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GSA TODAY

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# Farthest North: Ocean Drilling in the Arctic Gateway Region

*Leg 151 Shipboard Scientific Party*


## ABSTRACT

**The Ocean Drilling Program (ODP) recently recovered the first deep-drilled sediment sequences from the Arctic Ocean, on Leg 151 in July–September 1993. The ODP drillship Resolution took advantage of late summer low-ice conditions in the region northwest of Svalbard to drill three sequences on the Yermak Plateau at lat ~80°N and long 5°–8°E. Despite being chased away several times by advancing sea ice, ODP Leg 151 successfully obtained the northernmost long sediment cores (>500 m) ever drilled. The sediment sequences obtained provide the first opportunity for high-resolution records of arctic climates and paleoceanography from the mid-Pliocene to present. Surprisingly high sedimentation rates involving high fluxes of glacially derived dropstones and terrigenous detritus attest to dynamic circumarctic continental ice sheets at least episodically since the mid-Pliocene. "Overconsolidated" Quaternary sediments at site 910 suggest that a massive ice sheet may have been grounded on the Yermak Plateau during at least some glacial intervals, perhaps derived from the Barents Sea shelf and buttressed by Svalbard. The oldest dropstones in the Arctic gateway region, recovered at Fram Strait site 909, were late Pliocene in age. At site 907 on the Iceland Plateau, however, an earlier appearance of dropstones during the late Miocene suggests individual ice sheets had different histories. Other ODP Leg 151 cores from Fram Strait, the East Greenland margin, and the Iceland Plateau provide important information on the Cenozoic paleoceanographic history of the Norwegian-Greenland Sea and its relation to global climates. In particular, late Miocene laminated biosiliceous sediments on the Iceland Plateau suggest that active deep convection did not occur in this area until ca. 7 Ma.**


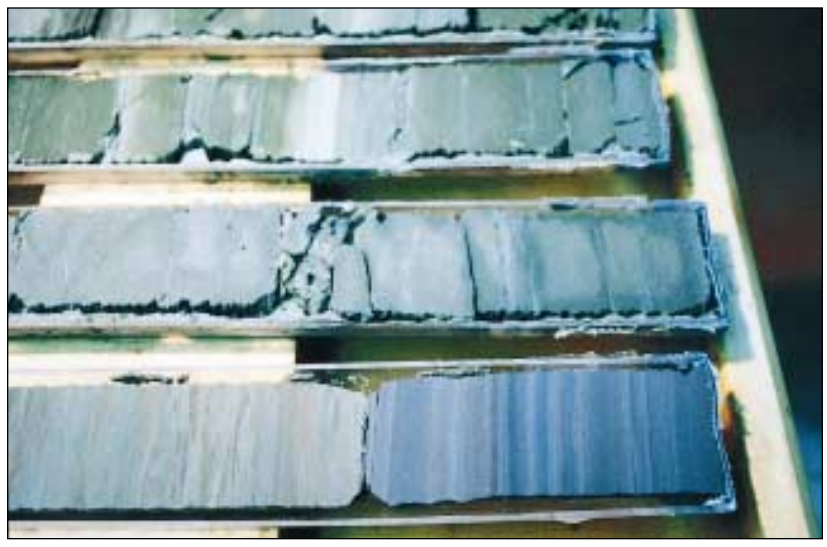

**Figure 1.** Left: Finnish icebreaker *Fennica* patrolling sea ice on the Yermak Plateau in the Arctic Ocean at lat ~80°N. Photo by Suzanne O'Connell, Wesleyan University. Above: Laminated biosiliceous oozes from the late Eocene on the East Greenland margin (site 913), showing rich green and blue surficial coloration attributed to the presence of vivianite. Photo by ODP Operations Superintendent Gene Pollard.

## INTRODUCTION

Leg 151 of the Ocean Drilling Program (ODP) has ushered in a new era of scientific exploration of the arctic region by recovering the first deep-drilled sediment cores (>500 m) from the Arctic Ocean. The sediment sequences recovered, featuring high sedimentation rates with abundant ice-rafted dropstones, indicate a dynamic history for the arctic cryosphere since at least the mid-Pliocene. An integral part of a long-term effort for renewed study of the arctic region, ODP Leg 151 sailed exactly 100 yr after Fridjof Nansen's famous expedition across the Arctic Ocean. Nansen and his crew allowed their ship the *Fram* to be frozen into the arctic sea ice in the Laptev Sea north of Siberia in order to transit the Arctic Ocean, relying on the transpolar drift of the sea ice. As chronicled in Nansen's (1899) account of the journey and subsequent scientific papers, the *Fram* drifted toward Fram Strait in the northernmost North Atlantic over the course of 3 yr, providing the first scientific information from the Arctic Ocean. A century after the *Fram* expedition, the ODP drillship *Resolution* (SEDCO/BP 471), administered by the Joint Oceanographic Institutions for Deep Earth Sampling, drilled the first sites in the Arctic Ocean proper and its main gateway at Fram Strait.

One of the long-standing questions about Arctic Ocean climates is the history of the arctic cryosphere, including the circum-arctic continental ice sheets and the Arctic sea ice. The *Fram* expedition documented that the present-day sea-ice cover is a pervasive feature of the Arctic Ocean, which Nansen felt had existed "since the earliest dawn of time." Today, considerable uncertainty exists about the onset of an extensive Arctic sea-ice cover (e.g., Thiede et al., 1990). Estimates of its age range from middle to late Miocene (Clark, 1982) to late Quaternary (Herman, 1985). Based on the appearance of planktonic foraminiferal assemblages similar to modern communities, sea ice may have become a permanent feature as recently as ca. 0.9 Ma (Herman, 1970, 1974, 1985). Ice-rafted detritus in Arctic Ocean sediments suggests that the circumarctic ice sheets have existed since at least the early Pliocene (Herman, 1970; Margolis and Herman, 1980). These paleoclimatic interpretations are based exclusively on short piston cores (<10 m in length) in areas with low sedimentation rate, which provide greatly condensed records. A major advantage of deep-sea drilling in areas of high sedimentation rate is that long sediment sequences (>500 m) may be obtained for greater stratigraphic coverage and high-resolution sediment records. Specifically, such records should document the formation of the circumarctic continental ice sheets and the arctic sea ice, and their subsequent evolution in Quaternary glacial-interglacial cycles.

Reconstructing pre-glacial arctic environments will provide insights into possible future arctic environments that may develop in response to greenhouse warming. Very warm Arctic Ocean climates have been suggested for the mid-Pliocene, on the basis of fossil faunal distributions including planktonic foraminifera (Herman, 1970, 1974), sea otters and mollusks (Carter et al., 1986), as well as elevated sea-level terraces (Brigham-Grette and Carter, 1992). Documenting the pre-glacial arctic paleoenvironment and its subsequent evolution will illuminate its sensitivity to future anthropogenic climate change.

## REGIONAL OCEANOGRAPHY

The ability of the *Resolution* to conduct operations in the Yermak Plateau region is directly tied to surface-water oceanography in this area. Relatively warm surface waters derived from the warm Norwegian Current flow north through the Norwegian Sea and enter the Arctic Ocean as the West Spitsbergen Current through the Fram Strait west of Svalbard. This current melts extensive sea ice and icebergs in this area in the summer, including the area over the Yermak Plateau. Correspondingly, cold surface waters of the East Greenland Current flow south along the east coast of Greenland and enter the North Atlantic Ocean through Denmark Strait west of Iceland. Thus, much of the western Greenland Sea receives arctic sea ice transported by the cold East Greenland Current, making this area inaccessible for deep-sea drilling by ships without icebreaker capabilities. These surface current systems create a strong east-west asymmetry in surface-water temperatures and strongly influence the climate of the surrounding lands, accounting for mild climates in Scandinavia at latitudes where glacial conditions prevail on Greenland.

In the present day, the North Atlantic–Arctic gateway region is also a center for deep-water exchange between the Arctic and North Atlantic Ocean, and the Norwegian-Greenland Sea is an important locus for deep-water formation. The only deep connection between the Norwegian-Greenland Sea and the Arctic Ocean is through the narrow Fram Strait, with a sill depth of ~2600 m. In the cyclonic gyre of the Norwegian-Greenland Sea, surface waters derived in part from the warm, salty Norwegian Current are sufficiently cooled to become dense, to sink, and to form cold deep waters. These waters fill the series of basins that comprise the Norwegian-Greenland Sea, enter the Arctic Ocean through Fram Strait, and spill over sills in the Denmark Strait (~600 m) and Iceland-Faeroe Channel (~1100 m) to contribute to the formation of North Atlantic deep water. Deep-water exchange thus occurs through both the northern gateway through Fram Strait and the southern gateway to the North Atlantic across the Greenland-Iceland-Faeroe ridge.

The present-day system in the Norwegian-Greenland Sea of surface-water inflow and deep-water outflow represents a lagoonal-style circulation

**Drilling** *continued on p. 31*

Each month, *GSA Today* features a short science article on fast-breaking items or current topics of general interest to the 15,000 members of GSA. What do you think of these articles? Do you have an idea for an article that you would like to see published in *GSA Today*? If so, please contact Eldridge Moores, Science Editor, *GSA Today*, (916) 752-0352, fax 916-752-0951.

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# GSAF UPDATE

*Robert L. Fuchs*

## Four Major Gifts Boost Second Century Fund

R. W. Bromery, chair of GSA's Second Century Fund for Earth • Education • Environment, announced the receipt in late 1994 of a total of more than $500,000 in new gifts to GSA and the Foundation from corporations, foundations, and individuals. The awards and contributions are in the form of both program funds and additions to endowment. Some of the funds received and pledged are for specific programs, while other monies are unrestricted.

"These contributions, including four major gifts, are the result of the diligent work of the Second Century Fund Committee, Foundation personnel, GSA members, and friends, continuing an undertaking that began in late 1992," said Bromery in making the announcement. "I fully expect that with the number of proposals that have been made and the verbal indications we have received, almost one-third of the Fund's $10,000,000 goal will have been reached in the first quarter of 1995."

### Shlemon Applied Geology Fund

Roy J. Shlemon of Newport Beach, California, a 25-year member of the Society, has made a substantial gift to the GSA Foundation which has been used to establish the Roy J. Shlemon Fund for Applied Quaternary Geology and Geomorphology. The purpose of the fund is to support the application of Quaternary geology and geomorphology to the pragmatic siting of domestic, commercial, and industrial developments, as well as for dams, waste repositories, and other large engineered structures. The Shlemon Fund will focus on the interchange of technology and ideas between the practicing scientist-engineer and the academic community, with special emphasis on geoscience students.

Roy Shlemon is a consulting geologist and principal of Roy J. Shlemon & Associates, Inc., and has specialized in the application of Quaternary geology, geomorphology, and soil stratigraphy to engineering practice. Representative assignments have included assessments of fault activity (neotectonics and paleoseismicity), soil erosion, and mass-wasting phenomena, and the identification of channel-bound ore deposits, sand and gravel sources, and potential contaminant pathways. Typical applied Quaternary geology and geomorphology projects have focused on the siting of nuclear power plants, LNG terminals, dams, radioactive waste facilities, and landfills, and on impact assessments of ground fissures, accelerated sedimentation, and landslides. These projects have been undertaken worldwide, but particularly in the western United States, Middle East, and Latin America. Clients include various U.S. government and State of California agencies, utility companies, national laboratories, and private engineering, mining, and geological consulting firms.

In addition to degrees from Fresno State College, University of Wyoming, and University of California, Berkeley (Ph.D.), Roy Shlemon has held teaching and/or research positions at the University of California (Davis), Louisiana State University, Stanford, UCLA, and California State University (Los Angeles). In discussions prior to making this gift, Shlemon pointed out that there is always a need to bridge the apparent gap between academia and the applied world of consulting geology. He has accomplished this in his career by applying the principles of Quaternary geology and geomorphology to "real world" geotechnical and environmental problems. This is the philosophy underlying the Shlemon Fund: the necessity for the research scientist to transfer ideas to those working in applied geology and the necessity for practitioners in the consulting community and industry to inform academia, particularly the geoscience student, about applied geology and its constantly changing requirements, opportunities, and challenges.

### Exxon Corporation Funding for In-STEP

GSA has recently received notification from the Exxon Corporation of Irving, Texas, that a $200,000 grant has been approved to provide funding over a five-year period for a key SAGE program entitled Involving Scientists and Teachers in Educational Partnerships (In-STEP). Payments will be made in annual installments of $40,000, beginning in 1994 and ending in 1998, subject to the achievement of various program mileposts.

With this award, which is part of the Industry Support Program for Earth Science, one phase of the Second Century Fund, Exxon, the nation's largest energy company, continues its leadership role in support of geology and earth science. Exxon was a principal contributor to GSA's Decade of North American Geology project, with a ten-year pledge in 1981.

During the next five years, In-STEP will become an integral part of SAGE's Partners for Excellence (PEP). In-STEP serves to strengthen PEP by providing training and support for those scientists and teachers who are working together to improve scientific education in K–12. The program will focus on developing a series of workshops, attended by scientists and teachers, that will be designed to support systemic science education reform at the local level. Additional leadership workshops will allow development of teams of experienced partner resource agents throughout the country. These teams will, in turn, train and support partners in their regions. Other activities will eventually include resource materials, a newsletter, recognition awards, and an Internet home page. In-STEP training will emphasize critical thinking, hands-on activities, real-world scientific investigations that cut across traditional disciplinary boundaries, and support of systemic reform efforts at the state and local level. Partners will also learn about effective pedagogical techniques such as cooperative learning, guided discovery, and concept mapping.

### Gates Foundation Grant for Boulder Headquarters Addition

Colorado's Gates Foundation has awarded a $50,000 grant to the GSA Foundation, which is to be applied to the costs of the recent addition to the Boulder headquarters building. The grant is particularly timely and important as a capital award, since the Society in recent months has received a


**Update** *continued on p. 27*


## CORRECTIONS:
### North-Central–South-Central Sections 1995 Meeting

Two field trips were published with incorrect dates on the preregistration form:
**Field Trip #1** will be on April 26, 1995
**Field Trip #5** will be on April 29, 1995.

Also, if you wish to attend the **State Museum Tour** or the **North-Central Section Management Board Breakfast,** please indicate your attendance when you register.

Questions? Please contact the GSA Registration Coordinator at 1-800-472-1988, ext. 113.

# GSA ON THE WEB

What's new on the GSA home page on the World Wide Web? If you haven't yet connected to the Web, the Universal Resource Locator (URL) is **http://www.aescon.com/geosociety/index.html.**

For current information on any of the GSA Section meetings, go to **Meetings** and choose the Section you want to know about. This month has all the information about the Cordilleran Section meeting in Alaska.

See the **Section and Division** area for newsletters, meetings, and other news.

If you want to know more about the GSA Employment Service or about becoming a GSA Campus Representative, check the **Membership** section, which also has information on nominating a member to fellowship and on obtaining forms for applying to become a GSA Member or Student Associate.

See the **Geoscience Calendar** section for a listing of meetings of general geological interest.

*GSA Research Grants* applications are currently being accepted. Look under the **Administration** section for ways to acquire applications and how to submit them. Also in this section is information about application for the GSA Congressional Science Fellowship.

The **Publications** section has a monthly table of contents for the *GSA Bulletin* and *Geology.* Also in this section is a guide for authors preparing manuscripts for submission to GSA publications.

**Update** *continued from p. 26*

number of large gifts, including those described above, that are for the most part in support of programs. The Gates Foundation recognized that for programs to be entirely effective, there must be adequate facilities for those who direct and operate these activities. For this reason, the Gates grant has a special significance.

The Gates Foundation is located in Denver and was established in 1946 by Charles C. Gates, Sr., the founder of The Gates Corporation. Charles Gates graduated as a mining engineer from Michigan Tech and was mine superintendent at Tincup, Colorado, when he purchased the small, barely profitable Colorado Tire and Leather Company in 1911 for $3500. Under the leadership of the Gates family, the still-private company has since grown to an organization with 16,000 employees in 18 states and 15 foreign countries and with sales exceeding $1.5 billion.

GSA and the Second Century Fund have now received grants from four Colorado foundations, a showing of strong support by these leading philanthropic organizations in GSA's home state. Previously, the Boettcher and El Pomar Foundations joined in a $250,000 total grant for state-of-the-art technology for publications, internal systems, and education. The Ruth and Vernon Taylor Foundation recently awarded program funds for SAGE.

## Private Foundation Underwrites SAGE - Partnering Costs

The GSA Foundation recently received the first installment of a three-year, $150,000 grant for the Partners for Excellence Program. The grantor, a family foundation one of whose trustees is a GSA member, advocate, and contributor, has a strong interest in improving education, particularly K–12 science education.

The funds will be used to offset the costs of operating PEP. To achieve PEP objectives over the next few years, GSA will need additional staff support and funding for partnering workshops, materials development, communications, travel, awards, and spin-off projects. This grant will go a long way toward strengthening, expanding, and sustaining PEP.

An immediate, tangible benefit will be the designation of Barbara Mieras as the Partners for Excellence program manager. Mieras has been working as an educational consultant for GSA, and she will now become a full-time employee. She is a former classroom teacher, has a Ph.D. in geology, and is working on a doctorate in education. Her work experience includes the oil industry, curriculum development for native American students, and facilitator for Project WILD.

Edward E. Geary, GSA's Coordinator of Educational Programs, was very enthusiastic about this grant, which will provide the ability to manage and direct the partnering program, and about the Exxon award for In-STEP, which will fund program development. "These two grants go hand in hand. With them we have the ability over the next three to five years to train and support participants, and also to develop the necessary resources to expand PEP so that effective scientist-teacher-student partnerships become commonplace in schools across the nation." ■

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Robert C. Newton
James J. Norton
Waite R. Osterkamp
Elizabeth F. Overstreet
Judith T. Parrish
Ralph B. Peck*
David A. Phoenix
Frederick H. Pough
Harriet E. Powell
Richard C. Quittmeyer
Robert G. H. Raynolds
Leslie D. Reed
Richard Rezak
Robert H. Rutford
Henry R. Schmoll
Glenn L. Shepherd
Eugene S. Simpson
Laurence L. Sloss*
David P. Stewart
Thompson M. Stout
Stephen M. Strachan
Kathryn Sullivan
Rowland W. Tabor
Manuel Tello-B.
Harry L. Thomsen
Peter B. Thurston
George R. Tilton
Joshua I. Tracey, Jr.*
George Viele, Jr.
E. Bruce Watson
Robert J. Weimer
Ray E. Wells
John O. Wheeler
Robert T. White
William B. Whiteford
Kemble Widmer
John W. Williams
James E. Wilson
Richard B. Winston
Michael B. Winter
Paul A. Witherspoon, Jr.
J. Lamar Worzel
Christopher Wright
Lauren A. Wright
Herbert E. Wright, Jr.
Frederick Zoerner*

**Unrestricted—GSA**
Michele L. Aldrich
Alice S. Allen
Rachel M. Barker*
Virgil E. Barnes
Paul C. Bateman
Robert W. Blair
Randy Blomquist
Arthur A. Bookstrom
Bruce A. Brown
Elizabeth T. Bunce*
G. Arthur Cooper*
Michael L. Cummings
Carlton Davenport
Dan A. Davis
Roberta Dixon
Chester L. Dodson
Mark T. Duigon
John A. Ferguson
Willard C. Gere
Vivien M. Gornitz
William C. Graustein*
Norman Greenman
Louis H. Groffman
Gerald H. Haddock
George Hallberg
Wallace R. Hansen
James W. Hood
Richard K. Hose
Frank H. Howd
Lisle T. Jory
John P. Kempton*
Frank H. Kilmer
Robert C. Lafferty*
Morris W. Leighton*
Frederic Loomis
Tom H. W. Loomis
John B. Lyons
Thomas M. McCormick
E. Allen Merewether
Akiho Miyashiro
George E. Moore, Jr.
Donald A. Myers
Willis H. Nelson
Ned A. Ostenso
Joanne R. Ouellette
William C. Overstreet
Gordon W. Prescott
Augustin Pyre
William A. Ranson
Paul R. Shaffer
Eli A. Silver
Clay T. Smith
Craig L. Sprinkle
Thompson M. Stout
George C. Taylor, Jr.
Manuel Tello-B.
Bennie W. Troxel
Joseph E. Upson II
Adam R. Wasem
Edgar L. Weinberg
Malcolm P. Weiss
Robert W. Wilson
Stephen S. Winters
Donald U. Wise

**Women in Science**
Rachel G. Craig*
Valerie-Ann Eagen
Grant Garven
Kathleen M. Johnson
Margaret O. Oros
Marilyn E. Quas
Daniel B. Sass
Ruth A. M. Schmidt*
Billie Jo Sorenson

*Century Plus Roster (gifts of $150 or more).

