GEOPHYSICAL INSTITUTE *QUARTERLY*

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Brooks Range explored by geologists

The rise and fall of ancient seas, combined with the forces of mountain building and erosion, have created the physical record of the earth's structure and history. Locked in layers of rock and sediment, these clues to the past are the raw material of researchers working to reconstruct over a billion years of geologic history in the northeastern Brooks Range.

"The spectacular geology exposed there is an exciting research laboratory," said Wesley Wallace, who since 1985 has been working with Keith Crowder and Keith Watts to carry out a research program on the area's geology. "Although the Brooks Range is similar in size to the Alps, it has hardly been studied at all. Our goal is to unravel the complex geological history of this mountain belt."

The three scientists organized the Tectonics and Sedimentation Research Group in 1985 and began a major and ongoing project to integrate several types of geological studies to gain a comprehensive geologic picture. Graduate student thesis projects are an important part of the program; the research presently supports the work of seven graduate students and has involved 22 master's and doctoral students since 1985.

Intrinsically interesting to geologists, northeastern Alaska is also of concern to the petroleum industry, government agencies, and conservationists; it is adjacent to oil fields in the Prudhoe Bay vicinity, and it encompasses the Arctic National Wildlife Refuge (ANWR).

"The rocks exposed in the northeastern Brooks Range are similar to hydrocarbon-rich strata at Prudhoe Bay," said Crowder, "and with the adjacent ANWR coastal plain under consideration for possible oil lease sales, these studies provide a framework for resource evaluation."

Interpreting the earth's history is much like solving a four-dimensional puzzle, with three spatial dimensions and one of time. Rock outcrops are sampled to analyze their composition and fossil content and to interpret the sedimentary processes and ancient environments in which they formed. By mapping the distribution of rock units at the earth's surface and measuring their orientations, models are made of geological structures formed by tectonic or mountain building processes. Once structural style and paleoenvironmental distribution of the rocks are understood, inferences on subsurface geology and the presence of potential reservoirs can be made.

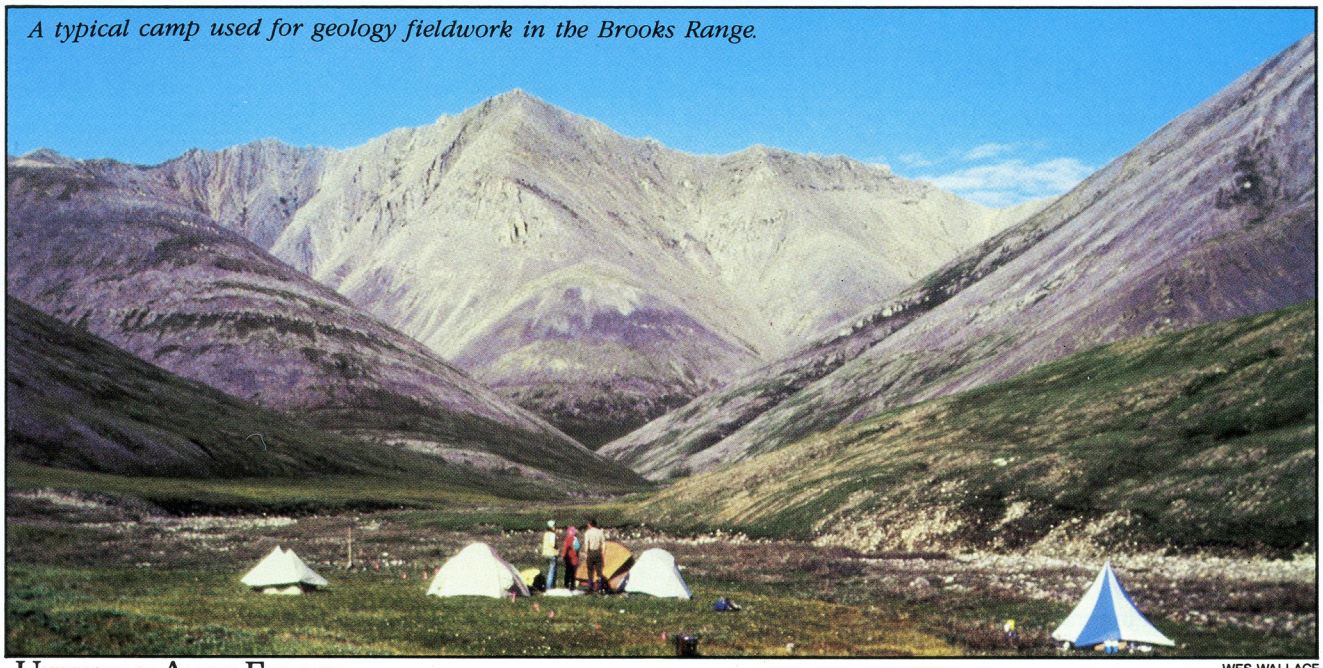
"It's a step-by-step process, but we are slowly reconstructing a geologic history measured in hundreds of millions of years. It's like traveling in a time machine," Crowder said.

