Vol. 3, No. 1 January 1993

GSA TODAY

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INSIDE

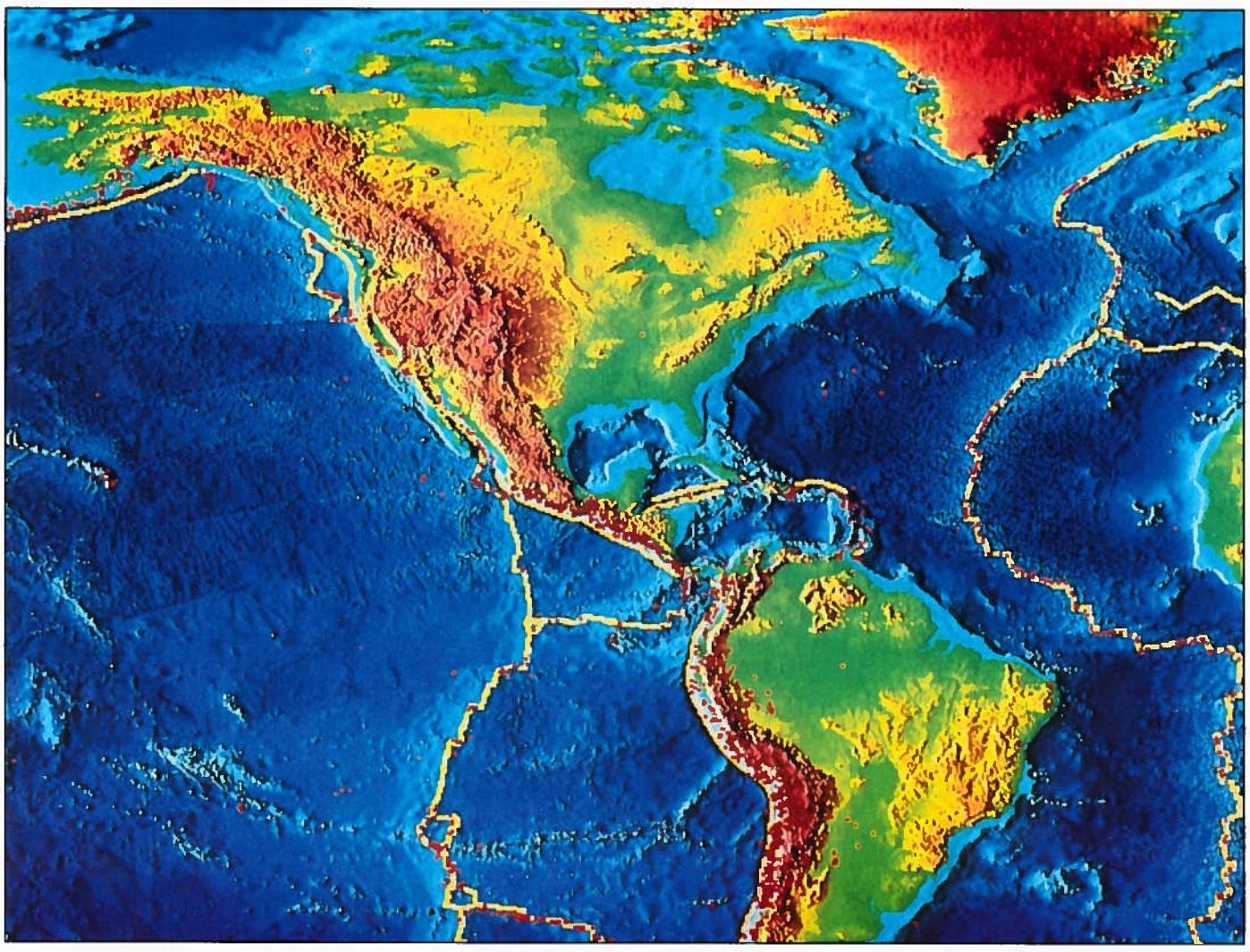

Figure 1. Color shaded relief images of the East Pacific Rise and the Mid-Atlantic Ridge .

It's Only Topography: Part 1

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Editor's Note

The science article in this issue is the first of two parts, the second part of which will be published in February. The article summarizes much recent work on mapping the ocean floor. As Macdonald et al. point out, we have made much less progress in the past 500 years mapping the part of Earth's surface covered by the oceans than we have in the past 20 years mapping the surface of our neighboring planets. This ironic situation inspired a series in *GSA Today* on planetary surfaces which includes several previous articles as well as this one.

Because this article represents a major synthesis of a great deal of new information, and because of space limitations in *GSA Today,* we have elected to publish the paper in two parts, this month and next. We do not plan to make a habit of having articles appear in two installments, however. Accordingly, the space limitations on articles for *GSA Today* will remain as they have been.

—Eldridge M. Moores

ABSTRACT

New swath-mapping sonar systems have revealed the structure of the mid-ocean ridge and surrounding deep-ocean floor with unprecedented clarity. These images show that the ridge is partitioned into segments by a variety of offsets such as transform faults, overlapping spreading centers, and very fine scale discontinuities, which are barely detectable. The smallest scale segments are the fundamental building blocks for creation of new oceanic crust. They are only ~2–20 km long and are active, distinct units for only 100–10000 yr. At fast-spreading centers, the axial neovolcanic zone is at a persistent 300–400 m elevation produced by the buoyancy of hot rock and magma; it is not a volcanic construction, so there is almost no vestige of it off-axis. Along most of its length, the spreading center is characterized by an axial summit caldera produced by volcanic inflation and collapse. The size and shape of the axial high are very sensitive indicators of a relatively steady and robust magma supply at fast-spreading ridges, and they have been used to predict the location of magma chambers and to forecast recent volcanic eruptions, including one witnessed from the submersible *Alvin* in March–April 1991. At intermediate spreading rates, the axial region cools sufficiently for a volcanic constructional edifice to develop episodically and for normal faulting to occur along an axial graben. Under these conditions axial volcanoes are split in two by the axial graben, and remnants can be found on the flanks of spreading centers. At slow-spreading ridges, the magma budget is relatively starved, as indicated by a persistent axial rift valley, a highly discontinuous neovolcanic zone, and strong asymmetry in profiles along and across the strike of the ridge.

INTRODUCTION

When we read a year ago about the mapping of Venus in *GSA Today* (Head and Saunders, 1991), the Magellan mission had provided spectacular images of 10%–20% of that planet's surface, and now Magellan has scanned more than 90% of the surface of Venus. In the 500 years since Ferdinand Magellan circumnavigated the world's oceans, oceanographers have scanned less than 10% of the deep ocean floor at the resolution provided by spacecraft Magellan's synthetic aperture radar images. Why has oceanography lagged so far behind the space effort? It was not until after World War II that any systematic effort was launched to map the ocean floor. To the present day, efforts to accurately map the seafloor are made from ships with sonar systems, because electromagnetic waves do not travel far through sea water. Progress has been slow, when compared to the mission to Venus, because oceanographic ships wallow over the waves at 18 km/h rather than soaring through space at 19500 km/h. Furthermore, the U.S. oceanographic fleet is funded at levels much lower than NASA (1/50), and the acquisition and support of new mapping tools for the fleet has been a slow process. At present, four of the university-operated ships are equipped with high-resolution mapping systems, and plans are in place for the acquisition of three more systems over the next several years. However, these systems are not routinely operated because of lack of funds, and there is currently no plan to map systematically the shape of the global abyss, Earth's last frontier.

SEGMENTATION OF THE MID-OCEAN RIDGE

When viewed in an along-axis perspective, the axial depth and continuity of the mid-ocean ridge is segmented at various scales and in various ways. At the longest wavelengths, the along-strike axial profile of the ridge is characterized by a broad swell with dimensions in excess of 1000 km (Fig. 1). The crests of these swells are defined by hot spots, reach anomalously shallow levels, and are associated with excessive and long-lived magmatic budgets. At shorter wavelengths (a few tens to hundreds of kilometres), the global ridge system, independent of spreading rate or proximity to hot spots, is partitioned into discrete segments by a family of ridge-axis discontinuities that have distinctive structural signatures. Because these offsets exhibit distinctive morphologic and geochemical characteristics, in both space and time, they, and the ridge segments they partition, have been arranged in a hierarchical classification scheme of orders 1–4 (Table 1; Fig. 2) (for a review, see Schouten et al. [1985], Langmuir et al. [1986], Macdonald et al. [1988], and Macdonald and Fox [1990]).

Transform faults define first-order segments; they are large offsets of opposing ridge segments in terms of both distance (tens to hundreds of kilometres) and age (approximately one to tens of millions of years). They link ridge segments along a narrow strike-slip fault zone against which terrain parallel to the ridge axis is truncated (Figs. 3A, 4, 5A). These boundaries are stable for long periods of time (millions of years). Their aseismic extensions describe parts of small circles, and these extensions can be traced as continuous

Topography *continued on p. 24*

IN THIS ISSUE

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The Citizen–Geologist
GSA Presidential Address, 1992

E-an Zen
Department of Geology, University of Maryland, College Park, MD 20742

E-an Zen

I'd like to talk about a matter that calls for our collective attention: What the role of GSA and of geologists should be in the future well-being of our world.

For over a century, GSA has enjoyed the respect of the geological community, earned by a superb record of promoting and spreading scholarly information on geology. If the self-image of an institution can be measured by the people it chooses to honor, then our Penrose Medalists may gauge our ideal. Searching among the names of only those medalists no longer with us, I find Charles Schuchert, Norman Bowen, Reginald Daly, William Morris Davis, Arthur Holmes, William W. Rubey, Preston Cloud, and Harry Hess. Discoverers and innovators all, their thoughts have shaped the way we look at Earth and at our science.

With a few notable exceptions, however, these honored men (for they are all men) spoke mainly to other geologists. We have not expected our leading scientists to reach out to the public or to the political leaders. Should GSA play an active role in public outreach, or should it keep to the traditional focus of propagating scholarly knowledge? These questions deserve serious debate.

Science is too important to be left to the scientists. Geology directly impinges on human welfare and so cannot be an ivory-tower science. Conservation of the environment, discovery and recovery of Earth's resources, avoidance of natural hazards, disposal of wastes, forecasting of global change, decisions on land use, equity for the future—these and other issues need geological knowledge both for technical resolution and for guiding public policy. Public policy needs public support; we ignore the public at our own peril.

That peril is something we geologists know only too well. We feel frustrated that we are under-represented in science, in education, and in the shaping of public policy; that earth science is often regarded as a second-class subject in schools; that when the news media describe our natural world they often omit geological information; and that in a budget crunch, departments of geology and state geological surveys are among the first casualties. These situations cry out for us to improve the visibility of geology and to widen its public role. Public outreach is a responsibility from which we may not shirk.

We can help improve people's appreciation of geology by building a record of timely, useful, and visible contributions to their welfare. We can also set an example for interdisciplinary cooperation in matters that affect society's well being. Physicists in the United States enjoy their political credibility partly because they rose to meet the demands of the Second World War, symbolized by the Manhattan Project. To save our planet may well be the next, global, Manhattan Project or, using Albert Gore's (1992) more positive metaphor, a globally shared Marshall Plan. Such an undertaking will involve many disciplines and different kinds of institutions, but geology should have a central role. Will we be ready with wise and specific plans to steer decision makers toward good choices? Let's prepare ourselves for that happy prospect.

Clearly, better science education is a key to any long-term effort to inform people about our natural world, and GSA is actively promoting earth-science literacy. Scientific literacy is part of a public agenda because it can enhance ballot-box competency. We must relate scientific knowledge to society's sense of value—what is right, what is wrong, what is important—so that people can meld scientific knowledge with their own lives. How do we begin?

Let's first consider the public image of a scientist. This is not a frivolous consideration; public perception of a scientist reflects and affects how the public reacts to science. A scientist is often depicted as an egocentric white male, a brilliant weirdo in a white lab coat, deficient in common sense, working like a fiend, driven equally by curiosity and by greed. This caricature permeates science fiction, comic strips, TV, and even serious newspapers. I suspect that this image feeds partly on misunderstandings and partly on revulsion against research that offends some people's moral sense. We have not fully faced this issue, and we aggravate the problem every time we duck people's questions about science or scientists. As a start, we need to show people that scientists are normal human beings having the same basic human concerns and impulses.

Another element affecting the image of a scientist has to do with scientific ethics. Issues involving ethics are rightly newsworthy, and cases of scientific misconduct do catch public attention. People now realize that scientists, being human, are not only fallible but temptable, and that research organizations sometimes fail to police themselves.

Ethics does indeed permeate science. Every step we take, from observation to publication, involves ethical decisions. When may I throw out anomalous data? How do I interpret ambiguous information? Should I admit an error in judgment? Who should be my coauthors? Is my research topic intrinsically immoral? These decisions shape the quality of the results. Because science is a public enterprise and because ethical factors underlie the relation between the taxpayer and the scientist, we need to develop serious dialogue with our fellow citizens, and cultivate shared values as well as shared interests, based on our common stake in the future.

Environmental ethics is an area where geology has a natural role. I am thinking specifically of our responsibility to protect the long-term ability of Earth to sustain life in its myriad wondrous forms in the face of a growing human population enticed by the prospect of resource-hungry technology. To ask how much life Earth can support acknowledges that we are concerned with Earth as a habitat for all, and not just for *Homo sapiens*. The decision makers have to know that the needs of the other life forms, the entire ecosystem, require adequate attention if humankind is to thrive. They need to be reminded that decisions on land use wipe out future options; option itself is a nonrenewable resource (Zen, 1983).

Perhaps the issue of wetlands can illustrate some of my points. In 1988 George Bush proposed an environmental policy that included "no net loss" of wetlands. Today, an executive redefinition of wetlands reduces that protection. This legal juggling might put the integrity of significant wetland areas at risk (Alper, 1992; Nicholas, 1992). Is the mere preservation of the total area of wetlands enough to ensure their long-term robustness? Can wetlands be created or repaired fast enough to compensate for losses, yet sturdily enough to fully perform their natural functions (National Research Council, 1992)? How does one create new wetlands, and in whose backyard? Yours or mine?

As geologists, we can help discover the natural processes that sustain a wetland, as well as clarify how human activities might modify these processes. That's our normal job. But we also need to tell lawmakers and voters why wetlands are important, why they must be protected, and how their protection goes beyond satisfying legal definitions and filling administrative pigeonholes.

A different subject that demands attention is the public appreciation of where earth science fits into the school curriculum for kindergarten through twelfth grade. Does earth science qualify as a lab science? This question directly affects the ability of earth science to attract students. Confusion is rampant, in part because we geologists are schizophrenic on this matter. Earth science encompasses the lab sciences, meaning chiefly chemistry and physics, because first, we need these tools to calibrate and project natural relations, and second, we need the constraints of these disciplines to help us distinguish what's plausible from what's fantastical. However, earth science is more than just applied chemistry and physics, because geology is at its core. Geology is also a historical science that draws inferences from unique events, a process that gives our science its important concepts of time, sequence, and correlation.

Let me put it another way. Laboratory studies are usually so designed that the initial and boundary conditions, as well as the variables, are carefully controlled, so that one could gain detailed understanding of idealized systems. Earth science must practice this kind of discipline, but it also must deal with the real world. This real world is not simple and neat. It is nonlinear, it is contingent, it is time-dependent, and it usually consists of a complex and messy overlay of events. Thus, when we apply to Earth precise understandings gained from simplified systems, we have to extrapolate to situations where we cannot run away from nature's untidiness. The two approaches are as woof and warp in weaving: neither can serve

alone. We need to discuss the matter, one on one, with educators at both K through 12 and university levels, so that they will incorporate these understandings in their policy decisions.

Granted that science is vital to society; must we aim at literacy for all? Isn't that rather wasteful? After all, only a few percent of students can be expected to need science; the rest seem to get along quite well without it. Morris Shamos, a past president of the National Science Teachers Association, raised this question by asking, "Is it necessary that the mayor of New York be versed in plate tectonics to run city hall?" (Shamos, 1988).

Plate tectonics or not, science does enter into the running of city hall. That was also Pete Palmer's point in his article "What should my neighbor know?" (Palmer, 1990). Those who will be making policy choices in 15 or 20 years are today's students, and one of them may be the next city manager, the next CEO of a major industry, the next environmental activist, the next judge, the next legislator, or the next president or prime minister. Certainly, most citizens will have to respond to technology- and science-based issues at several levels of government: for example, pumping groundwater for irrigation, disposal of nuclear waste, or allocation of public land between preservation and use. Successful resolutions of these technical issues depend on the concurrence of the affected people. My answer to Mr. Shamos's challenge is that we are obliged to cast our nets widely and to expose as many people as possible to basic knowledge because we don't know who will need this knowledge.

If we want the world to pay greater attention to geology, and if we want decision makers to allocate more resources for geology, then we need to demonstrate the importance of geology in public affairs, and we must accept our public obligation to be good citizen-geologists. This means that we need to include nonscientists among the immediate beneficiaries of the knowledge we garner and disseminate, and we must make sure that, dealing with them, we use language that's free of jargon or hidden connotations. Our contribution should not exclude professional judgment, clearly labeled, of course, for if we withhold our professional judgment, we would still affect policy formulation, albeit in a negative way.

We are geologists by choice, but we are inhabitants of this fragile planet perforce. As geologists, we are supposed to know the importance of looking at Earth as a total system, and to know how to be its good stewards. We should be prepared to speak to our conviction. I, for one, would say this to the world: If we want sustainable global development, then we must learn to be good guests and walk lightly upon Earth. We must contain both the explosion of world population and the explosion of our consumption of resources. Both explosions devastate our Earth, both consume our future options, and both destroy hopes of sustainable development.

Consider this. In terms of consumption of key energy resources and emission of greenhouse gases, the United States contributes a good deal more than India, China, Indonesia, and Brazil combined, although the total population of those countries is about ten times that of ours (Table 1). In terms of lifetime load on the environment, every additional North American is equal to about 15 additional people in those countries. It seems to me that we cannot continue to enjoy our riches if the rest of the world has to queue up for their daily bread. All nations must share the responsibility of ensuring the equity of future societies because we live under the same blue sky. Indeed, unless we can contain the twin explosions of population and consumption, all other measures of conservation and natural hazard avoidance will be no better than putting Band-Aids over mortal wounds, or taking aspirin for cancer.

If geology is to play a major role in the effort to use Earth wisely, then we need to act on that conviction. GSA is already in there. Our SAGE program and our Institute for Environmental Education, as well as our various outreach committees, are working productively on many important challenges. Our joint sponsorship with the U.S. Geological Survey of the Congressional Science Fellows program has been a success, and our participation in the American Geological Institute's Government Affairs Program is off to a good start. Nevertheless, we must do more, especially toward building equity for the future. To do so, we need to collaborate with our colleagues in other lands. Perhaps together we can help figure out how to set aside some of our remaining natural endowment for the future world, in ways that meet each nation's own needs and perceptions. Going beyond that thought, perhaps we should consider whether we need an international earth-science–centered think tank; a group to define and recommend specific long-range actions, rather analogous to Resources for the Future. The Committee for the Wise Use of the Earth, chaired by Bill Fyfe, is pondering what GSA and geologists can do to assure sustainable global development. They'd welcome your ideas.

