Institute faculty members are currently involved in studies that require ice cores. Carl Benson has been investigating paleoclimate and volcanic event records in ice cores from Mt. Wrangell in Alaska. Willy Weeks, Lew Shapiro, and graduate student Richard Glenn are investigating changes in the physical-structural-mechanical properties of first-year sea ice growing at Barrow, Alaska. Using ice cores drilled by hand to depths of over 40 meters, Martin Jeffries and Bill Sackinger have been studying the physical-mechanical properties, structural characteristics and growth history of ice islands (tabular icebergs), ice shelves, and multiyear landfast sea ice along the north coast of Ellesmere Island in the Canadian High Arctic (see story below).

Some ice core analysis may be done at the drill site, but often the ice cores are returned to the institute by road and air in freezers or containers packed with dry ice. Once there, the ice core sections are cut up with a band saw and examined in the cold-room facilities at temperatures of -10°C to -20°C.

Some ice pieces may be measured and weighed to determine density; others are cut into very thin sections and illuminated in crossed-polarizers to reveal the ice crystal structure. The ice crystal shown here is from Hobson's Choice Ice Island. It revealed that the ice originated from snow that was quickly transformed into ice by melting and refreezing of the snowpack.

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Landsat captures view of northern Ellesmere Island

Earth images made from space fascinate most people, but satellite perspectives are particularly exciting when you've traveled the same high Arctic terrain by foot and snowmobile.

"We believe these are the first Landsat images acquired of Ellesmere Island north of latitude 80°N," said Martin Jeffries, whose glaciological research includes studies of the ice shelves off the island's northern coast. Jeffries is a research associate professor with the Alaska Synthetic Aperture Radar (SAR) Facility at the institute.

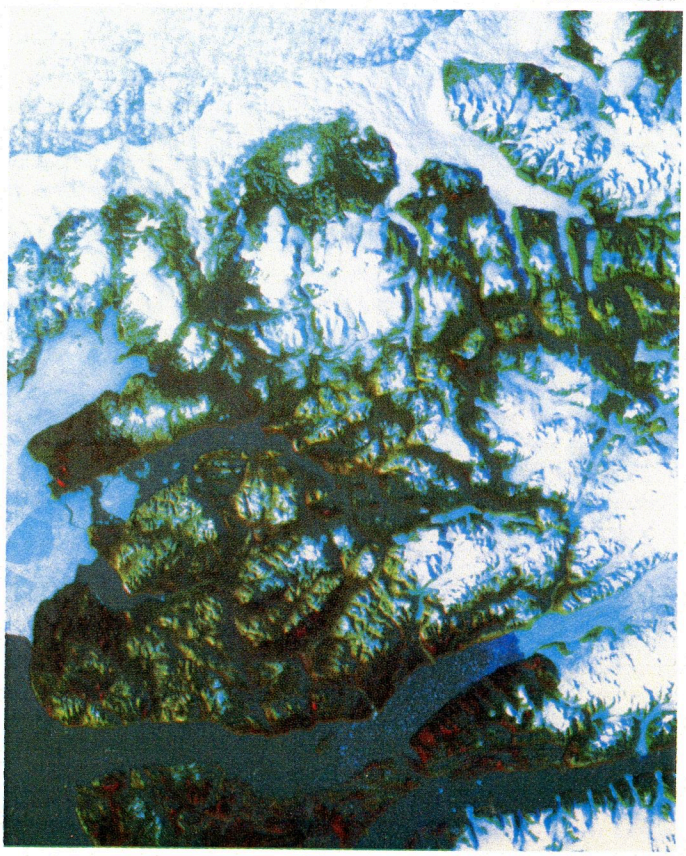
The northernmost part of Ellesmere Island was once thought to be beyond the imaging range of the U.S. satellite Landsat-5, which is the primary U.S. source for land-based satellite data.

The nearly cloud-free images show extensive snow-covered ice caps and melting surfaces of piedmont, valley, and trunk glaciers. Three surge-type glaciers are visible, including Otto Glacier (calving many icebergs into Otto Fiord) and Milne Glacier, which is part of the Milne Ice Shelf. The images also show some of the multiyear landfast sea ice fringe along the north coast of Ellesmere (including the Nansen ice plug), and the effects of mountain barriers and climatic gradients on cloud cover and summer sea ice conditions.

"All of these phenomena are sensitive to global change factors," said Jeffries. "This demonstration of Landsat capability to image so far north shows that we now have another tool for studies of environmental change at latitudes greater than 80° north. The capability should also benefit the Ellesmere Island National Park Reserve."