# 1995 GeoVentures

GeoHostel

## Geological History of Southwestern Montana

**June 17–22, 1995** • 6 days, 6 nights • Western Montana College, Dillon, Montana

A glacial tarn on the high peaks of the Pioneer Mountains, southwestern Montana. *Photo by Rob Thomas.*

**Scientific Leader**

*Robert Thomas*, Department of Geosciences, Western Montana College

Currently an assistant professor of geology at Western Montana College, Rob Thomas has been involved in geological field camps in the Dillon area since 1986. A graduate of the University of Washington, Rob has studied the patterns and processes of Cambrian mass extinctions, but his current research involves the origin and timing of extensional tectonism in southwestern Montana.

**Schedule**

June 17, Saturday . . . . . Welcoming get-together
June 18–22, Sunday–Thursday . . . . . Classes and field trips
June 20, Tuesday . . . . . Western Barbecue
June 22, Thursday . . . . . Farewell Party

The beautiful Beaverhead Valley of southwestern Montana was visited by the Lewis and Clark expedition nearly 200 years ago, and human activity has little changed this part of Big Sky Country since then. The valley is surrounded by the mountain peaks (>11,000 ft) of the Blacktail Deer, Pioneer, Ruby, and Tobacco Root Mountains. The base for our trips will be the small college town of Dillon, best known for its abundant wildlife, trout streams, pioneer history, and spectacular geology. The GeoHostel will include field trips to the fold-and-thrust belt structure in the Beaverhead Valley, Cretaceous intrusions, ore mineralization and glaciation in the Pioneer Mountains, fossil insects and plants in the Ruby Valley, Cenozoic extensional tectonics along the northern edge of the Yellowstone hotspot tract, and thermal features in Yellowstone National Park. Trips will be both full and half-day. Plenty of leisure time will be available to enjoy the solitude of the "last best place" in America.

**Lodging, Meals, Transportation.** The group will be lodged for six nights at Western Montana College, Dillon, Montana, single-occupancy (or double for couples) dormitory–style rooms. Meals will include breakfast and a sack lunch daily through Thursday, western barbecue on Tuesday evening, a farewell dinner on Thursday evening, and breakfast on Friday before check-out. Field trip transportation will be in air-conditioned, 15-passenger rental vans.

***Included in the fee*** (see box) are classroom programs and materials; field trip transportation; lodging for six nights; meals outlined above; welcoming and farewell events. ***Not included*** are air transportation to and from Dillon, Montana; transportation during hours outside class and field trips; meals and other expenses not specifically included.♦

GeoHostel

## Scenic Geology of Northwestern Colorado and Dinosaur National Monument

**June 24–29, 1995**

6 days, 6 nights • Colorado Mountain College and Vernal, Utah

**Scientific Leaders** ***Gregory Holden and Kenneth Kolm,***
*Department of Geology and Geological Engineering, Colorado School of Mines*

*Ken Kolm* and *Greg Holden* are among the brightest and most refreshing of the younger generation of geologists. Experienced GeoHostel Leaders, Ken and Greg received their doctoral degrees from the University of Wyoming, and both are currently associate professors at the Colorado School of Mines.

**Schedule**

June 24, Saturday . . . . . Welcoming get-together
June 25–29, Sunday through Thursday . . . . . Classes and field trips
June 29, Thursday . . . . . Farewell Party

Steamboat Springs, Colorado, in a high, green mountain valley, will be our base for two loop trips to explore the geology of northwestern Colorado, from Precambrian basement to Tertiary volcanic rocks. We'll also take a three-day trip west to see Dinosaur National Monument and the isolated back country that surrounds it. High points of the trip will be remote Brown's Hole (original hideout of Butch Cassidy's Wild Bunch), intimate views into and a raft trip through the deep canyons of Dinosaur National Monument, and a tour of the dinosaur quarry itself.

**Lodging, Meals, Transportation.** The group will stay on Saturday, Sunday, Wednesday, and Thursday at Colorado Mountain College, Steamboat Springs, in single rooms (doubles for couples). Lodging on Monday and Tuesday nights will be at the EconoLodge in Vernal, Utah, in double occupancy accommodations. Single rooms for Monday and Tuesday nights are available for the single-supplement fee of $50. Meals will include breakfast and a sack lunch on Sunday, Monday, and Thursday, lunch on Tuesday during the raft float trip or optional van trip, a farewell dinner on Thursday evening, and breakfast on Friday before checkout. Field trip transportation will be in air-conditioned, 15-passenger rental vans.

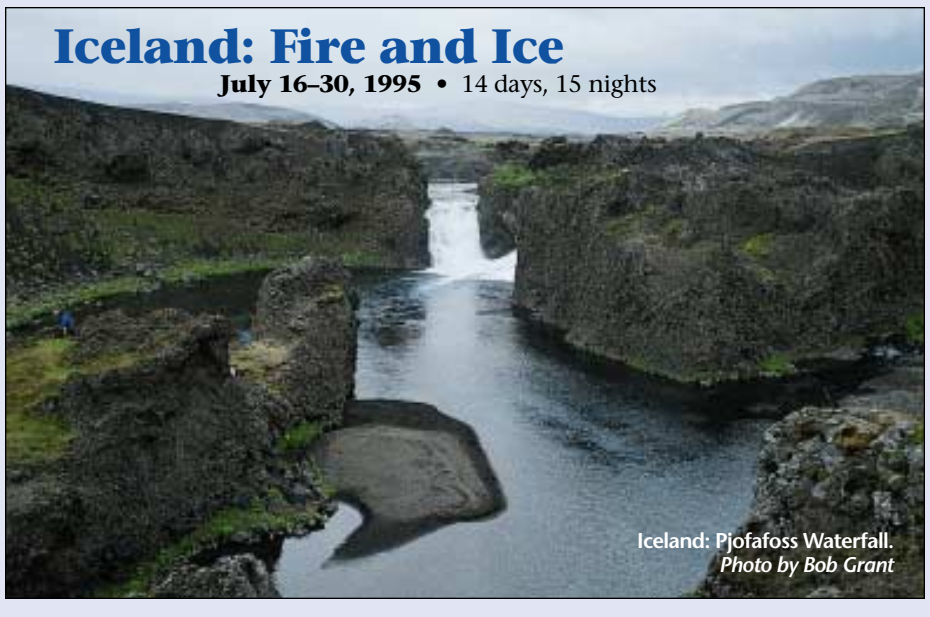
View from Harper's Corner on the Green River. Canyon of Ladore in the background, classic monocline in the foreground. *Photo by Ken Kolm*

***Included in the fee*** (see box) are classroom programs and materials; field trip transportation; lodging for six nights (single occupancy, or double for couples); meals outlined above; raft float trip (or optional van trip); welcoming and farewell events. ***Not included*** are air transportation to and from Steamboat Springs, Colorado; transportation during hours outside class and field trips; breakfast on Tuesday; breakfast and lunch on Wednesday; and other expenses not specifically included.♦

GeoTrip

## Iceland: Fire and Ice

**July 16–30, 1995** • 14 days, 15 nights



Iceland: Pjofafoss Waterfall. *Photo by Bob Grant*

**Scientific Leaders:**
***Haraldur Sigurdsson,*** *Graduate School of Oceanography, University of Rhode Island*
***Haukur Johannesson,*** *Natural History Institute, Reykjavik, Iceland*

A native of Iceland and professor of oceanography, *Haraldur Sigurdsson* is a leading volcanologist with an international reputation for his research on many aspects of volcanism in Iceland, Italy, Mexico, Colombia, the United States, and Indonesia, among others. *Haukur Johannesson* has devoted most of his career to the geologic mapping of the uncharted volcanic regions of Iceland. He is an expert in the tectonic structure and origin of the Iceland basalt plateau and is also very knowledgeable about the natural history of Iceland in general.

**Schedule**

July 16, Sunday . . . . . Travel day from Baltimore or New York to Reykjavik, evening departure on Icelandic Air
July 17–30, Mon.–Sun.. . . . . Iceland GeoTrip
July 30, Sunday . . . . . Travel day from Reykjavik to next gateway

This trip will reveal many unaltered and fresh geologic features that can be seen nowhere else on land. Expect to acquire a newly expanded understanding of volcanoes, hotspots, and rifts. There will be great views of steep-walled and flat-topped hyaloclastite ridges derived from subglacial eruption, young hyaloclastite islands produced by submarine eruptions, great explosion craters, tephra cones, calderas,

## CALL TODAY!
## HOLD A SPOT FOR YOURSELF AND FRIENDS.

We encourage you to make your decision as soon as possible. There is high interest in these trips, and several people have registered already.

**General Fee Information:** If you have been with us previously on a GeoTrip, the surcharge will be waived. Please remind us of this when you register. Sorry, there is no fee waiver for GeoHostels due to their low operation margin. However, if you attend both 1995 GeoHostels, you will receive a $50 discount.

**Single/shared Accommodation:** Some trip fees are based on double occupancy. If you wish single accommodations, a limited number of rooms are available at an extra cost on a first-come, first-served basis. In the case of double occupancies, we will do our best to help find a suitable roommate, but if none is found, the single rate will apply. Please read the lodging information.

**Age Limitations:** In general, the age limit is 21.

**Health:** You must be in good physical and mental health. Any physical condition requiring special attention, diet, or treatment must be reported in writing when the reservation is made. We reserve the right to decline any person as a member of a trip. We also reserve the right to require a person to withdraw from the trip at any time when such action is determined to be in the best interests of the health, safety, and general welfare of the group.

**Special Needs:** We will do our best to accommodate special needs, including dietary requirements and physical disabilities. Please feel free to call and discuss your situation with us.

**Air Travel:** Arrangements are handled by the individual unless specified as group travel in the description. Cain Travel, GSA's official travel agency, is ready to help you find the least expensive routing to your destination. Call Cain at 1-800-346-4747 toll free, or (303) 443-2246 collect from outside the U.S., fax 303-443-4485. 8:30 a.m. to 5:30 p.m. MT, Monday through Friday.

**Cancellation Processing Fee:** Deposits and payments are refundable up to the cut-off time, less processing fees of $20 for GeoHostels and $50 for GeoTrips. Termination of a trip in progress for any reason will not result in a refund, and no refund will be made for unused parts of the trip.

**Itineraries and Other Information:** Detailed itineraries for each GeoVenture and helpful travel information are available from GSA. Feel free to call, fax, or E-mail: Edna Collis, GSA GeoVentures, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020 or 1-800-472-1988, fax 303-447-0648, E-mail: ecollis@geosociety.org ♦

## 1995 GeoVentures Fee Schedule

| Name | Grand Canyon | Montana | Colorado | Iceland |
|---|---|---|---|---|
| **Type** | GeoTrip | GeoHostel | GeoHostel | GeoTrip |
| **Dates** | April 21–28 | June 17–22 | June 24–29 | July 16–30 |
| **No. of Days** | 8 | 6 | 6 | 14 |
| **Member Fee** | $1450 | $500 | $520 | $2780 |
| **Nonmember Fee** | $1550 | $550 | $570 | $2880 |
| **Deposit** | $250 | $100 | $100 | $250 |
| **Balance Due** | March 1 | April 15 | April 15 | April 15 |
| **100% Deposit refund date (less $20/$50 processing fee)** | March 1 | April 15 | April 15 | April 15 |

GeoTrip

## Geology of the Grand Canyon—Lee's Ferry to Pierce Ferry

**April 21–28, 1995**

***As we go to press there are only two spaces available on the Grand Canyon trip.***

blocky obsidian flows, waterfalls descending into the rift valley, and, of course, extraordinary glacial panoramas.

**Lodging, Meals, Transportation.** During most of the trip, the group will stay in country hotels (Edda hotels), rural secondary and high schools operated as simple but comfortable summer hotels. Food will be provided at all lodging locations, plus picnics during the day. Travel will be by four-wheel-drive mountain trail bus and by car ferry to the volcanic Westmann Islands.

**Air Transportation.** The Baltimore gateway has the best connecting flights to most of North America. Round trip travel from Baltimore to Reykjavik will be on IcelandicAir. The current group round-trip fare is $748. Trip participants are required to travel on the group flight so that everyone can benefit from the advantages of a group reservation. You may use air mile coupons for your domestic flights, however.

Travel arrangements are being handled by Volcano Tours—TR Consultants, which can help you with plans for your entire itinerary (1-800-923-7422, fax 401-247-0270). They will also offer a brief post-trip option to Greenland.

***Included in the fee*** (see box) are all meals in Iceland; double-occupancy lodging; comfortable bus and ferry transportation; transfers and entrance fees; baggage handling; geologic road log; and field guidebook. ***Not included*** are airfare to and from Reykjavik, and hotel nights and meals, if any, in Baltimore.♦

## 1995-1996 JOI/USSAC Distinguished Lecturer Series

*The series*

Joint Oceanographic Institutions, Inc./U.S. Science Advisory Committee (JOI/USSAC) is pleased to announce the 1995-1996 JOI/USSAC Distinguished Lecturer Series. JOI/USSAC, associated with the international Ocean Drilling Program (ODP), initiated the series as a means to bring the results of ODP research to students at both the undergraduate and graduate levels and to the earth science community in general. During the 1995-1996 season JOI/USSAC will sponsor eighteen talks, three by each of the speakers listed below.

*Distinguished Lecturers:*

**Jack Casey, University of Houston**
Mid-ocean ridge processes and the formation of MORB: A view from oceanic mantle and plutonic complexes

**Bobb Carson, Lehigh University**
Subduction zone dewatering and seafloor hydrogeology on the Cascadia Margin: A view from the bottom

**William Curry, Woods Hole Oceanographic Institution**
Climate and deep ocean connections: Drilling results from the equatorial Atlantic

**Mary Anne Holmes, University of Nebraska – Lincoln**
Paleosols from the deep sea: ODP's dirty little secrets

**Miriam Kastner, Scripps Institution of Oceanography**
Fluids in subduction zones: A record of the interplay between tectonics, geochemistry, fluid flow, and expulsion

**William Normark, U.S. Geological Survey**
The Amazon Deep Sea Fan: High-resolution environmental records from rapidly deposited turbidite sequences

*Application information:*

Applications are available to U.S. institutions interested in hosting a presentation by one of the lecturers. The application deadline is April 7, 1995. To receive an application contact the JOI/USSAC Distinguished Lecturer Series, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, NW, Suite 800, Washington, DC 20036-2102; fax: (202) 232-8203; Internet: joi@brook.edu.

## GeoVentures Registration Form

If you would like to send a deposit to hold your reservation, please pay by check or credit card, which will be used only for this deposit. If all of your payments are by check, instead of credit card, you will receive a $25 refund at the end of the trip. You will receive further information and a confirmation of your registration within one week after we receive your reservation.

Name _____

Institution/Employer _____

Mailing Address _____

City _____ State ____ Country _____ ZIP _____

Phone: ( ) _____ ( ) _____
Business Home

Guest Name _____

GSA Member # _____

| | Deposit Per Person | No. of Persons | Total Deposit |
|---|---|---|---|
| GT951—**Grand Canyon** | $250 | _____ | _____ |
| GT952—**Iceland** | $250 | _____ | _____ |
| GH953—**Southwestern Montana** | $100 | _____ | _____ |
| GH954—**Northern Colorado** | $100 | _____ | _____ |

**TOTAL DEPOSIT** _____

☐ I've enclosed no deposit, but I'm interested. Please send more information.
☐ VISA ☐ MasterCard ☐ American Express

Credit Card #_____ Exp. Date _____

Signature _____

Make checks payable to: **GSA 1995 GeoVentures**

Please mail Registration Form and check or credit card information to:
1995 GSA GeoVentures, GSA Meetings Department
P.O. Box 9140, Boulder, CO 80301
Phone: 1-800-472-1988 or (303) 447-2020: ext. 134 or 141
E-mail: ecollis@geosociety.org or mball@geosociety.org

Fax: 303-447-0648

# 1994 GSA Honorary Fellows

The GSA Council last May conferred Honorary Fellowship on three internationally known geologists, who were honored at the 1994 GSA Annual Meeting in October. GSA Honorary Fellowships are awarded to outstanding geologists who have distinguished themselves internationally through their geological work or have rendered special service to the Society. Most Honorary Fellows live outside North America.

## Francisco Hervé

Considered by his peers to be among the most eminent of modern geologists, Chilean geologist Francisco Hervé helped lay the foundation for much of what is known about the geology of the southern Andes. His long, distinguished career has focused on the igneous and metamorphic petrology, geochronology, and tectonics of the Andean Cordillera and the pre-Andean basement of South America and the Antarctic Peninsula and includes more than 100 papers.

Francisco Hervé

Hervé's most significant scientific contributions involve the study of accretionary prism rocks in Chile and Antarctica, the chronology of plutonic rocks in Patagonia, and the evolution of the Liquiñe-Ofqui fault. His research on accretionary prism rocks led to subsequent studies on blueschist and greenschist metamorphic facies in Paleozoic and Mesozoic accretionary prism rocks and still later work on the Paleozoic evolution of the Patagonian region of Chile.

His recent research activities are diverse. His work on the Liquiñe-Ofqui fault in southern Chile has helped link it to the geological evolution of the north Patagonian Andes and has contributed measurably to what is known about the tectonics of transpressive plate margins. Other research interests involve accretion phenomena in the southern Andes, the geology and geochronology of the Antarctic Peninsula, and geological investigations along geotraverses in the Argentine-Chilean Andes.

Fluent in several languages, Hervé has been a leader in fostering scientific cooperation between geologists inside and outside Chile and in familiarizing the worldwide geological community with the research efforts of Chilean geologists. He has actively encouraged international cooperation in Andean geological research and has collaborated with Argentine, Brazilian, U.S., British, French, and Japanese scientists. His international leadership is exemplified by his efforts as co-convener of Circum-Pacific Terrane Conference V in 1992 in Santiago and as co-leader of IGCP Project 279 on terranes in South America.

Hervé holds a degree in geology from the University of Chile and doctorates from the University of Paris and University of Hokkaido, Japan. He is currently a professor of geology and geophysics at the University of Chile in Santiago.

## Ali Mehmet Celâl Şengör

Şengör, a Turkish native, was educated at the State University of New York at Albany and has been a member of the faculty of the Geology Department of Istanbul Technical University since 1982.

Şengör is recognized as one of the leading authorities on the Tethys and the tectonics of Eurasia. His work is considered stimulating, remarkable, and uniquely influential. He has also been characterized as one of the world's foremost geologists.

Şengör has made several major contributions to geology. His work on plate tectonics has successfully linked continental collisions and the disruption of continental interiors. He recognized the significance of the paleo-Tethys in Tethyan evolution through far-ranging studies in Asia. His interpretation of Turkish geology using plate tectonics has implications for geological work throughout the Middle East. He has also applied plate tectonics to Chinese geology, in particular through his recognition of the Songpan-Ganzi System. Şengör's recent work recognizing the role of accretionary complexes in the evolution of the Altaids in Asia supports a new orogenic theory that may be applicable to many mountain systems worldwide. Much of Şengör's work has been published as finely detailed regional syntheses that have been widely praised for their meticulous research.

Ali Mehmet Celâl Şengor

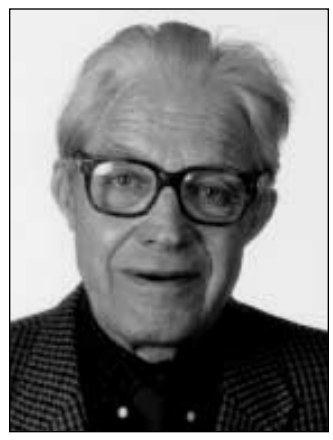
Şengör's current research interests include the tectonic evolution of the Tethyan domain since the Paleozoic; the tectonics of China, particularly the Tibetan/Himalayan region; the tectonics of Turkey; the tectonics of extensional areas, with special focus on the Aegean region; the petroleum geology of Asia; the history of the study of tectonics; and eustatic sea-level controls and orogeny.

Şengör is an active member of the scientific community. As a member of professional organizations on three continents, he travels frequently, maintaining close personal ties with geologists throughout the world, but particularly with those in Europe and Asia. As a member of GSA for more than 20 years, he has been a frequent contributor to the Society's books and journals.