The scientists and their graduate students work as a team, conducting studies in their individual disciplines that can be combined into an integrated picture of the region's geologic history. Because of the strong geological ties between stratigraphy and structure, they believe this approach will be particularly worthwhile.

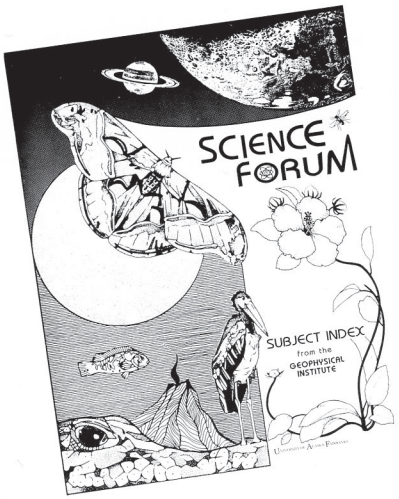
Structural geology, determining the relationship between mountain building and rock deformation, is Wallace's specialty. Watts analyzes paleoenvironments and evolution of limestones, particularly their response to sea-level fluctuations, and Crowder specializes in the interpretation of ancient sandstone depositional

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A typical camp used for geology fieldwork in the Brooks Range.



WES WALLACE



The institute has published a subject guide to the weekly science column it has produced and distributed since 1976. The *Science Forum Index* can be used by teachers and others to request copies of articles covering specific topics of interest to them.

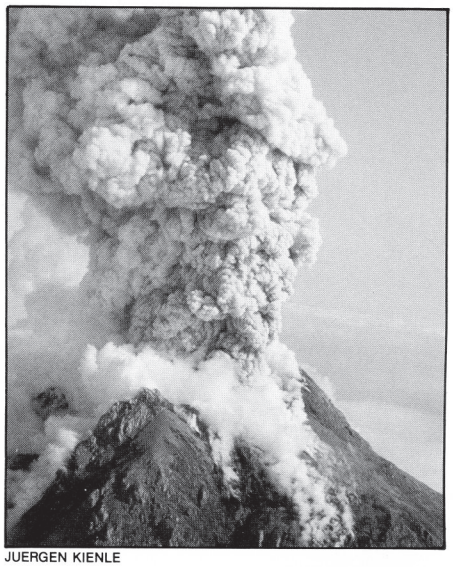
Written and edited at the institute as a public service, the science forum column is designed to share information about the subjects and methods of science with a general audience. Each week it is distributed to media organizations, and regularly appears published under various headings in approximately 20 newspapers.

The new index has been distributed to all school and public libraries in Alaska so that teachers and others can select columns on specific topics. The column covers subjects of current scientific or specifically northern interest—human health, plants, animals, and natural phenomena such as volcanoes and glaciers. To cover postage and handling, there is a minimal charge for copies of the column.

An institute staff member is usually responsible for the column, although guest authors also contribute. It is currently written by former GI editor Carla Helfferich. Others who have produced the column regularly are Sue Ann Bowling, Larry Gedney, and Neil Davis, who initiated the project.

To date, more than 1,000 columns have been produced. Roughly one-half are covered by the new index; most of the first 500 columns are collected in the book *Alaska Science Nuggets*, by Neil Davis. The book is available from the University of Alaska Press, 1st Floor Gruening Bldg., UAF, Fairbanks, AK 99775-1580.

Copies of *Science Forum Index* may be available at a local library, or you can request a copy from the


JUERGEN KIENLE

Guide to Volcanoes

Nearly one hundred years after Israel Russell authored the first detailed publication on the volcanoes of North America, a reference work on the subject has been published by Cambridge University Press. *Volcanoes of North America* was edited by Charles Wood of the Johnson Space Flight Center in Houston, Texas, and Juergen Kienle, professor of geophysics at the Geophysical Institute.

The 354-page book presents detailed information about the volcanoes of Alaska, Canada, Hawaii, and the continental United States. Experts in volcanology have contributed brief accounts of 262 volcanoes and volcanic fields. The descriptions are necessarily variable in detail, as some of the volcanoes are extremely well studied, while others have never before been described in print. References are included to direct readers to further information.

The descriptions of each volcano include name, geographic location, and basic information such as type, elevation, relief, volcano diameter, caldera diameter, eruptive history, composition, a narrative volcano description, and information on how to get there.

Although the book is designed as a reference for specialists in volcanology, petrology, and geochemistry, much of the material is sufficiently nontechnical for a general audience, and it should be of particular interest for natural history enthusiasts. A special effort was made to include photographs, and most of the volcanoes are pictured.

Some active volcanoes are famous, while others, due to inactivity or remote location, have received hardly any press at all. This work brings to light all the active volcanoes known to exist in the Americas north of Mexico.

The book is available from Cambridge University Press, 40 West 20th Street, New York, NY 10011. List price is $70. Include $2 postage for the first book, $.75 for a second copy.