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QUICK-LOOK/EOSAT



This Landsat-5 Multispectral Scanner image was made of northern Ellesmere Island on August 20, 1990.

Landsat

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Jeffries' research at Ellesmere focuses on ice shelves on the island's northern coast. Ice shelves, found along polar coasts, are thick sheets of ice with fairly level or undulating surfaces. They are attached to the shore; though sometimes grounded locally to the sea floor, mostly they float, rising and falling with the tide.

"In the Antarctic, ice shelves are huge and primarily derived from glaciers," Jeffries said. "The Ellesmere ice shelves are much smaller than those in Antarctica, and originate not only from glaciers, but also from sea ice. On the West Ward Hunt ice shelf, our work shows very thick layers of sea ice, some exceeding 20 meters. But in the eastern ice shelf, using ice cores from Hobson's Choice Ice Island, we have found there is no longer any sea ice. It has probably been melted off the bottom in the past by relatively warm fresh water. However, looking at the East Ward Hunt ice shelf, we have clear evidence that fresh water has actually been freezing to the bottom in the past 30 to 40 years."

Jeffries is winding up his work at Ellesmere Island and in December will begin field work for a study of the Ross Sea pack ice in the Antarctic (story on page 4). The Ellesmere research included six field trips to study multiyear landfast ice, the ice shelf, and the ice islands (tabular icebergs) that break off the shelf. Most of the field work involved drilling to collect ice cores. Back in the institute's ice laboratory, analysis was done on such parameters as the liquid electrical conductivity, salinity, density, stable isotopes, crystallography, and strength of the ice.

"The goal is to improve knowledge of ice types, ice properties and structures, ice growth processes, and the history of the ice shelves since they began to grow three to four thousand years ago," Jeffries said.

The interesting discovery that Ellesmere Island satellite images could be obtained was an incidental one, made during testing of new systems for the Alaska SAR Facility (ASF) at the institute.

Landsat is the type of satellite that can deliver images only to a line-of-sight receiving station. Before the installation of the ASF, it was not possible to capture Landsat signals for locations as far north as Ellesmere Island's northern coast.

"In 1989, equipment for the institute's Quick-Look Project for Landsat images was relocated, making it possible to use the new ASF antenna on the Elvey Building, which has an unobstructed horizon in nearly every direction," said John Miller, operations manager for ASF.

"Because the schedule of available passes for each day is known in advance, we need only have current orbital parameters to position the antenna on the horizon to capture the signal as it comes within range," said Greta Reynolds, ASF research technician. "Generally, Quick-Look acquires two passes a day over the Alaska landmass, western Canada, and eastern Siberia."

Reynolds and research aide Walter Rutherford were working on the system when the Ellesmere images were obtained, and they later checked the location with Jeffries.

Satellite imaging has become an important tool for research in many areas of geophysics and its importance is expected to grow as new applications and methods of analysis are perfected.

"In the case of the Ellesmere ice shelves—the only ones in North America and probably the most extensive in the entire Arctic—much remains to be learned about their growth, structure, and decay," said Jeffries. "Also, in this region we know very little about sea ice dynamics, drift, and extent, while glacier dynamics, extent, and mass balance have not been studied there for twenty or thirty years. We need to improve this knowledge base substantially to understand the potential effects of climate change. The availability and analysis of Landsat satellite images is an exciting resource that has introduced a new dimension to our work."

—Doreen Fitzgerald

Ice cores

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Other pieces of ice will be melted for measurement of liquid electrical conductivity and salinity (a measure of the dissolved impurities). A small amount of the ice may be sent to colleagues at other universities for stable and radio-isotope analysis.

Jeffries has been particularly interested in the structure and growth history of the Ward Hunt Ice Shelf in northern Canada, the largest ice shelf in North America and a major source of ice islands.

"In the western area of this shelf are massive layers of sea ice, 10 to 25 meters thick, that are perhaps as much as 3000 years old," said Jeffries, "yet they contain higher volumes of brine than the much younger multiyear ice that covers much of the Arctic Ocean today."

"The analysis of crystallographic, salinity, and isotopic variations in this ice indicates that it has never been subject to the primary means of brine loss from most sea ice—brine flushing by meltwater infiltrating from the surface. This suggests that other processes of brine loss from sea ice, such as gravity, drainage, brine pocket migration and expulsion, are very slow-acting processes indeed."