His numerous awards include medals, an honorary doctorate from the Université de Neuchâtel, and the first Turkish membership in Academia Europaea—he is the youngest member ever elected to that body. Şengör is one of 10 founding members of the Turkish Academy of Sciences. He is also a patron of the earth sciences in Turkey, and he provides substantial financial support for geological research and library acquisition.

## François Ellenberger

At age 79, French geologist François Ellenberger is one of the deans of the earth sciences in Europe. During his long and varied career he has made contributions of fundamental importance in a wide range of fields, including stratigraphy, structure, and metamorphism of alpine mountain belts, Hercynian migmatites, comparison of the Caledonides and Mauritanides, fossil vertebrates and invertebrates in Europe and southern Africa, and the history of geology.



François Ellenberger

During the 1950s, Ellenberger carried out major field work in the Vanoise, a particularly isolated part of the metamorphic French Alps. His multidisciplinary approach, including stratigraphy, paleontology, sedimentation, paleogeography, tectonics (including microtectonics), and metamorphic petrology, exemplifies the breadth of his background and the approach he has brought to research problems throughout his career. By carefully etching a Triassic dolomite from the Vanoise in weak acid, he revealed an important flora and fauna in a formation that had been thought unfossiliferous. His well-supported arguments for syntectonic metamorphism in the Massif de la Vanoise and in certain other complex mountain structures were not well received in France at that time. As a result of his work, he also advocated a major revision of Swiss tectonics that was intensely opposed. However, this work is now universally accepted.

Ellenberger's studies of fossil assemblages in the Paris Basin contributed significantly to understanding of events at the Cretaceous-Tertiary boundary. His work in the Upper Triassic Stormberg Series of South Africa revealed an exceptional bone bed with primitive vertebrates that seemed to be transitional between quadrupedal and bipedal. His research in paleontology earned him an honorary fellowship from the Geological Society of London.

While engaged in field work, Ellenberger always thoroughly investigated the writings of earlier workers in these study areas. As a result, he developed a profound appreciation for the value of the history of geology. His lifelong study of the history of geology has resulted in the recent publication of two major books on the subject. Ellenberger is also the recipient of the GSA History of Geology Award for 1994. Details of Ellenberger's work on the history of geology will appear in *GSA Today* in March in the medals and awards citations and responses.

Widely recognized as a naturalist and honored as a geologist, François Ellenberger now lives near Paris, pursuing botany and his studies of the history of geology. ■

# CALL FOR NOMINATIONS REMINDERS

Materials and supporting information for any of the following nominations may be sent to GSA Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. For more detailed information about the nomination procedures, refer to the October 1994 issue of GSA Today, or call headquarters at (303) 447-2020, extension 136.

## Distinguished Service Award

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Student Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the Annual Meeting of the Society. Deadline for nominations for 1995 is **MARCH 1, 1995.**

## John C. Frye Environmental Geology Award

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a $1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund. The 1995 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in New Orleans.

Nominations can be made by anyone, based on the following criteria: (1) paper must be selected from GSA or state geological survey publications, (2) paper must be selected from those published during the preceding three full calendar years, (3) nomination must include a paragraph stating the pertinence of the paper.

Nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers). Deadline for nominations for 1995 is **MARCH 31, 1995.**

## National Awards

The deadline is **APRIL 30, 1995,** for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award.

**Drilling** *continued from p. 25*

that results in nutrient-depleted surface waters and oxygen-rich deep waters. This circulation system plays a significant role in heat transport to the high northern latitudes and contributes directly to North Atlantic deep-water formation, thereby representing an important driving force of the deep-ocean "conveyor belt" that transits the world ocean.

## DRILLING RESULTS: ODP LEG 151

ODP Leg 151 is part of the North Atlantic–Arctic gateway (NAAG) project, a coordinated effort to study the paleoceanographic evolution of the Arctic Ocean, Norwegian-Greenland Sea, and northern North Atlantic during the Cenozoic. This research effort consists of two ODP drilling legs to this area, Leg 151 in the summer of 1993 and Leg 162 in the summer of 1995. These ODP drilling efforts are also linked to the Nansen Arctic Drilling Program, dedicated to studying the long-term climatic evolution of the Arctic Ocean. Obtaining long sediment sequences from the Arctic Ocean and the northern North Atlantic is central to documenting the Cenozoic evolution of climate and ocean circulation in the northern and southern gateway regions. The major objectives of this project are (1) to study the Cenozoic paleoceanography of the Nordic seas, including the history of surface- and deep-water exchange through the northern and southern gateways; (2) to investigate the role of the tectonic evolution of the North Atlantic–Arctic gateways in regional and global climatic change; (3) to examine the late Neogene evolution of arctic and subarctic sea ice and continental ice sheets; and (4) to document the latest Quaternary climatic history of the northern North Atlantic through high-resolution studies of Milankovitch- to millennial-scale variability.

NAAG I drillsites were planned to take advantage of late summer sea-ice–free conditions in the Norwegian-Greenland Sea and Arctic Ocean. Ice-free conditions are essential to the operation of the drillship JOIDES *Resolution*. In order to drill hundreds of meters below the sea floor in water depths of several hundreds to thousands of meters, the ship must be able to remain stationary for several days to a week or more. Consequently, the Finnish icebreaker *Fennica* was contracted to protect the drillship from any advancing sea ice or icebergs (Fig. 1). Although extensive sea-ice cover prevented drilling at two important sites (proposed sites Yerm-1 and Yerm-5), ODP Leg 151 recovered the first deep-drilled sedimentary sequences from the Arctic Ocean in August and September 1993. The JOIDES *Resolution* drilled three sites in a depth transect on the Yermak Plateau northwest of Svalbard at lat ~80°N and long 5°–8°E. Leg 151 also recovered material from two sites in Fram Strait between Svalbard and Greenland, and from one site each on the East Greenland Margin and the Iceland Plateau (Fig. 2). Nearly 3500 m of section were drilled, ranging in age from middle Eocene (~45 Ma) to present (Fig. 3).

The sites successfully drilled on the Yermak Plateau were the first drillsites in the Arctic Ocean proper, and are of particular interest to the scientific community. These sites were selected to study the Neogene evolution of arctic glacial conditions and to examine vertical differences in sediment properties, accumulation rates, and surface- to deep-water circulation. Sites 910, 911, and 912 were drilled in water depths of ~556, 902, and 1037 m, respectively. The drilling program included triple hydraulic piston coring, rotary coring, and well logging. The sediments recovered are silty clays and clayey silts with a large component of terrigenous material including glacial dropstones, and are Pliocene–Quaternary in age. Biogenic material occurs sporadically throughout the sequences but is abundant only in the upper Quaternary. Carbonate contents are very low, ranging from 1.5%–6%, and organic carbon values are high for such an open shelf setting, ranging from 0.7%–1.4%. The upper Quaternary is also marked by enhanced preservation of color banding; thin, very dark gray layers alternate with olive-gray sediments. The Yermak Plateau sequences are interpreted as nearly uniform hemipelagic sediments with a significant component of ice-rafted terrigenous material, including terrestrial organic carbon. High organic carbon contents are attributed to a combination of terrigenous flux and marine organic carbon supply associated with sea-ice edge productivity.

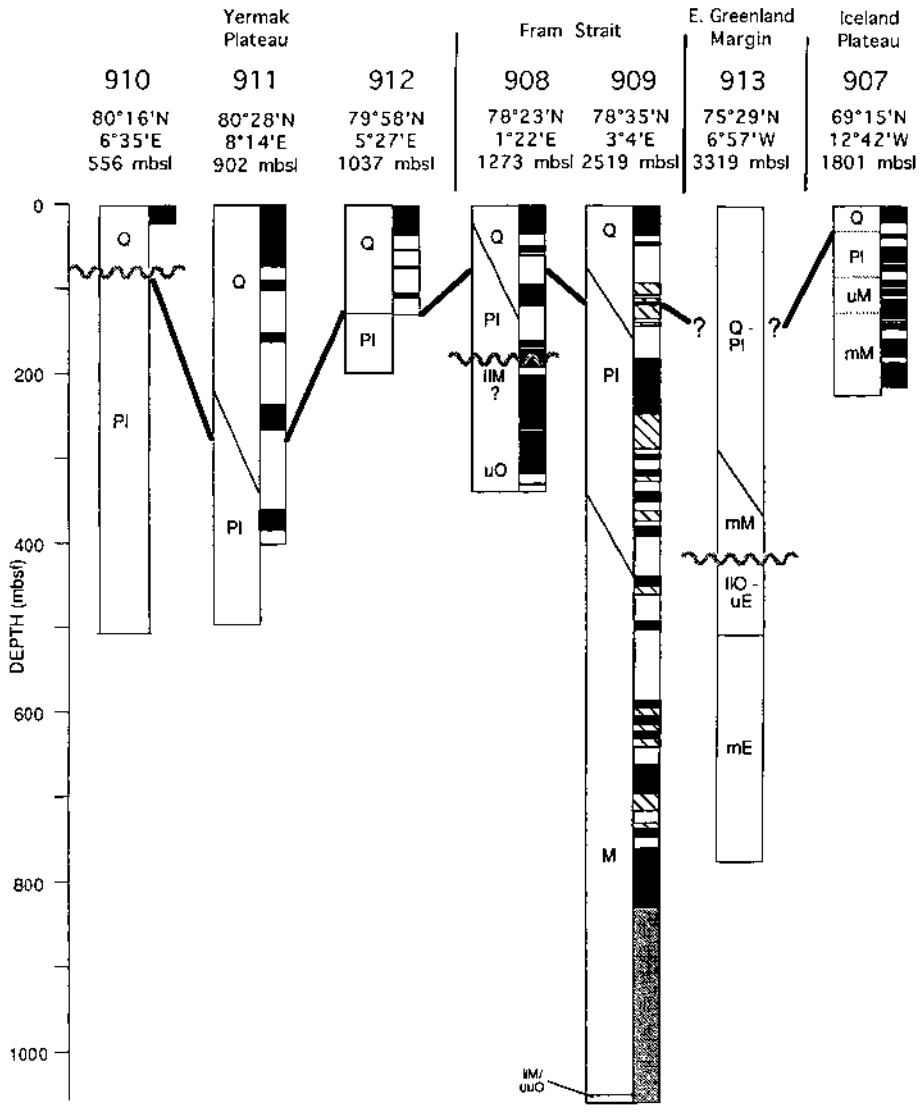



**Figure 3.** ODP Leg 151 drilled sequences vs. depth, grouped north to south as sites from the Yermak Plateau, Fram Strait, East Greenland margin, and Iceland Plateau. Location, water depth in meters below sea level (m bsl), age, major unconformities, and magnetic polarity records are shown for each site; lIM = lower lower Miocene, lIO = lower lower Oligocene and uuO = upper upper Oligocene.

## High Sedimentation Rates on the Yermak Plateau

Obtaining long sediment sequences from the Yermak Plateau to document the onset of arctic glacial conditions proved to be a difficult task, not only because of sea-ice conditions, but mainly because of an unexpectedly thick Pliocene–Quaternary sedimentary section. When drilling terminated at ~500 m below sea floor (m bsf) at both sites 910 and 911, the sediments were still Pliocene in age (Fig. 3). Sedimentation rates based on magnetostratigraphy at Site 911 range from ~17 cm/ka during the late Pliocene to ~10 cm/ka during the past 1 m.y. These rates are distinctly higher than those based on piston cores from the area; sedimentation rates for the last glacial-interglacial cycle on the Yermak Plateau range from 1.6 to 5 cm/ka (Gard, 1986, 1990, Baumann, 1990), and rates in the central Fram Strait average ~3 cm/ka (Eisenhauer et al., 1990; Köhler and Spielhagen, 1990).

The remarkable thickness of the Yermak Plateau sequences relative to upper Quaternary sediments from piston cores, and their large terrigenous component, need explanation. High sedimentation rates suggest that the Yermak Plateau was a locus of deposition for hemipelagic and terrigenous sediments, including ice-rafted material, during most of the Quaternary. When and how did conditions change such that hemipelagic sedimentation and supply of ice-rafted material to the Yermak Plateau decreased during the late Quaternary? One possible explanation is that decreased transport and melting of sediment-laden sea ice and icebergs derived from circumarctic land masses was due to changing surface current systems. In the present day, the transpolar drift funnels sea ice from the circumarctic across the Yermak Plateau through the narrow Fram Strait, where the warm West Spitsbergen Current accelerates sea-ice and iceberg melting and sediment deposition. Decreased strength of either the transpolar drift or the West Spitsbergen Current could account for such a decrease in detrital sedimentation rates. Alternatively, decreased supply of ice-rafted material could reflect the establishment of a semipermanent sea-ice cover and/or increased stability of circumarctic ice sheets. Refining the timing of this change in sedimentation rates and establishing the environmental changes that caused it may be key to reconstructing the glacial evolution of the Arctic gateway region during the Quaternary.

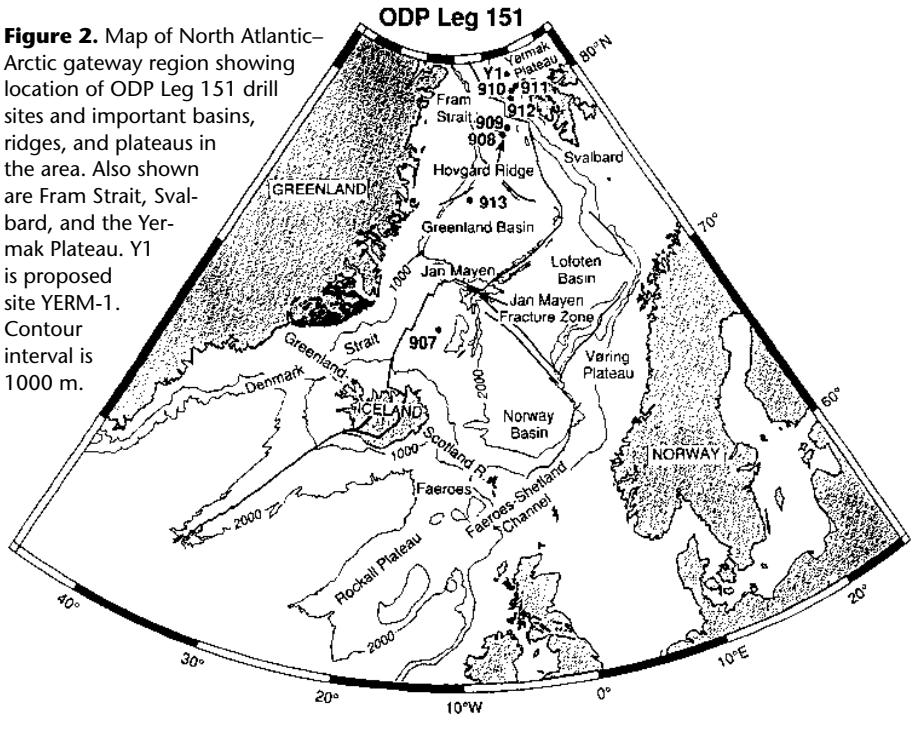



**Figure 2.** Map of North Atlantic–Arctic gateway region showing location of ODP Leg 151 drill sites and important basins, ridges, and plateaus in the area. Also shown are Fram Strait, Svalbard, and the Yermak Plateau. Y1 is proposed site YERM-1. Contour interval is 1000 m.

## "Overconsolidated" Sediments at Site 910

The puzzle of relatively high Pliocene–Quaternary sedimentation rates is compounded by apparent "overconsolidation" of the sedimentary section within the Quaternary at site 910, which constitutes an important change in physical properties observed in the Yermak Plateau sites. Coring at site 910 met with "overconsolidated" silty clays and clayey silts, at ~19 m bsf, which were very difficult to penetrate with the hydraulic piston corer. Shipboard measurements of physical properties of these sediments (from ~9 to 20 m bsf) revealed a sharp increase in sediment strength with depth from <100 to >300 kPa, an increase in wet bulk density from 1.7 to 2.2 g/cm$^3$, and an abrupt decrease in porosity from 50% to 35%. One possible explanation for such overconsolidation prior to the latest Quaternary is that an expanded Barents ice shelf buttressed by Svalbard may have repeatedly become grounded in certain Quaternary glacial intervals and overcompacted shallow sediments on the Yermak Plateau. This possibility has implications for models of Barents Sea shelf glaciation in particular (e.g., Elverhøi et al., 1990) and ideas about the possibility of a large arctic ice sheet during the Pleistocene (e.g., Hughes et al., 1977). A fourth hydraulic piston core hole was drilled for more detailed shore-based geotechnical and stratigraphic studies, which are underway

**Drilling** *continued on p. 32*

**Drilling** *continued from p. 31*

to determine the mode and timing of sediment compaction.

## Late Neogene Dropstone Input

Dropstones are found throughout the sequences recovered from the Yermak Plateau, which extend to the mid-Pliocene (site 910). Increases in dropstone input and siliciclastic abundances in these sequences suggest that glacial conditions in the Arctic gateway region became especially intense at ca. 1 Ma. The onset of arctic glacial conditions in this region is inferred from the first consistent occurrence of dropstones at Fram Strait sites 908 and 909 during the early Pliocene. Increased glacial conditions are indicated at ca. 2.5 and ca. 1 Ma. The oldest ice-rafted dropstones in the Leg 151 sites were seen in the late Miocene ca. 6.4 Ma at site 907 on the Iceland Plateau, significantly earlier than in the Fram Strait region. This finding is consistent with the age of the oldest dropstones known from the Vøring Plateau in the Norwegian Sea at ca. 10 Ma (Jansen et al., 1988, 1991; Krissek, 1989) and in the Greenland Sea in the late Miocene at ca. 7 Ma (ODP Leg 152). The glacial record in the Greenland-Iceland-Norwegian Seas clearly extends farther back in time than in the North Atlantic, where the onset of ice-rafted terrigenous material occurred in the late Pliocene ca. 2.5 Ma (Shackleton et al., 1984). Differential glacial histories of the source areas involved may account for these discrepancies in timing. Post-cruise research will attempt to address the individual histories of the circumarctic ice sheets.

## Cenozoic Deep-Water Circulation in the Norwegian-Greenland Sea

The oldest sediments drilled during Leg 151 were middle Eocene in age from site 913 on the East Greenland margin. The sediments are finely laminated, highly organic and carbon rich (reaching peaks of >2%), and contain many sediment-gravity deposits. Biosilica content was very high in the late Eocene at this site, at a similar age to that observed elsewhere in the Atlantic Ocean (e.g., Berggren and Van Couvering, 1974). Laminated upper Eocene biosiliceous sediments are locally very colorful greenish blues and purplish blues, attributed to the presence of vivianite (Fig. 1B). These laminated sediments with high amounts of terrigenous organic matter and biosilica indicate a restricted basin with high surface productivity in close proximity to a continental source during the initial phase of rifting in the Greenland basin. Site 913 also recovered upper Eocene–lower Oligocene sediments with abundant biosiliceous material that will allow examination of the response of biosiliceous plankton in the Norwegian-Greenland Sea to high-latitude cooling at this time.

Laminated sediments with significant biosilica contents recovered in several upper Oligocene and lower Miocene sections suggest poor ventilation of deep waters continued into the Neogene. An unconformity encompassing much of the early Miocene–early Pliocene is present at site 908, below which are found biosilica- and biocarbonate-bearing upper Oligocene–lower Miocene sediments from ~190 to 330 m. These sediments are commonly laminated and color banded and have relatively high organic carbon values (~0.7%–2.2%), confirming that the early rifting phase in Fram Strait featured only limited deep-water exchange between the Arctic Ocean and Norwegian-Greenland Sea. The sequence at site 909 (~1060 m in length) provides a continuous lower Miocene–Quaternary record in Fram Strait. The presence of laminated and color-banded sediments through the middle Miocene, with organic carbon values ranging from ~0.7% to 1.5%, suggests low oxygen and high carbon dioxide levels in deep waters, indicative of sluggish deep-water circulation during this interval in Fram Strait.

Biosilica-rich deposition continued at site 907 on the Iceland Plateau (~1800 m water depth) well into the late Miocene until ca. 7 Ma. Accumulation of biosiliceous material until ca. 7 Ma at this site suggests that nutrients were concentrated in deep waters and upwelled to foster surface-water productivity. This pattern of circulation marked by deep-water inflow and surface-water outflow suggests an estuarine-style system, in contrast to the modern anti-estuarine circulation in the Norwegian-Greenland Sea, which is marked by deep convection. This inferred circulation history in the Norwegian-Greenland Sea suggests that deep convection could not have been a major contributor to North Atlantic deep-water formation until after ca. 7 Ma. This result needs to be reconciled with previous findings that northern component water formation has been significantly enhanced since ca. 12.5 Ma (Woodruff and Savin, 1989, 1991; Wright et al., 1992). One possible resolution is that during the interval from ca. 12.5 to 7 Ma, northern component water could have been derived mainly from other source areas such as the Labrador Sea, or from shallower depths in the Norwegian-Greenland Sea.