Service recognized

Several GI people were among the University of Alaska Fairbanks employees honored November 20 for service to the university for 25 or more years. They are Syun-Ichi Akasofu, professor and director of GI; professor of geophysics Charles Deehr, scientific director of Poker Flat Research Range; administrative assistant Jeanne Hume; associate professor of geophysics Tom Hallinan; professor of physics Dan Swift; professor of geophysics Eugene Wescott; and engineer John Miller, who is technical director of the Alaska SAR Facility. Miller began working for the university in 1958 as a part-time electronics technician for Skip Bates and the C-4 ionospheric sounder.

All of the faculty members have been involved in both teaching and research at the institute.

Akasofu earned a Ph.D. at the University of Alaska in 1961 and joined the faculty that year. He is known for his contributions to space physics and auroral science and has directed the institute since 1986.

Charles Deehr, who earned his Ph.D. from the University of Alaska in 1968, has conducted various ground-based optical studies of the aurora, airglow and related phenomena. He is presently working on the development of a high-latitude space and environmental center at the institute's Poker Flat Research Range.

Hallinan received master's and Ph.D. degrees from UAF, joining the faculty in 1976. He studies mechanisms responsible for characteristic auroral forms and works on development of television systems for auroral imaging.

Hume came to the Geophysical Institute in 1956, beginning her university career as a data scaler. She is now administrative assistant to the institute director. Between 1968 and 1976 she worked for university relations and other administrative offices at UAF before returning to GI.

Arriving at the institute in 1963, Swift has worked in ionospheric physics, radio wave propagation, and simulation of convective flow in porous media. He currently studies methods of numerical simulation of magnetospheric processes responsible for auroral and geomagnetic storm phenomena.

After earning master's and Ph.D. degrees from the University of Alaska, Wescott joined the faculty in 1964. He has investigated a range of magnetically conjugate geophysical phenomena and is now involved primarily in auroral and magnetospheric electric field studies.

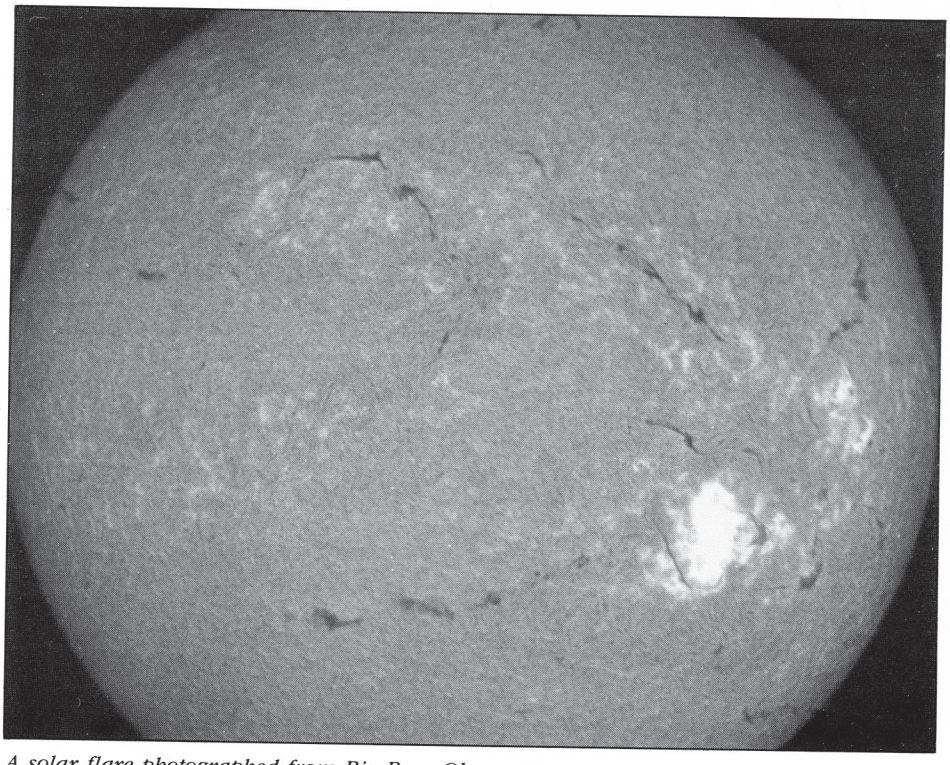
Selected Project Briefs

ELECTRIC POTENTIALS—Dan Weimer of the space physics and aeronomy group has received a National Science Foundation (NSF) grant for "A study of polar cap electric potentials—a GEM related program." The $50,000 award will fund an investigation of physical processes that couple the solar wind with the earth's magnetosphere and upper ionosphere. Satellite measurements of electric fields above the ionosphere are used to determine the electric potentials of the so–called polar cap. In space physics, the polar cap is considered to be that region in the ionosphere where the plasma (ionized gas) is flowing anti–sunward, driven by the flow of the solar wind. The most intense auroras occur on the boundaries of this anti-sunward flow, and the degree of auroral activity is related to the electric potential. The polar cap potentials will be compared with data from other satellites positioned in the solar wind, in order to determine how the solar wind energy is transferred to the earth's magnetosphere. This project is related to the NSF's Geospace Environment Modeling (GEM) program, and may be extended a second year to a total of $100,000.