As important in the long haul, we need to work with people as individuals. We need to reach out to students and to their parents; we need to work with teachers. We ought to get involved in public service, and we should convey our views to our elected representatives. Although a single person is unlikely to make a large mark, if we all make an effort, we just might make a difference. This will be a great challenge to us individually as well as collectively as members of GSA. This will be a great adventure, where we need to thing big and think ahead. Our involvement will demand a high standard of work as well as a high level of sensitivity to public perception. This call cannot wait for someone else, because singly and collectively *we* are that someone else.

In closing, I thank Sam Adams, Norman Newell, Pete Palmer, Craig Schiffries, Catherine Skinner, Reds Wolman, and especially Alta Walker for commenting on various drafts of this talk. I appreciate having the privilege to take a turn at standing watch for GSA. It has been a challenging and stimulating year. I gratefully acknowledge the wonderful help and support from the entire headquarters staff. I've had fun.

TABLE 1. COMPARISON OF RESOURCE CONSUMPTION AND GREENHOUSE GAS GENERATION

		Four populous developing nations				
	United States	China	India	Indonesia	Brazil	Combined
Population, 1990 (x 10^6)						
	249	1139	853	184	150	2326
Commercial energy consumption, 1989 (joules)						
Total	73,370 x 10^{15}	26,156 x 10^{15}	7528 x 10^{15}	1453 x 10^{15}	3445 x 10^{15}	38,582 x 10^{15}
Per capita	295 x 10^9	23 x 10^9	9 x 10^9	8 x 10^9	28 x 10^9	17 x 10^9
Metals consumption, 1990 (tons, x 10^3)						
Aluminum	4352	650	420	n.d.	n.d.	n.d.
Copper	2143	512	n.d.	n.d.	n.d.	n.d.
Crude steel	102,351	69,504	20,036	n.d.	n.d.	n.d.
Greenhouse gas emission, 1989 (tons)						
Industrial CO_2						
Total	4869 x 10^6	2389 x 10^6	652 x 10^6	138 x 10^6	207 x 10^6	3386 x 10^6
Per capita	19.7	2.2	0.8	0.8	1.4	1.5
Anthropogenic methane						
Total	37 x 10^6	40 x 10^6	36 x 10^6	6.5 x 10^6	8.8 x 10^6	91.3 x 10^6
Per capita	0.15	0.04	0.04	0.04	0.06	0.04
CFC						
Total	130,000	12,000	4000	1000	6000	23,000
Per Capita	523 x 10^{-6}	11 x 10^{-6}	5 x 10^{-6}	5 x 10^{-6}	40 x 10^{-6}	9.9 x 10^{-6}

Note: Data from World Resources Institute (1992, from Tables 16-1, 21-2, 21-5, 24-1, and 24-2); n.d. indicates no data from the institute.

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GSA GeoVentures 1993

Photo by Haraldur Sigurdsson.

Picture yourself here.

GEOTRIP

Iceland: For Geologists

July 31–August 15, 1993
16 Days

Scientific Leaders
Haraldur Sigurdsson, Graduate School of Oceanography, University of Rhode Island, Narragansett

Haukur Johannesson, Museum of Natural History, Reykjavik, Iceland

Haraldur Sigurdsson, professor of oceanography, is well known and respected as an expert on Iceland geology. He has led many trips there. Haukur Johannesson is considered the most experienced field geologist in Iceland and has a tremendous knowledge of regional and local geology and history. Both will be with the group throughout the trip. Other interpretive scientific leaders will also contribute to the group's understanding and enjoyment.

Program Schedule

July 31, Saturday ..... Travel day from Baltimore to Reykjavik, evening departure on Icelandic Airlines
August 1–15, Sunday through Sunday ..... Iceland GeoTrip
August 15, Sunday ..... Travel day from Reykjavik to next gateway

Itinerary

This trip is an exceptional educational adventure with an enormous wealth of geologic features and outstanding leadership. The complete daily itinerary, available from GSA headquarters, includes geologic sites and lodging locations.

Transportation and Lodging

Travel will be by Mercedes Benz four-wheel-drive mountain trail bus. During most of the trip, the group will stay in country hotels, which are simple but comfortable, so-called Edda hotels, run by the Icelandic Tourist Bureau. They are basically secondary schools and high schools in rural areas which are operated as summer hotels. The group will spend three nights in mountain cabins and use sleeping bags. Food will be provided at all lodging locations, plus picnics during the day.

Cost

Estimated GSA Member Land Cost: $2650 based on 30 people
(May be additional if there are fewer registrants)
Nonmembers: $2800
(If you have previously traveled on a GSA GeoTrip, the $150 additional will be waived.)

Fee includes almost all meals; double-occupancy lodging; comfortable bus and ferry transportation; transfers and entrance fees; baggage handling; sleeping bags; geologic reading materials and guidebook; and, of course, the companionship of expert scientific leaders. **Not included** is airfare to and from Reykjavik. The current airfare is approximately $750 from Baltimore. All participants must depart from this gateway. The Baltimore gateway has the best connecting flights to mid-America. Dave Bentzin, Cimarron Travel (Uniglobe), Littleton, Colorado, will be handling airline reservations. Dave will be happy to answer questions on flight schedules, airfares from your home city, and trip extensions. Call from 3:00 to 5:00 p.m. (MST), Monday through Friday at (800) 854-0872 (toll free), or 850-7711 (metro Denver). Also, a few meals are not included.

Please make your decision as soon as possible.
There is high interest in this trip, and several people have registered already.

If you decide to go, send $350 per person to hold your place. The fee is refundable, less a $50 processing fee, through February 28. Cancellation options after this date, together with a full itinerary, will be sent either on request or with confirmation of your deposit.

GEOHOSTEL

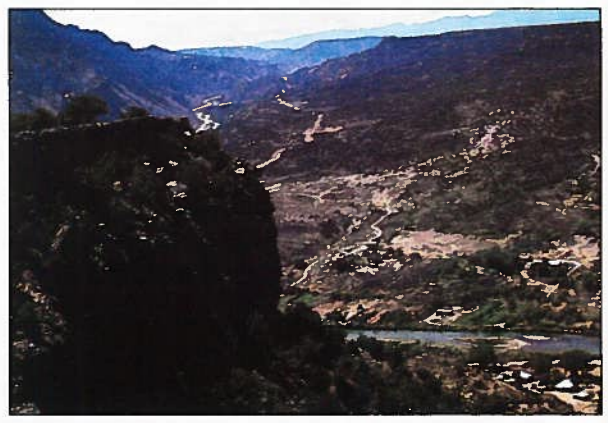
Geology, Paleontology, and Cultural History of North-Central and Northwestern New Mexico

Plaza Resolana en Santa Fe, Santa Fe, New Mexico
Five Days and Six Nights: May 29–June 3, 1993

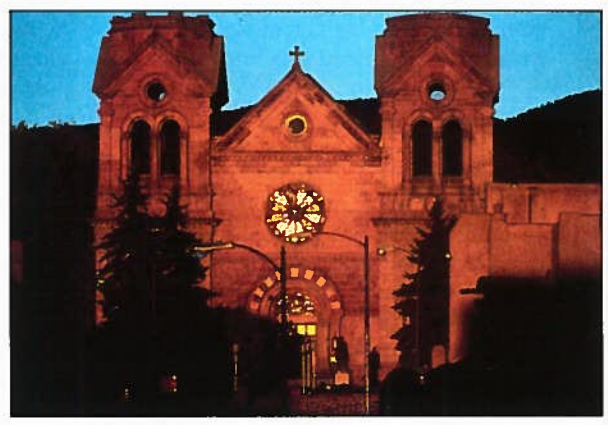
Scientific Leaders
Donald L. Wolberg, New Mexico Bureau of Mines and Mineral Resources
Diane Bellis, U.S. Department of Agriculture, Forest Service

Daily Itinerary
All trips begin and end in Santa Fe.

Day One—Saturday, May 29
6:00 to 8:00 p.m.—**Arrive in Santa Fe.** Welcoming Reception and Orientation, Plaza Resolana en Santa Fe.



Near Taos; Pilar looking down the Rio Grande.



St. Francis Cathedral, Santa Fe.
Photo by Jack Parsons.

GEOHOSTEL

Scenic Geology and Natural History of East Yellowstone, Beartooth, and Absaroka Country, Wyoming

Northwest College, Powell, Wyoming
Five Days and Six Nights: July 17–22, 1993

Scientific Leaders
Kenneth E. Kolm and Gregory S. Holden, Colorado School of Mines

Fall Creek Falls—Clarks Fork.
Courtesy of Wyoming Travel Commission.

Mountain wild flowers.
Courtesy of Wyoming Division of Tourism.

Day Two—Sunday, May 30

8:30 to 12:00 noon—**Classroom lecture: Geology of Northern and Northwestern New Mexico; Introduction to the Cultural History of the Region.** Afternoon is free for touring Santa Fe, the City Different.

Day Three—Monday, May 31

8:00 a.m. to 5:00 p.m.—**Taos and the Rio Grande Gorge.** This trip will be dominated by the development of the Rio Grande Rift and associated structural geology. The route will include the Tertiary Tesuque Formation of the Santa Fe Group and unusual geomorphic features such as Camel Rock, eroded from soft sedimentary strata. The spectacular Rio Grande Gorge is approximately 650 ft deep, and has cut into volcanic flows 4.5–3.6 million years old. Afternoon is free for touring Taos.

Day Four—Tuesday, June 1

8:00 a.m. to 5:00 p.m.—**Albuquerque and Tramway to Sandia Peak.** Albuquerque is situated on several river terraces of the Tertiary Santa Fe Group and Pleistocene and Holocene deposits, beneath the Sandia Mountains. The tram provides exciting views of 1.4-billion-year-old Precambrian granite cliffs of the Sandia Granite, which forms the core of the Sandias. Afternoon is free for touring Albuquerque.

Day Five—Wednesday, June 2

7:00 a.m. to 6:00 p.m.—**San Juan Basin, Geology of the Southern Part of the Basin, and Tour of the Ruins at Chaco Canyon.** This trip will skirt the eastern edge of the San Juan Basin, initially crossing the sharply uplifted Precambrian and Paleozoic Nacimiento uplift. Farther northward, the San Juan Basin provides an excellent record of Late Cretaceous marine transgressions and regressions. Chaco Canyon is a spectacular archaeological area. Between 1050 A.D. and 1300 A.D. large stone masonry apartment complexes were built to house substantial populations.

Day Six—Thursday, June 3

8:00 a.m. to 2:00 p.m.—**Madrid.** This trip will include a traverse of the Espanola Basin, part of the Sangre de Cristo uplift, and part of the Jemez volcanic field and the Hagen embayment. The rock units will include basement Precambrian rocks, Paleozoic and Mesozoic sedimentary rocks, and Tertiary-Quaternary sedimentary and volcanic units.

The Farewell Party begins at 6:00 p.m.

Fee and Deposit

Cost: $550 for GSA members. Nonmembers $595.
$125 deposit, due with your reservation, is refundable through March 30, less $20 processing fee.
Total balance due: April 1
Minimum age: 21 years. Limit: 28 persons.

Fee includes classroom programs and materials, field trip transportation, lodging for 6 nights (double occupancy, dormitory rooms), breakfast and lunch daily through Thursday, and welcoming and farewell events. **Not included** are transportation to and from New Mexico, transportation during non-class and field trip hours, meals or other expenses not specifically included.

GeoVentures Registration Form

Registration Open

GeoVentures are a special benefit created for members, but are open also to guests and friends. GeoVentures is the overall name for adult educational and adventure experiences of two kinds: GeoTrips and GeoHostels. Both are known for expert scientific leadership. Fees for both are low to moderate (relative to the length of time and destination) and include lodging and meals as designated. The venues, however, are quite different.

Please keep in mind that the GeoVentures fill quickly and it is best to make a decision early.

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. (Future charges will be authorized by you first.) You will receive further information and a confirmation of your registration within one week after your reservation.

Cancellation: Each GeoVenture has its own set of cancellation dates which will be sent out to registrants and provided in response to phone queries.

Name _____

Institution/Employer _____

Mailing Address _____

City _____ State ____ Country _____ ZIP _____

Phone: ( ) _____ ( ) _____
Business Home

Guest Name _____

GSA Member # _____

	Deposit Per Person	No. of Persons	Total Paid Deposit
GT931—**Iceland GeoTrip**	$350	_____	_____
GH931—**Yellowstone-Powell, Wyoming, GeoHostel**	$100	_____	_____
GH932—**Santa Fe, New Mexico, GeoHostel**	$125	_____	_____
		TOTAL DEPOSIT	_____

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

Credit Card #_____ Exp. Date _____

Signature _____

Mail Registration Form and check or credit card information to:
1993 GSA GeoVentures, GSA Meetings Department,
P.O. Box 9140, Boulder, CO 80301

Non–U.S.-based registrants are encouraged to use GSA's fax number:
303-447-0648

Call today for more information:
Dottie Weigand or Edna Collis at (303) 447-2020 or 1-800-472-1988

Daily Itinerary

All trips begin and end in Powell.

Day One—Saturday, July 17

6:00 to 8:00 p.m.—**Arrive in Powell.** Welcoming Reception and Orientation, Homesteader's Park.

Day Two—Sunday, July 18

8:00 a.m. to 12:00 noon—**Dead Indian Hill.** A short drive and walk to a spectacular overview of the region. We will review northwestern Wyoming geology, specifically local stratigraphy, Laramide tectonics, the Heart Mountain thrust, local geomorphology, and plant communities.

Day Three—Monday, July 19

8:00 a.m. to 5:00 p.m.—**Yellowstone.** We will drive up the Wapiti Valley to Yellowstone Park, stopping at Rattlesnake Mountain, Holy City Hoodoos, Yellowstone Lake, and Yellowstone Falls. Emphasis will be on the Absaroka volcanic suite and the development of the Yellowstone caldera and surrounding plateau.

Day Four—Tuesday, July 20

8:00 a.m. to 12:00 noon—**Bighorn Basin.** We will traverse the Big Horn Basin and examine the famous Sheep Mountain anticline. Emphasis will be on stratigraphy, Laramide structures, petroleum resources, and basin hydrogeology.

Day Five—Wednesday, July 21

8:00 a.m. to 4:00 p.m.—**Daisy Pass–Cooke City.** This trip will take us to the upper Clark Fork of the Yellowstone River. We will start with a look at the spectacular Sunlight Basin, then drive above Cooke City to Daisy Pass near timberline. Highlights will be complex geology, an old mining area with good mineral collecting, and beautiful flowers.

Day Six—Thursday, July 22

8:00 a.m. to 5:30 p.m.—**Beartooth Highway Loop.** This trip will take us over the Beartooth Highway through Redlodge, Montana. This highway, often called the most scenic in America, earns the title with spectacular geology as well. Highlights will be Laramide structures on the north scarp of the Beartooth Plateau and vast-scale alpine and ice-cap glacial features on a road that is above timberline for 30 miles. Precambrian rocks of the plateau are more than 3 billion years old. Culmination of the trip is the Beartooth Butte, the favorite spot on Earth of trip leader Ken Kolm.

The Farewell Party begins at 7:00 p.m.

Fee and Deposit

Cost: $425 for GSA members. Nonmembers $475.
$100 deposit, due with your reservation, is refundable through April 30, less $20 processing fee.
Total balance due: May 1
Minimum age: 21 years. Limit: 28 persons

Fee includes classroom programs and materials, field trip transportation, lodging for 6 nights (single-occupancy, dormitory rooms), breakfast and lunch daily through Thursday, and welcoming and farewell events. **Not included** are transportation to and from Wyoming, transportation during nonclass and field trip hours, meals, or other expenses not specifically included.

Science-Government Interaction

The GSA Committee on Geology and Public Policy sponsors a session at each annual meeting to relate the need for science-government interaction and the need for informed involvement by the geoscience community.

The following is an excerpt from a presentation at the 1992 Annual Meeting by Kenneth B. Taylor, GSA Congressional Science Fellow for 1991–1992. Taylor worked in the office of Senator Harry Reid (D—NV), serving as the in-office scientific and technical advisor, information collector, and analyst. As a Congressional Science Fellow, Taylor was able to participate in a variety of legislative initiatives such as nuclear waste and nuclear licensing, the Nevada Test Site, earthquake hazard mitigation, and appropriations for the Departments of Interior and Energy.

Needed: More Friends and a Stronger Message

Kenneth B. Taylor
1991–1992 GSA Congressional Science Fellow

During this past year, I served as the sixth Congressional Science Fellow from GSA. Our society was one of 17 that sent one or more scientists to the American Association for the Advancement of Science (AAAS) Congressional Science and Engineering Fellowship Program. The AAAS program has placed scientists on Capitol Hill for nearly 20 years, and the program is well regarded by both political parties as a source of scientific and technical expertise, input that is sorely needed in the public policy debate.

Congress Is Seeking Expertise

As a Congressional *Science* Fellow and a technologically literate person, I was asked on several occasions to work on science and technology issues that were well outside my area of expertise. The argument used was that as a scientist, at least I could understand the technical issues. In that capacity, I sat in on briefings on genetically altered foodstuffs, clean-water issues, and advanced-materials research.

Fellows have total freedom to select the office they wish to work in. All of the offices I contacted during the placement period looked at expertise and background in terms of the level of assistance that the Fellow could provide to a specific problem or project. One member of the House Appropriations Committee wanted an analysis of the Federal Emergency Management Agency (FEMA). Another member asked if I would organize a legislative solution to earthquake hazard, earthquake insurance, and tsunami-flood insurance problems in Hawaii. One legislator wanted an analysis of nuclear discrimination and detection technology, while another wanted an overview of science education—what works and what doesn't. Several asked for assistance in evaluating the geohazards associated with proposed low-level and high-level radioactive waste sites, as well as earthquake hazards in the legislator's state. Finally, one member wanted assistance on legislation concerning oil and natural gas issues.

Predictions of Status Quo on the Hill

During the AAAS orientation in September 1991, all of the invited speakers were unanimous in their belief that the coming year would be interesting, but the outcome of the November election, still 14 months away, was a foregone conclusion—the present administration would remain in office and divided government would continue.

The demand for change that swept the country made my year politically very interesting, but the adversarial relationships between the administration and Congress, as well as between the majority and minority parties in Congress, made the process of enacting legislation very difficult.

My fellowship year was marked by several protracted disputes over energy, gun control, the environment, and civil rights. These disputes caused the process to nearly grind to a halt. Part of this inaction was founded in a breakdown of the old adage; the President *proposes,* Congress *disposes*.