ODP Leg 151 also recovered material from distinctly warm intervals of the Cenozoic, including the mid-Pliocene at sites 907, 909, and 910, the late Oligocene–early Miocene at site 908, and the middle–late Eocene at site 913. Records from these sequences will help refine climate models by allowing comparison of northern polar and subpolar paleoenvironments to global climates.

## FUTURE DRILLING

Sequences drilled by ODP Leg 162 in the summer of 1995 as part of NAAG II will improve the stratigraphic and geographic coverage of sediment records from this region. Two sites on the Yermak Plateau (proposed sites Yerm-1 and Yerm-5) not drilled on Leg 151 because of ice cover are high-priority targets for NAAG II. The major aim at these sites is to reach preglacial arctic sequences. A site proposed from the southern Svalbard margin is situated to better document the history of the Svalbard and Barents Sea shelf ice sheets. Sites on the Iceland Plateau are planned to study the dynamic history of surface- and deep-water circulation in the Norwegian-Greenland Sea during the Neogene. Additionally, several high-sedimentation-rate drift deposits near the southern gateway, including the Feni and Gardar drifts, are targeted to document the late Quaternary history of surface- and deep-water exchange across the Denmark Strait and the Iceland-Faeroe Ridge. The NAAG II drilling program will continue the effort to address the paleoceanographic and climatic history of the northern and southern gateway regions during the Cenozoic, including the late Neogene evolution of the arctic cryosphere. Further drilling within the Arctic Ocean proper by the Nansen Arctic Drilling Program awaits intensive efforts to develop a platform suited to the arctic pack ice.

## SUMMARY

Despite logistical problems including dynamic sea-ice cover, ODP Leg 151 recovered the first deep-drilled sequences (>500 m) from the Arctic Ocean on the Yermak Plateau, as well as from Fram Strait, the East Greenland margin, and the Iceland Plateau. Material from these sites, ranging in age from middle Eocene (ca. 45 Ma) to present, allow investigation of the paleoceanographic and tectonic history in several important areas and intervals in the North Atlantic–Arctic gateway region.

Shipboard results from piston cores indicate much higher sedimentation rates on the Yermak Plateau and Fram Strait in the Pliocene–Quaternary than in the late Quaternary. A decrease in glacially derived sediments in the late Quaternary may have resulted from some combination of decreased supply from the circumarctic continental ice sheets, changes in surface circulation patterns, and possibly the establishment of a semipermanent sea-ice cover. Overconsolidated Quaternary sediments at site 910 on the Yermak Plateau suggest that a massive ice sheet may have become grounded in certain Quaternary glacial intervals, perhaps derived from the Barents Sea shelf and buttressed by Svalbard.

The oldest dropstones recovered from Leg 151 sites were of late Miocene age at site 907 on the Iceland Plateau, consistent with previous results from the Norwegian-Greenland Sea. However, the first appearance of dropstones in Fram Strait was during the early Pliocene, which may reflect differential histories of the circumarctic ice sheets. Important increases in dropstone input were observed throughout the region at ca. 2.5 and ca. 1 Ma.

Laminated sediments with significant biosilica and terrestrial organic matter recovered in several middle Eocene–middle Miocene sections suggest poor ventilation of deep waters during the early rifting phase in the Norwegian-Greenland Sea. Termination of laminated, biosiliceous sedimentation in the Norwegian-Greenland Sea in the late Miocene also suggests that active deep-water convection did not occur until perhaps ca. 7 Ma.

## ACKNOWLEDGMENTS

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# Majority or Minority, Geology Still Matters

*Jill S. Schneiderman, 1994–1995 GSA Congressional Science Fellow*

After the Republicans overwhelmingly won the November 8 elections, the media used geological vocabulary to describe the election results—tsunami, landslide, tectonic shift—lending irony to a Republican success based on a promise, among many in the Republican "Contract with America," to abolish the U.S. Geological Survey. The personal impact of the election results was to leave me working for the would-be minority, rather than majority, leader, Senator Tom Daschle (D—S.D.).

While other fellows contemplated shifting their assignments, I delved into work in an office still in campaign mode. Senator Daschle's leadership campaign office was readjusting for his race for *minority* leader against Senator Christopher Dodd (D—Ct.) who had stepped into the race since Jim Sasser (D—Tn.) was not reelected. Sasser, and then Dodd, were the favored candidates for leader among the senior Democratic Senators who figured my boss too young for the job. Daily until December 2, the day set for the leadership race, four or five Senators came to our office to meet with Senator Daschle to discuss direction for the Democrats and the nature of the leadership needed to steer the party. Quickly, I became familiar with the faces of regulars such as Senators Barbara Mikulski (D—Md.), Jay Rockefeller (D—W.Va.), John Breaux (D—La.), Byron Dorgan (D—N.D.), and John Kerry (D—Ma.)

Leadership races are notoriously personal elections; since voting is by secret ballot, promises for support may not be firm. Thus, when Senator Daschle left our office the morning of December 2, we wished him good luck and waited anxiously for word on the vote. When the Senators met to hear the leadership nomination speeches in the Old Senate Chamber (restored to its 1859 appearance and open to the public), where Dolley Madison listened to Daniel Webster, Henry Clay, and John Calhoun debate the issues of their day, a proxy vote made Senator Daschle the new Democratic leader with a 24 to 23 count. Posted outside the Chamber, our staff person called the office to report the news. We cheered, not knowing the tumult into which it would send our office.

While Senator Daschle and his policy advisers met with colleagues to craft an agenda that meets the challenges sent by voters, I worked on the issue of flooding along the Missouri River in South Dakota. Constituents in the Pierre–Fort Pierre region had recently brought the matter to Senator Daschle's attention. The issue interests me, as a geologist and educator, for it occupies the intersection of appreciation for the cycles of Earth's rock sphere and hydrosphere and the necessity of living delicately on an ever-changing, heavily-populated Earth. Depending on one's approach, that intersection will be characterized by frustration in encountering obstacles or satisfaction in crafting durable solutions.

One of five major river basins in South Dakota, the Bad River originates in the South Dakota Badlands and flows 130 miles east into the Missouri River. It empties into the Lake Sharpe Reservoir at Pierre six miles downstream from the Oahe Dam. The Bad River drainage encompasses approximately 3120 square miles in western South Dakota which consist of easily eroded claystone and siltstone. The watershed, almost entirely privately owned land, is approximately 65% rangeland and 35% cropland.

The Bad River carries an average of 3.25 million tons of sediment into Lake Sharpe annually. Erosion and sediment accumulation from the drainage has caused water-quality concerns in the region over the past 30 years. Currently, aggradation of the Missouri River channel in the Pierre and Fort Pierre area from heavy sediment influx has restricted the main channel and causes flooding. The Corps of Engineers, though studying the problem, has not offered a remedy. Thus, potential flooding in winter months in Pierre and Fort Pierre prompted constituents to contact Senator Daschle. Though aggradation results in increased river stages throughout the year, during the winter, ice accumulation exacerbates the problem by further restricting the flow of water discharged from behind the Oahe Dam. In order to control the flooding during ice-affected conditions, Oahe Dam power plant releases are reduced. This practice interrupts power generation and is not a permanent solution; it imposes severe constraints on the ability of the Western Area Power Administration to meet power demands in the region during severe cold. The problem represents a difficult conflict between two important purposes of the dam—flood control and hydropower.

By speaking with professionals from the Corps of Engineers, the Natural Resources Conservation Service, the South Dakota Department of Environment and Natural Resources, and South Dakota constituents, I was able to absorb different viewpoints on the problem and to understand Senator Daschle's ability to facilitate a solution. Residents and city officials consider the situation untenable because storm sewers back up, streets flood, water inundates house foundations, leaking into basements, and water-supply well houses have been flooded, a threat to municipal water supplies.

In a 1992 reconnaissance report requested by Rep. Tim Johnson (D—S.D.), the Corps of Engineers investigated alternative solutions to alleviate the power constraints at the dam and control flooding. The corps suggested levee construction as an economically feasible means to provide flood protection. Water-resource management professionals at the South Dakota Department of Environment and Natural Resources view levee construction as a temporary measure that delays the inevitable additional flooding or construction of higher levees. Townspeople object to levees because of their aesthetic and economic impact. Additionally, they recognize that levees would adversely affect high-quality aquatic and terrestrial habitats of two riverine islands used by wintering wildlife populations. Power plant releases would produce higher stages and flood large areas of hardwood habitat and wetlands in LaFramboise and Farm Islands to several feet (U.S. Army Corps of Engineers, Omaha District, May 1992 report). In my opinion, after having

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confronted the floods of 1993, perhaps the Corps should reevaluate the wisdom of levee construction.

South Dakotans living in the affected region recognize the inevitability of sediment transport by the Bad River. Amidst estimates of one foot of additional aggradation at the Pierre stream gage over the next 50 years and predictions of flooding under open-flow conditions, they have cooperated in projects to understand their physical environment. Public involvement led to the Lower Bad River Basin study, which found that: (1) channel and gully erosion are the main sources of sediment; (2) composition of rangeland grasses significantly impacts infiltration rates, which affect runoff and erosion; (3) riparian regions deteriorate because of heavy livestock use, reducing the sediment filtering effects of riparian vegetation; (4) cropland erosion does not produce substantial sediment, but increased runoff from poorly managed croplands accelerates off-site erosion; and (5) one-third of the sediment deposited in Lake Sharpe originates above the study area. An Upper Bad River Watershed study will be completed in 1996 and will be used to implement conservation practices to significantly reduce erosion in the watershed.

Meanwhile, farmers and ranchers are applying accepted conservation techniques on 95% of the land in the watershed. Rather than opt for a Band-Aid solution, South Dakotans are trying to curtail the source of the problem by interacting with Earth in a way that acknowledges the impact of human activities on it. The willingness of local land users to cooperate has attracted national attention: the Bad River Watershed has been selected as a demonstration project as a result of Vice President Al Gore's National Performance Review.

From the standpoint of local residents, the ideal solution is dredging to enlarge the Missouri River channel, in addition to comprehensive plans to prevent soil erosion and curtail sedimentation. During the early weeks of my tenure on Senator Daschle's staff, in addition to talking with the parties involved, I met with Rep. Johnson's staff to discuss future actions on the matter. Senator Daschle and Rep. Johnson will hold a meeting in Pierre in order to air the results of the most recent Corps of Engineers study of the problem and to facilitate communication among the stakeholders. Though it would be preferable to avoid cumbersome legislation, Senator Daschle may be forced to amend the Water Resources and Development Act when it comes up for consideration this year in order to address the problem. Constituent work has always had a high priority in Senator Daschle's office. Thus my efforts on the Missouri River flooding were much appreciated while the office was restructured.

Also during recent weeks, I arranged a seminar for the AAAS fellows with Cokie Roberts, correspondent covering politics for National Public Radio and ABC news. We met with Roberts, whose parents were both members of Congress, at the National Press Club, where she treated us to an analysis of the elections and offered her predictions about the functioning of the 104th Congress.

Finally, but not least, Senator Daschle offered me the opportunity to contribute to the development of the Comprehensive Congressional Reform Act, which he introduced as S.10 on the first day of the 104th Congress. The bill would have extended to Congress the laws that cover all other employers, reformed lobbying registration and disclosure requirements, amended the gift rules of the Senate and the House of Representatives, and reformed the federal election laws applicable to Congress. As a result, I monitored debate on the Senate floor concerning S.2, the Republican Congressional Accountability Act, which will only make certain laws applicable to the legislative branch of the federal government and will not involve a gift ban, lobbying, or campaign finance reform. I also wrote a floor statement for the Senator concerning S.2, which he read in the Senate chamber during debate on the bill.

The events of the past few weeks have been tremendously exhilarating. Upon being elected Democratic Leader, Senator Daschle asserted, "The Members of our Caucus are ready to move forward with legislation the nation needs. To move forward will demand unity and a great deal of hard work. I will be looking for the help and advice of all my colleagues as I take up the leadership." As the year unfolds, I hope to be able to provide support to Senator Daschle on a variety of legislation both at the state and the national level in order to help him achieve his goals. ■

Jill S. Schneiderman, 1994–1995 GSA Congressional Science Fellow, is serving on the staff of Senator Thomas Daschle (S. Dak.). Schneiderman may be contacted at (202) 224-2321. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 1434-94-G-2509. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government.

# WASHINGTON REPORT

*Bruce F. Molnia*

Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. In future issues, Washington Report will present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

## Draft "National Science Education Standards"—A Chance to Formulate Earth Science Content Standards for the Future

February 28 is a very important date, because it is the deadline for you to provide your input into the development of new "National Science Education Standards." The draft "Standards" includes new earth science education content guidelines for primary and secondary school students in grades K–4, 5–8, and 9–12.

The "National Science Education Standards" were developed by a national committee of nearly 100 teachers, scientists, and science educators to improve scientific literacy among all students. Earth scientists who served on committees and working groups involved in "Standards" development included: Bonnie J. Brunkhorst (California State University at San Bernardino), Charles Groat (Center for Coastal Energy and Environmental Resources, Baton Rouge, Louisiana), Robert W. Ridky (University of Maryland), John Snow (University of Oklahoma), Dana Van Burgh (Dean Morgan Junior High School, Casper, Wyoming), and E-an Zen (University of Maryland).

The "Standards" identify what students "should know and be able to do in science." The guidelines are aimed at "stimulating a dramatic improvement of science education." The draft "Standards" encompasses not only content (i.e., what children should know and be able to do) but also teaching and assessment standards, and guidelines for science education programs and school systems in general.

The development of the draft "Standards" and the preparation of the summary report was coordinated by the National Research Council (NRC). Richard D. Klausner of the National Institute of Child Health and Human Development, chair of the science education standards project, stated that "Our aim is to use the draft to build national consensus about what is important in science education. By placing science education in the context of the entire school system, these science education standards will allow everyone to move in the same direction. However, it is decisions made at the local level that will drive the process of change."

On the local level, several thousand individuals in more than 200 focus groups will have an opportunity to review the "Standards" during the formal review period that ends on February 28. The focus groups are composed of parents, teachers, school administrators, scientists, science educators, and others from around the nation. My purpose in devoting this column to describing the draft "Standards" is twofold: first, to stimulate as many of you as possible to examine the details presented in the "Standards," and second, to challenge you to provide the NRC with your comments.

The following paragraphs paraphrase and summarize the "Earth Science Content Standards" and "Fundamental Concepts" presented for each of the three grade groups.

### CONTENT STANDARDS—GRADES K–4

As a result of their activities in grades K–4, all students should develop an understanding of the properties of Earth materials. Young children are naturally interested in everything they see around them. They should be encouraged to closely observe the objects and materials in their environment and note their properties. They should have opportunities to observe rapid changes, such as the movement of water in a stream, as well as gradual changes, such as the erosion of soil and the change of the seasons.

Children come to school aware that Earth's surface is composed of rocks, soil, water, and living organisms, but a closer look will help them identify many additional properties of Earth materials. By carefully observing and describing the properties of many rocks, children will begin to see that some rocks are made of a single substance but that most of them are made of several substances. In later grades the substances can be identified as minerals. Understanding rocks and minerals should not be extended to the study of the source of the rocks and their characterization as sedimentary, igneous, and metamorphic, because the origin of rocks and minerals has little meaning to children at these grade levels.

The playground and nearby vacant lots and parks provide convenient study sites to observe a variety of Earth materials. As students collect rocks and observe vegetation, they become increasingly aware that the soil varies from place to place in its color, texture, and reaction to water. If they revisit study sites on a regular basis, children begin to develop an understanding that Earth's surface is constantly changing. They can also simulate some changes such as erosion in a small tray of soil or a stream table and compare their observations to photographs of similar, but larger scale changes.

Emphasis in grades K–4 should be on developing observation and description skills and the explanations based on these observations.

**Fundamental Concepts**

*Properties of Earth Materials*

- Earth materials are solid rocks and soils, liquid water, and the gases of the atmosphere.
- Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants.
- The surface of Earth changes.
- Fossils provide evidence about plants and animals that lived long ago and the nature of the environment at that time.

### CONTENT STANDARDS—GRADES 5–8

As a result of their activities in grades 5–8, all students should develop an understanding of the structure of the Earth system, Earth's history, and Earth in the Solar System. A major goal of science in the middle level is for students to develop an understanding of Earth and the solar system of which it is a part, as a set of closely coupled systems. Students can investigate the four major interacting components of the Earth system—geosphere (crust and the interior), hydrosphere (water), atmosphere (air), and biosphere (the realm of all living things). Students may investigate the water and rock cycles as introductory examples of geophysical and geochemical cycles. By plotting the locations of volcanoes and earthquakes, students can see a pattern of geological activity which suggests that the planet's crust consists of an array of huge, slowly moving plates. Research with students of this age indicates that some explanation of moving plates and the evolution of life must be reserved for late in this age range.

**Fundamental Concepts**

*Structure of the Earth System*

- The solid Earth is layered, with a thin brittle crust, a hot convecting mantle, and a dense metallic core.
- Crustal plates on the scale of continents and oceans constantly move. Major geologic events, such as earthquakes, volcanoes, and mountain building, result from these plate motions.
- Land forms are the result of a combination of constructive and destructive forces.
- Changes in the solid Earth can be described as the rock cycle.
- Oil consists of weathered rocks, decomposed organic material from dead plants, animals, and bacteria.
- Water, which covers the majority of Earth's surface, circulates through the crusts, oceans, and atmosphere in what is known as the water cycle.
- Water is a solvent.
- The atmosphere is a mixture of oxygen, nitrogen, and trace gases that include water vapor.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement influence local weather.
- Living organisms have played many roles in the Earth system, including affecting the composition of the atmosphere and contributing to the weathering of rocks.

*Earth History*

- The Earth processes we see today are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.
- Fossils provide important evidence of how life and environmental conditions have changed.

*Earth in the Solar System*

- The Earth is the third planet from the sun in a system that includes the moon, the sun, and eight other planets and their moons. The sun, an

**Standards** *continued on p. 36*

# SAGE REMARKS

*Lincoln S. Hollister*
*Department of Geology, Princeton University, Princeton, NJ 08544*

## Talking to the Public—An Example

Last September, I had an experience that is an example of how a field project can be integrated with the education of the public in the earth sciences.

The ACCRETE pilot seismic study was a successful eight-institution experiment that was designed to obtain an image of the Moho and features in the middle to lower crust along a 500 km transect that crosses several accreted terrane boundaries in southeast Alaska and British Columbia. We combined the marine seismic capabilities of the 73-m-long R/V *Maurice Ewing* with Reftek portable seismometers placed along the shores of the inland waterways.

From the perspective of people living in the area of study, the seismic field experiment was, at first glance, so environmentally invasive that we were worried we might never get the necessary permits. The project was threatening because we planned to "shoot" airguns every 20 s for 10 days in the waters of one of the north Pacific's highly productive fishing grounds and through the feeding grounds of marine mammals, including several endangered species. If we could not demonstrate that our experiment would be harmless to fish and marine mammals, we would not be permitted to do our study.

How to get the permits? There were two routes: either contact government authorities in Juneau, Ottawa, Victoria, and Washington and cross our fingers, or get the local inhabitants so interested in our experiment that the government authorities couldn't say no. Because other projects had faced horrendous problems in following the first route, we tried the second.

Our approach brought geology into the public consciousness in a way that not only helped the ACCRETE project succeed, but also generated local public support for geology in general. We succeeded in getting the local population (approximately 30,000 people in the Ketchikan, Alaska, and Prince Rupert, British Columbia, area) to be so supportive of ACCRETE that the inevitable four people who disapproved of it could not find a constituency.

My colleagues and I began the permitting process almost 2 years before we did the experiment. We learned what the core concerns of the region were and who represented those concerns. A colleague from the Geological Survey of Canada, Glenn Woodsworth, and I talked directly with community representatives and, in the process, developed a vocabulary that we could use in answering the three core questions: What harm will your airguns do? Why here? What's in it for us? Then we prepared a video and a press release that addressed these questions and, making myself available to reporters, generated positive interest in the local press and radio. (Those radio talk shows don't have to be negative!)