SOLAR PHYSICS—A $48,000 NSF grant has been awarded to Yu–Qing Lou of the space physics and aeronomy group for research on "Magnetohyrodynamic (MHD) processes in the surface layers of the Sun." In collaboration with scientists at the University of Chicago, Lou will carry out theoretical and numerical investigations on the excitation mechanisms for the observed MHD oscillations in sunspots and for the solar acoustic oscillations. The basic processes under study are the onset and the nonlinear evolution of acoustic and MHD overstabilities in thermally and gravitationally stratified (magnetized) atmosphere. The feasibility of wave heating processes will be assessed by providing quantitative estimations for the acoustic wave flux which is thought to be important for heating the chromosphere and for the MHD wave flux which is, at least partially, responsible for the intense X-ray emissions from the coronal loop structures in solar active regions. This grant supports research for one year. The project may be extended up to three years.

STEP—"Definition and implementation of science objectives for the Solar–Terrestrial Energy Program" (STEP) has been funded by an NSF grant of $30,000 to Juan Roederer, international STEP coordinator, for continuing work on the five-year program (1990-1995). Its main goal is to advance quantitative understanding of the coupling mechanisms responsible for transfer of energy and mass from one region of the solar–terrestrial system to another. Integral to STEP is a set of 13 major spacecraft missions approved by the Inter–agency Consultative Group as the next cooperative project of the National Aeronautics and Space Administration (NASA), the European Space Agency, the Japanese Institute of Space and Aeronautical Science, and the space agency of the Eastern countries, INTERCOSMOS. The program also includes ground–based, aircraft, balloon, and rocket research; theory and simulations studies; and dedicated data and infomation systems. STEP is sponsored on the international level by the Scientific Committee on Solar–Terrestrial Physics of the International Council of Scientific Unions.

TROPOSPHERIC OZONE—Dan Jaffe of atmospheric sciences has received funding of $96,000 from the NSF to continue work on the three-year project, "Tropospheric Nitrogen Oxide Chemistry in Central Alaska." Total funding to date is $300,000. The project investigates the relationship between nitrogen oxides and tropospheric ozone in remote regions. The purpose is to identify the cause of increased surface ozone concentrations in Alaska. In 1988 and 1989, the first ever nitrogen oxide measurements were made from the Barrow station of the National Oceanic and Atmospheric Administration. Data from 1990 are now being analyzed and new measurement campaigns are in the planning stage. The project required building complex chemical instrumentation for measuring nitrogen oxides at very low concentrations. Some characteristics of this arctic pollution have been identified: nitrogen oxide levels are about four times greater in spring than in summer; northerly air flow is associated with nitrogen oxide concentrations twice as great as those when the general flow is from the south; the ration of nitrogen to sulfur of pollutants arriving at Barrow suggests that substantial sulfur deposition has occurred.



A solar flare photographed from Big Bear Observatory.

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WES WALLACE

The Sadlerochit Mountains, northernmost part of the Brooks Range, are adjacent to the ANWR coastal plain (in distance). Geologic structures and sedimentary rocks exposed here provide valuable clues to northern Alaska's geologic history and the coastal plain subsurface.

Geologists explore the Brooks Range

environments. Watts and Wallace are assistant professors, Crowder is an associate professor. All three hold joint appointments in geology with the Geophysical Institute and the UAF Department of Geology and Geophysics.

"Because rocks in this critical area are less deformed than in the rest of the Brooks Range, our studies here may provide keys to the tectonics and paleogeography of northern Alaska and its relationship to other parts of the circumarctic region," said Watts. "And in a broader sense, the rocks we're analyzing can provide insights of general geological interest because they're excellent examples of a variety of depositional systems and structural behaviors."

WES WALLACE



In the Franklin Mountains, light-colored, relatively rigid limestones of the Lisburne Group slid over the relatively weak Kayak Shale (vegetated slope) and were folded like a rumpled rug. These folds were detached from older rocks (foreground) which deformed in a different manner.