Based on ice core studies of Hobson's Choice Ice Island, which broke off the East Ward Hunt Ice Shelf in 1982-1983, Jeffries and Sackinger found that there is no longer any sea ice in large parts of that area of the ice shelf. They concluded that this contrast between the western and eastern ice shelf is indirect evidence of the patterns of water circulation and melting and freezing at the base of the ice shelf.

"Without the ice cores, it would have been difficult to learn about the processes at the base of the thick ice shelf, since it is very hard to gain access to the undersurface of ice by other means and this is necessary to make direct observations and measurements," Jeffries said.

Analysis of the salinity, temperature, brine volumes, isotopic composition and crystal structure of ice cores obtained during the new antarctic sea ice project (story on page 4) will contribute answers to similar questions about processes and conditions of ice growth, variations in physical-structural properties of frazil, platelet, and congelation ice, changes with time, and ice thickness variations. To analyze ice crystal size and shape during this research, Weeks and Jeffries will use relatively new techniques of microcomputer-based image processing. To investigate ice substructure, they will use optical and scanning electron microscope techniques, a method they feel has been under-utilized in the past.

Sea ice

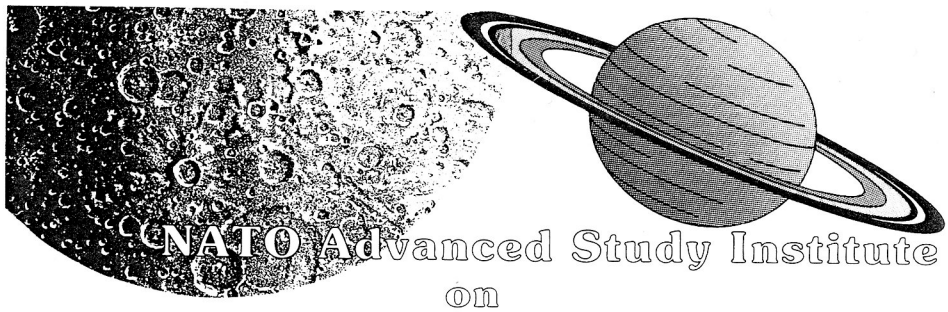
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Sound to Valpariso, Chile, in order to cover a maximum geographic area, we'll study the ice off the Pennell Coast, east of Cape Adare, and in the area between Ross Island and the Ruppert Coast, two other areas where sea ice occurs year-round."

"We expect this work to expand knowledge of the geographic distribution of each ice type, as well as their physical and structural properties," said Jeffries. "We want to know how salt, micro-organisms and sediment are redistributed within the Southern Ocean. We also want to understand the mechanical properties, the rheology and dynamics of Southern Ocean pack ice, and the relative importance of frazil ice as a factor in the thermodynamics of the ice."

The research will also contribute to future interpretation of synthetic aperture radar (SAR) images of antarctic pack ice. Funded by the National Aeronautics and Space Administration, the Alaska SAR Facility is designed to support a generation of SAR satellites scheduled for launch during the 1990s. The antarctic ice pack research described here is funded by a $286,400 grant from the National Science Foundation Division of Polar Programs.

—Doreen Fitzgerald



DYNAMIC MODELING AND FLOW IN THE EARTH AND PLANETS

FLUID MOTIONS—A NATO Advanced Study Institute will be June 17-28, 1991 at the University of Alaska Fairbanks. "Dynamic Modeling and Flow in the Earth and Planets" will encourage a comparative approach to the study of fluid motions in the earth and solar system. A NATO Science Office grant of $60,000 was awarded to UAF Chapman Professor S. Keith Runcorn, FRS, and Professor of Geophysics David Stone of GI for the meeting. To be discussed are fluid motions in the core, mantle, magma chambers, oceans, glaciers, atmosphere, solar wind, and magnetosphere. The cross-disciplinary study of fluid dynamics will introduce researchers to techniques used in disciplines other than their own that are aimed at understanding flow within the earth and planetary system. The institute is designed to foster development of advanced graduate students and post-doctoral researchers and travel grants will be available to those from NATO countries to attend the meeting. Applications from non-NATO countries will be considered under special circumstances. Applications should be sent by January 1, 1991, to David Stone, Co-director, NATO ASI, Geophysical Institute, Fairbanks, Alaska, 99775-0800, USA. Also on the organizing committee are Drs. Syun-Ichi Akasofu, Claude Froideaux, and Raymond Hide, FRS.

GI NOTES . . .