Several aspects of "working the crowd" were particularly important. First, it was the project leader who was taking the time to meet with the people. I showed respect for their concerns, and, if I didn't know an answer, I would get it, often within 24 hours. Second, I discovered how profoundly curious virtually all people are about their immediate surroundings. I gave a talk at a small museum in a room where 30 people could sit. The museum director was concerned that very few people would brave an evening deluge (it rained 6 inches that night) to hear about geology. Eighty people came—I had to be careful not to step on someone sitting on the floor in front of the screen. The attendance and questions generated were noticed by a local reporter, which led to more good press. I conducted a class at the North Coast Tribal Council Community College, and 40 First Nations students (ages 18–35) kept me 2 hours with their questions. We had an "open house" on the R/V *Ewing* before the experiment, and a high school class toured the ship after the experiment.

What were the key concepts that attracted such positive public interest? It certainly helped that our study was in an area where Canada's largest recorded earthquake and most recent volcanic eruption had occurred. But the really simple and obvious question that seemed to catch everyone's imagination was "How are mountains made?"

I promised to return to speak to local groups about our results. I think this is important because it will return to the community something we took: the geologic history of their area. I think that, without my promised follow-up, the people in the area would not be so receptive to any future large science project.

I strongly recommend that when you are doing a field project, you plan, at the least, to go to a local high school and talk about the local geology to a few classes, and then return at a later date with the product of your efforts. If enough of us do this, the potential impact could be huge. I heard the chair of a department lamenting at the GSA meeting in Seattle that his young hot-shot faculty feels "above" doing such things. I suggested that maybe this was something *he* should do, to help ensure a future for his younger colleagues. ■



**Standards** *continued from p. 35*

average star, is the central and largest body in the solar system.
- Most objects in the solar system are in regular and predictable motion.
- Gravity is the force that keeps planets in orbit. Gravity also holds us to Earth's surface and explains the phenomena of the tides.
- The sun is the major source of energy for phenomena on Earth's surface.

### CONTENT STANDARDS—GRADES 9–12

As a result of their activities in grades 9–12, all students should develop an understanding of energy in the Earth system, geochemical cycles, and the origin and evolution of the universe. In grades 9–12, students focus on matter, energy, crustal dynamics, cycles, geochemical processes, and the expanded time scales necessary to understand events in the Earth system. Students review the water cycle as a carrier of material, and they deepen their understanding of this key cycle to see that it is also a carrier of energy. Students' explorations are directed toward the carbon cycle. Studies develop the concept of the Earth system existing in a state of dynamic equilibrium. The Earth system will generally stay within a certain narrow range for millions of years. This long-term stability can be understood through the working of planetary geochemical cycles and the feedback processes that help to maintain or modify these cycles.

As an example of this long-term stability, students find that the geologic record suggests that the global temperature has fluctuated within a relatively narrow range for more than three billion years. They explore the regulation of Earth's global temperature by the water and carbon cycles.

The age of the universe and its evolution into galaxies, stars, and planets, and eventually life on Earth is a story that fascinates and challenges students.

**Fundamental Concepts:**

*Energy in the Earth System*
- Earth systems have both internal and external sources of energy, both of which create heat.
- The outward transfer of Earth's internal heat drives convection circulation in the mantle which propels the crustal plates. Global climate is determined by the heat transfer from the Sun at and near Earth's surface.

*Geochemical Cycles*
- The Earth is a system containing essentially a fixed amount of each stable chemical atom or element.
- Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. Carbon, for example, occurs in rocks as limestone, in the atmosphere as a gas, in water as dissolved carbon dioxide, and in all living things as complex molecules that control the chemistry of life.

*Origin and Evolution of the Earth System*
- The sun, Earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. The early Earth was very different from the planet we live on today.
- Geologic time can be estimated by observing rock sequences.
- Interactions among the solid Earth, the oceans, the atmosphere, and living things have resulted in the ongoing evolution of the Earth system.
- Evidence for simple, one-celled forms of life, such as bacteria and algae, extends back more than 3.5 billion years.

*Origin and Evolution of the Universe*
- The origin of the universe remains one of the greatest questions in science.
- Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars.
- Stars produce energy from nuclear reactions.

After you have had an opportunity to digest the contents of the "Standards," I invite you to contact Ed Geary, facilitator of GSA's Focus Group on the Standards, and to submit your comments. Request the full copy of the "Earth Science Standards" if you wish more detail. The address is: Ed Geary, Education Dept., Geological Society of America, 3300 Penrose Place, Boulder, CO 80301, (303) 447-2020. ■

## Memorial Preprints

The following memorial preprints are now available, free of charge, by writing to GSA, P.O. Box 9140, Boulder, CO 80301.

**Robert L. Bates**
*Donald D. Carr, Michael C. Hansen, Walter C. Sweet*

**Ronald Kinnison DeFord**
*Samuel P. Ellison, Jr.*

**Louis Heyman**
*Tony Kolodziej*

**Ian McKay Johnston**
*Michael J. Walawender*

**Heinz Lowenstam**
*Stephen Weiner*

**Sherman Kennerson Neuschel**
*Frank C. Whitmore, Jr.*

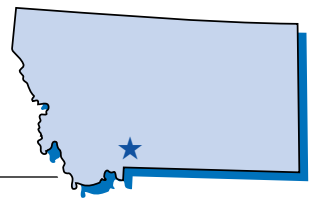
**Charles Vernon Theis**
*Robert R. White*

**William Herbert Yoho**
*E. C. Pirkle*

**Final Announcement**

# ROCKY MOUNTAIN SECTION, GSA 47th Annual Meeting

## Bozeman, Montana
## May 18–19, 1995



The Rocky Mountain Section of the Geological Society of America will meet jointly with the Rocky Mountain Section of the Paleontological Society of America and the Southwest Section of the National Association of Geology Teachers in the Strand Union Conference Center on the campus of Montana State University in Bozeman, Montana. Host for the meeting is the Department of Earth Sciences at Montana State University.

## ENVIRONMENT

Bozeman, a community of 32,000, is 90 miles north of Yellowstone National Park. A wide variety of rock types and ages are represented in the Bozeman area, including 4 Ga basement rocks, Middle Proterozoic clastic and carbonate rocks of the LaHood Formation (Belt Supergroup), Paleozoic and Mesozoic marine shelf strata, volcaniclastic assemblages related to Late Cretaceous and early Tertiary igneous centers, and more recently, Tertiary basin-fill sedimentary rocks. The Gallatin Valley overlaps the Middle Proterozoic Belt basin, the Sevier orogenic belt, the Laramide foreland province, several igneous provinces, and the eastern margin of the Basin and Range province. The tectonomagmatic effects of the Yellowstone hotspot have overprinted all of the above over the past 2 m.y., and Quaternary processes are evident in the glaciated mountains and fluvial terraces of the region.

The meeting will be held in the Strand Union (SUB) on the Montana State University campus (student population 10,000). May in Bozeman can be rainy and/or snowy. The mean May precipitation is 3.2 inches. The average minimum May temperature is 37° F, and the average maximum temperature is 63° F. Expect a wide range of weather conditions.

## TRAVEL

Air service to Gallatin Field is provided by Delta, Northwest, and Frontier. Delta Airlines, the official air carrier for the meeting, is offering discounts of 5% off the lowest applicable fare or 10% off a nonrestricted full coach fare. Call Montana Travel at 1-800-247-3538 and tell them you will be attending the GSA meeting. Car rental agencies operating at the airport are Budget, Avis, Hertz, and National. Car rentals off airport include Payless, Thrifty, and Rent-A-Wreck. Call for Montana Travel's special rates at 1-800-247-3538. The airport is about 10 miles from Bozeman. A shuttle bus will run from the airport to the motel district on Tuesday and Wednesday May 16 and 17, from noon to 11 p.m. Shuttle service from the primary hotel centers to the airport will run on Saturday and Sunday, May 20 and 21, from 5:30 a.m. to 3:30 p.m. If you arrive at a time when the shuttle is not operating, you'll need to call City Taxi, (406) 586-2341. Many of the hotels have shuttle service for registered guests. A shuttle bus will operate between campus and the primary hotel centers in Bozeman in the morning before the first session and in the evening after the last session. Registration is in the Strand Union on the Montana State University Campus. The recommended route to Strand is 11th to Grant. Both parking and the Union are at the corner of Grant and 7th.

## ACCOMMODATIONS AND MEALS

Residence hall facilities are available on the Montana State University campus in North Hedges, just west of the corner of Grant and 11th; a three-day package is available. Direct your questions to MSU Conference Housing, Montana State University, Bozeman, MT 59717, (406) 994-2661.


Blocks of motel rooms have been reserved for GSA meeting attendees at the following: Comfort Inn, 1-800-833-3833; Days Inn, 1-800-325-2525; Fairfield Inn by Marriott, (406) 587-2222; Gran Tree Inn, 1-800-624-5865; Holiday Inn, 1-800-366-5101. Tell them you are attending the GSA meeting. Make your reservation before April 15, 1995, to get the best rate.

Food will be available at the Strand Union and Miller Dining Hall on campus. Registrants not staying in a residence hall may also preregister to purchase meals at Miller Dining Hall, which is open Monday through Friday for breakfast, lunch, and dinner.

## CALL FOR PAPERS

Technical papers are invited for presentation in conventional theme sessions, symposia, and poster sessions. Papers dealing with all aspects of the Rocky Mountain region as well as those of general geologic interest will be considered. Technical sessions will allow 15 minutes for presentation and 5 minutes for questions and discussion. Speakers are asked to adhere stringently to these time limits.

## FIELD TRIPS

For details on both premeeting and postmeeting field trips, contact the respective field trip leaders. General questions should be addressed to David Mogk, Field Trip Coordinator, Department of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6916, fax 406-994-6923, Internet: uesdm@msu.oscs.montana.edu. Both a premeeting and a postmeeting trip to Paradise Valley will provide an opportunity to explore the outstanding local geology. Field trip costs include travel, lunch, guidebook, and, for two-day trips, lodging. Overnight trip costs do NOT include breakfast or dinner. A guidebook for self-led local field trips in the Gallatin Valley will be available for purchase.

### Premeeting

1. **The Yellowstone Valley from Livingston to Gardiner, Montana: A Microcosm of Northern Rocky Mountain Geology.** Wednesday, May 17, 1995. Most of the geologic history of the central Rockies is represented here, from Archean crustal evolution to Quaternary glaciation, to contemporary land-use issues. John Montagne, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6917, fax 406-994-6923; A. D. Barnosky, S. G. Custer, J. E. Elliott, S. Harlan, D. R. Lageson, W. W. Locke, C. Montagne, D. W. Mogk, J. G. Schmitt, M. Smith, Z. Wu. (Also postmeeting.)
2. **Sedimentology and Tectonics of the Bannack–McKnight Canyon–Red Butte Area, Southwest Montana: New Perspectives on the Beaverhead Group and Sevier Orogenic Belt, Southwest Montana.** Tuesday and Wednesday, May 16 and 17, 1995. Relations between deposition of coarse syntectonic deposits (Beaverhead Group) and thrust and fold evolution in the Sevier orogenic belt of southwest Montana will be examined. Development of syntectonic progressive unconformities, coarse facies sedimentology, syntectonic volcanism, and models of thrust system evolution will be topics of discussion. Jim Schmitt, Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6903, fax 406-994-6923, Internet: uesjs@msu.oscs.montana.edu. David Lageson, Chris Haley.
3. **Patterns and Processes of Cambrian Mass Extinctions: An Integrated Approach Illustrated at Nixon Gulch in the Gallatin Valley.** *Sponsored by the Rocky Mountain Section of the Paleontological Society.* Wednesday, May 17, 1995. This trip will visit the classic Nixon Gulch locality in the Gallatin Valley. Rob Thomas, Dept. of Geosciences, Western Montana College, Dillon, MT 59725, (406) 683-7615, Internet: r_thomas@wmc.edu; Dave Backus, Matt Saltzman.
4. **Mine Geology, Reclamation, and Acid Drainage Research at the Golden Sunlight Mine, Whitehall, Montana.** Wednesday, May 17, 1995. Led by Troy Smith, Golden Sunlight Mine. David Mogk, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6916, fax 406-994-6923, Internet: uesdm@msu.oscs.montana.edu.
5. **Archean and Early Proterozoic Geology in the Highland Mountains, Southwestern Montana.** Wednesday, May 17, 1995. Led by J. Michael O'Neill, U.S. Geological Survey, Denver. The rocks and structures of this area exhibit the development of a Proterozoic mantled gneiss dome and provide evidence of an important stage of crustal evolution in southwestern Montana. The crystalline rocks include Archean basement that was partially reworked ca. 1800 Ma and mafic to felsic Proterozoic intrusive rocks. David Mogk, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6916, fax 406-994-6923, Internet: uesdm@msu.oscs.montana.edu.

### Postmeeting

6. **The Yellowstone Valley from Livingston to Gardiner, Montana: A Microcosm of Northern Rocky Mountain Geology.** Saturday, May 20, 1995. See field trip 1 description. William Locke, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6917, fax 406-994-6923. See trip 1 for co-leader list.
7. **Hydrogeologic Aspects of Remediation of Metal-Mine Impacts on Upper Clark Fork Superfund Sites, Butte, Montana.** Saturday, May 20, 1995. Ted Duame, Montana Bureau of Mines and Geology, Butte, MT 59701, (406) 496-4157, fax 406-496-4344.
8. **Tertiary Tectonics of the Northern Border Zone of the Yellowstone Hotspot Track, Montana and Idaho.** Saturday and Sunday, May 20 and 21, 1995. Jim Sears, Dept. of Geology, University of Montana, Missoula, MT 59812, (406) 243-2341, fax 406-243-4028, Internet: jwsears@selway.umt.edu; Susanne Janecke, Bill Fritz, Rob Thomas.

## REGISTRATION FEES

| | Before April 8 | After April 8 |
|---|---|---|
| Professional— | | |
| Member | $50 | $60 |
| Nonmember | $65 | $75 |
| Student or Teacher— | | |
| Member | $10 | $20 |
| Nonmember | $20 | $30 |

## SYMPOSIA

Sessions will include general geology, Quaternary geology, igneous geology and volcanology, metamorphic

**Rocky Mountain** *continued on p. 38*

**Rocky Mountain** *continued from p. 37*

geology, structural geology, stratigraphy and sedimentation, tectonics, paleontology and paleobotany, and earth science education. The following symposia will include both invited papers and selected volunteered papers. Prospective authors are encouraged to contact the respective conveners. Address general questions to either Dave Lageson, (406) 994-3331, fax 406-994-6923, Internet: uesdl@msu.oscs.montana.edu, or Jim Schmitt same address as above (406) 994-6903, fax 406-994-6923, Internet: uesjs@msu.oscs.montana.edu, both at Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348.

1. **The Yellowstone Valley from Livingston to Gardiner, Montana: A Microcosm of Northern Rocky Mountain geology.** Classic examples of and exceptions to regional geological evolution from Archean lithogenesis to modern land-use planning. John Montagne, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6915, fax 406-994-6923, Internet: ueswl@msu.oscs.montana.edu; Bill Locke.

2. **Tertiary Tectonics of the Northern Border Zone of the Yellowstone Hotspot Track, Montana and Idaho.** Jim Sears, Dept. of Geology, University of Montana, Missoula, MT 59812, (406) 243-2341, fax 406-243-4028, Internet: jwsears@selway.umt.edu; Bill Fritz, Rob Thomas, Susanne Janecke.

3. **Late Cretaceous–Early Paleogene Paleofaunas and Paleoenvironments of the Northern Rocky Mountains.** *Sponsored by the Rocky Mountain Section of the Paleontological Society.* Rob Thomas, Dept. of Geosciences, Western Montana College, Dillon, MT 59725, (406) 683-7615, Internet: r_thomas@wmc.edu; Jason Lillegraven.

4. **Patterns and Processes of Mass Extinction: An Integrated Approach.** *Sponsored by the Rocky Mountain Section of the Paleontological Society.* Rob Thomas, Dept. of Geosciences, Western Montana College, Dillon, MT 59725, (406) 683-7615, Internet: r_thomas@wmc.edu.

5. **Geology (Hydrogeology, Geomorphology, Sedimentation, and Stratigraphy) of Metal-Mine Impact and Remediation in the Rocky Mountains.** *Sponsored by the Institute for Environmental Education.* William Woessner, Dept. of Geology, University of Montana, Missoula, MT 59812, (406) 243-5698, fax 406-234-4028, Internet: gl_www@selway.umt.edu.

6. **Recent Advances in Understanding the Sevier Orogenic Belt of the Western United States.** New understanding of the Sevier orogen based on out-of-sequence thrusting, syntectonic progressive unconformities, microdeformation mechanisms, hinterland wedge thickening, and other concepts has led to dramatic advances in unraveling the kinematic and sedimentologic history of the orogen. This symposium will provide a forum for presenting new work from Canada to Mexico from this classic thrust belt. Jim Schmitt, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6903, fax 406-994-6923, Internet: uesjs@msu.oscs.montana.edu; David Lageson.

## SHORT COURSES AND WORKSHOPS

The **GSA Institute for Environmental Education** is presenting a Public Information and Education Training Workshop free of charge on Saturday, May 20, 1995. The **Montana University System Geographic Information and Analysis Center** will provide a short course introducing ArcView 2 on Tuesday and Wednesday, May 16 and 17, 1995. Cost of the short course is $350. *Registration deadline is May 1, 1995*. To obtain registration forms, contact Jannett Cherry, Geographic Information and Analysis Center, Montana State University, Bozeman, MT 59717-0348, (406) 994-2374, fax 406-994-6923, Internet: zgi7001@msu.oscs.montana.edu.

## ABSTRACTS

Abstracts are limited to 250 words and must be submitted camera ready on the official 1995 GSA Abstracts form available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020. An original and five copies are required for each abstract. Authors of symposium papers should send their abstracts directly to the appropriate convener (the first name in the list of symposium organizers above). All other abstracts should be sent to David Lageson, Technical Program Chair, Rocky Mountain GSA, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348. Abstracts will be reviewed for informative content and format, appropriate geographic coverage (Rocky Mountain region), and originality. To simplify scheduling and provide opportunities for a diversity of views, only one volunteered paper may be presented by each individual, although a person may also be a co-author of additional papers. One exception to this rule will be made: authors presenting papers on advances in earth science education may also present a paper in another technical section. The abstract deadline was Monday, January 23, 1995.

## PROJECTION EQUIPMENT

All slides must by 2" × 2" and fit standard 35 mm carousel trays. Two projectors and two screens will be available for all oral sessions. Authors are strongly encouraged to bring their own preloaded carousels. The organizing committee will not be responsible if a carousel is unavailable for your talk (but will provide a limited number of carousels for general use, availability being at the author's risk).

## POSTER SESSIONS

Poster sessions will be located adjacent to the exhibit and registration area. Each presenter will be allotted two 4 × 6 foot Cellotex boards. Questions regarding posters should be directed to Dave Lageson or Jim Schmitt (addresses under symposia).