KEITH WATTS

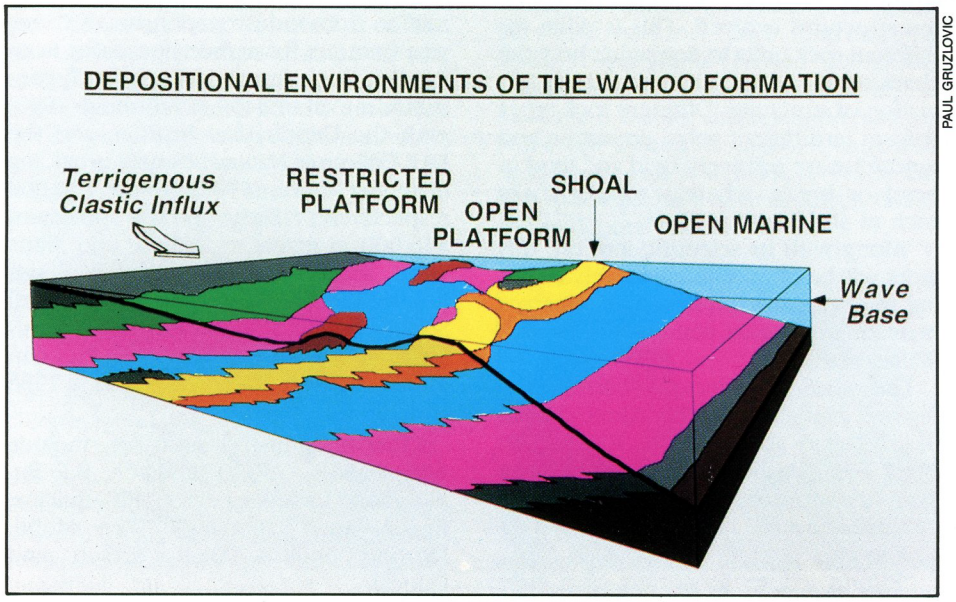
Rocks in the Sadlerochit Mountains (at left) are relatively undeformed, as seen here along the Katakturuk River. Limestones of the Lisburne Group are well exposed and lend themselves well to analysis of depositional history and evolution of this carbonate platform sequence. Dark sandstones forming the ridge crest are equivalent to the hydrocarbon reservoir rocks at Prudhoe Bay and younger terrigenous sedimentary rocks occur in Ignek Valley (in background). Below, Randall Carlson and field assistant Buck King measure and sample limestones of the Lisburne Group as part of Carlson's master's thesis research. The model (below left) for the Wahoo Formation relates different types of limestone (different colors) to their depositional environments.

Although geological evidence shows that Alaska is a collage of terranes and formed as parts of separate land masses, the origin of northern Alaska (the Brooks Range and North Slope) is controversial. It may have drifted to its present location from other circumarctic regions, or may always have been there. In either event, it was once connected to a continental landmass located to the north with respect to its present position, and was once covered by warm, shallow seas.

"At the core of the northeastern Brooks Range, the oldest rocks formed in various tectonic settings, but their original relationships have been obscured by one or more mountain-building and erosional events of more than 350 million years ago," Wallace said. "Then about 330 million years ago, during Late Paleozoic time, northeastern Alaska began to subside. We assume the region was part of a south-facing, passive continental margin, comparable to the present margins bounding the Atlantic Ocean.

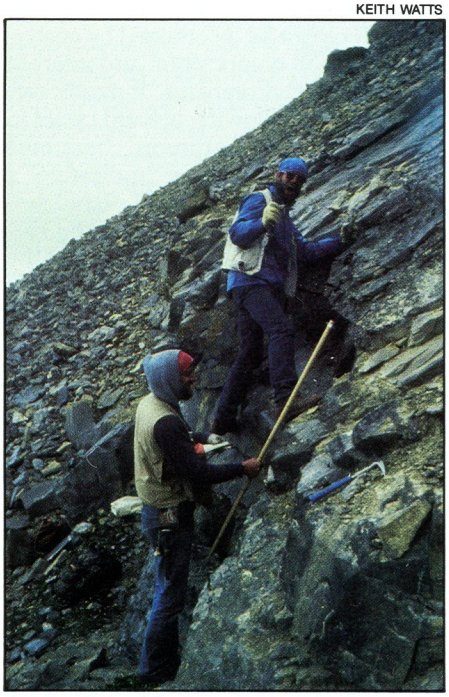
"As the sea encroached from the south," said Watts, "river deposits from erosion of ancient mountains were progressively flooded and buried by mud. Then, as a now-missing continental source area built southward in the form of deltas and other shallow-water deposits, clastic sediments were deposited on the North Slope. Then, as the margin continued to subside, these were replaced by offshore deposits."

The combined mechanical action of gravity, water, wind, and ice cause the formation of clastic rock or sediments, which consists mainly of broken fragments (clasts) from preexisting rocks or minerals. The fragments are eroded and transported from their place of origin and deposited as sandstone, conglomerate, or shale. The characteristics of sediments, such as beach sands or river gravels, provide clues to the mechanism of deposition and depositional environments.



PAUL GRUZLOVIC

KEITH WATTS



"Sedimentologists typically analyze layer-cake sequences of sedimentary rocks that have accumulated through time, recording attributes such as thickness, composition, texture, fossil content, and sedimentary structures," said Crowder. "These attributes and their arrangement in the layers, particularly their sequence through time, reveal how they originated and in what environments." By using fossils, age-equivalent strata in different areas can be correlated in order to determine their paleogeography (the geographical relationship of different ancient environments).

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Brooks Range

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"As subsidence continued and warm, shallow seas migrated northward to cover a broad area, most of northern Alaska, shifting carbonate environments were created that recorded sea-level fluctuations," said Watts, who studies the sedimentary environments and depositional history of limestones.