PUBLICATIONS—The institute has published *Science Forum Index*, a guide to the science column it produces for weekly publication. The index can be used by teachers and others who would like to obtain copies of writing on specific topics like volcanoes, glaciers, health, and so on. Copies of the Index are being distributed to Alaskan school and public libraries, or may be obtained from the Publications Office, 611-C Elvey Building, UAF, Fairbanks, AK 99775-0800. Also available from the Publications Office is the *GI Biennial Report* covering the years 1987 and 1988. The review of research for the calendar years 1989 and 1990 will be available in June, 1991. *Port and Ocean Engineering Under Arctic Conditions*, edited by William Sackinger and Martin Jeffries, is a three-volume work containing 131 refereed papers on advances in arctic science and engineering, 1977-1987. The cloth bound books include many color photographs and illustrations. Volume I, 763 pages, $95; Volume II, 124 pages, $24; Volume III, 707 pages, $90. Available from POAC, GI, University of Alaska Fairbanks, Fairbanks, AK 99775-0800.

Model used to track volcanic plume

A new computer simulation model combined with satellite image analysis may mitigate the threat posed to aviation by volcanic eruptions in Alaska.

The city of Anchorage, one focal point of the international aviation corridor, is surrounded by several active and potentially active volcanoes. Along the west shore of Cook Inlet are Hayes, Spurr, Redoubt, Iliamna, Augustine, and Douglas, while Wrangell is to the east.

In this century, eight significant eruptions involving Spurr, Redoubt, and Augustine have spread ash over a broad area of southcentral Alaska, occurring on average once every twelve years.

One question this poses for researchers is how to establish a reliable scheme for predicting the distribution of volcanic plume in the air, a question that has not been systematically addressed until now.

The founding of the Alaska Volcano Observatory (AVO) in 1988 paved the way for tackling this problem. Established to monitor volcanic activity and study Alaska's volcanoes, AVO is operated jointly by the U.S. Geological Survey, the Geophysical Institute, and the State of Alaska Geological Survey. The work is carried out at the institute in Fairbanks and in Anchorage, with computer links and cooperative studies also involving laboratories in Washington and California.

Volcano monitoring alone does not directly counter the aviation hazard posed by volcanic eruptions. Institute researchers are combining the methods of atmospheric dynamics research with remote sensing to develop a volcanic plume simulation model for use with satellite image analysis. Assistant professor Hiroshi Tanaka of the Atmospheric Sciences group and remote sensing geologist Ken Dean have been working together on this problem.

"By combining a simulation model, satellite image analysis, and AVO monitoring capability with a high-speed computer, we can predict the volcanic plume distribution on a near real-time basis for both clear sky and dense cloud situations," said Tanaka. "The products from the satellite observations and the prediction model will be useful in guiding air traffic, and thereby support commercial activity in the state."

Tanaka explained that the plume simulation is based on a general pollutant-tracking Lagrangian model.

"In this model, thousands of plume particles are released in the air column over the volcanic point source," he said. "Trajectories of every particle are then computed, using upper-air wind data. The three-dimensional diffusion of the plume is simulated by imposed random walk processes for a large number of particles. Finally, gravitational fallout removes the plume particles from the air. Here, the fallout speed is given as a function of the particle size—the larger particles drop sooner."

Upper-air wind data are the fundamental input for plume modeling. That information comes from Unidata, a national program in atmospheric sciences that makes it possible to acquire, via satellite downlink, near real-time meteorological data from around the world. Unidata also provides the weather predictions that are released by the National Meteorological Center in Washington, D.C. The new plume model depends on Unidata for predicting the distribution of volcanic plumes as a function of time after an eruption.

The statistical significance of the model result will increase as the number of particles released increases. The high-speed computer allows the computation of a large number of particle trajectories and

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Plume

continued from 7

provides a prediction of plume distribution. This can be compared to plume predictions currently available at AVO and the National Weather Service, which display trajectories of a single particle at several vertical levels.

These operational models consider only the effects of advection, or horizontal wind currents. During calm wind conditions, the plume is shown remaining over the volcanic point source. The simulation model now being developed can account for advection, diffusion or dispersal effects, and gravitational fallout. This will improve reliability of predictions because it better reflects actual conditions and behavior of the plume particles.

As a demonstration, the new plume tracking simulation model was applied to a January 8, 1990, eruption of Redoubt Volcano that started at 19:09 UT and continued for 30 minutes. A circular-shaped plume was observed on a satellite image (NOAA-11 Advanced Very High Resolution Radiometer, or AVHRR) recorded 20 minutes after the eruption.