## STUDENT PRESENTATIONS

Students, both graduate and undergraduate, are strongly encouraged to present the results of their research in poster sessions, symposia, or general sessions. The Geology Division of the Council on Undergraduate Research (CUR) will sponsor a special poster ses-

**Rocky Mountain** *continued on p. 39*

# Preregistration Form

## GSA Rocky Mountain Section

**Preregistration deadline is April 8, 1995.** *(Cancellation deadline is May 1, 1995.)*

**Bozeman, Montana • May 17–18, 1995**

**Please print clearly.**

Name (First) (M.I.) (Last)

Employer/Affiliation

Mailing Address

City State Zip Code

( ) Business Phone ( ) fax ( ) Home Phone

NAME TO APPEAR ON NAME TAG

Please indicate if you will need services to accommodate a disability ☐ Yes

**TRAVEL INFORMATION:** *(Please provide travel information so that we can adequately plan for airport transportation.)*

Mode of Travel: ☐ Car ☐ Air ☐ Bus Arrival Date: _____ Time: _____ a.m./p.m. Airline: _____ Flight: _____

Departure Date: _____ Time: _____ a.m./p.m. Airline: _____ Flight: _____

| **REGISTRATION** | Before APRIL 8 | After APRIL 8 | Qty | Amount |
|---|---|---|---|---|
| Professional Member (#_____) | $50 ☐ | $60 ☐ | 1 | $_____ |
| Professional Nonmember | $65 ☐ | $75 ☐ | 1 | $_____ |
| Student or Teacher Member (#_____) | $10 ☐ | $20 ☐ | 1 | $_____ |
| Student or Teacher Nonmember | $20 ☐ | $30 ☐ | 1 | $_____ |
| **GUEST PROGRAM** *(see separate form)* | | FREE | ___ | $_____ |

Guest Name for Badge _____

| **BUSINESS LUNCHES** | | | | |
|---|---|---|---|---|
| Paleontological Society, Rocky Mountain Section | | $ 8 | 1 | $_____ |
| GSA, Rocky Mountain Section | | $ 8 | 1 | $_____ |
| **FIELD TRIPS** | | | | |
| 1. Yellowstone Valley: A Microcosm | May 17 | $ 30 | 1 | $_____ |
| 2. Bannack-McKnight Sedimentation and Tectonics | May 16–17 | $100 | 1 | $_____ |
| 3. Cambrian Mass Extinctions | May 17 | $ 25 | 1 | $_____ |
| 4. Golden Sunlight Mine | May 17 | $ 30 | 1 | $_____ |
| 5. Highland Mountains Precambrian | May 17 | $ 40 | 1 | $_____ |
| 6. Yellowstone Valley: A Microcosm | May 20 | $ 30 | 1 | $_____ |
| 7. Upper Clark Fork Hydrologic Remediation | May 20 | $ 35 | 1 | $_____ |
| 8. Tertiary Tectonics of the Yellowstone Hotspot | May 20–21 | $165 | 1 | $_____ |

**SUBTOTAL MEETING REGISTRATION $** _____

**ON CAMPUS HOUSING**

Check Dates Room Needed: 5/14 ☐; 5/15 ☐; 5/16 ☐; 5/17 ☐; 5/18 ☐; 5/19 ☐; 5/20 ☐; 5/21 ☐; 5/22 ☐

| On-Campus Residence and Breakfast Package for May 17, 18, and 19, 1995 | | | |
|---|---|---|---|
| 1. Single (price for 3 days includes 4% bed tax) | $ 35 | 1 | $_____ |
| 2. Double (2 persons, 2 beds; price for three days w/tax) | $ 47 | 1 | $_____ |
| On-Campus Daily Residence Cost | | | |
| 1. Single (price includes 4% bed tax) | $ 16/day | 1 | $_____ |
| 2. Double (2 persons, 2 beds; price w/ tax) | $ 12/day | 1 | $_____ |

Person requested as roommate _____

| **ON CAMPUS MEALS AT MILLER DINING HALL** *(Meals served Monday through Friday)* | | | |
|---|---|---|---|
| Breakfast (check date: May 15 ☐; 16 ☐; 17 ☐; 18 ☐; 19 ☐; 22 ☐) | $ 4/meal | 1 | $_____ |
| Lunch (check date: May 15 ☐; 16 ☐; 17 ☐; 18 ☐; 19 ☐; 22 ☐) | $ 5/meal | 1 | $_____ |
| Dinner (check date: May 15 ☐; 16 ☐; 17 ☐; 18 ☐; 19 ☐; 22 ☐) | $ 6/meal | 1 | $_____ |

☐ No Meals

**SUBTOTAL ON-CAMPUS HOUSING AND MEALS $** _____

**GRAND TOTAL MEETING, HOUSING, AND MEALS $**_____

**Cancellation and request for refunds must be received in writing by May 1, 1995. There will be no refunds after that date.**

**Remit in U.S. funds (sorry, no credit cards or P.O.s) payable to: Montana State University**

**MAIL TO:** **RMGSA, Conference Services**
**280F Strand Union**
**Montana State University,**
**Bozeman, MT 59717-0402**

FOR OFFICE USE

Check #_____

Amount paid $ _____

_____

_____

_____

Refund Check # _____

# GSA ANNUAL MEETINGS

## 1995

**New Orleans, Louisiana**
**November 6–9**
**Ernest N. Morial Convention Center,**
**Hyatt Regency New Orleans**

General Chair: *William R. Craig, University of New Orleans*
Technical Program Chair: *Laura Serpa, University of New Orleans*
Field Trip Chair: *Whitney Autin, Louisiana State University*
See November 1994 *GSA Today* for a complete list of field trips.

## 1996

**Denver, Colorado • October 28–31**
**Colorado Convention Center, Marriott City Center**

General Chairs: *Kenneth E. Kolm and Gregory S. Holden, Colorado School of Mines*
Technical Program Chair: *John D. Humphrey, Colorado School of Mines*
Call for Field Trip Proposals: *Please contact the Field Trip Chairs listed below.*
*Charles L. Pillmore, Ren A. Thompson*
*U.S. Geological Survey, MS 913, P.O. Box 25046*
*Denver Federal Center, Denver, CO 80225*
*phones: Charles L. Pillmore, (303) 236-1240; Ren A. Thompson (303) 236-0929*

*For general information on any meeting call the GSA Meetings Department, 1-800-472-1988 or (303) 447-2020, ext. 141; E-mail: mball@geosociety.org*

# GSA SECTION MEETINGS

### NORTHEASTERN SECTION
**Radisson Hotel and Conference Center in Cromwell, Hartford, Connecticut, March 20–22, 1995.** Information: Gregory McHone, Graduate Liberal Studies Program, Wesleyan University, 255 High St., Middletown, CT 06457, (203) 344-7930, fax 203-344-7957.

### SOUTHEASTERN SECTION
**Knoxville Hilton Hotel, Knoxville, Tennessee, April 6–7, 1995.** Information: Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-2368, fax 615-974-2368, E-mail: bobmap@utkvx.utk.edu.

### NORTH-CENTRAL and SOUTH-CENTRAL SECTIONS
**University of Nebraska, Lincoln, Nebraska, April 27–28, 1995.** Information: Robert F. Diffendal, Jr., 113 Nebraska Hall, University of Nebraska–Lincoln, Lincoln, NE 68588-0517, (402) 472-2410, fax 402-472-2410, E-mail: rfd@unlinfo.unl.edu.

### ROCKY MOUNTAIN SECTION
**Montana State University, Bozeman, Montana, May 18–19, 1995.** Stephan G. Custer, Department of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6906, fax 406-994-6923, E-mail: uessc@msu.oscs.montana.edu.

### CORDILLERAN SECTION
**University of Alaska, Fairbanks, Alaska, May 24–26, 1995.** Information: David B. Stone, Geophysical Institute, University of Alaska, Fairbanks, AK 99775-0800, (907) 474-7622, fax 907-474-7290, E-mail: ffdbs@aurora.alaska.edu.

## ORDER FORM—1995 *GSA Abstracts with Programs*

For advance-copy purchases of GSA *Abstracts with Programs*, use this form and submit by the deadline listed for each section (deadlines vary). *Prepayment is required.* **Members,** check your records to make sure that you have not previously purchased any of these publications on either your dues statement or through Publication Sales. **No refunds for duplicate orders.** The *Abstracts with Programs* books will be mailed about three weeks prior to the meeting.

| Meeting | Deadline | Price | Quantity | Amount |
|---|---|---|---|---|
| Northeastern | 1/19/95 | $10 | | $ |
| Southeastern | 2/7/95 | $10 | | $ |
| North-Central/South-Central | 3/1/95 | $15 | | $ |
| Rocky Mountain | 3/14/95 | $10 | | $ |
| Cordilleran | 3/23/95 | $10 | | $ |
| Annual Meeting (New Orleans) | 8/17/95 | $22 | | $ |
| | | **Total** | | $ |

**SHIP TO:** ☐ Check here if GSA Member. (Member # _____)

Name _____

Address _____

City _____ State ____ ZIP _____ Daytime Phone _____

**METHOD OF PAYMENT:**
☐ CHECK or MONEY ORDER (payable in U.S. funds on U.S. bank)
☐ Credit Card (Please print information)

MC VISA AmEx Diners (circle one) Exp. Date _____

Card No. _____

Signature of Cardholder _____

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Send this form to *GSA Publication Sales, P.O. Box 9140, Boulder, CO 80301-9140*

**TO ORDER BY PHONE OR FAX** *using a major credit card*
fax (24 hour line): 303-447-1133; or
phone (303) 447-2020 or 1-800-472-1988 (8:00 to 4:30 MST)

**ON-SITE PURCHASES** may be made in the registration area. Supplies may be limited.

Due to prohibitive postal costs and delays in overseas mailings, this offer for the advance copies is for U.S., Canada, and Mexico only.

## Student Travel Grants

The GSA Foundation will award matching grants up to a total of $3500 each to the six GSA Sections. The money, when combined with equal funds from the Sections, will be used to assist GSA Student Associates traveling to the 1995 GSA Annual Meeting in New Orleans in November and to the 1995 Section meetings. Contact your Section Secretary for application procedures.

| | | |
|---|---|---|
| Cordilleran | Bruce A. Blackerby | (209) 278-2955 |
| Rocky Mountain | Kenneth E. Kolm | (303) 273-3932 |
| North-Central | George R. Hallberg | (319) 335-4500 |
| South-Central | Rena M. Bonem | (817) 755-2361 |
| Northeastern | Kenneth N. Weaver | (410) 554-5532 |
| Southeastern | Harold H. Stowell | (205) 348-5098 |

**Rocky Mountain** *continued from p. 38*

sion to highlight the research done by undergraduate students. In order to participate in this session, the first author on the paper must be an undergraduate student. Students are encouraged to submit abstracts for posters on any topic in geology, and they should indicate interest in participation in the Undergraduate Research in Geology Poster Session on the abstract form.

The Paleontological Society will sponsor an award for the best student paper in paleontology. A nonstudent can be a coauthor, but the student must be both the presenter and the senior (primary) author. To be eligible, the speaker must either be currently enrolled in a graduate or undergraduate program or have completed such a program no longer than one month prior to the meeting. The award will be a one-year subscription to *Paleobiology*.

### EXHIBITS

Exhibits are planned for the registration–poster-session area. The cost per booth is $50 for a 12 × 10 ft space. Additional adjacent booths may be purchased for $50 each to expand display space. For further information and space reservations, contact Melanie Stocks, MSU Conference Services, Room 280F, Strand Union, Montana State University, Bozeman, MT 59717-0402, (406) 994-3333, fax 406-994-3228, Internet: acfms@msu.oscs.montana.edu.

### STUDENT SUPPORT

The Rocky Mountain Section has funds available to support GSA Student Associates who plan to attend the meeting. Preference for support will be given to presenters of papers and posters and to group applications. Send a letter of application which identifies all student travelers in the group, GSA Student Associate member numbers, and a summary of cost to Rocky Mountain Section Secretary Ken Kolm, Dept. of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, (303) 273-3932, fax 303-273-3858, Internet: kkolm@mines.colorado.edu. If you are presenting a paper or poster, please include a copy of your notification of acceptance. Applications must be received by Ken Kolm by Friday, April 14, 1995. Rocky Mountain GSA will award full or partial field trip registration for two students on each field trip. To receive free registration, the students must write letters that describe why participation in the field trip will enhance their research or education. Letters may also address financial need and minority status. Letters must be sent to David Mogk, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348. *Letters must be postmarked no later than April 8, 1995.*

### SPECIAL EVENTS

Planned events include an evening welcoming reception on Wednesday, May 17, 1995. An alumni reception will be held on Thursday, May 18, 1995, from 5 to 7 p.m. Those schools wishing to have an alumni meeting area with banner reserved in the ballroom at the Strand Union should register with Steve Custer, Meeting Chair, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348.

The deadline for a reservation is May 1, 1995. The Structure and Tectonics Division of GSA will hold a reception on Thursday, May 18, 1995, from 5 to 7 p.m. The annual business meeting of the Rocky Mountain Section of the Paleontological Society will be held on Thursday, May 18, 1995, at noon. Montana-at-large members of the Association for Women Geoscientists will host an informal reception on Thursday, May 18, 1995, from 5 to 7 p.m. The annual business meeting of the Geological Society of America Rocky Mountain Section will be held on Friday, May 19, 1995, at noon.

### GUEST ACTIVITIES

In addition to museums, shopping, and hiking, Montana Travel offers two tours. Tour #1: **Yellowstone Park.** Thursday, May 18, 1995, 7 a.m.–7 p.m., $49. Tour #2: **Lewis & Clark Caverns**—Missouri Headwaters, Friday, May 19, 1 p.m.–5 p.m., $19. ■

## GUEST TOUR REGISTRATION FORM
**(Send to Montana Travel)**

**Yellowstone Park,** May 18, 1995 . . . . . $49 × ____ Persons = $ _____

**Lewis & Clark Caverns,** May 19, 1995 . . . . $19 × ____ Persons = $ _____

**Total Amount Enclosed:** (check or money order only) $ _____

Names of person(s) to be included: _____

Full name, address, and phone number of contact person for this reservation:

_____

_____

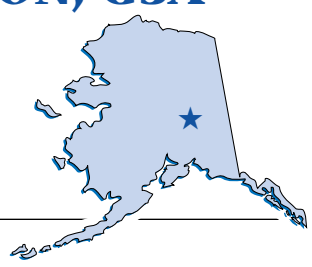
Mail form and check for tour to
MONTANA TRAVEL, INC., P.O. BOX 100, BOZEMAN, MT 59771.

Deposit equal to the full amount of the tour must accompany this reservation. A minimum of 44 participants is required, or the tour will be subject to cancellation (with full refund). ***Registration is required by March 18, 1995.*** If you cancel before March 18, 1995, you will receive a full refund; after March 18, 1995, you will receive a 50% refund. If you cancel after April 1, 1995, you will forfeit the entire amount.

**Final Announcement**

# CORDILLERAN SECTION, GSA
# 91st Annual Meeting

## Fairbanks, Alaska
## May 24–26, 1995



Located in the rolling hills of the "Golden Heart" of Alaska, Fairbanks began as a gold-rush community and has a strong mining tradition. The University of Alaska, Fairbanks campus continues this tradition and is home to a variety of geological and geophysical research groups that focus on arctic and global phenomena. Although Fairbanks is known for extreme weather, late May is usually beautiful, with temperatures in the 60s (°F). You can get to Fairbanks by national airlines, the Alaska Railroad, and via highways from south-central Alaska and Canada. Fairbanks also serves as a starting point for other destinations within interior Alaska, including the Alaska Range and Brooks Range.

## REGISTRATION

**New registration system at GSA!**

### Preregistration Deadline: April 17, 1995

***If you preregister, you will not have to wait in long registration lines to pick up materials in Fairbanks, because badges will be mailed within two weeks prior to the meeting. Save yourself time and money—preregister today!***

1. There is a savings in fees if you register before the preregistration deadline! *See preregistration form for fees*. Advance registration is suggested for many of the special activities because of participation limits. Use the preregistration form provided in this announcement.

2. Badges must be worn for access to ALL activities, 7:30 a.m. Wednesday through 12:00 noon Friday.

3. Registration discounts are given to members of both GSA and Associated Societies listed on the registration form. Please indicate your affiliation(s) to register using the member rates.

4. Full payment MUST accompany registration. Unpaid purchase orders are NOT accepted as valid registration. Charge cards are accepted as indicated on the preregistration form. If using a charge card, please recheck the card number given. Errors will delay your registration. The confirmation card will be your receipt for charge-card payments. No other receipt will be sent.

5. Register one professional or student per form. Copy the form for your records.

6. Guest registration is required for those attending guest activities, technical sessions, or the exhibit hall. Guest registrants MUST be accompanied by either a registered professional or student. A guest is defined as a nongeologist spouse or friend of a professional or student registrant.

7. Students and K–12 teachers must show a CURRENT ID on site in order to obtain these rates. Students or teachers not having a current ID when registering on site will be required to pay the professional fee.

8. Due to the mailing of badges, it is imperative that ALL preregistrations are RECEIVED by the preregistration deadline of April 17. All registrations received after April 17 will be held for on-site processing and charged the on-site rates.

9. On-site registration will be in Great Hall, University of Alaska, Tuesday afternoon through Friday morning.

### Cancellations, Changes, and Refunds

All requests for registration additions, changes, and cancellations must be made in writing and received by April 24, 1995. GSA will refund or credit preregistration fees for cancellations received in writing by April 24. NO REFUNDS OR CREDITS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER THIS DATE. Refunds will be mailed from GSA after the meeting. Fees paid by credit card will be credited according to the card number on the preregistration form. There will be NO refunds for on-site registration and ticket sales.

### Accessibility for Registrants with Special Needs

GSA is committed to making the Cordilleran Section Meeting accessible to all people interested in attending. If you need any auxiliary aids or services because of a disability, check the appropriate box on the registration form. If you have suggestions or need further information, contact Tami Krull at GSA, (303) 447-2020. Please let us know your needs by April 17, 1995.

## FIELD TRIPS

For details regarding specific field trips, please contact the trip leader(s). Address general questions to Don Triplehorn or Wes Wallace, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-6891 (Triplehorn) or (907) 474-5386 (Wallace), fax 907-474-5163. Preregistration for all field trips is required (see preregistration form). Participants will be accepted on a first-come, first-served basis. Be aware of cancellation penalties imposed by the airlines. Plan alternatives in advance should the trip you are registered for be canceled. Field trips marked with an asterisk are designed for primary and secondary teachers of earth sciences, but are open to all interested geoscientists. Contact the field trip leaders for detailed information.

### Premeeting

1. **Superfund Remedial Investigations at Eielson Air Force Base, Alaska.** Tuesday, May 23, 8:30 a.m. to 4:30 p.m. Richard Lewis, Geology & Geophysics, MSIN K9-48, Pacific Northwest Laboratory, Richland, WA 99336 (509) 372-6079, E-mail: richard_lewis@ccmail.pnl.gov; Mark Murphy. We will visit several areas that demonstrate the importance of "geologic reasoning" to CERCLA-style remedial investigation, design, and application. Cost: $30 (includes transportation, box lunch, and handouts). Limit: 13.

2. **Quaternary Loess and Tephras near Fairbanks, Alaska.** Tuesday, May 23, 8:30 a.m. to 4:30 p.m. James E. Beget, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-5301; Shari Preece. We will examine tephras, paleosols, loess facies, and unconformities at several key sections in the Fairbanks area, including the Pliocene-Pleistocene boundary and the Old Crow tephra. Cost: $35 (includes transportation, lunch, and handouts). Limit: 18.

3. **Tertiary Coal-bearing Strata at Healy, Alaska.** Tuesday, May 23, 7:30 a.m. to 7:30 p.m. Don Triplehorn, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-6891; Gary Stricker. Regional stratigraphy, sedimentology, and quality of economic coals. Cost: $40 (includes transportation, box lunch, and handouts). Limit: 26.

4. **The Alaska Pipeline and Permafrost Tunnel.** Tuesday, May 23, 1 to 5 p.m. Nils I. Johansen, Dept. of Mining and Geological Engineering, University of Alaska, Fairbanks, AK 99775-5800, (907) 474-6878. The U.S. Army CRREL Permafrost Tunnel and the Alaska Pipeline, major achievement in arctic engineering. Cost: $20 (includes transportation and handouts). Limit: 30.

*5. **Mammoths, Permafrost, and Gold—Fairbanks and the Last Ice Age.** Saturday, May 20, 9 a.m. to 2 p.m. Roland A. Gangloff, University of Alaska Museum, Fairbanks, AK 99775-6960, (907) 474-7862, fax 907-474-5469. Fairbanks and vicinity are famous for an abundant late Quaternary fossil record contained in permanently frozen silt or loess deposits, and gold-bearing gravels are commonly covered by these frozen deposits. Cost: $25 (includes transportation, refreshments, field guide. Add $5.00 for box lunch). Limit: 25.

### Postmeeting

6. **Accretion, Orogenesis, and Oil: A Transect Across Northern Alaska from Fairbanks to Prudhoe Bay.** Saturday, May 27, 8 a.m. to Tuesday, May 30, 8 p.m. (or optional three-day trip, May 27–29). Wesley K. Wallace, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-5386; C. G. (Gil) Mull; Thomas E. Moore. Visit continental and oceanic terranes accreted to or displaced along the North American continental margin, an orogen and foredeep formed by collisional collapse of a passive continental margin, and a later passive continental margin that is home to North America's largest oil field. Cost: $725 (four-day trip includes transportation by van to and from Prudhoe Bay, 3 nights' lodging, meals, guidebook, and handout. Optional three-day trip ($850) includes return by air from Prudhoe Bay to Fairbanks, 2 nights' lodging, and meals.) Limit: 21.