Limestones consist mainly of calcium carbonate in the form of calcite. They usually form in warm, shallow seas from the growth of organisms in shell banks or coral reefs similar to those of the Bahamas. To a lesser degree, carbonate sediments form by inorganic precipitation from sea water.

"The type of organisms and composition of limestones are closely tied to the environment in which they formed. If we microscopically analyze their composition, we can interpret them in terms of their paleoenvironments," Watts said.

"In a sequence of limestones, sea level fluctuations can be determined by analyzing changes in composition and inferred depositional environments. Typically, carbonates have shallowing-upward cycles in which the environment becomes shallower through time, indicating a relative lowering of sea-level. Rapid sea-level rises result in flooding of the carbonate platform and the beginning of the next cycle. Because extensive southern-hemisphere glaciation occurred during limestone deposition in northeastern Alaska, these sea-level fluctuations might have been driven by glacial cycles that periodically tie up large volumes of water, similar to what occurred during the recent ice ages."

One of the fossil elements analyzed are tooth-shaped conodonts. "These appear to be the mouth-parts of ancient worms which evolved rapidly and provide information on age, paleoenvironments, and post-burial heating. The color of conodonts indicates maximum temperature during burial and can be related to hydrocarbon maturation levels," Watts said.

The conodont analysis is being performed by paleontologist Anita Harris of the U.S. Geological Survey (USGS). Along with providing data essential for correlation and age dating of conodonts, Harris has co-supervised one student's master's thesis research.

"After tens of millions of years of carbonate platform sedimentation, northern Alaska was uplifted and the carbonate platform died," Crowder said. "It sat exposed for as much as 40 million years and was deeply dissected by weathering and erosion. Then the platform was buried by another phase of clastic sedimentation that began about 290 million years ago. During the Permian and Triassic Periods, thick accumulations of sandstone and conglomerate were deposited by ancient deltas and rivers."

Today these sediments are the reservoir rocks for North America's largest producing oil field at Prudhoe Bay, and it is these rocks that Crowder and his students have been studying for the last five years.

The long period of passive-margin sedimentation was brought to a close by two major tectonic events that have dominated the geologic history of northeastern Alaska ever since: formation of the Brooks Range and the Arctic Ocean basin.

"About 170 million years ago, the Brooks Range mountain belt began to form, as a southern ocean basin was closed by collision of an intraoceanic volcanic arc, analogous to the Aleutian arc," Wallace said. "After collision, mountain building continued, although at a slower pace, because of northward motion of tectonic plates in the Pacific Ocean basin and the arrival of mobile terranes in southern Alaska. The highest elevations in the Brooks Range are found in the northeastern Brooks Range and the adjacent coastal plain is seismically active, both indicating that the process of mountain building continues in the region to this day."

Wallace and his graduate students analyze the deformational structures formed during this mountain-building process. "Because of the combination of high mountains and sparse vegetation cover, we can study examples of structures that in many other parts of the world are buried, covered by vegetation, or eroded away," he said. "This provides valuable information on the processes by which mountain ranges form, and how the rocks deform.

Once the type and shape of deformational structures, such as folds and faults, are determined, they attempt to reconstruct the sequence of events by which the structures evolved. This is done for different rock units to determine how the character of the rock influenced the formation of structures. Different rock types deform in different ways: limestone and sandstone are relatively rigid and tend to bend or break, whereas weaker rocks such as shale tend to flow.

"Along with its scientific interest, this work will be of value in objectively assessing the potential for structural oil traps beneath the coastal plain to the north," Wallace said.

The other major tectonic event in the region, formation of the Arctic Ocean basin, began about 125 to 100 million years ago. Northern Alaska rifted away from the northern continent that had previously served as the main sediment source area.

"Rifting led to formation of a new ocean basin that was bounded by the new north-facing passive continental margin of northern Alaska. A new ocean to the north, coupled with the uplift and erosion of the Brooks Range, drastically rearranged the patterns of sedimentation in northern Alaska, establishing depositional systems that persist today," said Wallace.

"The study area is made up of a thick sequence of mostly sedimentary rocks that were folded and thrust faulted to form the northeastern Brooks Range. The complex array of geological structures developed during deformation in the Brooks Range mountain belt, and erosion of the rising mountain range, greatly influenced sedimentation in neighboring areas," Wallace said.

The extensive fieldwork for the research is carried out during a two-month period each summer.

"The logistics of such a large-scale project, with many people doing field work over a vast region, are complex and expensive," said Wallace. "Our work would not have been possible without logistical support from the U.S. Fish and Wildlife Service (at cost) and the Alaska Division of Geological and Geophysical Surveys (ADGGS), and we have worked jointly with scientists from ADGGS, the USGS, and the Geological Survey of Canada."

The project also benefits from the scientific cooperation of paleontologists Anita Harris and Robert Blodgett of USGS, Bernard Mamet of the University of Montreal, and John Utting of the Geological Survey of Canada. At the University of Kansas, Drs. Robert Goldstein and Paul Enos, and Ph.D. student Randall Carlson (master's graduate of UAF) are currently working with Watts to study how carbonate sediments were lithified into limestones.