In theory, legislation should start with the Executive Branch—the President puts forward a program and Congress conducts hearings on that program. Congress then may choose to reject the bill or modify it and pass it back to the President. If the President's bill has been altered too much, he may choose to veto it. Note that in theory legislation moves, it does not just sit, ignored, in Congress. The President owes it to Congress to propose something that can be enacted. Congress owes it to the American people to act upon the plan proposed. This rarely happened during the 102nd Congress.

For example, during my year, it was the energy bill of Senator Johnston, Representative Dingell, or Representative Sharp that moved through Congress. The President's program was abandoned from the start, and only when it became obvious that his bill would not move did the administration choose to support one of the other bills. I had the privilege of participating in two of these fights, both of which were centered on authorization and/or appropriations for the Department of Energy.

Observations and Recommendations

From the experiences gained by my year on Capitol Hill, I have gathered a list of observations and recommendations that I hope the members of GSA as well as others in the geoscience community will consider.

1. **Find friends for geoscience and geoscience agencies on Capitol Hill.** You make friends with people you know. Offer to help your Member of Congress as part of his or her staff's information network. Tell *your* legislator what you are doing and why it is important. The message you want to deliver is simple: "Geoscience is working for the greater good of *all Americans* on issues of great importance." Be willing to testify before Congress at appropriations time in support of funding for geoscience agencies such as the USGS, National Science Foundation, Department of Energy, NOAA, NIST, Bureau of Mines, Bureau of Reclamation. Be ready to respond. For the Geological Mapping Act, each Congressional office got a few letters, *but not a flood.* Other interest groups can mobilize a flood of letters on most issues that they feel are of fundamental concern to their constituents.

2. **Inform your legislator, whether at the local, state, or national level.** Let legislators' staff members know about your interest in helping; let them know about you. You don't have to travel to Washington to meet and talk to your legislators. Arrange a meeting with them when they are in the district or state during the legislative year. In addition, arrange a tour of your facility so that your legislator can learn about your research as well as meet the other individuals in your program.

3. **Present articulate messages; no science-speak here.** Legislators and their staffs are not scientists. Carefully chosen simplifications, ones that fully explain the issue but do not go into minute detail, are excellent teaching tools for educating legislators and their staffs. Always present both sides in a clear and concise manner. Don't ask "Could we testify?"; rather say, "We wish to testify, whether as a group, individual scientists, or private citizens."

4. **Be willing to serve.** Not everyone can serve as a Congressional Science Fellow, but you can volunteer to serve on advisory boards, especially those formed by legislators. In this capacity you can help legislators form the ideas that could lead to new initiatives. Productive discussion of critical issues is important, not just ideas thrown out by academics.

I urge the mid-career, experienced scientists of GSA to consider serving as the Congressional Science Fellow. Tenured faculty, GSA councilors, and other senior members have many life experiences that they can combine with their advanced education. Senior scientists can speak from authority on the Hill, where the average age of a congressional staff member is about 25. Experienced scientists have written or at least worked within a budget; they have served on national boards and/or peer review panels and are already aware of funding and new initiatives at the federal level. Finally, they can bring back to their university or institution the lessons learned firsthand as a Fellow on how the interaction between the legislative and executive branches works. This could lead to the introduction of new curricula on science and policy within their institution.

5. **Find a high-profile spokesperson.** Other fields, such as astronomy with Carl Sagan, have one or two scientists willing to speak to wide audiences of nonprofessionals on the virtue of their field. These people are gifted teachers and role models of what scientists can and should give back to the community. We have many fine geoscientists who can inspire people with their vision of an articulate message of what geoscience is—and why it is important to society. Such role models would enhance our image not only in Washington, but nationwide.

6. **Take charge.** Become motivated, both as individuals and as a professional society to participate more fully in public policy and science. Decisions affecting nearly all Americans are made every day in Congress, but also in state legislatures, local planning boards, and city councils. Legislators cast votes on the basis of information they have, voting by gut reaction (only what a member knows), political pressure (which may or may not be accurately represented), or sound technical judgment based on scientifically and economically factual information. Let's help our legislators make those sound choices. ■

Since 1986, the GSA Congressional Science Fellowship has been jointly funded by GSA and by a grant from the U.S. Geological Survey.

The views and conclusions contained in this article 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.

The Geological Society of America

Congressional Science Fellowship 1993–1994

The Geological Society of America is accepting applications for the 1993–1994 Congressional Science Fellowship. The Fellow selected will spend a year (September 1993–August 1994) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is open to highly qualified earth scientists in early or mid-career. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy problems.

Award

The GSA Congressional Science Fellowship carries with it a $38,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (Employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact AAAS or the Geological Society of America.)

To Apply

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from: Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

DEADLINE FOR RECEIPT OF ALL APPLICATION MATERIALS IS FEBRUARY 16, 1993

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.

Responsible Science

> For the last fifty years, the United States has supported the world's most innovative and productive scientific research system, a system designed to create new knowledge and technology that can help, in the words of Vannevar Bush, to"insure our health, prosperity, and security as a nation in the modern world." Today, however, the United States faces wide-ranging societal crises and challenges, in our educational system, our environment, our manufacturing sector, our health care system, our inner cities, our financial institutions, even our system of government.
>
> This paradox—growing knowledge, accompanied by growing societal crisis—implies a complex, nonlinear relationship between advances in knowledge and advances in society. More specifically, it suggests that we are not adequately using the knowledge that we have, or that we are not sufficiently producing the knowledge that we actually need. Of course, both of these conditions may be partly true.
>
> —George E. Brown, Jr., Chairman of the House Committee on Science, Space, and Technology in his letter of transmittal which accompanies a new *Report on the Task Force on the Health of Research.*

> There has been much conjecture about the prevalence of misconduct in science. Our panel found the research data inadequate to draw firm conclusions about this. The reported incidence of misconduct is low compared to the level of research activity in the United States. Yet it is unclear how much misconduct goes unreported. What is clear is that every case of misconduct in science is serious and requires attention. And some research institutions and governmental bodies need better methods for ensuring that their response to allegations and incidents of misconduct is effective and prompt.
>
> Some of these organizations are now having difficulty developing and implementing adequate procedures. They've had problems investigating members of their own communities. These problems have led some observers to conclude that research institutions generally are failing to treat the misconduct issue with enough speed, rigor, honesty, fairness, or openness. That's going too far. But the best way to ease this criticism is for the community as a whole to adopt clearer procedures for evaluating and dealing with misconduct.
>
> —Edward E. David, Jr., Chairman of a National Academy of Sciences–National Academy of Engineering–Institute of Medicine Panel on Scientific Responsibility and the Conduct of Research, on the occasion of the release of his panel's report, *Responsible Science: Ensuring the Integrity of the Research Process.*

Although dealing with significantly different aspects of the science-research issue, these two quotes clearly show that our discipline is being carefully scrutinized from without. These quotes also show that the results of the scrutiny are not all favorable.

The July 1991 Washington Report discussed Congressman Brown's committee's concerns about the benefits and value of federally funded research. The 1992 Task Force Report is the next step in the committee's effort to create better linkages between the research that Congress authorizes and national goals. The report concludes by recommending "two nested areas of systematic policy action: developing better mechanisms for government-wide science-policy making; and establishing a system of performance assessment that is integrated within the research system."

The National Academy committee, which included earth scientists Victor Baker of the University of Arizona and Frank Richter of the University of Chicago, was given three charges: (1) to examine the factors that affect the integrity of the research process; (2) to weigh the pros and cons of formal guidelines for conducting research; and (3) to look at the experience of both public and private institutions in fostering research integrity. The result of their deliberations is a very readable 189-page report that contains several simple but fundamental statements about the conduct of research. Three examples: "Science is a cumulative activity in which each scientist builds on the work of others. Publication of results is an integral and essential component of research because it enables others to gain access to each scientist's contribution." "Authorship and allocation of credit are primary benchmarks of achievement and rewards for scientists." "Scientists in universities accept the obligation to pass along knowledge and skills to the next generation of scientists."

The committee proposes a precise definition of misconduct in science, specifically formulated to reject the "ambiguous language" contained in many existing definitions. Specific examples given of the type of language to be avoided are phrases such as "other serious deviations from accepted research practices." This phrase is contained in both the National Science Foundation and Public Health Service definition of misconduct. The committee's definition of misconduct in science is:

> Fabrication, falsification, or plagiarism, in proposing, performing, or reporting research. Misconduct in science does not include errors of judgment; errors in the recording, selection, or analysis of data; differences in opinions involving the interpretation of data; or misconduct unrelated to the research process. (Fabrication is defined as making up data or results, falsification is changing data or results, and plagiarism is using the ideas or words of another person without giving the appropriate credit.)

The report concludes by presenting 12 recommendations "to strengthen the research enterprise and to clarify the nature of the responsibilities of scientists, research institutions, and government agencies." Three recommendations "Acting to Define and Strengthen Basic Principles and Practices" are presented:

1. Individual scientists and officials of research institutions should accept formal responsibility for ensuring the integrity of the research process. They should foster an environment, a reward system, and a training process that encourages responsible research practices.

2. Scientists and research institutions should integrate into their curricula educational programs that foster faculty and student awareness of concerns related to the integrity of the research process.

3. Adoption of formal guidelines for the conduct of research, which can provide a valuable opportunity for faculty and research institutions to clarify the nature of responsible research practices, should be an option, not a requirement, for research institutions.

Six recommendations "Dealing with Misconduct—Institutional Roles" are also presented:

4. Research institutions and government agencies should adopt a common framework of definitions for distinguishing among misconduct in science, questionable research practices, and other forms of misconduct. They should adopt a single consistent definition of misconduct in science that is based on fabrication, falsification, and plagiarism. Accordingly, the panel recommends that federal agencies review their definitions of misconduct in science to remove ambiguous categories such as "other serious deviations from accepted research practices."

5. Government agencies should adopt common policies and procedures for handling allegations of misconduct in science. The Office of Science and Technology Policy (OSTP) should lead the effort to establish government-wide definitions and procedures. OSTP should consider adopting the definition of misconduct in science proposed in the report and use this definition in formulating government-wide model policies.

6. Research institutions and government agencies should have policies and procedures that ensure appropriate and prompt responses to allegations of misconduct in science. Research institutions should foster effective and appropriate methods for detecting and handling instances of misconduct in science and should strengthen the implementation of misconduct-in-science policies and procedures that incorporate fundamental elements of due process.

7. Scientists and their institutions should act to discourage questionable research practices through a broad range of formal and informal methods in the research environment. They should also accept responsibility for determining which questionable research practices are serious enough to warrant institutional penalties. But the methods used by individual scientists and research institutions to address questionable research practices should be distinct from those for handling misconduct in science or other misconduct.

8. Research institutions should have policies and procedures to address other misconduct—such as theft, harassment, or vandalism—that may occur in the research environment. Where procedures for handling complaints about other misconduct do not exist, allegations should be examined according to the same administrative mechanisms as those designed to address misconduct in science, although the procedural pathways for responding to other misconduct and misconduct in science may differ.

9. Government research agencies should clarify their roles in addressing misconduct in science, other misconduct, and questionable research practices. Although government agencies have specific regulatory responsibilities in handling the categories of misconduct in science and other misconduct, their role in addressing questionable research practices should be designed to support the efforts of scientists and research institutions to discourage such practices through the processes of education and peer review.

Finally, three recommendations are presented under the heading "Taking Additional Steps":

10. An independent Scientific Integrity Advisory Board should be created by the scientific community and research institutions to exercise leadership in addressing ethical issues in research conduct; in framing model policies and procedures to address misconduct in science and other misconduct; to collect and analyze data on episodes of misconduct in the research environment; to provide periodic assessments of the adequacy of public and private systems that have been developed to handle misconduct-in-science cases; and to facilitate the exchange of information about and experience with policies and procedures governing the handling of allegations of misconduct in science.

11. The important role that individual scientists can play in disclosing incidents of misconduct in science should be acknowledged. Individuals who, in good conscience, report suspected misconduct in science deserve support and protection. Their efforts, as well as the efforts of those who participate in misconduct proceedings, can be invaluable in preserving the integrity of the research process. When necessary, serious and considered whistle-blowing is an act of courage that should be supported by the entire research community.

12. Scientific societies and scientific journals should continue to provide and expand resources and forums to foster responsible research practices and to address misconduct in science and questionable research practices.

Do you have comments on the question of scientific responsibility? Write to Bruce Molnia, *GSA Today* Forum Editor, U.S. Geological Survey, National Center, MS 917, Reston, VA 22092. ■

In Memoriam

John W. Anthony
El Paso, Texas
November 1992

Kenneth E. Caster
Cincinnati, Ohio

Stafford C. Happ
Alberta, Ontario, Canada

John F. Mason
Princeton, New Jersey
May 1991

F. Patrick Seabeck
Seattle, Washington
August 6, 1992

Kenneth Segerstrom
Denver, Colorado

Arthur R. Still
Tucson, Arizona
September 1, 1992

Lawrence A. Warner
Boulder, Colorado
December 20, 1991

Environment, Education, and Discovery Are Primary Topics

Sue Beggs, Meetings Manager
Sandra Rush and Stephanie Pas, Media Consultants for 1992 Meeting

1992 POSTER SESSION AWARD WINNERS

Monday Morning

1st Place: H. M. Edenborn, L. A. Brickett, D. H. Dvorak, and S. L. Edenborn, "Monitoring Manganese Diagenesis in a Constructed Wetland Using Continuous Gradient Gels"
2nd Place: Eva M. Dupuis-Nouillé and John Grover, "The Origin of Gypsum and Its Pseudomorphic Replacement by Quartz in Vertically Oriented Joint Sets in Central Kentucky"
3rd Place: S. J. Sutton, D. N. Awwiller, and L. S. Land, "Ouachita Facies Sm-Nd Depleted-Mantle Model Ages and Detrital Zircon Compositions Consistent with a North American Cratonic Source"

Monday Afternoon

1st Place: Ann Molineux, "Enigmatic Encrusters from the Upper Pennsylvanian of North-Central Texas—A Late Paleozoic Stromatoporoid Bloom?"
2nd Place: S. J. Fowell, "Rare Palynofloras from the Fundy Basin: Implications for a Regional Triassic/Jurassic Boundary Event"
3rd Place: L. Paul Knauth and Robert J. Horodyski, "Life on Land in the Proterozoic"

Tuesday Morning

1st Place: Stephen D. Hurst, Ronald D. Perkins, and Jeffrey A. Karson, "Interactive Computerized Geologic Field Trips as Case Studies for Geologic Instruction"
2nd Place: Roberta H. Yuhas, Patrick H. Dolan, and Alexander F.H. Goetz, "Monitoring Landscape Response to Climate Change Using Remote Sensing and GIS Techniques"
3rd Place: Marcia Bjornerud, A. Dwight Baldwin, Jr., John M. Hughes, and Maryellen Cameron, "Beyond Rocks in Boxes: An Introductory Geology Laboratory Course Organized Around Themes of Earth Systems"

Tuesday Afternoon

1st Place: Kevin R. Pogue, Michael D. Hylland, and Robert S. Yeats, "Stratigraphic and Structural Framework of Himalayan Foothills, Northern Pakistan"
2nd Place: Michael D. Campbell and Walter E. Reed, "Lithologic Evidence of the Transverse Ranges as a Native Terrane"
3rd Place: Anthony J. Caldanaro, Jr., and William M. Dunne, "Three-dimensional Development of a Buckle Fold"

Wednesday Morning

1st Place: O. Gallango, M. Escandon, M. Alberdi, F. Parnaud, and J. C. Pascual, "Hydrodynamism, Crude Oil Distribution and Geochemistry of the Stratigraphic Column in a Transect of the Eastern Venezuelan Basin"
2nd Place: J. Devera, J. Nelson, E. Kvale, M. Barnhill, C. Eble, J. Staub, and W. Dimichele, "Peat Deposition on a Tidally Dominated Coastline: Tradewater Interval (Morrowan-Atokan, Pennsylvanian) Illinois Basin"
3rd Place: Jun Lu and James R. Craig, "Zinc Mineralization and Paragenesis at the Idol Mine, Copper Ridge District, East Tennessee"

Wednesday Afternoon

1st Place: E. Cabral-Cano, H. Lang, C.G.A. Harrison, and G. Draper, "Preliminary Stratigraphic and Structural Assessment of the Tierra Caliente Metamorphic Complex (TCMC), Southern Mexico
2nd Place: Urs Möder and R. G. Berman, "Amphibole Thermobarometry: A Thermodynamic Approach, with Application to Metamorphic Map Compilation"
3rd Place: W. D. Means and Y. Park, "A Thiocyanate System for Direct Observation of Textural History in Polyphase, Crystal/Melt Mixtures"

Thursday Morning

1st Place: Susan G. Zimmerman and Edward B. Evenson, "Ramifications of Extensive Boulder Spalling Resulting from a Range Fire at the Pinedale Type Locality, Fremont Lake, Wyoming"
2nd Place: Lewis E. Hunter and Ross D. Powell, "Ice-proximal Sediment Dynamics and Their Effect on the Stability of Muir Glacier, Alaska: A Case Study of Non-climatic Glacier Response"
3rd Place: R. E. Gerber and Ken W.F. Howard, "Migration of Contaminants Through Till: Implications for the Selection of Landfill Sites"

Thursday Afternoon

1st Place: Steven P. Lundblad, Kevin G. Stewart, and Michael F. Follo, "Strontium Isotope Stratigraphy and its Applications for Age Correlation in the Calcare Massiccio Formation of the Northern Apennines, Italy"
2nd Place: F. Parnaud, I. Truskowski, I. Gou, J. DiCroce, and J. C. Pascual, "Stratigraphic Model of Chacopata-Uverito Transect (Eastern Venezuelan Basin)"
3rd Place: Benedikt L. Lehner, "Mass Transport Trends of Downslope Calciclastic Sediments"

Involvement and concern were in evidence in many of the events at the Cincinnati meeting, a pleasant and convenient venue allowing for easy exchange between colleagues. The meeting, which drew 4788 registrants, had three primary themes that related to President Zen's call for involvement—environment, education, and discovery. These themes were highlighted in many of the presentations and events. The numbers of programs, as well as numbers of participants in these programs, have grown substantially over the past two years and will continue to have considerable influence on programming for future annual meetings. These myriad programs, as well as many other aspects of the meeting, were ably organized by General co-chairs Raphael Unrug and J. Barry Maynard, their committee chairs, more than 200 volunteers, and the GSA staff.

This being the quincentenary of Columbus's 1492 landing in America, the Annual Meeting Committee designated *From Columbus to Magellan—Discovery* as the meeting's general theme. The Monday morning Keynote Discovery Symposium had an impressive roster of presenters, who spoke on the most recent discoveries in the geological sciences. The convener of the symposium was Nicholas Rast, Technical Program Chair, and Umberto G. Cordani, current president of the International Union of Geological Sciences, presided. Several other symposia, theme sessions, and other technical sessions on issues of discovery drew major audiences.