7. **Southern Alaska Tectonic Transect—Fairbanks to Anchorage.** Saturday, May 27 to Monday, May 29 (depart Fairbanks at 8 a.m., arrive in Anchorage at 9 p.m.). Warren J. Nokleberg, U.S. Geological Survey, Menlo Park, CA 94025, (415) 329-5732; George Plafker; Gary R. Winkler. Bedrock and surficial geology along the Richardson and Glenn highways. Various geophysical interpretations and tectonic models will be evaluated in light of key geologic features and findings of the Trans-Alaskan Crustal Transect. Cost: $365 (includes transportation by tour bus, 2 nights' lodging, and guidebook; meals not included; participants will need to bring 3 back-pack style lunches and drinks). Limit: 37.

8. **Quaternary Geology of the Central Alaska Range: Geomorphic Consequences of Tectonic Uplift in a Glacial Environment** *(Clyde Wahrhaftig Memorial Field Trip)*. Saturday morning, May 27, to Tuesday evening, May 30. Dan Mann, Alaska Quaternary Center, University of Alaska, Fairbanks, AK 99775, (907) 474-7925. Visit quaternary geology exposed along the Richardson Highway to Paxson, the Denali Highway to Cantwell, and the Parks Highway back to Fairbanks. Participants must bring their own tents and sleeping gear. Cost: $175 (includes transportation and handouts; participants must bring food for all meals except one dinner). Limit: 20.

9. **Bedrock and Glacial Geology of Denali National Park and Preserve.** Saturday, May 27, 8 a.m. to Sunday, May 28, 10:30 p.m. Phil Brease, Denali National Park and Preserve, P.O. Box 9, Denali Park, AK 99775, (907) 683-9551; Alison Till. Examine metamorphosed Proterozoic to early Paleozoic age basement rocks, late Mesozoic to early Tertiary sedimentary and volcanic rocks, and Pleistocene features, and discuss new data with important implications for the tectonic evolution of central Alaska. Cost: $221 (includes ground transportation to and from Fairbanks, one night's lodging [double occupancy], all meals, and handouts). Limit: 16.

10. **Bedrock Geology of the Fairbanks Area.** Saturday, May 27, 9 a.m. to 6 p.m. Rainer Newberry, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-6895. Amphibolite- and eclogite-grade metamorphic rocks, Cretaceous plutons, dikes, W-Au skarns, Au veins, subtle thrust faults, hidden high-angle faults, new detailed airborne geophysics, and seismological data provide clues to the geologic history of Fairbanks. Cost: $50 (includes transportation, lunch, and handouts). Limit: 70.

11. **Volcanology of Augustine Island, Alaska.** May 28–31, departing from and returning to Homer, Alaska. Juergen Kienle, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-7467; Jim Beget. Examine numerous volcanic features on Augustine Island and possibly climb to the summit to see active fumaroles and recent lava domes. Participants must bring adequate tents and sleeping bags. *Changing weather may affect our ability to fly to or return from Augustine Island as planned. Participants in this field trip must have flexible travel schedules*. Cost: $500 (includes cost of air charter to and from Augustine Island, handouts, and all meals during 4 days on Augustine Island. Participants will be responsible for their own air travel from Fairbanks to Homer and lodging in Homer). Limit: 14.

12. **Fairbanks District Gold Mining Operations.** Saturday, May 27, 9 a.m. to 5 p.m. James A. Madonna, Mining Extension, University of Alaska, Fairbanks, AK 99775-5960, (907) 474-7702. Visit a hard-rock gold property and a placer gold mine. Cost: $30 (includes transportation, box lunch, and handouts). Limit: 13.

*13. **Granite, Volcanoes, and Ocean—The Geologic Foundation of Fairbanks and Vicinity.** Saturday, May 27, 9 a.m. to 2 p.m. Roland A. Gangloff, University of Alaska Museum, Fairbanks, AK 99775, (907) 474-7862, fax 907-474-5469. Visit outcrops that represent the main chapters in the early geologic history of Fairbanks. Participants will be able to collect a representative set of rocks and minerals. Cost: $25 (includes transportation, refreshments, field guide; add $5.00 for box lunch). Limit: 25.

*14. **The Rock Cycle—A Dynamic View of the Alaska Range, Delta to Summit Lake.** Saturday, May 27, 8 a.m. to 7:30 p.m. Don Triplehorn, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-6891; Roland A. Gangloff. The eastern end of the range, begin-

**Cordilleran** *continued on p. 41*

**Cordilleran** *continued from p. 40*

ning with the glacial and fluvial features in the Delta area, into the range's early history of oceans and marine life in its core. Different components of the rock cycle will be illustrated to emphasize how the earth changes. Participants will be able to collect rocks, minerals, and fossils for use in the classroom. Cost: $35 (includes transportation, refreshments, field guide; add $5 for box lunch). Limit: 24.

## SYMPOSIA and THEME SESSIONS

Please contact the conveners for information about a specific symposium or theme session. Individuals needing general information should contact Catherine Hanks, Geophysical Institute, University of Alaska, Fairbanks, AK 99775 (907) 474-5562, E-mail: chanks@dino.gi.alaska.edu.

### Symposia

1. **Deep-Crustal Structure and Tectonics of Alaska and Adjacent Regions.** Warren J. Nokleberg, Branch of Alaskan Geology, U.S. Geological Survey, Menlo Park, CA 94025, (415) 329-5732; George Plafker. New isotopic, geochemical, petrologic, and structural data are causing considerable revision of deep crustal structural and tectonic models of Alaska and adjacent regions.
2. **Lode Gold in the Northern Cordillera.** Rainer Newberry, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-6895, fax 907-474-5163. Genesis, occurrence, and exploration for lode gold deposits in the northern Cordillera. Talks will be 30 minutes long, and there will be a break every two hours for discussion and examination of rocks and drill core.
3. **Glaciers of Beringia: Glaciological Process and the Geologic Record.** Dan Mann, Alaska Quaternary Center, University of Alaska, Fairbanks, AK 99775, (907) 474-7925. Understanding modern glaciological processes and interpreting glacial geologic records.
4. **High-Latitude Geomorphology and Global Changes.** Dave Hopkins, Alaska Quaternary Center, University of Alaska, Fairbanks, AK 99775, (907) 474-6894. Geomorphic systems, notably those with sensitive thresholds to climatic change, that will be important parts of the response of the arctic landscape to global changes.
5. **Early Humans in the Arctic: Archaeological Sites and Their Paleoecological Settings.** Richard Reanier, Reanier and Associates, Seattle, WA, (206) 323-8450. Geoarchaeological, palynological, and limnological records of paleoenvironment that foster understanding of the interactions between paleoenvironnments, culture, and the movements of human groups.
6. **Open Frontiers: Tectonics of the Circum-Arctic.** Kazuya Fujita, Dept. of Geology, Michigan State University, East Lansing, MI 48826, (517) 355-0142, E-mail: kaz@siberia.glg.msu.edu; Wes Wallace. New work in northeastern Russia, northern Alaska, Arctic Canada, Svalbard, and Greenland has provided new evidence on the relations between the northern Cordillera and other parts of the circum-Arctic.
7. **The Earth Science Component in Public Decision Making: Case Histories.** Jeanine Schmidt, U.S. Geological Survey, 4200 University Dr., Anchorage, AK 99508, (907) 786-7494, E-mail: jschmidt@tardaddy.wr.usgs.gov; Tina Neal. Effective use of earth science information in public decisions, and examples in which the decision-making process could benefit from increased input of earth science data.
8. **Selected Topics on the Geology of Alaska and California, with Emphasis on the Central Alaska Range, Geomorphic Processes, and Geology in the Public Service:** *A Symposium in Memory of Clyde Wahrhaftig*. Doris Sloan, Museum of Paleontology, University of California, Berkeley, CA 94720, (510) 642-3703, fax 510-643-9980; Art Grantz. New developments in the diverse research areas pioneered by Clyde Wahrhaftig, including bedrock geology, coal deposits, and geomorphic evolution of the central Alaska Range and California; the application of geology to public land use policy; and public education.

### Theme Sessions

1. **Proterozoic and Paleozoic Sedimentology, Stratigraphy and Paleontology of Alaska and Northwestern Canada.** James G. Clough, Alaska Division of Geological and Geophysical Surveys, 794 University Ave., Suite 200, Fairbanks, AK 99709-3645, (907) 451-5030, fax 907-451-5050, E-mail: ftjgc@aurora.alaska.edu; Robert B. Blodgett. New biostratigraphic and sedimentologic data on Proterozoic and Paleozoic strata of Alaska and northwestern Canada, with an emphasis on placing the data within the framework of sequence stratigraphy and in an inter-regional context.
2. **Metamorphic Belts of Northern and Central Alaska: A Comparison of Protolith Packages, Tectonic Affinities, and Metamorphic and Structural Histories.** Alison Till, U.S. Geological Survey, 4200 University Dr., Anchorage, AK 99508-4667, (907) 786-7444, E-mail: atill@tardaddy.wr.usgs.gov; Cynthia Dusel-Bacon. Protoliths of metamorphosed continental crust exposed in northern and central Alaska as remnants of the Late Proterozoic to mid-Paleozoic North American continental margin.
3. **New Developments in the Geology and Geophysics of the Arctic Ocean Basin.** Lawrence A. Lawver, Institute for Geophysics, University of Texas, 8701 N. MoPac Expy., Austin, TX 78759-8397, (512) 471-0433, fax 512-471-8844, E-mail: larry@utig.ig.utexas.edu; Art Grantz; Bill Witte. Recent geological and geophysical data from the Arctic Ocean area which impact our interpretation of the crustal structure, tectonic history, paleogeography, and paleoceanography of the arctic basin.
4. **Devonian Tectonics and Sedimentation in the Cordillera and Circum-Arctic.** Keith Crowder, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-7810, fax 907-474-5163. Depositional environments and tectonic settings of Devonian strata throughout the circum-Arctic region and northwestern Cordillera, and implications for circum-Arctic crustal evolution.
5. **New Concepts and Discoveries in Alaskan Petroleum Basins.** John Decker, ARCO Alaska, Inc., P.O. Box 100360, Anchorage, AK 99510-0360, (907) 265-1521. Current trends in the evaluation of Alaska's petroleum basins.

**Cordilleran** *continued on p. 42*

# Preregistration Form

## GSA Cordilleran Section

**Preregistration deadline is April 17, 1995.**

**Fairbanks, Alaska • May 24–26, 1995**

**Please print clearly. Copy for your records.**

Name (last) (first name/nickname as it should appear on badge)

Employer/University (affiliation as it should appear on badge)

Employer/University mailing address for Employer/University above

City State ZIP Code

Country (other than USA) Business Phone ( ) Fax ( ) Home Phone

Spouse/Guest Name (last) (first name/nickname as it should appear on badge)

City/State Country

Please inform us by April 17 of any special considerations that you or your guest require.

☐ I will need special considerations. Please call me.

Circle member affiliation (to qualify for registration member discount):

(A) GSA (B) AEG
(C) AGS (D) PS

| REGISTRATION | BY APRIL 17 Full Meeting | BY APRIL 17 One Day | ON SITE *for comparison only* Full Meeting | ON SITE *for comparison only* One Day | Qty | Amount |
|---|---|---|---|---|---|---|
| Professional Member *(circle affiliation above)* | (01) $58 ☐ | (02) $29 ☐ | $68 | $40 | 1 | $ |
| Professional Nonmember | (03) $68 ☐ | (04) $34 ☐ | $78 | $45 | 1 | $ |
| Student Member *(circle affiliation above)* | (05) $25 ☐ | (06) $15 ☐ | $30 | $20 | 1 | $ |
| Student Nonmember | (07) $30 ☐ | (08) $20 ☐ | $35 | $30 | 1 | $ |
| Guest/Spouse *(per guest listed above)* | (09) $20 ☐ | NA | $25 | NA | 1 | $ |
| K–12 Teacher | (42) $20 ☐ | NA | $25 | NA | 1 | $ |
| Cont. Ed./Field Trip Only Fee | (98) $15 ☐ | NA | $15 | NA | 1 | $ |

| | | | | |
|---|---|---|---|---|
| **SPOUSE/GUEST AND SPECIAL EVENT PROGRAM** | | | | |
| Dinner cruise on riverboat *Discovery* | May 25 | ( 20) $ 35 | ____ | $ |
| Tour of Fairbanks Area | May 24 | ( 21) $ 35 | ____ | $ |
| Shopping in Downtown Fairbanks | May 25 | ( 22) $ 15 | ____ | $ |
| **MEALS** | | | | |
| On campus meals (May 24—B, L, D; May 25—B, L; May 26—B, L) | | ( 23) $ 80 | ____ | $ |
| **FIELD TRIPS** | | | | |
| 1. Superfund Remedial Investigations, Eielson AFB | May 23 | (101) $ 30 | 1 | $ |
| 2. Quaternary Loess and Tephras near Fairbanks | May 23 | (102) $ 35 | 1 | $ |
| 3. Tertiary Coal-bearing Strata near Healy | May 23 | (103) $ 40 | 1 | $ |
| 4. Alaska Pipeline and Permafrost Tunnel | May 23 | (104) $ 20 | 1 | $ |
| 5. Mammoths, Permafrost and Gold | May 20 | (105) $ 25 | 1 | $ |
| 6A. Accretion, Orogenesis and Oil: Transect across N Alaska | May 27–29 | (106) $850 | 1 | $ |
| 6B. Accretion, Orogenesis and Oil: Transect across N Alaska | May 27–30 | (107) $725 | 1 | $ |
| 7. Alaska Tectonic Transect—Fairbanks to Anchorage | May 27–29 | (108) $365 | 1 | $ |
| 8. Quaternary Geology of the Central Alaska Range | May 27–29 | (109) $175 | 1 | $ |
| 9. Bedrock and Glacial Geology of Denali National Park | May 27–28 | (110) $221 | 1 | $ |
| 10. Bedrock Geology of the Fairbanks Area | May 27 | (111) $ 50 | 1 | $ |
| 11. Volcanology of Augustine Island, Alaska | May 28–31 | (112) $500 | 1 | $ |
| 12. Fairbanks Gold Mining Operations | May 27 | (113) $ 30 | 1 | $ |
| 13. Geologic Foundation of Fairbanks and Vicinity | May 27 | (114) $ 25 | 1 | $ |
| 14. Dynamic View of the Alaska Range | May 27 | (115) $ 35 | 1 | $ |
| **SHORT COURSES** | | | | |
| 1. Internet for Geologists | May 23 | (151) $ 50 | 1 | $ |
| 2. Geoscience Applications of SAR | May 23 | (152) $ 50 | 1 | $ |
| ***Abstracts with Programs*** | | (301) $ 10 | ____ | $ |
| **TOTAL FEES** | | | | **$** |

**Remit in U.S. funds payable to: 1995 GSA Cordilleran Section Meeting**
(All preregistrations must be prepaid. Purchase Orders not accepted.)
Payment by (check one): ☐ Check ☐ American Express ☐ VISA ☐ MasterCard

Card Number

Signature Expires

**MAIL TO: GSA CORDILLERAN SECTION MEETING, P.O. BOX 9140, BOULDER, CO 80301**

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**Cordilleran** *continued from p. 41*

6. **Uplift Studies and Their Applications to Structural and Stratigraphic Problems.** Paul Layer, Geophysical Institute, University of Alaska, Fairbanks, AK 99775-7320, (907) 474-5514, E-mail: player@giuaf.gi.alaska.edu; Paul O'Sullivan. Integration of new and standard geochronologic techniques with structural, stratigraphic, and tectonic information in hypotheses of the geologic evolution of the Cordillera and circum-Arctic region.
7. **Cretaceous Magmatism, Metamorphism and Gneiss Dome Development from Canada to Alaska and the Russian Far East.** Elizabeth L. Miller, Dept. of Geology, Stanford University, Stanford, CA 94305, (415) 723-1149, E-mail: miller@pangea.stanford.edu; Jeffrey M. Amato; James E. Wright. Geological, geochronological, and geochemical data on the nature, along-strike variation, and tectonic setting of Cretaceous magmatic rocks in Canada, Alaska, and the Russian Far East.
8. **Quaternary Geology and Paleoclimates in the Western Arctic and Subarctic.** Mary Edwards, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775, (907) 474-5014, fax 907-474-5163; James Beget. Quaternary proxy climate data from marine and terrestrial records in the western Arctic and sub-Arctic, including western North America, Beringia, and northeastern Asia.
9. **Advances in Geological Applications of Spaceborne SAR.** Craig Lingle, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-7679, E-mail: clingle@gi.alaska.edu. Use of SAR for geologic mapping and analysis, including surficial and bedrock geology and glaciers.
10. **Magmas of the Aleutian and Cascade Arcs.** John Eichelberger, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-5530; E-mail: eich@gi.alaska.edu; Terry Keith. Characteristics of magma storage and transport in volcanoes of the Cascade and Aleutian Ranges deduced from petrologic and geophysical insights, and observations of recent eruptions.
11. **Seismology and Tectonics and Subduction Zones.** Doug Christensen, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-7426, E-mail: doug@deus.gi.alaska.edu; Steve McNutt. The various tectonic features and existence of and potential for great earthquakes associated with the Alaska and Cascade subduction zones.
12. **Contaminant Transport and Fate: Focus on Western U.S. Hydrogeologic Settings.** *Sponsored by the Institute for Environmental Education.* Kent Keller, Geoscience, Hydrology Program, New Mexico Tech, Socorro, NM 87801, (505) 835-5259 or 5307, E-mail: ckkeller@wsuvm1.csc.wsu.edu or ckkeller@prism.nmt.edu. Contaminant occurrence and fate in western settings and their similarities to and differences from "classical" settings of unconfined sand aquifers in humid-to-subhumid continental climates.
13. **Remedial Investigations in Cold Climates: CERCLA/RCRA Examples from Alaska.** Mark T. Murphy, Geology & Geophysics, MSIN K9-48, Pacific Northwest Laboratory, Richland, WA 99352, (509) 372-6321, E-mail: mt_murphy@ccmail.pnl.gov; Jennifer L. Roberts. The Alaskan experience with CERCLA and RCRA clean-up investigation, including permafrost hydrogeology, bioremediation, and cold-climate wetland restoration.
14. **Spatial and Temporal Distribution of Clades, Facies, and Paleoenvironments in the Rock Record: Implications for Our Understanding of Earth's History.** *Sponsored by the Pacific Coast Section of the Paleontological Society.* Charles Marshall, Dept. of Earth and Space Sciences, UCLA, Los Angeles, CA 90024-1567, (310) 206-2303, fax 310-825-2779, E-mail: marshall@ess.ucla.edu. Do patterns observed in the fossil and rock records reflect reality, biased collecting practices, or biases in the preservation of certain taxa and/or environments?
15. **Undergraduate Research Poster Session.** *Sponsored by the Council on Undergraduate Research.* Susan M. DeBari, San Jose State University (408) 924-5027, E-mail: susan@geosun1.sjsu.edu. Undergraduate research in any field within the geological sciences. The only criteria is that the undergraduate is first or sole author.

## SHORT COURSES AND WORKSHOPS

1. **Internet for Geologists.** May 23, 9 a.m. to 12 p.m. Steve Smith, Rasmuson Library, University of Alaska, Fairbanks, AK 99775, (907) 474-6655; Julia Triplehorn. A hands-on workshop on the tools necessary to search the Internet and have entire articles delivered to your desktop computer. Included will be a survey of current geological and geophysical resources online. Cost: $50 (includes a textbook and handouts). Limit: 45.
2. **Geoscience Applications of SAR and Other Remote Sensing Data.** May 23, 8 a.m. to 5 p.m. Ken Dean, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-7364, fax 907-474-7290, E-mail: kdean@dino.gi.alaska.edu. How SAR imagery can be used for geoscience analyses (including interferometry), and how other data sets can be used in conjunction with SAR imagery. Participants will learn how to order SAR data from off-site computers, and use personal computers (Mac and IBM) and workstations for analysis of SAR data. Cost: $50 (includes a copy of ASF CD-ROM, mini-manual, morning and afternoon refreshments [not lunch]). Limit: 20.

## EARTH SCIENCE EDUCATION

A special two-evening workshop and two half-day field trips are being cosponsored by the Alaska Science Teachers Association and the GSA Cordilleran Section Committee on Education. The emphasis of the workshop will be on teachers sharing successful classroom techniques on how to make earth science more real and understandable to K–12 students, and it will include a tour of the Geophysical Institute and University of Alaska Museum. For more information, contact Roland Gangloff, University of Alaska Museum, P.O. Box 756960, Fairbanks, AK 99775, (907) 474-7862, E-mail: ffrag@acad3.alaska.edu.