Since 1985, the work in ANWR has been supported by grants from various sources, including approximately $1 million from industry sponsors. A three-year contract for carbonate studies from the U.S. Department of Energy will contribute a total of $450,000 through 1992, with the Geophysical Institute and the UAF College of Natural Sciences providing matching funds ($90,000 and $30,000 respectively). Early in the program, $36,000 in grants to Wallace and Watts were received from the Petroleum Research Fund of the American Chemical Society. Logistical support by ADGGS was instrumental in getting the program started, when funding was sparse in 1986 and 1987.

Current industry sponsors include ARCO Alaska, ARCO Research, B.P. Exploration (Alaska), Chevron, Elf Aquitane, Exxon, Japan National Oil Corp., Mobil, Murphy, Phillips, Shell, Texaco, and Unocal.

GI NOTES

MERIT AWARDS—In November five GI employees were selected by coworkers to receive the 1990 UAF Chancellor's Merit Award. They are Dolores Baker, compositor and audio-visual coordinator for the Photo-Graphics Service Center; Penelope Dufseth, administrative assistant for technical services; Johni Meshell, ledger accountant for the business office; Debbie LaBarre, secretary for the Poker Flat Research Range upgrade office; and Rick Guritz of the Computer Resource Center, who works on image analysis systems for the Alaska SAR Facility.

FACULTY EXCELLENCE—Roger Smith, professor of physics and member of the space physics and aeronomy group, has received the 1990 College of Natural Sciences Merit Award in recognition of his distinguished achievement in teaching, research, and service to the Department of Physics and GI. Smith, who joined the institute faculty in 1984, teaches graduate and undergraduate courses. His research involves the study of upper atmospheric dynamics by optical methods, optical investigations of the mesosphere, and optical imaging of ionospheric convection and magnetospheric dynamics from space.

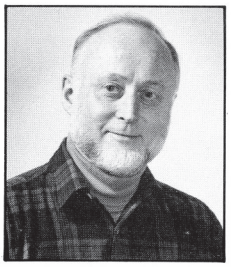
CHINESE HONOR LEE—Academia Sinica, the Chinese Academy of Sciences, has given an honorary professorship to GI physics professor Lou-Chuang Lee for his contributions to space research and work with scientists at the Chinese Center for Space Science and Applied Research. While on sabbatical leave in Taiwan this year, Lee toured and lectured at several universities and institutes during a fall visit to China. In Taiwan he taught a special topics course in space physics at the National Central University. At GI he is working under a three-year grant from the NASA Space Physics Theory Program. He joined the GI faculty in 1978.

STUDENTS HONORED—Two institute graduate students, Ling-Hsiao Lyu and William Bristow, were chosen to receive the Outstanding Student Paper Award at the fall meeting of the American Geophysical Union. Of the 92 student papers presented, only 9 were chosen for this honor. Lyu is a doctoral student working under professor Joe Kan of the space physics group. Bristow is also a doctoral student in space physics. His major professor is Brenton Watkins.



EVELYN TRABANT

Receiving 1990 merit awards for outstanding service were (from left) Debbie LaBarre, Dolores Baker, Johni Meshell, Rick Guritz, and (not pictured) Penelope Dufseth.



Carl Benson

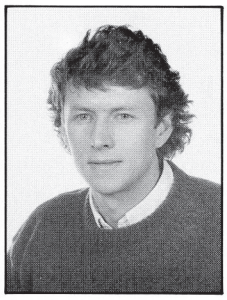


Roger Smith

APPOINTMENT—professor Gunter Weller was appointed in February to serve a three-year term on the U.S. Committee on Global Change. The appointment was made by M. Gordon Wolman, chairman of the National Research Council, which is the principal operating agency of the National Academy of Sciences and National Academy of Engineering. The Committee on Global Change provides guidance to the government on the scientific content of the U.S. Global Change Research Program. It also serves as liaison between national and international research programs related to global change. Weller is project director of the Alaska SAR Facility and scientific director of the UAF Center for Global Change and Arctic Systems Research. He serves on the National Academy's Polar Research Board and is deputy director of GI.