Leading off the environmental theme was GSA's Institute for Environmental Education (IEE), which sponsored the first Annual Environmental Forum, held Sunday afternoon; it was made possible by a gift from the ARCO Foundation. IEE Executive Director Fred Donath organized the forum, *Ground Water Cleanup vs. Ground Water Protection: Where Should the $$$ Go?,* which featured eight noted speakers. The attendance and the follow-up discussion indicated considerable interest in this forum. (A booklet on the forum is available through GSA.) The forum's impact went beyond educating the local audience. CBS Radio subsequently interviewed forum speakers for a special national program on environmental issues moderated by Howard K. Smith. The IEE, along with GSA's Geology and Public Policy Committee, also sponsored two environmental theme sessions, as well as several other sessions and a field trip to a landfill operation.

The education theme emphasized GSA's continuing commitment to geoscience education. As guests of the meeting and GSA's SAGE program, 97 primary through secondary school teachers participated in workshops, a field trip, a special Geoscience Education Division luncheon featuring guest speaker Stephen Jay Gould, and NAGT's symposium, *Reform in Geoscience Education.* In addition, the annual Geoscience Day was hosted by the GSA Ad Hoc Committee on Minorities and Women in the Geosciences and the U.S. Geological Survey. One hundred seventy students from two schools in Cincinnati visited the Cincinnati Museum of Natural History and Caesar Creek State Park. The event was guided by geologists in an outreach effort to interest students from the inner city in careers in the earth sciences.

On the college level, excellence in education and commitment to graduate studies were encouraged through both the Top Seniors Program and the Graduate School Information Forum. (See side articles.) In addition, professionals and students giving poster presentations were judged for presentation excellence through GSA Best Poster Awards. Awards were based on scientific content, clarity, coherence, and graphics. Technical Program Co-chair Roy Kepferle arranged for the judging and awards. This was the first time for such recognition at a GSA annual meeting. Also as a service for professionals and students in the continuing education area, 17 courses and workshops were available; seven were sponsored by GSA and its divisions and ten by GSA's associated societies.

Field Trip Chair Thomas Berg capably organized 17 excellent field trips, with a total of 460 participants. The trips ranged in length from one to four days and in cost from $10 (IEE half-day) to $985 (Bahamas). Most of the trips were two days or less, however, making the average cost $108. Of these, three were half-day mini-trips that captured 25% of the total field trip attendance. The minimal cost and time commitment make these mini-trips accessible for those with economic and time restrictions.

Educational outreach extended to the general public from the News Room; more than 25 media representatives attended and continue to publish articles on geological topics. Associated Press, Reuters, the *Cincinnati Enquirer* and *Cincinnati Post, Science, Science News, Columbus Dispatch, Dallas Morning News,* and *Earth* magazine, as well as local radio and television, were represented. Telephone inquiries came from coast to coast, including newspapers such as the *New York Times, Washington Post,* and *Los Angeles Times.* In addition, on October 27 the Public Broadcasting Service TV series NOVA aired a documentary with extensive footage of the 1992 GSA Grand Canyon trip.

Authors of papers given at the meeting helped substantially by submitting news releases in advance and by making themselves available for press interviews at a moment's notice. On the first day of the meeting, GSA was featured on the front page of *USA Today,* with an article about Curtis McKinney's dating of the bones of "Midland Woman" at 11,600 years. Found in 1953 by Keith Glasscock near Midland, Texas, these represent the oldest American bones discovered. Previously, many anthropologists believed that human migration from northeastern Asia to North America had occurred more than 10,000 years ago, and McKinney's dating of the bones substantiates their theories.

Another presentation attracting national press attention concerned meteorite impacts. C. Wylie Poag revealed

1992

Graduate School Information Forum

In Cincinnati the Graduate School Information Forum attracted 50 schools and more than 170 students. Held Monday through Wednesday from 8:00 a.m. to 5:00 p.m., the forum gave students an excellent opportunity to meet with representatives from schools of their choice without having to spend time and money traveling to these schools for interviews. In return, the school representatives had the opportunity to meet with serious geology students without having to spend much on recruitment.

Students from as far away as Australia and Algeria participated in this year's forum. The students spoke to professors and graduate students from the universities in order to determine the program that best fit their interests. The schools provided literature and visual displays that could help students make an informed decision.

The forum is scheduled again for next year's Annual Meeting in Boston. If your university is interested in participating, please write, call, or fax Kathy Ohmie Lynch, GSA Meetings Department, (303) 447-2020 or fax 303-447-0648.

—**Matt Ball,** *Meetings Assistant*

results of research indicating that a half-mile-wide meteorite slammed into the area of the Atlantic Ocean 35 million years ago, creating a wave that may have been 1000 feet high and 360 miles long, which crashed against the east coast of North America. The impact tore up the land from present-day New Jersey to North Carolina and scrambled layered deposits of seven previous geologic ages. In addition, of course, media attention was directed to the controversy over the cause of extinction of dinosaurs—a bolide impact, sea-level change, volcanic eruption, or just natural selection.

Larry Codington's discovery of the oldest known fossilized spider web, dated at 47.5 million years, was carried by the press just in time for Halloween. Scientists believe spiders to have been around for about 400 million years, and evidence of this fossilized web, found in Garfield County, Colorado, shows that spiders indeed were producing webs at least as far back as 47.5 million years.

Local media were interested in the discovery of Ohio's oldest fossils by Peter MacKenzie and Loren Babcock, as well as the new Quaternary geology map of Ohio, which was shown for the first time at the meeting. The GSA field trip to a Dayton cemetery was featured on local television as well as in the *Dayton Daily News*. Michael Sandy arranged the field trip to Woodland Cemetery in Dayton to admire and study the different types of rock in the headstones—marble, granite, and limestone from such places as Norway, Italy, South Africa, and Vermont.

As participants in the meeting hurried from session to session, they enjoyed the impressive 163-foot-long U.S. Geological Survey display, GLORIA: Sonar Images of the Entire U.S. Seafloor. This was the first time all of the remarkable sonar mosaics were displayed together. At any time, groups of attendees could be seen studying one or another of the 1:2,000,000 panels, which provide a new perspective on the U.S. continental margins.

In the process of discovery and involvement, no time went unused. Noontimes and evenings were scheduled with special technical events. At Tuesday noon the Geology and Public Policy Forum, *Economic Benefits and Public Policy Issues of Geologic Mapping,* addressed the potential cost-benefit scenario of the 1992 U.S. National Geologic Mapping Act. The geological implications of Hurricane Andrew were described during a special Tuesday evening session organized by Harold Wanless and attended by approximately 500 geologists. At Wednesday noon, registrants had the opportunity to meet GSA's 1991–1992 Congressional Fellow, Kenneth Taylor, who worked in the office of Senator Harry Reid of Nevada. Taylor had addressed such policy issues as nuclear waste and licensing, earthquake hazard mitigation, and appropriations for the Departments of Interior and Energy.

Many of the 158 exhibitors contributed to the themes of involvement and discovery through their scientific and technical products and services displayed in the 252 exhibit booths. As engineering, hydrogeological, and other environmental areas impact the programming, we will continue to see increasing representation from a new set of exhibitors. This applies to the

Cincinnati *continued on p. 10*

1992 Cincinnati Annual Meeting Facts and Figures

Technical Program	
Abstracts submitted	1858
Abstacts presented	1712
Abstracts rejected or withdrawn	146
Percentage of abstracts accepted	92.1
Oral presentations:	
Invited symposia	184
Volunteered	1528
Poster presentations (including theme posters)	421
Number of presentations in discipline sessions	1202
Number of presentations in theme sessions	326
Number of presentations in symposia	184
Highest number of concurrent oral sessions	16
Registration	
Professional	2665
Student	1395
Exhibitor	555
Guest	173
Total attendance	4788
Short Courses	
Number of GSA-sponsored courses	7
Participants	202
Field Trips	
Half-day trips	3
Participants	115
One or more days	14
Participants	345
Exhibits	
Number of booths	252
Number of exhibitors	158
Employment Service	
Applicants	193
Employers	22
Interviews	352
Positions available	34

Cincinnati *continued from p. 9*

educational market as well. These, plus computer technologies, will have even greater prominence at the 1993 Boston Annual Meeting.

The sold-out premeeting Saturday evening of dinner and the Cincinnati Ballet production of *Swan Lake* foretold the success of future smaller social events offered throughout the meeting. The well-attended Welcoming Reception on Sunday night provided a chance to meet colleagues as well as to preview the exhibits. Another opportunity to meet old friends—and to make a few new ones—was provided by the ever-popular alumni receptions on Monday evening.

Guest registrants were welcomed to the Cincinnati area through 13 separate guest functions and the Hospitality Room. Guest Chair Suzanne Costandi enthusiastically organized these as well as *A Taste of Cincinnati,* the Wednesday social event, which featured favorite Cincinnati food (including five-way chili) and a tour of the new Museum of Natural History, housed in the renovated train station. Among the museum highlights were a lifelike recreation of Ohio's Ice Age, a replica of a limestone cavern, a special exhibit titled African Reflections, and even a chance to hold a live bat. Party-goers danced in the grand former waiting room of the train station, now the lobby of the museum, or listened to the harpist in an adjoining room.

A well-attended 5K run on Wednesday morning and the traditional Thursday Afternoon Club in the Poster Session area rounded out the social calendar for the meeting.

The three themes of discovery, environment, and education meshed together well in Cincinnati, where change and involvement were in the air and congeniality came with the location. GSA's divisions mutually took the first steps toward long-range planning and joint programming. At the end of the meeting, there were plans in place for Boston, and the IEE had several interesting proposals for its second Annual Environmental Forum. Plans for a cooperative SAGE program for teachers at the Boston Science Museum are underway.

Geology and Health is the 1993 Annual Meeting theme. Special sessions are scheduled on Boston Harbor in addition to other national environmental concerns. If you are interested in information on these, or any other programs, or on GSA's publications, call GSA headquarters (303) 447-2020 or (800) 472-1988. ■

If we want the world to acknowledge the importance of geology, and if we want decision makers to allocate more resources for geology, then we must improve our public visibility and do more as citizen-geologists. This implies effective dissemination of knowledge, which has always been a central purpose of GSA, but we must expand this dissemination to benefit all humankind. This is a challenge, not only to us as individuals, but to GSA, as we face the critical opportunity of exemplifying leadership in applying geology to improving the quality of Earth as a place to live. This is a great adventure, an opportunity perhaps not to be repeated, where we can at once enlarge our intellectual horizon and directly serve our fellows.

E-an Zen, 1992 Presidential Address Program

Top Seniors—The Future is Discovered

This year 34 undergraduates participated in the second annual Top Seniors Program at the Annual Meeting in Cincinnati. This unique program, initiated by the 1991 San Diego Annual Meeting Committee, was designed to reinforce students' commitment to the earth sciences. The Annual Meeting gives each student an opportunity to explore graduate school and career opportunities, as well as to learn of the latest research in the field.

GSA provides lodging and registration, including an abstracts volume for the Top Seniors. The participating schools, which nominate their top seniors, provide transportation as well as an optional daily stipend.

Kristin Carl, a senior at the University of North Carolina, Chapel Hill, said, "The experience was informative and enjoyable. I had a great time meeting both representatives from graduate schools and fellow top seniors, who I hope will be future colleagues."

Thanks to the Department of Geology at the University of Cincinnati and Dames and Moore, the students at this year's Annual Meeting spent Sunday, October 25, exploring the geology of Cincinnati. The field trip included the bedrock geology of northern Kentucky, Ordovician fossils at Thomas More College, and the hillside features of downtown Cincinnati.

The Top Seniors Reception, held Tuesday, October 26, gave the students an opportunity to socialize with leading geologists from the area. The reception, sponsored by J. Wiley & Sons, was an informal gathering, with soft drinks and pizza. The noise level in the room made it apparent that the reception was a success.

The selection process for the Top Seniors program is designed to include a senior with the highest academic achievement from each geology department in the United States. Schools are invited by GSA headquarters to participate on a rotating basis. Schools within a 200 mile radius of the Annual Meeting host city are excluded from that year's program. Schools that have participated in the past are placed at the end of the rotation. In January a mailing goes out to the first 75 schools on the rotation. The first 30 schools to return a letter of commitment are chosen to send a top senior to the Annual Meeting.

Erin Holmstad, a senior at the University of Washington, said, "The Top Seniors program was wonderful. The field trip was great, and the reception very useful. Don't change a thing!"

—Matt Ball, *Meetings Assistant*

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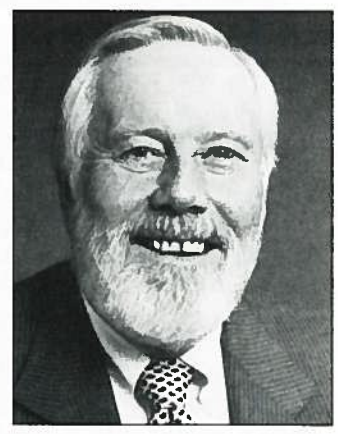

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GSA and Ethnic Minority and Women Geoscientists

A. W. Ward, Chairman, GSA Committee on Minorities and Women in the Geosciences

1988 Geoscience Day field trip in the Golden-Morrison area west of Denver.

Many members of the Geological Society of America may not be aware of the Society's long-standing efforts to recruit ethnic minorities and women into the geosciences. GSA has a long-term need to keep young people interested in the earth sciences (in effect to train our replacement scientists and develop more for the next century), and it makes special efforts to reach out to those whom, historically, our profession and our society have overlooked.

For two decades the GSA ad hoc Committee on Minorities in the Geosciences (now the Committee on Minorities and Women in the Geosciences) has been a principal outreach avenue of the Society, through GSA committee programs and interaction with member societies and agencies. During the GSA Annual Meeting, the committee sponsors a field trip (called Geoscience Day) for science students, counselors, and teachers from middle and junior high schools in the host city. We have held programs in Denver (twice), Seattle, San Diego (twice), Cincinnati (twice), Atlanta, New Orleans, Indianapolis, Reno, Orlando, San Antonio, Phoenix, St. Louis, and Dallas, working specifically with schools of the heavily minority districts in those cities. This committee's interest lies in targeting both urban (inner-city) and rural schools to reach minority students and in providing minority and women geoscientists as role models, when possible.

The purpose of Geoscience Day is to share some of our professional geoscience knowledge and experience with the schools and especially with minority students, who have even less exposure to the geosciences than do most students. About 160 students and teachers participate. Society geoscientists and graduate students ride with our guests on buses, guided by a local trip leader. GSA members adopt small groups of students to work with, posing and answering questions on the outcrop and holding discussions between stops on careers in the geosciences.

Corporate underwriters such as Kentucky Fried Chicken and Pepsi-Cola provide lunches and beverages. The American Geological Institute, the U.S. Geological Survey, and GSA provide brochures and information packets on career development, education, financial support, and teacher-partnering programs. The National Earth Science Teachers Association donates hundreds of mineral and rock souvenirs. Transportation costs are shared by USGS and GSA.

Often, half-day programs (e.g., question-and-answer sessions with minority graduate students and professionals, and science fairs) have been part of the Geoscience Day program. GSA typically gave dozens of day passes to Annual Meeting technical sessions to science teachers so that they might attend a few of the presentations.

At the 1992 Cincinnati meeting, the Council made ours a standing committee, demonstrating the GSA's long-term commitment to the recruitment of women and minorities into the profession. The committee and GSA had debated for years the issue of status (and stature) of the committee. With an ad hoc status, the committee was generally free to determine its program elements and members. Given the experimental nature of minority re-

Minorities & Women *continued on p. 28*

About People

GSA Fellow **Robert N. Farvolden,** University of Waterloo (Iowa), has accepted a senior scientific counsel position with the National Ground Water Association.

Fellow **Stanley Hart,** Woods Hole Oceanographic Institution, has been honored by the Geochemical Society as recipient of the V.M. Goldschmidt Award.

Member **Kenneth G. Johnson** has been appointed director of the Environmental Studies Program at Skidmore College, Saratoga Springs, New York. He continues as chair of the college's Department of Geology.

Member **Donald E. Owen,** Department of Geology, Lamar University, Beaumont, Texas, was elected chairman of the North American Commission on Stratigraphic Nomenclature for 1992–1993.

Member **Russell G. Slayback,** president of Leggette, Brashears & Graham, Inc., Wilton, Connecticut, has been elected president of the American Institute of Professional Geologists for 1994.

GSAF UPDATE

Robert L. Fuchs

Student Travel Grants in 1993

At the Trustees' meeting held in Cincinnati during the GSA Annual Meeting, funding for the Foundation's student travel grant program was approved. The Trustees approved the expenditure of $21,000 from Foundation funds to match grants from each of the six GSA sections to students attending GSA meetings during 1993.

This very popular program began in 1988 when $2000 was made available to each section. Since then this amount has grown to $3500. The travel grants program is administered by the sections, who provide money to those applicants who have been accepted. The Foundation then reimburses the sections in the amount of $.50 for each $1 spent. Recipients must be students in the geographic area of the section and travel must be to and from a GSA section meeting or the GSA annual meeting.

Since the first year of the student travel grants program, the GSA sections and the Foundation have provided money to more than 600 recipients. For many, those grants have been the difference between attending a meeting, giving a paper, and communicating directly with other geoscientists, or missing out entirely on valuable and formative scientific contacts.

Applications for student travel grants can be obtained from GSA section secretaries.

Pooled Income Fund Enters Second Year

The GSA Pooled Income Fund began one year ago with a gift from Carol McGill, a gift that also established the Carol G. and John T. McGill Fund to support studies and research in engineering geology.

The Pooled Income Fund is a form of planned giving whereby the donor makes a gift to the fund, but reserves the income from the gift for life. Upon the donor's death that individual's respective share of the fund is transferred to the Foundation's endowment. Henceforth, the income can be used for any purpose that might have been specified by the donor, or for the general mission of the Foundation.

The GSA Foundation Pooled Income Fund is a good way for a GSA member to obtain retirement income, reduce current taxes, and at the same time make a gift to GSA in support of its ongoing programs. At the time of the gift, the donor receives a charitable deduction for income tax purposes, the amount of which is determined by the donor's life expectancy and the expected income from the fund. Monthly income is distributed to the donor out of the earnings of the fund.

Further information about the GSA Foundation's Pooled Income Fund can be obtained by calling or writing the Foundation office at GSA headquarters in Boulder, Colorado. ■

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The Crisis in Scientific Publication

John E. Costa, Arthur G. Sylvester
Editors, *Geological Society of America Bulletin*

Abstract

Too many papers and too many expensive journals strain library budgets and sap human and financial resources of institutions. Studies by libraries reveal that some commercial publishers have increased prices at much faster rates than inflation. It is possible to identify high-cost, low-impact journals. Impact factors for society journals are higher than for commercial journals. Society journals have cost/quality indexes four times more favorable than commercial journals. Society journals have much wider circulation. We geoscientists are responsible for permitting publishers to take advantage of our egos and our naivete as authors and purchasers of scientific information. Institutional dependence on "counting" papers for promotion, rather than encouraging quality science, leads to increasing numbers of journals, many of them highly specialized. The lack of citations of much of the geoscience literature indicates that many papers filling journals contribute little if at all to geoscience knowledge. Proposed solutions include (1) carefully selecting journals to which to submit papers, and to serve as editors and referees; (2) encouraging universities and government agencies to publish more of the research of their faculty and staff; (3) encouraging funding agencies for publication through noncommercial sources of public funded research; (4) sharply de-emphasizing peer-review journals and replacing them with nonrefereed computer bulletin boards and on-line journals; and (5) encouraging institutions to recognize quality rather than quantity of research contributions.