## PROJECTION EQUIPMENT

Each lecture room will be equipped with two standard 35 mm carousel projectors and an overhead projector. A *limited* number of carousels will be available. Other special equipment is available but must be requested in advance.

## EXHIBITS

The exhibit hall will be open Wednesday, Thursday, and Friday from 9 a.m. to 5 p.m. For information on available exhibit booths, contact Roland Gangloff, University of Alaska Museum, P.O. Box 756960, Fairbanks, AK 99775-6960, (907) 474-7862, E-mail: ffrag@acad3.alaska.edu.

## STUDENT SUPPORT

The GSA Cordilleran Section provides grants to support GSA Student Associates who are presenting (or are coauthors of) papers at the meeting. For further information and application forms, contact Cordilleran Section Secretary Bruce Blackerby, Dept. of Geology, California State University, Fresno, CA 93740, (209) 278-2955 or 3086, E-mail: bruceb@zimmer.csufresno.edu. Applications should include certification that the student is presenting a paper and is a GSA Student Associate of the Cordilleran Section. *All applications must be received by March 15, 1995.*

## SPECIAL EVENTS

**Midnight Sun Icebreaker.** Tuesday, May 23, 7–10 p.m. Cost is included in registration. Preregistration is necessary.
**Progressive Open House.** Wednesday, May 24, 7–10 p.m. Cost is included in registration. An evening walking tour of campus, with specialty desserts provided along the way.
**Dinner Cruise on the Riverboat *Discovery.*** Thursday, May 25. Cost: $35/person (includes transportation and buffet dinner).

## SPOUSE, GUEST, AND FAMILY ACTIVITIES

Guest registration includes admission to the Midnight Sun Icebreaker and Progressive Open House. In addition, two tours are being offered for guests and families during the GSA meeting.
**Tour of the Fairbanks Area.** Wednesday, May 24, 9 a.m.–4 p.m. Cost: $35/person (includes transportation, admission fees, and buffet lunch). University of Alaska Museum, the University of Alaska, Fairbanks Large Animal Research Station, and the Trans-Alaska Pipeline, and panning for gold at Gold Dredge #8.
**Shopping in Downtown Fairbanks.** Thursday, May 25, 9 a.m.–4 p.m. Cost: $15/person (includes transportation only). Authentic native crafts, Alaskan art, or gold nugget jewelry, and Alaskaland, a 44-acre theme park that features Fairbanks' history, and the restored sternwheeler *Nenana*.

## HOUSING AND MEALS

Although Fairbanks has many hotels, they are expensive, not within easy walking distance of campus, and commonly nearly full in late May. We strongly recommend that participants use on-campus student housing. Single and double rooms are available, as well as pleasant and convenient two-bedroom apartments. Please indicate on the housing form your roommates' names or your willingness to share a unit, in which case the Housing Office will assign roommates. Use the housing form to book, or call (907) 474-7247, fax 907-474-6423.
*Student Apartments:* Two-bedroom with kitchen and one bath; $148 for 1 to 4 occupants.
*Dormitories:* Shared bathrooms on each floor; $50 single, $64 double.

Those who wish to stay at local hotels should make reservations directly, and as soon as possible. A limited number of rooms have been blocked at the Westmark Fairbanks Hotel and are available on a first-come, first-served basis until May 1. Indicate that you are attending the GSA 95 meeting at University of Alaska, Fairbanks, in order to receive the meeting rates. Some hotels are:

1. **Westmark Fairbanks Hotel.*** 1-800-544-0970. $115 single or double.
2. **Regency Hotel.*** (907) 452-3200. $99 single or double.
3. **Sophie Station Hotel,** Wedgewood Resort.*** 1-800-528-4916. $95 single, $105 double.
4. **Captain Bartlett Inn.*** In Alaska: 1-800-478-7900; in U.S. and Canada: 1-800-544-7528. $79 single or double
5. **Super-8 Motel.** (907) 451-8888. $92.88 and up.

Note: All hotels are subject to an 8% bed tax.
*Morning and evening shuttle to University of Alaska, Fairbanks.
**Courtesy car.

In addition, there are many bed-and-breakfast establishments (B&B Hot Line: 1-800-770-8165) and local tent and RV campgrounds.

Only a few restaurants are within easy walking distance of campus. We recommend signing up for the meal plan offered by the on-campus food service. Meals will be cafeteria style, breakfast and lunch all three days, dinner on Wednesday only, for $80. Sign up on the preregistration form.

## ROAD TRAVEL TO FAIRBANKS

Fairbanks is located at the end of the Alaska Highway. Starting at the beginning of the highway at Dawson Creek, British Columbia, drive north on a totally paved highway, past Whitehorse to the first traffic lights (1519 miles), turn left, go to University Avenue (2 miles), and turn right; the university will be on your left in another mile. An alternate route is the near-coastal Cassiar Highway. For a more relaxing trip, use the Alaska Marine Highway from Bellingham, Washington, to Skagway or Haines (3 days). Just put your car on the Alaska ferry and enjoy the scenery of the inland passage. All the surface routes to Fairbanks offer great opportunities to a geologist and/or a tourist. Many of the huge glaciers around the Gulf of Alaska are easy to visit, and the wildlife is abundant and easy to see, especially in Denali Park. If you take advantage of surface travel, we strongly recommend that you purchase a copy of *Milepost* (published by Alaska Northwest Books, 22026 20th Ave. SE, P.O. Box 3007, Bothwell, WA 98041-9912).

## OTHER INFORMATION

For more information, contact General Chair David Stone, Geophysical Institute, University of Alaska, Fairbanks, AK 99775, (907) 474-7622, fax 907-474-7290, E-mail: ffdbs@acad3.alaska.edu, or the **World Wide Web (http://www.aescon.com/geosociety/index.html).** ■

## CAMPUS HOUSING APPLICATION FORM

**Cordilleran Section—GSA**
**May 24–26, 1995**

Please reserve campus housing for me. No deposit is necessary, but full payment is required upon arrival.

☐ Single ☐ Double ☐ Apartment

I will be sharing an apartment or double room with

_____

_____

_____

See preregistration form for on-campus meal service.

☐ Please assign me a roomate

Name _____

Address _____

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Return completed housing form to: UAF Housing, P.O. Box 756860, University of Alaska, Fairbanks, AK 99775-6860

# CLASSIFIED ADVERTISING

Published on the 1st of the month of issue. Ads (or cancellations) must reach the GSA Advertising office one month prior. Contact Advertising Department (303) 447-2020, 1-800-472-1988, fax 303-447-1133, or E-mail:acrawfor@geosociety.org. Please include complete address, phone number, and E-mail address with all correspondence.

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| first 25 lines | $0.00 | $2.35 |
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## Positions Open

**SENIOR RESERVOIR GEOLOGY RESEARCH ADVISOR**

A position to work in Caracas, Venezuela is open for a research leader in reservoir geology. He will use his knowledge in clastic diagenesis and reservoir geometry and modelling to undertake and coordinate integrated studies of complex reservoirs. In addition, he will contribute to a strategic direction of the working group, and specially to the direction of long term applied research.

The following qualifications are also needed: A thorough knowledge of clastic diagenesis and reservoir geometry based upon a minimum of 10 years experience in the oil industry. Applicant must have a Ph.D. degree, experience in related oil industry research projects and internationally recognized research record. Extensive technical skills in laboratory techniques as inorganic geochemistry, stable isotopes, cathodoluminescence and fluid inclusions. Ability to manage interpersonal liaison.

Please send a resume to one of the following addresses: Human Resources Manager, LTQ-1055, P.O. Box 02-8537, Miami, Florida 33102-8537; International Program Management, att: Ms. Natalie Sayago, P.O. Box 4775, Houston, Texas 77210-4775; or Human Resources Manager, P.O. Box 76343, Zona Postal 1070A, Caracas, Venezuela.

**PAPUA NEW GUINEA**

The University of PNG has vacancies for lecturer/senior lecturer in Igneous & Metamorphic Petrology/Structure, and Geophysics. Applicants need Ph.D. or equivalent. Three year contract, renewable. Contact Hugh Davies, fax 675-267187 or 260369 for further information.

**ENVIRONMENTAL GEOSCIENTIST/HYDROGEOLOGIST OREGON STATE UNIVERSITY**

The Geosciences Department at Oregon State University seeks to fill a tenure-track position at the assistant professor level starting in September 1995, in groundwater geology, low-temperature aqueous geochemistry, geologic hazards, paleoclimatology, or engineering geology. A Ph.D. is required. Successful applicants will be expected to develop a vigorous, externally funded research program, to supervise and teach undergraduate geoscience courses and graduate level courses in their specialization, and to direct the research of M.S. and Ph.D. candidates. The Geosciences Department has strengths in petrology, geologic structure, sedimentary geology, surficial processes, physical and resource geography, and spatial analysis. The department has 20 faculty, 90 graduate students, and 170 undergraduate majors. The candidate is expected to play a central role in developing an interdisciplinary program in earth and environmental geosciences. Collaborative research opportunities exist with other local programs in the colleges of Forestry, Engineering, Agricultural Sciences, and Oceanic and Atmospheric Sciences, the Water Resources Research Institute, the Center for Analysis of Environmental Change, and the U.S. EPA Environmental Research Laboratory-Corvallis. Oregon State University is a Land Grant, Sea Grant, Space Grant, and Carnegie Class I Research University.

Those interested in applying for the position should send a letter of interest, curriculum vitae, names of three references, and a statement of anticipated research and teaching interests, along with evidence of teaching effectiveness and scholarly activity to Alan Niem, Chair, Geosciences Search Committee, Department of Geosciences, Oregon State University, Wilkinson Hall 104, Corvallis, OR 97331-5506; Telephone (503) 737-1233; FAX 503-737-1200; E-mail: niema@bcc.orst.edu. Candidates will be notified before letters of reference are requested. Applications will be reviewed starting February 1, 1995, until the position is filled.

Oregon State University is an affirmative-action/equal opportunity employer. OSU has a policy of being responsive to the needs of dual-career couples.

**ASSISTANT PROGRAM DIRECTOR OCEAN DRILLING PROGRAMS**

Joint Oceanographic Institutions, Inc. (JOI) is seeking qualified candidates for the position of Assistant Program Director for the Ocean Drilling Program (ODP) and the JOI/U.S. Science Support Program (JOI/USSSP).

Duties and responsibilities include assisting the Program Director with all phases of JOI/USSSP proposal review and scientist support activities, acting as liaison to JOIDES panels and committees as necessary, preparing reports, and assisting with general budget and subcontractor oversight.

Applicants must have a Ph.D. or equivalent in geoscience or oceanography and have three or more years of research, administration, and/or managerial experience. A knowledge of ODP and JOI/USSSP is highly desirable. The position requires excellent oral and written communication skills, and will require travel.

This position may be filled on either a permanent or 2- to 3-year limited term basis.

Qualified applicants should submit a curriculum vitae and three names and addresses of references to Director of Administrative Services, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Ave. NW, Suite 800, Washington, D.C. 20036-2102.

Review of applications will begin January 29, 1995, and continue until an appoinment is made. EEO, MFDV.

**GEOGRAPHY THE UNIVERSITY OF WEST FLORIDA**

Two positions at Assistant Professor rank for broadly trained Physical Geographer, tenure-track, beginning August 1995. Ph.D. required. Salary range: $32,000-$40,000. First position requires a strong background in Hydrogeology with an environmental emphasis. Teaching duties include a variety of courses, notably hydrology, physical geology, field methods, and various environmental science courses. Research interest in hydrogeology in coastal regions desired. Second position requires strong background in Remote Sensing/GIS with an environmental emphasis. Teaching duties include a variety of courses, notably remote sensing, GIS, climatology, and courses in coastal processes. Research interest in enviromnental analysis and coastal processes desired. For both positions a field orientation and commitment to hands-on learning as well as ability to gain external funding are a plus. The program in Earth and Atmospheric Sciences (EAS), housed within the Department of Ecology and Evolutionary Biology (EEB), leads to a B.S. in Environmental Science. There are approximately 300 majors. EEB offers several undergraduate and graduate programs, including a masters program in Coastal Zone Studies. The successful candidates will have some synergy of expertise with programs in biology.

Submit letter of interest, curriculum vitae, copy of transcripts, statement of teaching and research interests, and three letters of recommendation. Deadline to apply is March 10, 1995. The University of West FLorida has a strong commitment to the principle of diversity in all areas. In that spirit, we are particularly interested in receiving applications from women, members of ethnic minorities, and disabled persons. UWF is an EEO Access/AA employer.

Apply to Dr. Alan Goldin, Chair fo the Search Committee, Department of Ecology and Evolutionary Biology, The University of West Florida, 11000 University Parkway, Pensacola, FL 32514-5750.

**CHIEF SCIENTIST**

The Department of Energy's Office of Civilian Radioactive Waste Management is seeking an outstanding individual to serve in a Senior Level position, as Chief Scientist for our Project Office in Las Vegas, Nevada. The Chief Scientist will serve as senior scientific and technical advisor for the Yucca Mountain Site Characterization Project and the Director, Office of Civilian Radioactive Waste Management on matters directly related to the characterization of the Yucca Mountain Site, overseeing scientific activities, and reviewing and evaluating technical recommendations and site suitability evaluations for Yucca Mountain.

A bachelor's degree or equivalent in physical science, engineering or mathematics which includes at least 24 semester hours in the physical or engineering sciences field such as mechanics, dynamics, properties of materials and electronics, is required. An advanced degree is preferable, Candidate must have extensive specialized experience related to the conduct of scientific investigations in support of complex radioactive waste management programs of national significance.

The salary range for this position is from $82,401 to $119,275. Anyone interested in applying should contact Che McKittrick at (202) 586-3990 and request Announcement No. ERD 94-03A SER or obtain information on how to apply. Application must be postmarked by March 15, 1995.

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## Opportunities for Students

**Opportunity for multi-disciplinary graduate study in structural geology/surface geophysics/hydrogeology.** The University of Maine has a graduate assistantship available on a cooperative project with the University of Southern Maine and the Maine Geological Survey aimed at understanding fluid flow in fractured bedrock. This project is funded by a Department of Energy EPSCor grant. The student would be involved in bedrock mapping, fracture analysis, geophysical measurements, and/or hydrogeologic modeling. This project is ideal for the student with interests in structural geology and in learning tools that can be applied in the fields of environmental geology or water resources.

This assistantship is available September 1, 1995. For more information and an application form, contact Dr. Mary Hubbard, Department of Geological Sciences, University of Maine, Orono, ME 04469; (207) 581-2416; or fax 207-581-2202; or E-mail: Hubbard@Maine.maine.edu. The University of Maine is an affirmative-action/equal opportunity employer.

**Research Grants Available.** The Colorado Scientific Society invites graduate students to apply for monetary research grants to be awarded by the Society in early May 1995. Applicants must be enrolled in a Masters or Ph.D. program at an accredited private or state college or university. Four to six grants ranging from $500 to $1000 each will be awarded for field-oriented Earth-science thesis projects in Colorado and the Rocky Mountain region. Also, one or more grants from $500-$1000 will be awarded for engineering geology theses (with no aerial restriction) and a study of the Heart Mountain fault in northwest Wyoming. Interested students can obtain grant applications from the Chair of their department or by mail from the Chairman of the Memorial Funds Committee, Colorado Scientific Society, P.O. Box 150495, Lakewood, CO 80215. Deadline for applications is April 8, 1995.

**JOI/USSAC Ocean Drilling Fellowships.** JOI/U.S. Science Advisory Committee is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both one-year and two-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward the objectives of a specific leg or to broader themes. The award aims to encourage student participation on board ODP's drillship, JOIDES *Resolution*.

Applications are available from JOI and should be submitted according to the following schedule: Leg 165: Caribbean Ocean History, 5/1/95; Leg 166: Bahamas, 5/1/95; Leg 167: California Margin, 5/1/95; Leg 168: Juan de Fuca Hydrothermal, 5/1/95; Leg 169: Sedimented Ridges II, 5/1/95; Leg 170: Costa Rica, 5/1/95.

These legs will be staffed during the next few months. Students interested in participating as shipboard scientists must apply to the ODP Manager of Science Operations in College Station, Texas. An application for and leg descriptions are included in the JOI/USSAC Ocean Drilling Fellowship packet. For more information and to receive an application packet, contact: Andrea Johnson, JOI/USSAC Ocean Drilling Fellowship Program, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102 (Tel: 202-232-3900 ext. 213; Internet: JOI@brook.edu).

**Graduate Assistantships, Texas Christian University.** The Geology Department and the Center for Remote Sensing and Energy Research has assistantships available for M.S. students. Areas of department expertise include hydrogeology, groundwater modeling and remediation, remote sensing, environmental geology and geochemistry, carbonate and clastic sedimentology, paleovolcanology, structure and tectonics, Precambrian geology, paleontology, and computer applications in geology. Field research is carried out in Scotland, the Sierra Nevada in California, and Africa, as well as in Texas and Oklahoma. Department facilities include analytical equipment for environmental analysis and a state-of-the-art remote-sensing lab with computer work stations and image processing/GIS software. Financial aid includes a yearly stipend of $7,000, full tuition waiver, and up to $1,500 for research expenses. Contact the Graduate Advisor, Department of Geology, Texas Christian University, Fort Worth, TX 76129 (817-921-7270).

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GSA solicits applications and nominations of persons qualified to serve as GSA Books Science Editor. The term of the current Editor will end December 31, 1995, and the new Editor will begin a three-year term at that time.

This is not a salaried position, but GSA pays expenses for secretarial assistance, mail, telephone, and copying and for travel to meetings of the GSA Publications Committee. The GSA headquarters staff handles copyediting and production of books from accepted manuscripts.

Interested persons should submit a vita, a list of publications, and a letter describing relevant qualifications, experience, and objectives. Nominations should include a letter and the nominee's written permission, vita, and publications list. Applications and nominations should be sent BEFORE FEBRUARY 15, 1995, to: Donald M. Davidson, Jr., Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

### DUTIES

- Encourage submission of appropriate manuscripts or collections of manuscripts to GSA for publication as a Memoir or Special Paper.
- Respond to inquiries, oral or written, about possible manuscripts.
- Inform prospective authors and volume editors about GSA policies and procedures.
- Appoint volume editor(s) and supervise selection of reviewers for multi-paper volumes.
- Select and recruit reviewers for single-paper volumes; send out manuscripts for review. Advise author(s) about necessary revisions.
- Inform volume editors on procedures for review and revision of papers.
- Review each proposed volume upon receipt of final draft from author(s) or volume editors(s). If volume is up to standard, forward it to GSA headquarters with a recommendation for publication.
- Keep the GSA Committee on Publications and the headquarters staff informed about the flow of manuscripts and other GSA book business.

### THE GSA BOOKS SCIENCE EDITOR SHOULD HAVE

- Strong, broad background in geological sciences.
- Good organizational and English language skills.
- Willingness to invest the necessary time (up to 20 hours/week).
- Familiarity with many earth scientists and their work.
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- Patience, courtesy, and tact in dealing with authors and editors.
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## IEE to Sponsor Forum on Ground-Water Contamination

GSA's Institute for Environmental Education (IEE) will sponsor a panel discussion and public forum entitled "Remediating Ground-water Contamination: Have We Been Wasting Our Time or Is There Hope?" at the Northeastern Section meeting on Monday, March 20, 7:00–9:30 p.m. Gary A. Robbins, Department of Geology and Geophysics, University of Connecticut, will moderate what promises to be an informative and highly spirited evening involving a diversity of viewpoints and audience participation. For further information, contact Gary Robbins at (203) 486-1392.

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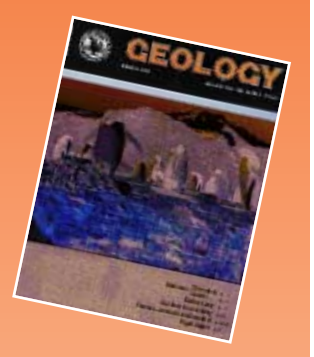


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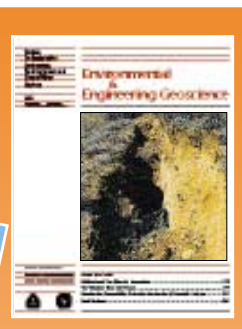


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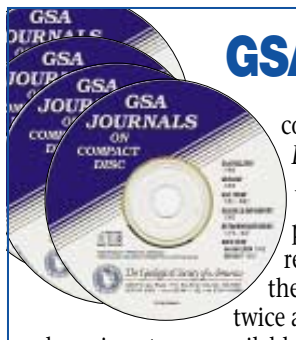


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