Ling-Hsiao Lyu



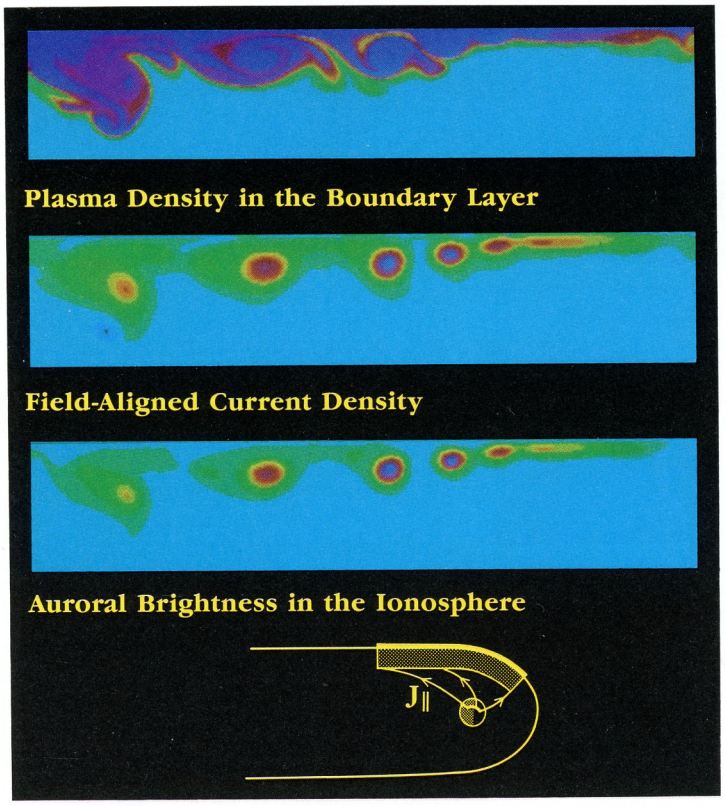
William Bristow

AAAS FELLOW—Professor emeritus Carl Benson has been elected a Fellow of the American Association for the Advancement of Science in recognition of his distinguished career in glaciology—development of a glacier facies concept, studies of glacier-volcano interactions, and research low-temperature air pollution. His work includes seasonal snow cover, low temperature air pollution problems, freezing of small turbulent streams, glacier mass balance problems on McCall Glacier, and glacier-volcano interactions in the Wrangell Mountains and on the west side of Cook Inlet. He taught in the department of Geology and Geophysics and was department chair from 1969 to 1973. Benson, who joined the institute in 1960, is still active in research.

OIL SPILL REPORT—Satellite data analysis at GI following the *Exxon Valdez* oil spill is reported in a new book, *Oil Spills, Management and Legislative Implications* (proceedings of the conference, May 1990), edited by Malcolm Spaulding and Mark Reed. The remote sensing research done after the tanker ran aground in March 1989 is reported by Ken Dean, Bill Stringer, Joanne Groves, and Kristina Ahlnaes of GI and Tom Royer of the UAF Institute of Marine Sciences. Images from four satellites were analyzed to help determine the extent of the spill and monitor its position and distribution along the Alaskan coast. Digital image processing techniques were used to emphasize spectral responses related to oil on the water surface and on beaches. Turbidity and sea-surface temperature data were enhanced to provide information on the circulation and distribution of surface water bodies. The work also used data from aerial observations, Side-Looking Airborne Radar, and shipboard sightings and samples. The book is available from the publisher, American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017-2398.

New computer simulation may explain auroral bright spots

ADVAL / GEOPHYSICAL INSTITUTE



The simulations above show a correspondence among (a) the plasma density in the low-latitude boundary layer, (b) the field-aligned current density, and (c) the auroral brightness in the polar ionosphere. Also shown is a schematic sketch of the mapping between the low-latitude boundary layer and the polar ionosphere.

Important to many scientific explorations, computer simulation models allow researchers to reduce complex physical processes to relatively isolated variables and explore the relationships among them. The simulation study is then compared with the results of active experiments and other observations.

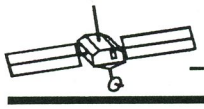
This type of research is used to develop and refine theories about how the magnetic fields and charged particles of the powerful solar wind interact with the earth's own field and aura, so to speak, of charged particles. The visible evidence of this interaction between the solar wind, the magnetosphere, and the upper polar ionosphere is the aurora. At the Geophysical Institute, research in space physics and aeronomy is focused on the physical processes that control these interactions.

Graduate student Changquan Wei recently developed a computer simulation model of the magnetosphere-ionosphere coupling process that offers a possible explanation for the occurrence of auroral bright spots. These features are periodically spaced along the post-noon auroral oval, the belt-like region surrounding both the north and south magnetic poles where auroras occur. Professor Lou-Chuang Lee, Wei's major professor, and graduate student Annette La Belle-Hamer contributed to the project.

When auroral bright spots were first observed by the Viking satellite in 1986, there was nothing in current theory to explain them. Wei's simulation results provide a possible explanation. Ultraviolet auroral images obtained with Viking often show the bead-like structures, which occur in the post-noon sector along the auroral oval.

Magnetic field and hot plasma measurements confirm the location of the bright spots, and suggest they may be associated with instability in the region of the magnetosphere known as the low-latitude boundary layer. Explaining these bright spots is important to understanding the broader question of the coupling processes of the polar ionosphere and the magnetosphere.

Through active experiments, satellite observations, and computer studies, researchers have learned that this interaction is considerably more complex than was thought when theories were first developed to explain them. Today, researchers at the institute and elsewhere are working to develop a more accurate picture of how the energy from the sun is channeled into our planetary environment, and how, in turn, Earth affects the stream of ionized particles and magnetic field we know as the solar wind.



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