FORUM Editor's Note: This editorial by John Costa and Arthur Sylvester, editors of the *GSA Bulletin,* is the first part of an in-depth look at the complex issue of geoscience publications. The March *FORUM* will present several additional perspectives focusing on geoscience literature pricing and its impact on geoscience libraries and the geoscience profession.

—Bruce Molnia

Introduction

Publication of the results of scientific inquiry is an essential element for all research scientists. Publication in peer-review journals has become such an accepted measure of the "productivity" or "quality" of individual scientists that it is nearly impossible for one to progress in scientific research stature (grants, tenure, promotion) without a long bibliography in peer-review journals. This is because the number of publications is more quantifiable than is the quality of publications, teaching, "service," professional activities, or measures of esteem. This inordinate dependence on *numbers* of publications to gauge the worth of individual researchers has fostered a cascade of misguided and unfortunate events and practices that sap research support and provide questionable benefits to science.

The Problem

Librarians maintain that costs for dissemination of scientific information in formal, bound serial format are becoming prohibitive. Many people complain that there are too many papers and too many journals. In the decade between 1978 and 1988, the number of science journals increased substantially (McDonald, 1990). New journals have become increasingly specialized and cater to smaller and smaller clienteles. Some colleagues feel there is no "problem," just too much of a good thing. The trend in reporting scientific results is toward shorter and shorter papers that resemble progress reports in order to extract as many papers from one piece of research as possible. At one extreme, the world's most "prolific" scientists, as calculated by the Institute for Scientific Information, includes natural scientists who publish an average of one paper every 4–11 days; 45% of these authors are American (Science, 1992). Whatever the perspective, research librarians are engaged in a dilemma, which is as much our problem, as practitioners of science, as it is their problem, as purchasers and archivists of science (Wilson, 1989).

Escalating journal costs mean that most libraries can no longer have rich research collections in all areas. Most libraries have undertaken major serials cancellation projects, and many can add new journals only when canceling one of equal or greater cost. The University of California, Santa Barbara, could purchase only 82% of the journals in 1991 that it acquired the year before; the University of Iowa cut its budget 20%. This story is repeated at many other libraries.

Costs of some commercial periodicals are rising faster than inflation rates (Dougherty and Johnson, 1988; Abelson, 1989), but causes are debatable. Throughout the 1980s, a few European journal publishers became increasingly dominant in the American market. At Louisiana State University, for example, just three European publishers accounted for 3.7% of the library's subscriptions but 25% of the serials budget (Holden, 1987; McDonald, 1990). At the University of Kansas in 1991, 65% of its serials budget went to foreign publishers (Kean, 1991). Decline in the value of the dollar overseas is frequently cited as the root cause of escalating journal budgets, so the Association of Research Libraries commissioned a study of the costs of scholarly journals (Economic Consulting Services, Inc., 1989; Okerson, 1989). After examination of the pricing of four large commercial publishers (three European, one American), the study concluded: "In our estimation, each targeted publisher has increased subscription prices for the sample of titles examined at a much faster rate than the rate at which their costs have increased" (Economic Consulting Services, Inc., 1989, p. 21). In 1991, the average increase in costs for nonprofit American society journals was 8.2%; for commercially published journals the price increase was three times greater—26% (Kean, 1991).

Some unfortunate and costly practices exist. One commercial European publisher arranges for papers presented at an annual symposium to be published first in one of its specialty journals and then later as a hard-covered symposium volume. Individual symposium volumes are rarely identified in advertisements or other listings as a reprint of a journal issue; thus, many libraries are asked to procure the identical literature twice under different covers. This has escalated costs for libraries that struggle to stretch constant or diminishing resources to acquire more periodicals that cost more and more, but authors are happy to have the additional citations for their dean and granting agencies.

The acquisition of smaller publishing houses by larger ones reduces competition, with negative impacts on professional societies that publish journals through commercial publishers. In 1991, Elsevier N.V. acquired Pergamon Press, and reinforced Elsevier's position as the world's biggest publisher of scientific journals. Elsevier's science division publishes about 650 journals and 750 books each year, with profit margins of around 30% (*Wall Street Journal,* March 29, 1991, p. B8). Elsevier caused trauma for the Geochemical Society when its wholly owned subsidiary, Pergamon Press, renegotiated the contract to publish *Geochimica et Cosmochimica Acta,* the official journal of the Geochemical and Meteoritical Societies. The experience of the Geochemical Society in negotiating with Pergamon (Elsevier) is documented in the newsletter of the Geochemical Society, *The Geochemical News* (Lindsley et al., 1991, p. 11): "Even after months of arduous negotiation which produced the best contract that could be obtained from Pergamon [Elsevier], we still have little control on subscription rates for libraries, and much less control over editorial policy and the future of GCA [*Geochimica et Cosmochimica Acta*] than is desirable."

Many librarians encourage more focus on publications produced by universities, government agencies, and in nonprofit American society journals as a way to conserve resources. Universities and government agencies could assume more responsibility for publishing the research of their own faculty and staff, rather than procuring their own work from expensive outside sources (Astle, 1989; Dougherty, 1992). Some university-founded journals have evolved into highly regarded publications—*American Journal of Science* and *Journal of Geology* come to mind, and U.S. Geological Survey Professional Papers have long been landmarks of scholarly geoscience research.

Measurement of Journal Impact and Cost/Quality Indices

If libraries are being forced to become more selective in their serials procurements, then how do they identify high-quality, cost-effective journals? One objective and reproducible measure utilizes citation indexes (Ribbe, 1988; King, 1989). Journal Impact Factor (JIF) is defined as the average number of citations of articles published by a particular journal during the past two years, divided by the total number of articles published in the journal during that two-year period. These data are compiled annually in the *Science Citation Index* Journal Citation Reports.

Several attempts to measure the value of journals conclude that *who* publishes the journal largely determines its cost and relative worth (Astle, 1989). For example, a retired physics professor, Henry Barschall, compiled a survey of more than 200 physics journals. He demonstrated that their cost effectiveness, measured by the ratio of

Crisis *continued on p. 14*

Crisis *continued from p. 13*

cost per printed character to the frequency with which articles were cited, varied over three orders of magnitude (Barschall, 1988). He concluded that the most cost-effective journals were published by nonprofit scientific societies, whereas journals with the highest ratios of cost to impact were published by certain commercial presses. Barschall's 1988 article caused one commercial publisher of a low–cost-effectiveness journal to bring legal suit. This challenge was rejected by the courts, at least for now. The subterfuge of the plaintiff in reaction to Barschall's report is documented in the *Chronicle of Higher Education* (Turner, 1990). This incident and stories about commercial publishers pressuring editorial boards of specialized journals to accept more papers because the subject of the journal is a "hot topic," or coaching editors about how to increase the impact factor of their journals strain the credibility of some publishers and the objective progress of science.

The story is similar for evaluations of geoscience journals. For 54 geoscience periodicals (Tables 1 and 2), impact factors over seven years are slightly higher for society journals than for commercial journals, society journals have cost/quality indexes *four* times more favorable than commercial journals, and society journals have much wider circulation (Ribbe, 1990). Many journals have a JIF less than 1.0, which means that on average, each article published in that particular journal is cited less than once in the two years following publication. Journal Impact Factors vary widely among disciplines, and even among subspecializations within disciplines. They are an interesting qualitative indicator that should be used in context with other information in evaluating journal quality.

The significance of the numbers in Tables 1 and 2 is underscored by the latest Institute for Scientific Information analysis of "uncitedness" of journal articles. In the sciences, 22.4% of published papers in 1984 were *never* cited in the first five years after publication. This includes even self-citations, which may account for 5%–20% of all citations. If just U.S. authors are used, this figure decreases to about 15%. Library use studies indicate many journal articles are seldom or never read or cited (Thompson, 1989). From these data, one may conclude that some papers do not contribute significantly to geoscience knowledge (Pendlebury, 1991). *Science* quoted Frank Press, geophysicist and president of the National Academy of Sciences: "There are obvious concerns which are worrisome—namely that the work is redundant, it's me-too type of follow-on papers, or the journals are printing too much" (Hamilton, 1990, p. 1331).

Publishers serve an important function by collating and distributing scientific information. The fact that some do so at a profit is not the issue—publishers are entitled to make a profit like any other business for an important service if it is well done. Who is more to blame: certain publishers who have developed elaborate schemes for exploiting captive market libraries by co-opting scientists, or geoscientists because they pressure librarians to continue subscriptions to high-cost, low-impact journals and to continually acquire new and highly specialized journals? Librarians want to have complete holdings, and they depend on scientists to provide sage advice on the worthiness and quality of new journals, especially highly specialized ones. It is the library base that continues to support new journals and sustain poor ones. Geoscientists and librarians must abandon the perception that all journals are like Pentagon new-weapons systems: the cost is unfortunate, but we have to have them.

The Numbers Game

A major factor for the increasing numbers and size of geological journals is that our parent institutions and granting agencies expect us to demonstrate our worth and value by a continuous and prolific stream of publications. Graduates of the past decade or so have been weaned in the publish-or-perish environment. The Association of Research Libraries (1989) reported that the approximately 28% of American scientists who work in academe account for nearly 70% of scientific papers written by Americans. Some faculty encourage graduate students to organize their theses as a series of three to five journal articles. Departments and university administrators are establishing norms or quotas of two to three "refereed" publications per year for faculty. In these ways quantity is unduly emphasized over quality. One Associate Editor of the GSA *Bulletin* relayed a candid comment from a university dean who said, "Because I personally cannot judge the quality of a scientific publication, I simply count them." Under current conditions, long-term projects whose published results require time to complete are not encouraged, especially for young scientists seeking stature and job security.

In our view, the quest for scientific recognition and acceptance has resulted in wide adoption of a three-stage model for scientific publication that we call the Three-M model: Make-way stage, in which authors rush to establish interest or priority by fast publication in rapid, widely distributed outlets such as *Geology, Nature,* and *Science;* My-turn stage, in which scientists produce a rash of overlapping journal articles with rotating authorship so that everyone can have a turn being first author; and Mopping-up stage, in which authors "put it all together" in symposium volumes or special series to capture the big picture, usually as a cut-and-paste job from previous publications. Although this model assures wide distribution of research results, and is therefore pleasing to granting agencies, it also guarantees wide overlap, duplicate publication, and the accompanying strain on human and institutional resources.

Substantial hidden costs are involved in each journal article submitted or published, including the time donated by faculty advisors or colleagues to read first drafts, and time contributed by at least two referees and editors to review each submitted paper. For the GSA *Bulletin,* we estimate that the value of volunteer service provided by referees, Associate Editors, and Editors amounts to about $1000 for every manuscript submitted (25 hours of referees', Associate Editors', and Editors' time x $40 per hour). If an author asks two colleagues to review a paper prior to submission, then the cost for review of each submitted manuscript could exceed $1200. For the GSA *Bulletin,* volunteer review service amounts to about $300,000 per year. Few people question the propriety of this volunteerism for nonprofit association journals.

The costs to science for rejecting a manuscript are far greater than those for accepting a paper, because of time spent on appeals, resubmissions, and re-reviews. We estimate that 80%–90% of papers rejected by the best journals end up being published elsewhere, thereby adding costs. Any "research" that someone bothers to cast into quasi-readable prose will likely be published by some journal or symposium proceedings somewhere, although it may take several tries. "Almost every article—no matter how bad, how unreadable, and no matter that it probably will never be read—eventually finds its way into print" (Broad, 1982). The major rationale for some journals appears to be to provide profits to publishers and outlets for authors, rather than resources for readers and archives for science. How is the librarian to know? Some journals have found the formula for complete customer (author) satisfaction: no page charges, no-charge reprints for authors, glossy paper, and no-hassle review policies. These amenities do not come free; it is the library that pays the pass-on costs. The least publishable unit continues to shrink, and we drown in expensive periodicals while libraries drown

TABLE 1. AVERAGE JOURNAL IMPACT FACTORS FOR GEOCIENCE JOURNALS, 1984–1990

Journal	Pub.*	Avg. impact factor
Journal of Petrology	U	3.39
Annual Reviews of Earth and Planetary Science	S	3.28
Tectonics	S	3.05
Meteorites	S	2.92
Limnology and Oceanography	S	2.87
Geochimica et Cosmochimica Acta	S	2.85
Earth and Planetary Science Letters	C	2.79
Earth Science Reviews	C	2.56
Geology	S	2.45
American Journal of Science	U	2.44
Reviews of Geophysics	S	2.41
Geological Society of America Bulletin	S	2.40
Contributions to Mineralogy and Petrology	C	2.38
Geophysical Research Letters	S	2.27
Journal of Geology	U	1.80
Journal of the Geological Society of London	S	1.74
Journal of Structural Geology	C	1.72
American Mineralogist	S	1.68
Bulletin of the Seismological Society of America	S	1.62
AAPG Bulletin	S	1.60
Quaternary Research	U	1.57
Sedimentology	S	1.50
Journal of Metamorphic Geology†	C	1.33
Journal of Sedimentary Petrology	S	1.29
Tectonophysics	C	1.29
Journal of Volcanology and Geothermal Research	C	1.25
Economic Geology	S	1.18
Lithos	U	1.12
Precambrian Geology	C	1.10
Geological Magazine	U	1.08
Marine Geology	C	1.07
Geophysics	S	1.04
Chemical Geology	C	1.00
Canadian Journal of Earth Sciences	S	0.99
Boreas	S	0.94
Palaeogeography, Palaeoclimatology, Palaeoecology	C	0.85
Journal of Glaciology	S	0.75
Arctic and Alpine Research	U	0.74
Sedimentary Geology	C	0.70
Earth Surface Processes and Landforms	S	0.69
Journal of Paleontology	S	0.45
Journal of Petroleum Geology	C	0.38

Note: Data compiled by *Science Citation Index.* AGU *Journal of Geophysical Research* is not included because of inconsistent and inaccurate determination of citations for individual series. Journals that publish review papers, and short contributions (e.g., letters) generally have higher impact factors than general geoscience or specialty journals that publish full-length original research results.

*S = society publication, or journal of a society published by a commercial publisher; U = university or university press publication; C = commerical publisher.

†*Journal of Metamorphic Geology* impact factor is average of six years (1985–1990).

TABLE 2. AVERAGE JOURNAL IMPACT FACTORS FOR HYDROLOGY, HYDROGEOLOGY, AND ENGINEERING JOURNALS, 1984–1990

Journal	Pub.	Avg. impact factor
Water Resources Research	S	1.54
Geotechnique	S	0.77
Ground Water	S	0.70
Journal of Hydrology	C	0.67
Journal of Hydraulic Engineering	S	0.56
Water Resources Bulletin	S	0.51
Environmental Geology and Water Science	C	0.40
Hydrological Sciences Journal	S	0.27
Quarterly Journal of Engineering Geology	S	0.18
Engineering Geology	C	0.08

Note: Data compiled by *Science Citation Index.* Pub. codes are the same as for Table 1.

in red ink, procuring and storing mountains of papers that few people apparently read or use. We must find ways to encourage excellence, rather than to discourage productivity.

Recommendations

The report of the Association of Research Libraries (Economic Consulting Services, Inc., 1989; Okerson, 1989) made several recommendations that we believe are worthy of thoughtful consideration. The most dramatic pertains to choosing outlets for reporting results of research. Because most research is funded by public money from sources such as NSF, USGS, DOE, and EPA, the Association of Research Libraries urges university and granting agencies to explore the feasibility of making publication through noncommercial publishers the preferred means for reporting the results of publicly funded research. Presumably, this would result in less costly acquisition for libraries. Another approach addresses the evaluation process of scientists. Some universities and the NSF have joined the USGS practice of detailed evaluation of only a small number (usually three to ten) of a scientist's best publications for grant and promotion consideration. Widespread adoption of this practice would go far in refocusing research and publishing on significant, important, comprehensive contributions.

A century ago, university presses were responsible for dissemination of most scientific information. Many state and federal agencies also have formal serials such as U.S. Geological Survey Professional Papers and Open-File Reports, Technical Bulletins of the U.S. Department of Agriculture, and state geological survey bulletins and reports. Marketing of products from university presses or governmental agencies was primarily by word-of-mouth and reputation. Geologists compiled several years' research into a single monograph, which was usually worth reading. Today these cost-saving alternative outlets may be less desirable to authors because they appear as "in-house" documents and are perceived to have little or no peer review. In the U.S. Geological Survey, this is far from correct. It seems inefficient to us for a university or governmental agency to use endowment, tuition, or taxpayer money to pay salary and furnish support for their scientists and then expect their library system to buy back the work of those scientists at inflated prices.

Some scientists have raised serious questions about the need for peer-review journals altogether (Mermin, 1991). Rapid technological advances in communications hardware and software present the potential for sidestepping or replacing refereed journals, and all the commensurate problems and costs, with computer bulletin boards linked to key words. Any author could place unrefereed work before the scientific community and let the users determine the individual worth of each contribution without the imprimatur of the journal or the association. There will likely be an increase in the volume of material to scan, but this would be temporary because there would no longer be an incentive to count contributions. In a completely open market for publication, authors would have to refocus on fewer but better papers as a way to get colleagues to recognize their work. Numerous points in favor of electronic journals are summarized in a recent conference report (Maddox, 1992); however, these have not yet found favor as a means of evaluating scientists' professional status or identifying priority results.

The pressure to publish is not going to diminish—regrettably, it will probably escalate. Those of us who do research, write papers, and publish the results can do five things.

1. Think about the outlets for our good science. What does the journal represent? Does it offer us free reprints and no page charges at the expense of the erosion of library resources and the undermining of research support for ourselves as well as others? Geoscientists must become aware of the policies and practices of various journals and must discourage their libraries from continuing to purchase bad journals. The choices can be difficult, but they are necessary (Maher, 1991; Hofmann, 1991).
2. Think before we loan our names, professional reputations, and efforts to journals with low cost/quality indexes or exploitative pricing policies. As editors or reviewers, do we indirectly offer legitimacy to a journal that may not serve the needs of science (Thompson, 1989)? One major European publishing house official even recommended that scholars refuse to serve on editorial boards of offending journals (Merriman, 1989), and American Geophysical Union Executive Director A. F. Spilhaus suggested that scientists refrain from serving as reviewers for low-quality, high-cost journals or allowing them to use their names (McDonald, 1990).
3. Encourage universities and government agencies such as the USGS to assume more responsibility for publishing the research of their faculty and staff as an alternative to buying it back later at much higher prices.
4. Encourage widespread university and research-institution adoption of the new NSF policy of allowing consideration of only the few best articles of the principal investigator of a grant application, to focus on quality rather than quantity.
5. Most important, Geoscientists must recognize that our publishing rituals and reward system are the fundamental cause of the crisis in the library and in geoscience publishing. Until fundamental behavioral and reward systems are overhauled, the publishing crisis will continue, and probably become exacerbated. We encourage all authors to become informed about these issues. Your university or institution librarian should be your first stop.