About four hours later, the simulation showed that the plume, represented by a group of particles, traveled eastward over the Kenai Peninsula, and had a south-north elongation.

"An AVHRR satellite image, also recorded approximately four hours later, revealed a cloud pattern in the same area as the plume simulation," said Dean. "Without the reinforcement of the tracking simulation, the color-enhanced, elongated cloud observed on the satellite image would have been difficult to distinguish as a plume rather than cloud."

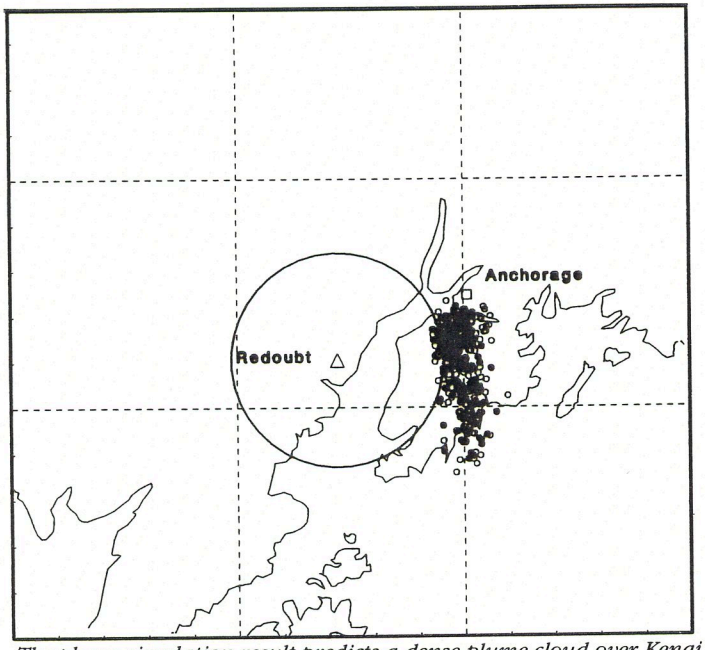
Field observation confirmed that the plume did pass over this region as the simulation predicted.

"The acquisition of satellite images depends upon the position of the satellite and on cloud cover, which is a chronic problem for imaging over the Alaska Peninsula region," Dean said.

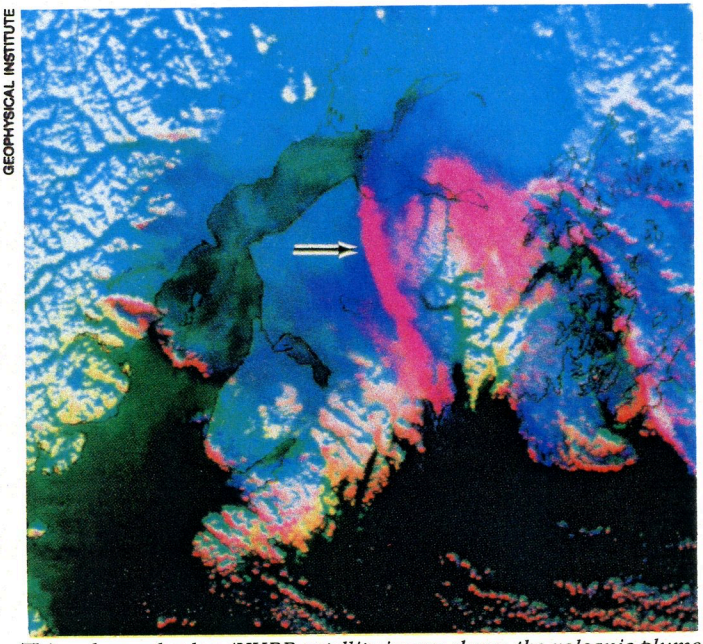
The simulation model can be used to predict the distribution, trajectory, and altitude of a plume at any time, regardless of meteorological conditions. This reinforces the satellite images that provide actual observations of the plume, conditions permitting. Satellite images are in turn used to calibrate and verify the model.

Although Redoubt volcano has quieted down at this time, the new model can be employed the next time one of Alaska's volcanoes sends a plume skyward.

To date the plume simulation model development has been funded by grants from several airlines, various state agencies, the National Science Foundation, AVO, and others.



The plume simulation result predicts a dense plume cloud over Kenai Peninsula at 23:00 UT from the eruption that began at 19:09 UT.



This enhanced color AVHRR satellite image shows the volcanic plume over the Kenai Peninsula at 23:13 UT on January 8, 1990.

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