Acknowledgments

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CALL FOR NOMINATIONS

Officers and Councilors

The GSA Committee on Nominations requests your help in compiling a list of GSA members qualified for service as officers and councilors of the Society. The committee requests that each nomination be accompanied by basic data and a description of the qualifications of the individual for the position recommended (vice-president, treasurer, councilor).

Nominations for 1994 officers and councilors must be received at GSA headquarters no later than **FEBRUARY 15, 1993.** Please send nominations and back-up material to the Administrative Department, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

Penrose and Day Medals, and Honorary Fellowship

Nominations for GSA's Penrose and Day Medals and for Honorary Fellowship in the Society are due at headquarters by **FEBRUARY 1, 1993.**

For procedures and additional information, please refer to the October 1992 issue of *GSA Today,* or call headquarters at (303) 447-2020.

Send your nominations and required back-up material to the Administrative Department, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 or younger during the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal called the Donath Medal and a cash prize of $10,000, was endowed by Dr. and Mrs. Fred A. Donath.

For the year 1993, only those candidates born on or after January 1, 1958, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1993 award must include

- biographical information,
- a summary of the candidate's scientific contributions to geology (200 words or less),
- a selected bibliography (no more than 10 titles),
- supporting letters from five scientists.

Nominations for the 1993 Young Scientist Award must be received at GSA headquarters by **FEBRUARY 1, 1993.** For procedures and additional information, please refer to the October 1992 issue of *GSA Today,* or call headquarters at (303) 447-2020.

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. Nominations and any supporting information may be addressed to Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. Deadline for nominations for 1993 is **MARCH 1, 1993.**

SAGE REMARKS

Edward E. "Dr. Ed" Geary, Educational Programs Coordinator

The 1992 Biggs Earth Science Teaching Award Recipient: R. Heather Macdonald, College of William and Mary

Citation

In the fall of 1983 R. Heather Macdonald began her full-time teaching career at the College of William and Mary, and from her early days in the classroom her enthusiasm for geology, devotion to her students, dedication to teaching, and eagerness to try new and innovative methods in the classroom became apparent to students and colleagues alike. Those qualities have flourished since then, and she has served as an outstanding role model for a multitude of students ranging from freshmen with little initial interest in geology to majors destined for careers in the geosciences. She was well prepared for this success by her undergraduate education in the liberal arts tradition at Carleton College and by her graduate studies at the University of Wisconsin at Madison. A letter from a former undergraduate student in Heather's laboratory section at Wisconsin clearly shows that her classroom skills were developing early. He wrote that "Heather had a wonderful combination of in-depth knowledge of geology, likeable personality, clear communication skills, and easy-going delivery style that all came out when she was in front of the classroom." She certainly must have been effective, because that student entered Heather's class undecided about his future career and is now a professional geologist. Heather's first seven years of excellence in the classroom were recognized by her being awarded William and Mary's prestigious Thomas Jefferson Teaching Award. That award, made annually to the best young teacher at the college, illustrates the high esteem in which Heather's abilities and teaching prowess are held, not just in geology but across the academic community.

Heather's teaching is superb. Student comments on her course evaluations stress her enthusiasm and love for geology, her concern for the students as individuals, and her success as a teacher. One former student commented that she "is one of those unusual teachers who manages to combine a comprehensive and challenging class with one that is both interesting and fun. Her students are easily involved through her hands-on teaching style and genuine concern and interest for their needs." Another student stated, "Her love for teaching and her excitement about earth science is contagious. She was one of the main influences in my desire to become a geologist." These comments are typical, and both are from students who are now pursuing graduate degrees in geology. Heather's courses, which range from physical geology to sedimentology, are rigorous and comprehensive, and she uses a variety of teaching techniques. Her teaching philosophy is to stimulate the students to be active learners, to get them to think for themselves, and to both challenge students and encourage them. In her courses students take an active role in learning and through Heather's creative techniques the students improve their ability to communicate both orally and in writing. Her pace-setting work on using writing to teach geology in both small and large classes has attracted much attention through her articles published in the *Journal of Geological Education* and elsewhere. Heather also teaches by supervising individual students on their research projects and has provided support for many of them through her grants. One student wrote that during the course of the senior research project, "I came to appreciate what it is really like to do scientific research."

R. Heather Macdonald

Not only does she excel in the classroom, but Heather has devoted much energy and enthusiasm to other aspects of academic and professional life. At William and Mary she has served on numerous committees, is a supportive freshman and sophomore advisor, and is in charge of the department's visiting speaker program. On campus she works closely with faculty members in the School of Education and the college's writing program to explore better methods of teaching. In addition, she has worked extensively with elementary and secondary teachers on the local and state level. An example of her inventiveness is her present effort to bring the excitement of geology to precollege students by establishing a partnering program between college students and 5th grade science classes.

Heather has also become a leader in the geoscience education community on the national level because of her diligence on committees, her publications on innovative techniques in teaching geology and on earth science education, and her leadership in planning and participating in paper sessions and symposia on geological education at Geological Society of America meetings. She edited a booklet, "Career Profiles of Women in the Geosciences," by the Association for Women Geoscientists, is chair of the SEPM Committee on K–12 Earth Science Education, is an NAGT councilor-at-large, chairs the NAGT Outstanding Earth Science Teaching Award Committee, and is a past-chair of the Geology Section of the Virginia Academy of Science.

In summary, Heather Macdonald is a most worthy recipient of the first annual Biggs Earth Science Teaching Award of the Geological Society of America. She has excelled in all her endeavors and is highly respected by her students and colleagues. She has devoted her career to being the best possible teacher and continually explores and introduces new methods to make her teaching more stimulating and effective. Each student is given the sense that she or he is a unique person about whom the teacher really cares. That takes a very special talent, and Heather has it.

Bruce K. Goodwin, Chair
Department of Geology
College of William and Mary

Response

I am honored to be the first recipient of the Biggs Earth Science Teaching Award. Teaching is not only important, but is also fun, and I am very fortunate to be able to share my enthusiasm about geology with students and colleagues. I first thank my students, past and present, geology majors and nonmajors, who have shared in the adventures of learning and have taught me so much. You represent the future of geology and I hope you continue to enjoy the stimulation of geology as much as I have. I also thank my colleagues in the geology department for their continued support and encouragement; together we have worked to make the department an environment where active learning is encouraged and where all students are welcomed. I am grateful to members of the larger William and Mary community who have discussed teaching philosophies and ideas with me; it is interesting to get the views of people from a variety of fields.

The students and faculty at Carleton College and the University of Wisconsin, where I did my undergraduate and graduate work, have influenced me in many ways, and I thank them. I have also benefited from my interactions with many others in the geoscience community. In particular, I thank Charlie Byers, Molly Miller, and Susan Conrad, who have worked closely with me at various stages of my career and share my interests in geology and teaching. Last, but not least, I thank my parents and my brothers who have all contributed to my success as a teacher in different ways.

This award means even more to me after talking with Larry Wu, a former graduate student of Donald Biggs and a friend of Don and his wife, Carolyn. He told me that Don believed that schools should be for *students*. Don was a wonderful advisor and teacher full of vim and vigor who really wanted his students not only to learn about the subject, geology, but also about themselves. Carolyn wanted the award to serve as an inspiration for beginning faculty to become involved in their students' education and careers. She also felt such efforts should be recognized. The BEST award is an appropriate memorial to this marvelous couple and embodies their attitude and spirit. It demonstrates that teaching and interacting with students is important, and that excellence in teaching as well as excellence in research is a valuable contribution to the geologic profession. I thank Donald and Carolyn Biggs and GSA for establishing this award, which will encourage other young geologists to strive for excellence in teaching in years to come.

R. Heather Macdonald
Department of Geology
College of William and Mary

Formal presentation of the first Biggs Earth Science Teaching Award will be made to Heather Macdonald at the 1993 Annual Meeting in Boston, Massachusetts, along with the 1993 recipient. The BEST award is financed by the GSA Foundation's Donald L. and Carolyn N. Biggs Excellence in Earth Education Fund. For additional information on the 1993 Biggs Earth Science Teaching Award, please contact the SAGE Director at 1-800-824-7243 or any Geoscience Education Division officer. ■

Cole Memorial Research Awards in Geomorphology and Micropaleontology

Through the generosity of W. Storrs Cole, two awards for support of research are offered through GSA. The Gladys W. Cole Memorial Research Award provides research support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. It is to be given to a GSA Member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology. Funds cannot be used for work already accomplished, but recipients of a previous award may reapply if additional support is needed to complete their work. The amount of this award in 1993 will be $7000.

The second award, the W. Storrs Cole Memorial Research Award, has been established to support research in invertebrate micropaleontology. This award will also carry a stipend of $7000 and will be given each year to a GSA Member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

Additional information and application forms may be obtained from June R. Forstrom, Research Grants Administrator, GSA, P.O. Box 9140, Boulder, CO 80301.

All applications must be postmarked on or before February 15, 1993. Actions taken by the Committee on Research Grants will be reported to each applicant in early April.

These are two of GSA's most prestigious awards; all qualified applicants are urged to apply.

Final Announcement

SOUTHEASTERN SECTION, GSA 42nd Annual Meeting

Tallahassee, Florida
April 1–2, 1993

The Southeastern Section of the Geological Society of America and the Southeastern Section of SEPM (Society for Sedimentary Geology) will meet at the Florida State Conference Center on the Florida State University campus. The meeting is sponsored by the Department of Geology at Florida State University and is co-hosted by the Bureau of Geology of the Florida Department of Natural Resources.

TALLAHASSEE

Florida's capital city hosts a population of 125,000 people, two universities (Florida State University and Florida A&M University), a large junior college (Tallahassee Community College), the state's executive, judicial, and legislative branches, and the headquarters of the various agencies of the nation's fourth most populous state. Points of interest include the Florida Capitol Complex, the Museum of Florida History, Alfred B. Maclay State Gardens, and Wakulla Springs. Beautiful Gulf Coast beaches such as St. George Island are within a two-hour drive of the city center. Early April in Tallahassee is a period of stunning beauty—spring blooms are at their maximum development.

TRANSPORTATION

Tallahassee is located along Interstate 10 in the eastern corner of the Florida Panhandle, 40 minutes from the Gulf Coast and five hours from Atlanta. Three other U.S. highways run through the city: U.S. 90, U.S. 27, and U.S. 319. The Tallahassee regional airport southwest of the city is serviced by Delta, USAir, American Eagle, ASA, and Conair. Ground transportation to the downtown area is available. Amtrak service to Tallahassee is scheduled to be restored by April, but one should check by calling 1-800-872-7245.

The downtown area is serviced by a free shuttle (Old Town Trolley) which runs to the Civic Center parking lot (adjacent to the Conference Center) every 15 minutes. City bus service is $0.75. A free Florida State Campus bus system services the campus area. A copy of bus routes and schedules will be included in the registration packets. Early morning and late afternoon shuttle service to and from the Conference Center will be available from participating hotels.

PARKING

Limited free parking for meeting participants is available at the Florida State Conference Center. Additional parking ($3.00/day) is available immediately adjacent to the Conference Center at the Leon County Civic Center.

WELCOMING PARTY

A Welcoming Party will be held in the Museum of Florida History in the R. A. Gray Building, 500 S. Bronough Street, on Wednesday, March 31, 7:00–9:30 p.m. The museum hosts exhibits ranging from a diorama on prehistoric Florida, through the Spanish period of exploration and colonization, the British colonial period, the Seminole Wars, and Florida's participation in the Civil War.

The Welcoming Party is for all who will be attending the meeting plus friends and guests. It will not be necessary to have registered for the meeting in order to attend the Welcoming Party. Plan to attend—visit with old friends, make new ones, and browse through the museum exhibits. Light refreshments will be served at this event.

TECHNICAL PROGRAM

Technical sessions will be scheduled as oral or poster presentations on Thursday and Friday, April 1 and 2.

Symposia

Symposia will include invited as well as volunteered papers. Scheduled symposia and their conveners are:

1. **Special Symposium: The Geology of the Southeastern U.S.: An Overview.** Designed to appeal to laypersons and earth science educators at the middle- and high-school levels, as well as specialists in geology. James Cowart, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-5784.
2. **Special Symposium: George Devore Symposium on Geochemistry.** Convened as a tribute to Devore's career—his contributions to geochemistry and to the mentoring of students of geology. A. Leroy Odom, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-3788; James O. Eckert, U.S. Geological Survey, Mail Stop 910, 345 Middlefield Road, Menlo Park, CA 94025-3591, (415) 329-5294.
3. **Episodic Sea-level Change during the Quaternary: Evidence from the Southeastern U.S.** *Co-sponsored by SEPM.* Joseph F. Donoghue, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-5860; Richard A. Davis, Department of Geology, University of South Florida, Tampa, FL 33620, (813) 974-2236.
4. **Public Policy Issues in the Geological Sciences.** *Sponsored by GSA Committee on Geology and Public Policy.* Walter Schmidt, Florida Geological Survey, Gunter Building, 903 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-4191.
5. **Character and Origin of Pre-Cretaceous Rocks beneath the Southeast Coastal Plain.** Jon Arthur, Florida Geological Survey, Gunter Building, 903 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-9380; Paul Mueller, Department of Geology, 1112 Turlington Hall, University of Florida, Gainesville, FL 32611-2036, (904) 392-6595.
6. **Ground-water Hydraulics and Transport in Complex Hydrogeologic Settings of the Southeast.** John Vecchioli, U.S. Geological Survey, 227 N. Bronough St., Suite 3015, Tallahassee, FL 32301, (904) 681-7620; Morris Maslia, ATSDR, 1600 Clifton Road, Bldg. 31, MS-E32, Atlanta, GA 30333, (404) 639-0674.
7. **10th Coastal Sedimentology Symposium: Beach Ridges.** *Co-sponsored by SEPM.* William Tanner, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-3208.
8. **Southeastern Mineral Deposits and Resources.** P. Geoffrey Feiss, Department of Geology, CB 3315, Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315, (919) 966-4516; Carl M. Lesher, Department of Geology, University of Alabama, Tuscaloosa, AL 35487-0338, (205) 348-5095.
9. **Evolution of the Florida Platform.** Douglas L. Smith, Department of Geology, 1112 Turlington Hall, University of Florida, Gainesville, FL 32611-2036, (904) 392-6766; Paul A. Mueller, Department of Geology, 1112 Turlington Hall, University of Florida, Gainesville, FL 32611-2036, (904) 392-6595.
10. **Extensional Tectonics in the Southern Appalachians.** Mark Steltenpohl, Department of Geology, 210 Petrie Hall, Auburn University, Auburn, AL 36849-5305, (205) 844-4282; Harmon Maher, Department of Geology, University of Nebraska at Omaha, Omaha, NE 68182, (402) 554-2662.
11. **Design of Well Networks in Ground-water Supply Studies of the Southeast.** Richard Spruill, Department of Geology, University of North Carolina at Greenville, Greenville, NC 27858, (919) 757-6016.
12. **Neoproterozoic to Middle Paleozoic Clastic Sedimentation and Stratigraphy in the Southern Appalachian Orogen.** *Co-sponsored by SEPM.* Loren A. Raymond, Department of Geology, Appalachian State University, Boone, NC 28608, (704) 262-3049; Fred Webb, Jr., Department of Geology, Appalachian State University, Boone, NC 28608, (704) 262-3049.
13. **Geologic Mapping and Public Needs.** *Sponsored by GSA Committee on Geology and Public Policy.* Steven Schamel, Earth Sciences & Resources Institute, University of South Carolina, Columbia, SC 29208, (803) 777-6484; Donald C. Haney, Kentucky Geological Survey, University of Kentucky, Lexington, KY 40506-0059, (606) 257-3758.
14. **Tempo and Mode of Evolution in the Fossil Record.** Anthony Arnold, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-4228; Michael L. McKinney, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-6359.

THEME SESSIONS

Theme sessions are similar to symposia in their focus on specific topics, but each is an open forum where all papers are volunteered (whereas symposia include invited papers). The following theme sessions are being organized.

1. **Hydrogeology of the Southeast**
2. **Geologic Considerations in Delineating and Remediating Contaminants in Ground Water**
3. **Biostratigraphy and Geochronology of Florida: An Integrated Approach**

POSTER SESSIONS

Poster sessions will be located in the Conference Center adjacent to oral session rooms. Poster booths will be constructed of three pieces of 4' x 8' pegboard mounted horizontally on a frame 3' above the floor. The two side pieces will be mounted perpendicular to the back, creating an 8' x 8' floor space area.

Special Poster Session

Council on Undergraduate Research Special Poster Session of Undergraduate Research. Undergraduate students are encouraged to submit papers regarding their senior thesis or similar independent-study projects. Abstracts should be submitted on official 1993 GSA forms. For information, contact William A. Ranson, Department of Geology, Furman University, Greenville, SC 29613, (803) 294-3364.

SPECIAL SESSION ON HURRICANE ANDREW

A special evening session on the geologic effects of Hurricane Andrew is being organized. This free session, organized by Harold Wanless, will begin at 7:30 p.m. Thursday evening, April 1, at the Florida State Conference Center and is open to the general public. Arrangements will be made to open the exhibit area for a limited time before and after this session.

FIELD TRIPS

Registration. *Field trip registrants must register for the meeting.* A one-day fee is available for those not attending the meeting. Cost includes transportation, guidebook, and other items as noted in the description. Registration procedures, deadlines, and forms are provided in this announcement. Registration at the meeting for the postmeeting field trips may be possible, if trip logistics and space permit. If trips are under-enrolled, participants will be notified no later than ten days before the start of the meeting, and all field trip registration fees will be refunded after the meeting. There will be no refunds if participants fail to show on time for a field trip other than documented serious illness or extreme family emergency. Sponsoring agencies assume no liability whatsoever for failure of participants to show for a trip, for missed connections, or for injury, loss, or damage during or resulting from transportation in the field trips. *The number of participants in most field trips will be limited, so get your registration in as soon as possible to ensure a seat.* Further information, if required, will be sent to trip participants by the trip leaders. Field trip coordinators are Bill Parker, Florida State University, (904) 644-5860; and Tom Scott, Florida Geologic Survey, (904) 488-9380.

Premeeting

1. **Cretaceous-Tertiary Boundary in Alabama.** March 30–31. Ernest Mancini and Nick Tew, Geological Survey of Alabama, 420 Hackberry Lane, Tuscaloosa, AL 35486, (205) 349-2852.

The Cretaceous-Tertiary contact is well exposed at several localities in the Gulf Coastal Plain of southern Alabama, thereby presenting an excellent opportunity for participants on this field trip to examine this important lithostratigraphic and chronostratigraphic horizon in detail, as well as subjacent and superjacent strata of Late Cretaceous and early Paleocene age. In the field trip area, the Cretaceous-Tertiary contact coincides with a well-defined unconformity that separates the Upper Cretaceous (Maastrichtian) Prairie Bluff Chalk (Selma Group) from the early Paleocene (Danian) Clayton Formation (Midway Group). The microfossils contained in these units provide excellent biostratigraphic resolution at this stratigraphic level, and macrofossils are locally abundant. Participants will visit four exposures of the contact: Moscow Landing on the Tombigbee River, Prairie Bluff Landing on the Alabama River, a

Southeastern *continued on p. 18*

Southeastern *continued from p. 19*

roadcut south of Braggs, and an exposure on Mussell Creek. The trip will begin and end in Tallahassee. Cost: $102 (includes 2 lunches, does not include lodging).

2. **Florida Phosphate Deposits.** March 29–31. Tom Scott , Florida Geological Survey, 903 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-9380.

The participants in this trip will visit several active phosphate mining operations in central Florida and one in northern Florida, and an operating separating plant. We will inspect some recent reclamation. On-site lectures will discuss the origin of phosphate deposits, mining operations, hydrogeology, and environmental impacts of phosphate mining. The trip will begin in Tampa and terminate in Tallahassee. Cost: $225 (includes three night's lodging, 2 lunches).

3. **Geology of the Southernmost Exposed Appalachian Piedmont Rocks Along the Alabama Fall Line.** March 30–31. Mark G. Steltenpohl and Peter A. Salpas, Department of Geology, Auburn University, Auburn, AL 36849, (205) 844-4282.

Participants will examine the southernmost exposed crystalline rocks in the Appalachian Piedmont where they contact overlying Cretaceous and younger sedimentary deposits of the Gulf Coastal Plain. Excellent, continuous exposures along the fall line provide a unique opportunity to investigate rocks of, from west to east, the Brevard Zone, Inner Piedmont, Pine Mountain basement massif, Goat Rock fault zone, and the Uchee belt. The trip, which originates in Auburn (8:00 a.m. at the Auburn Motel), emphasizes results of ongoing research on (1) how Brevard Zone lithologies trace around the hinge of the shallowly northeast plunging Tallassee synform, whereas some of the late structures do not; (2) the petrogenetic evolution of the Pine Mountain basement massif and our search for the oldest rocks; and (3) the tectonic character of the recently recognized late Paleozoic, Alleghanian event in this region. The trip will begin and end in Auburn, allowing plenty of time for the four-hour drive to Tallahassee. Cost: $57 (does not include lodging. Transportation to and from Auburn airport and to and from Tallahassee is available at an extra cost—please contact the field trip leader).

Postmeeting

4. **Late Eocene and Early Oligocene Carbonate Facies and Paleoenvironments of the Eastern Gulf Coastal Plain.** April 3–4. Jon Bryan, Antarctic Research Facility, Florida State University, Tallahassee, FL 32306-3026, (904) 644-2407; and Roger Portell, Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, (904) 392-1721.

Participants will visit and collect a wide variety of carbonate facies including open shelf, large foram banks (Ocala Limestone, Eocene); backreef, miliolid limestone (Suwannee Limestone, Oligocene); coralgal reef (Bridgeboro Limestone, Oligocene); rhodolith grainstone (Clayton Formation, Paleocene); and deep shelf–forereef algal banks (Marianna and Florala Limestones, Oligocene). We will examine, in core, facies deposited within the Gulf Trough and discuss the influence of this structure on facies development. The Eocene-Oligocene boundary will also be seen in core and outcrop, and the nature of the transition in Florida will be discussed in the context of the well-known Alabama-Mississippi section. The trip will begin and end in Tallahassee. Cost: $100 (includes one night's lodging and four meals).

5. **Quaternary Sedimentation along the Northeastern Gulf Coast: Evidence for Quaternary Sea-level Change.** April 3. William Tanner and Joe Donoghue, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-5860.

Since Neogene time the geologic character of the northwest Florida coastline has been determined by the sediments of the Apalachicola River and the rise and fall of sea level. The Apalachicola is the largest river in Florida and the fourth largest in the northern Gulf basin. At the river's mouth, an extensive delta-estuary-barrier island system has developed during the Holocene. Sedimentologic and geomorphologic evidence of earlier delta-barrier complexes is present throughout the coastal region. Participants will examine these and other coastal phenomena, including: historic evidence of long-term shoreline change; coastal evolution in response to changes in the sediment pool; evidence of late Holocene sea-level fluctuations (above and below present); evidence of dune reddening; origin of transverse bars; beach-ridge plain development; and development of the modern barrier system. The trip will begin and end in Tallahassee. Cost: $21.

6. **Modern Fluvial Processes in a Sand-bedded Meandering Stream: Flow Structure, Sediment Transport, Bed Forms and Bend Migration.** April 3. David Furbish, Stephen Thorne and Valerie Croup, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-5892.

On this field trip we will outline essential aspects of flow and transport that bear on river dynamics and fluvial depositional environments. Emphasis will be on how river reaches—straight and meandering—are mechanically interdependent, and how this translates to systematic sorting of transported material and to rates of reworking of flood-plain sediments. We will examine processes of flow and sediment transport operating within a sand-bedded meandering stream. The objective will be to illustrate how bed forms, river migration patterns, and related flood-plain deposits are systematically related to flow conditions. In addition, we will discuss the results of an experiment that involved replacing the naturally roughened bank of a river bend with a smooth wall to document how roughness due to riparian vegetation influenced flow in the bend. Part of the trip will involve a moderately strenuous hike. Participants should expect to get wet and should wear clothing and tennis shoes suitable for wading. The trip will begin and end in Tallahassee. Cost: $28 (lunch included in cost).

7. **Karst Features of Northern Florida.** April 3, morning. Frank Rupert, Florida Geological Survey, 903 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-9380.

Participants will visit several karst features developed in the shallow Oligocene and Miocene limestones of the

Preregistration Form

GSA Southeastern Section
Tallahasse, Florida • April 1–2, 1993

Preregistration deadline: March 5, 1993.

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (list last name first)

Employer/University Affiliation

City | State or Country

Mailing Address (use two lines if necessary)

City | State | ZIP Code | Country (if other than USA)

( ) Business Phone

( ) fax

( ) Home Phone

Please indicate if you will need services to accommodate a disability: ☐ Yes ☐ No

Member Affiliation (to qualify for registration discount): (A) GSA or affiliated society Member #_____ (B) NAGT (C) AWG (D) PS (E) SEPM
Section Affiliation: (F) Southeastern (G) Other _____

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on badge | City/State or Country

PREREGISTRATION			Qty	Amount
Professional Member*	(01)	$ 45 ☐	1	$
Professional Nonmember	(03)	$ 55 ☐	1	$
Student Member*	(05)	$ 15 ☐	1	$
Student Nonmember	(07)	$ 20 ☐	1	$
Secondary School Teacher	(42)	Free ☐	1	$
Guest/Spouse	(09)	$ 10 ☐	____	$
Field Trip/Short Course One-day Fee	(98)	$ 23 ☐	1	$

*Member fee applies to any existing professional OR Student Member of GSA or Associated Societies listed above. Discount does not apply to guest registrants.

GUEST PROGRAM					
Visit to Wakulla Springs State Park	April 1	(20)	FREE	____	$

FIELD TRIPS					
1. Cretaceous-Tertiary Boundary in Alabama	March 30–31	(100)	$102	1	$
2. Florida Phosphate Deposits	March 29–31	(101)	$225	1	$
3. Geology of Southernmost Exposed Appalachian Piedmont Rocks Along Alabama Fall Line	March 30–31	(102)	$ 57	1	$
4. Late Eocene and Early Oligocene Carbonate Facies and Paleoenvironments, Eastern Gulf Coastal Plain	April 3–4	(103)	$100	1	$
5. Quaternary Sedimentation along Northeastern Gulf Coast	April 3	(104)	$ 21	1	$
6. Modern Fluvial Processes in a Sand-Bedded Meandering Stream	April 3	(105)	$ 28	1	$
7. Karst Features of Northern Florida	April 3	(106)	$ 45	1	$
8. Coastal Processes of Florida Panhandle—Introduction for Undergraduates and Science Teachers	April 2–4	(107)	$ 65	1	$
9. Hydrogeology of Western Santa Fe River Basin	April 3	(108)	$ 70	1	$

SHORT COURSES					
1. Kriging Techniques and Applications	March 31	Professional	(150) $ 50	1	$
		Student	(151) $ 25	1	$
2. Technical Aspects of Environmental Site Assessments	March 31	Professional	(152) $ 50	1	$
		Student	(153) $ 25	1	$
3. Antarctic Glacial-Marine & Biogenic Sedimentation	March 30–31	Professional	(154) $ 50	1	$
		Student	(155) $ 30	1	$

TOTAL FEES ..... **$**_____

Remit in U.S. funds payable to: 1993 GSA Southeastern Section Meeting
(All preregistrations must be prepaid. Purchase Orders not accepted.)

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GSA SOUTHEASTERN SECTION MEETING, P.O. BOX 9140, BOULDER, CO 80301

Woodville karst plain, south of Tallahassee. The stops will include Leon Sinks Geological Area, Wakulla Springs, and other local karst features. Recent research projects in the karst plain and the ongoing mapping of the extensive subaqueous conduit systems connecting the various sinks and springs will be discussed. The trip will begin and end in Tallahassee and takes approximately 4 hours. Cost: $45 (includes lunch).

8. **Coastal Processes of the Florida Panhandle—An Introduction for Undergraduates and Science Teachers.** April 2 (evening)–4. William Parker, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-1568.

Participants will observe and investigate ongoing sedimentary processes that shape the protected sandy coast to the south and west of Tallahassee and analyze subrecent shoreline features. Emphasis will be on simple observations and experiments that can be easily duplicated on most sandy coasts to illustrate the action of shoreline processes. Development and policy issues affecting coastal areas will also be discussed. The trip will begin and end in Tallahassee. Cost: $65 (includes two nights' lodging and 5 meals).

9. **Hydrogeology of the Western Santa Fe River Basin.** April 3. Katherine Kelley Ellins, Department of Geology, 1112 Turlington Hall, University of Florida, Gainesville, FL 32611-2231, (904) 392-6219.

Few locations in the United States are characterized by ground-water–surface discharge relations more intricate than found in the complex karst of the Santa Fe River basin in central-northern peninsular Florida. The objectives of this field trip are to describe the karst hydrogeology of the Santa Fe River basin and to provide information about subterranean flow patterns and groundwater–surface discharge interactions in the western Santa Fe River basin. The results of a National Science Foundation–sponsored study that used natural radon-222 and human-made sulfur hexafluoride as hydrologic tracers will be discussed. The last stop will be at Ginnie Springs, a popular site for recreational swimming, snorkeling, and diving. A substantial part of the trip will be by canoe (canoeing experience recommended). The trip will begin and end in Tallahassee. Cost: $70 (includes canoe rental and lunch).

SHORT COURSES

Registration. Short course registrants must register for the meeting. A one-day fee is available for those not attending the meeting. The following short courses will be offered before the meeting on the FSU campus.

1. **Kriging Techniques and Applications.** March 31. Bill Parker, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-5860.

The course will begin with an introduction to simple kriging theory and techniques and illustrate how to use kriging to make unbiased least-variance estimates of regionalized variates. Application of the methodology to hydrogeologic and terrain elevation data sets will be used to demonstrate how the method responds to different varieties of data. The effect on the kriged estimate and on its standard error due to violation of stationaryness and incorrect semivariance model choice will be discussed. Cross-validation will be used both to verify model choice but will also be explored as a mechanism for refining model choice and recognizing data outliers. Participants will receive a copy of software that allows them to explore simple kriging on a desktop PC. The latter part of the course will involve "hands-on" application of the methodology by the participants to "small" data sets. Attendees are encouraged to bring their own data for this part of the course. A limited number of PCs will be available for participant use. The course will be taught in the FSU student union, beginning at 8:00 a.m. Cost: $50 ($25 for students).

2. **Technical Aspects of Environmental Site Assessments and Industrial Compliance Audits.** March 31. Thomas Missimer, Missimer and Associates, Inc., Route 8, Box 625-D, 428 Pine Island Road, Cape Coral, FL 33991, (813) 574-1919.

The course will cover the scientific and business aspects of environmental site assessments (environmental audits). Many geologists are asked to evaluate a given parcel of property or a business to assess if any contamination, either soil or water, is present on or beneath the site. This type of investigation involves the use of basic hydrogeological principles and investigative skills in many other areas of expertise. The course will be divided into two 4-hour sessions; the morning and half of the afternoon will be dedicated to technical issues. The last two hours of the course will cover business issues, such as liability management and ethics. Topics to be covered include: the law, hydrogeologic issues, historical investigation, regulatory compliance, site inspection, off-site investigation, audit reports, operational audits, and business aspects. The course will be taught in the FSU student union, beginning at 8:00 a.m. Cost: $50 ($25 for students).

3. **Workshop on Antarctic Glacial-Marine and Biogenic Sedimentation.** March 30–31. John Anderson (Rice University), Amy Leventer (Ohio State University), Scott Ishman (U.S. Geological Survey). Contact Jonathan R. Bryan, Curatorial Director, Antarctic Marine Geology Research Facility, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-2407.

The course will consist of three parts: *Glacial marine sedimentation* (day one) will focus on glacial marine sedimentation processes in a variety of Antarctic settings, from bays and fjords to the abyssal floor. Sediment cores and high-resolution seismic records will be used to illustrate subglacial and glacial environments and to interpret Antarctica's climatic and glacial history. *Benthic foraminifera biology and sedimentology* (first half, day two) will look at the distribution of benthic foraminifers in the circum-Antarctic. This will include Antarctic "provincialism," regional variability of assemblages, environmental factors controlling distribution, and problems unique to the polar environment. Sample preparation methodology and experience with core materials are included. *Diatom biology and sedimentation* (second half, day two) will examine the use of diatoms as indicators of oceanographic and depositional conditions and provide a working knowledge of diatom identification. Topics will include diatom biology, morphology, and classification; modern distributions; diatom paleoecology and biostratigraphic utility; and sampling and processing techniques. The course will be taught in the Antarctic Marine Geology Research Facility (adjoins FSU geology department) starting at 8:00 a.m. Cost: $50 ($30 for students).

REGISTRATION

PREREGISTER TODAY!
DEADLINE: March 5, 1993

1. Note that there is a savings in fees if you preregister! Preregistration also assists the local committee in making final plans for the meeting. The preregistration form is provided in this announcement.
2. Badges must be worn for access to ALL activities except the Welcoming Party and Hurricane Andrew Symposium.
3. Registration discounts are given to GSA or associated society members. Associated societies that qualify for this discount are indicated on the preregistration form. Please indicate your affiliation(s) and member number to register at member rates.
4. Full payment must accompany the preregistration form. Unpaid purchase orders are not accepted as valid registration. Charge cards are accepted, as indicated on the form. Please recheck the charge card number given; errors will delay your registration. Your confirmation letter from GSA will be your only receipt.
5. Please register only one professional or student per form; keep a copy for your records.
6. Current student ID is required to obtain student rates at both the preregistration and on-site counters. Students must present their current student ID when picking up registration materials in order to receive the student rate.
7. Guest registrations must be accompanied by a regular professional or student registration. A guest is defined as a nongeologist spouse or friend of a professional or student registrant.

CANCELLATIONS, CHANGES, AND REFUNDS

All requests for registration additions, changes, and cancellations must be made in writing and received by *March 12, 1993*. GSA will refund advance registration fees for cancellations received in writing by that date. Faxes will be accepted. NO REFUNDS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER THAT DATE. Refunds will be mailed from GSA *after* the meeting. Refunds for fees paid by credit card will be credited to the card number on the preregistration form. NO refunds will be given for on-site registration.

ON-SITE REGISTRATION

Florida State Conference Center Lobby

Wed., March 31	2:30 p.m.–6:00 p.m.
Thurs., April 1	7:30 a.m.–4:30 p.m.
Fri., April 2	7:30 a.m.–11:30 a.m.

For registration information, please call the GSA registration coordinator at (303) 447-2020.

Southeastern *continued on p. 20*

REGISTRATION FEES

	Advance (by March 5)	On-Site	One-Day
Professional—Member	$45	$55	N/A
Professional—Nonmember	$55	$65	N/A
Student—Member	$15	$25	N/A
Student—Nonmember	$20	$30	N/A
Secondary School Teacher	N/A	N/A	N/A
Guest	$10	$10	N/A
Field Trip/Short Course—One day	$23	N/A	N/A

Southeastern *continued from p. 19*

PUBLICATIONS

Abstracts are published in the GSA *Abstracts with Programs*. Advance purchase orders must be received by *January 28, 1993;* prepayment is required. An order form is provided in this announcement. These advance copies will be mailed about three weeks prior to the meeting. Refunds for duplicate orders will not be given; members should check their records carefully to make sure that they have not previously purchased a copy of this publication on either their dues statement or through GSA Publication Sales. Meeting attendees may purchase copies of *Abstracts with Programs* on site, while the supply lasts, in the registration area of the Florida State University Conference Center.

A limited number of field trip guide-books will be available for sale at the meeting in the registration area. After the meeting, a limited number of guidebooks will be available for sale through the Southeastern Geological Society, P.O. Box 1634, Tallahassee, FL 32302.

EQUIPMENT AND FACILITIES

All slides used in oral presentations must be 2" x 2" and fit a standard 35 mm carousel projector. Two projectors, screens, and a pointer will be available in each meeting room. *Please bring your own loaded carousel trays,* identified with your name, session, and speaker number to the appropriate session projectionist *at least* 15 minutes before the session begins.

A speaker ready room equipped with projectors and screens will be available for reviewing slides.

CAMERAS, SOUND EQUIPMENT, AND SMOKING POLICY

GSA meeting policy prohibits the use of cameras or sound-recording equipment at technical sessions. A no-smoking policy has been adopted by the local committee and will be followed in all meeting rooms for technical sessions as well as the Welcoming Party.

EXHIBITS

Geological exhibits pertaining to education, research, and industry will be displayed near the technical sessions area in the Conference Center. Rental fees for exhibit booths are $100 for academic departments, $150 for nonprofit organizations, and $300 for business or commercial. Standard booth size will be 6' x 8'. Arrangements are being made to open the exhibit area before and after the Thursday night session on Hurricane Andrew. For further information, contact Sherwood Wise, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306, (904) 644-6265.

STUDENT ARRANGEMENTS

Travel Grants. Support for travel expenses of students presenting papers at the meeting is available from the Southeastern Section. For information, contact Michael J. Neilson, Department of Geology, University of Alabama at Birmingham, Birmingham, AL 35294, (205) 934-5102.

Graduate Student Recruitment. A room will be available on Thursday afternoon in the Conference Center to any graduate program in the geosciences that wishes to have representatives available to talk with prospective graduate students. Details will be posted at the meeting. There will be no charge for participating. Representatives may wish to bring a sign to identify their program as well as information to distribute to students. For information contact Anthony Arnold, (904) 644-4228.

SPECIAL EVENTS AND ACTIVITIES

Scheduled Meetings

All meetings will be held in the Florida State Conference Center. Times and locations of the following will be announced in the meeting program:

1. GSA Southeastern Section Management Board Meeting
2. GSA Southeastern Section Business Meeting
3. Meeting of Geoscience Department Chairs
4. SEPM Eastern Section Officers Meeting and SEPM Eastern Section Business Meeting
5. Southeastern Section of the National Association of Geology Teachers Annual Business Meeting
6. GSA Southeastern Section Education Committee
7. GSA Southeastern Section Geology and Public Policy Committee

Any other group that wishes to meet in conjunction with the GSA meeting in Tallahassee should contact Jim Tull at (904) 644-1448 by December 15, 1992, if they wish to have the meeting publicized in the meeting program.

MEETINGS

GSA Penrose Conferences

February 1993

Continental Tectonics and Magmatism of the Jurassic North American Cordillera, February 27–March 4, 1993, Havasu City, Arizona. Information: Dave Miller, (415) 329-4923, and Dick Tosdal, (415) 329-5423, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025; or Bob Anderson, (604) 666-2693, Geological Survey of Canada, 100 West Pender Street, Vancouver, B.C. V6B 1R8, Canada.

March 1994

■ **From the Inside and the Outside: Interdisciplinary Perspectives on the History of Earth Sciences,** March 1994, California. Information: Leo F. Laporte, Dept. of Earth Sciences, University of California, Santa Cruz, CA 95064, (408) 459-2248, fax 408-459-3074; Naomi Oreskes, Dept. of Earth Sciences, Dartmouth College, Hanover, NH 03755, (603) 646-2373; Kenneth L. Taylor, Dept. of the History of Science, University of Oklahoma, Norman, OK 73019-0315, (405) 325-2213.

1993 Meetings

January

Results of Drilling in Western Pacific Active Margins and Marginal Basins, January 18–21, 1993, Monterey, California. Information: Brian Taylor, University of Hawaii, 2525 Correa Rd., Honolulu, HI 96822, (808) 956-6649, fax 808-956-2538, E-mail: taylor@-elepaio.soest.hawaii.edu.

Quantifying Sedimentary Geochemical Processes, January 26–27, 1993, London, England. Information: Christine A. Johnson, Scientific Meetings Secretary, 6 Carlton House Terrace, London

Tallahassee Hotels and Motels Providing Special GSA Rates

Radisson Hotel	(904/224-6000)	$81 single/double
Holiday Inn		
@ University Center	(904/222-8000)	$47 single/double $57 concierge
@ Apalachee Parkway	(904/877-3141)	$43 single/double
Cabot Lodge	(904/386-8880)	$48 single $54 double
Ramada Inn	(904/386-1027)	$59 single/double

Other area accommodations near campus include Travel Lodge and Southernaire.

All hotels provide complimentary shuttle service to the Conference Center. Cabot Lodge provides complimentary continental breakfast and happy hour.

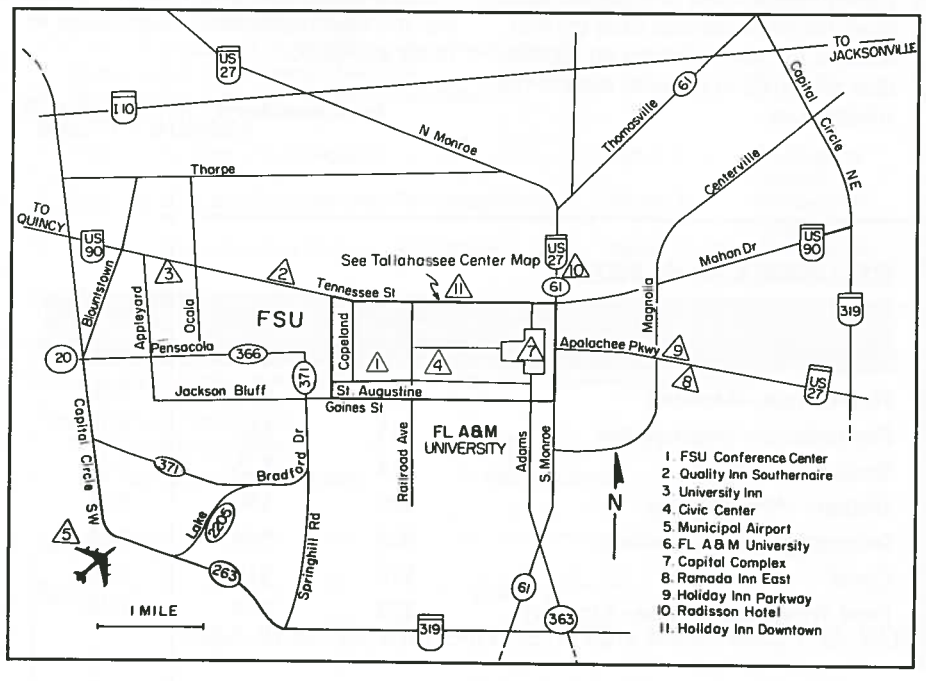
GUEST PROGRAM

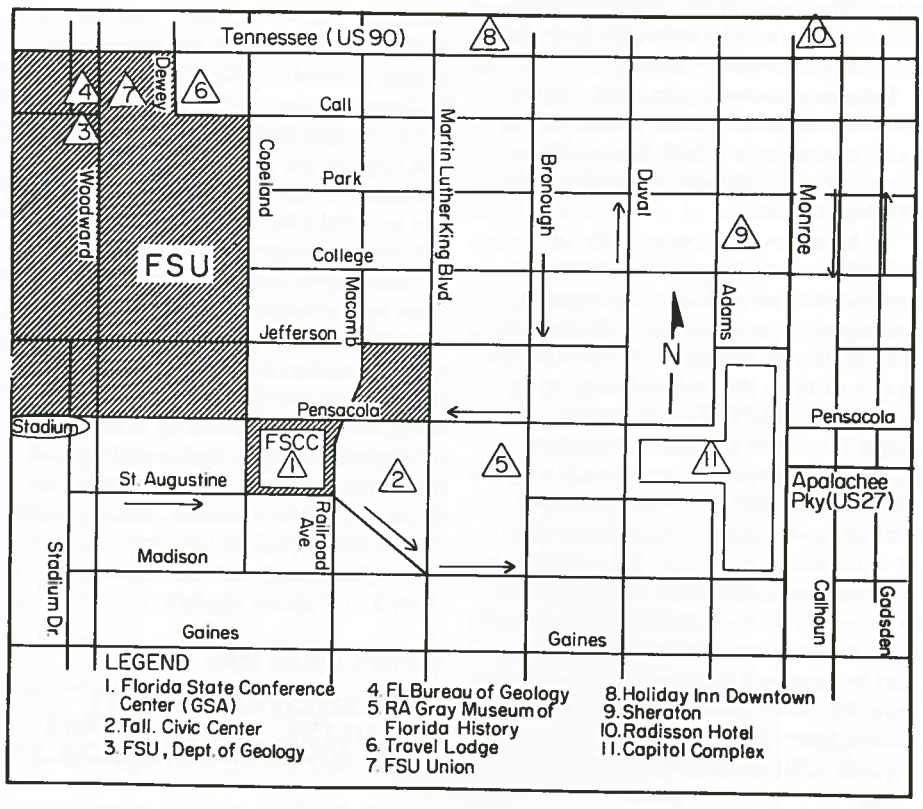
A guest program is being planned and will include a Thursday visit to Wakulla Springs State Park, featuring nature trails and glass-bottom and wildlife-observation boat rides. Meet at Conference Center at 8:30 a.m. There is no charge for registration if you are an official meeting registrant. Please indicate on the preregistration form if you plan to attend.

HOUSING

Rooms to be used by meeting participants and their guests have been blocked in the hotels listed below. To receive the room rates quoted below, reserve rooms by calling the hotels directly, before February 19, and requesting a reservation number. Be sure to inform the attendant that you are with the Geological Society of America. ■

Tallahassee Area and Florida State University





SW1Y 5AG, phone 071-839 5561, fax 071-930-2170, telex 917876.

February

Geologic Remote Sensing, 9th Thematic Conference, Exploration, Environment, and Engineering, February 8–11, 1993, Pasadena, California. Information: ERIM/Thematic Conferences, Nancy J. Wallman, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123.

Earthquake Engineering Research Institute 45th Annual Meeting, February 11–13, 1993, Seattle, Washington. Information: EERI, 499 14th St., Suite 320, Oakland, CA 94612-1902, (510) 451-0905, fax 510-451-5411.

Society for Mining, Metallurgy, and Exploration 1993 Annual Meeting, February 15–18, 1993, Reno, Nevada. Information: Meetings Department, SME, P.O. Box 625002, Littleton, CO 80162, (303) 973-3461.

■ **12th Annual Symposium on Caribbean Geology,** Geology of Puerto Rico, Genesis of an island arc terrane, February 24–28, 1993, Mayagüez, Puerto Rico. Information: J. H. Schellekens, Department of Geology, University of Puerto Rico, P.O. Box 5000, Mayagüez, Puerto Rico 00681-5000; phone/fax (809) 265-3845.

March

GSA South-Central Section Meeting, March 15–16, 1993, Fort Worth, Texas. Information: John Breyer, Dept. of Geology, Texas Christian University, Fort Worth, TX 76129, (817) 921-7270.

Lunar and Planetary Science 24th Annual Conference, March 15–19, 1993, Houston, Texas. Information: 24th LPSC, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058-1113, (713) 486-2166.

Michigan Geological Survey Division Symposium, Michigan: Its Geology and Geologic Resources, March 18–19, 1993, East Lansing, Michigan. Information: Carol L. Skillings, Dept. of Natural Resources, Geological Survey Division, Box 30028, Lansing, MI 48909-7258, (517) 334-6976.

GSA Northeastern Section Meeting, March 22–24, 1993, Burlington, Vermont. Information: Barry L. Doolan or Rolfe S. Stanley, Dept. of Geology, University of Vermont, Burlington, VT 05405-0122, (802) 656-0247.

■ **Society for Industrial and Applied Mathematics,** Sixth Conference on Parallel Processing for Scientific Computing, March 22–24, 1993, Norfolk, Virginia. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org.

Fluvial-Dominated Deltaic Reservoirs in the Southern Midcontinent Workshop, March 23–24, 1993, Norman, Oklahoma. Information: Kenneth S. Johnson, Oklahoma Geological Survey, University of Oklahoma, 100 East Boyd, Rm. N-131, Norman, OK 73019, (405) 325-3031.

■ **Prospectors and Developers Association of Canada International Convention,** March 28–31, 1993, Toronto, Ontario, Canada. Information: Rita Plaskett, Prospectors and Developers Association of Canada, 74 Victoria St., Suite 1002, Toronto, Ontario M5C 2A5, Canada, (416) 362-1969, fax 416-362-0101.

GSA North-Central Section Meeting, March 29–30, 1993, Rolla, Missouri. Information: Richard Hagni, Dept. of Geology and Geophysics, University of Missouri, Rolla, MO 65401, (314) 341-4616.

April

GSA Southeastern Section Meeting, April 1–2, 1993, Tallahassee, Florida. Information: James Tull, Dept. of Geology, Florida State University, Tallahassee, FL 32306, (904) 644-1448.

Computer Simulated Mineral Exploration 22nd Workshop, April 1–30, 1993, Fontainebleau, France. Information: L. Zanone, Ecole des Mines de Paris, CGGM-IGM, 35, rue Saint-Honoré, 77305 Fontainebleau Cédex, France, phone (33 1) 64 69 49 30, fax (33 1) 64 69 47 01, telex 694 736 F.

Remote Sensing and Global Environmental Change 25th International Symposium, April 4–8, 1993, Graz, Austria. Information: Dorothy M. Humphrey, ERIM, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 2290, fax 313-994-5123.

Mantle Composition, Structure, and Processes Workshop , April 4–8, 1993, Soda Springs, California. Send letters of application by Sept. 30, 1992, to: Jane E. Nielson, U.S. Geological Survey, MS 975, 345 Middlefield Rd., Menlo Park, CA 94025, (415) 329-4948, fax 415-329-4936; or B. Carter Hearn, Jr., U.S. Geological Survey, 959 National Center, Reston, VA 22092, (703) 648-6768, fax 703-648-6789.

Mechanisms of Deformation and Failure in Rocks and Ceramics, April 12–16, 1993, San Francisco, California. Information: Joanne Fredrich, TerraTek, Inc., University Research Park, 420 Wakara Way, Salt Lake City, UT 84108, (801) 584-2487, fax 801-584-2432.

Integrated Methods in Exploration and Discovery, April 17–20, 1993, Denver, Colorado. Information: SEG Conference '93, P.O. Box 571, Golden, CO 80402.

Canadian Quaternary Association, April 17–21, 1993, Victoria, British Columbia, Canada. Information: Environmental Geology Section, BC Geological Survey Branch, 553 Superior Street, Victoria, British Columbia, V8V 1X4, Canada, (604) 387-6249, fax 604-356-8153.

Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 6th Annual Symposium, April 18–21, 1993, San Diego, California. Information: Mark Cramer, ExpoMasters, 7632 E. Costilla Ave., Englewood, CO 80112, (303) 771-2000, fax 303-843-6232.

■ **Society for Industrial and Applied Mathematics,** Conference on Mathematical and Computational Issues in the Geosciences, April 19–21, 1993, Houston, Texas. Information: SIAM Conference

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Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org.

Operationalization of Remote Sensing International Symposium, April 19–23, 1993, Enschede, The Netherlands. Information: J. L. van Genderen, ITC, P.O. Box 6, 7500 AA Enschede, The Netherlands, phone 31-53-874 254, fax 31-53-874 436, telex 44525 itc nl.

■ **Geoscience Education and Training International Conference,** April 20–24, 1993, Southampton, England. Information: Dorrik A.V. Stow or Esther Johnson, Dept. of Geology, University of Southampton, Southampton, SO9 5NH, England, phone 0703-593049, fax 0703-593052, telex: 47662 SOTONU G.

■ **Midwest Friends of the Pleistocene,** May 21–23, 1993, Sturgeon Bay, Wisconsin. Information: Allan F. Schneider, Dept. of Geology, University of Wisconsin—Parkside, Box 2000, Wood Road, Kenosha, WI 53141, (414) 595-2439.

May

Pacific Sections 1993 Convention, American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists, Association of Engineering Geologists, Society of Petroleum Well Log Analysts, Society of Core Analysts, and American Institute of Professional Geologists, May 5–7, 1993, Long Beach, California. Information: Don Clarke, City of Long Beach–Department of Oil Porperties, 333 West Ocean Blvd., Long Beach, CA 90802, (310) 590-6084.

GEOTECHNICA 1993, International Trade Fair and Congress for Geosciences and Technology, May 5–8, 1993, Cologne, Germany. Information: KölnMesse, Messe- und Ausstellungs-Ges.m.b.H. Köln, Messeplatz 1, Postfach 21 07 60, W-5000 Köln 21, Germany, phone (0)2 21/821-0, fax (0)2 21/821-25 74, telex 8 873 426 mua d.

USA/CIS Second Joint Conference on Environmental Hydrology and Hydrogeology, Industrial and Agricultural Impacts on the Hydrologic Environment, May 15–21, 1993, Arlington, Virginia. Information: American Institute of Hydrology, 3416 University Ave. S.E., Minneapolis, MN 55414-3328, (612) 379-1030, fax 612-379-0169.

INQUA Commission on Formation and Properties of Glacial Deposits Field Conference and GIS Workshop, Work Groups on Glacial Tectonics and Mapping Glacial Deposits, mid-May, 1993, Regina, Saskatchewan, Canada. Information: D. J. Sauchyn, Dept. of Geography, University of Regina, Regina, Saskatchewan, S4S 0A2 Canada, (306) 585-4030, fax 306-585-4815; or J. S. Aber, Earth Science, Emporia State University, Emporia, KS 66801, (316) 341-5981, fax 316-341-5997. *(Abstract deadline: February 1, 1993.)*

GSA Cordilleran–Rocky Mountain Section Meeting, May 19–21, 1993, Reno, Nevada. Information: Richard A. Schweickert, Dept. of Geological Sciences, Mackay School of Mines, University of Nevada, Reno, NV 89557-0138, (702) 784-6050; or Walter S. Snyder, Dept. of Geosciences, Boise State University, Boise, ID 83725, (208) 385-3645, fax 208-385-4061. *(Abstract deadline: January 26, 1993.)*

■ **American Geophysical Union Spring Meeting,** May 24–28, 1993, Baltimore, Maryland. Information: AGU–Meetings Department, 2000 Florida Avenue, N.W., Washington, DC 20009, (202) 462-6900, fax 202-328-0566, E-mail: dsolomon@kosmos.agu.org. *(Abstract deadline: March 4, 1993.)*

International Basin Tectonics and Hyrdrocarbon Accumulation Conference, May 25–June 15, 1993, Nanjing, People's Republic of China. Information: David Howell, U.S. Geological Survey, 345 Middlefield Road, MS 902, Menlo Park, CA 94025, (415) 354-5430, fax 415-354-3224.

■ **American Society of Limnology and Oceanology, Society of Wetland Scientists, Society of Canadian Limnologists, Joint Annual Meeting,** May 30–June 3, 1993, Edmonton, Alberta, Canada. Information: Marcel Ouellet, Institut National de la Recherche Scientifique, 2700 rue Einstein, P. Box 7500, Sainte-Foy, Québec, (418) 654-2631, fax 418-654-2562.

June

Case Histories in Geotechnical Engineering Third International Conference, June 1–6, 1993, St. Louis, Missouri. Information: Shamsher Prakash, Conference Chairman, University of Missouri–Rolla, Rolla, MO 65401-0249, (314) 341-4489, fax 314-341-4729.

Global Aspects of Coral Reefs: Health, Hazards, and History, June 7–10, 1993, Coral Gables, Florida. Information: Global Reef Meeting, University of Miami/RSMAS, 4600 Rickenbacker Causeway, Miami, FL 33149-1098, fax 305-361-4632.

Geology and Confinement of Toxic Wastes International Symposium, June 8–11, 1993, Montpellier, France. Information: Michel Barrès, BRGM—Département "Environnement," BP 6009, 45060 Orleans Cedex, France, phone 33-38 64 34 14, fax 33-38 64 30 13, Telex BRGM 780 258 F.

Rock Mechanics 34th U.S. Symposium, June 27–30, 1993, Madison, Wisconsin. Information: Bezalel C. Haimson, Dept. of Materials Science and Engineering, 1509 University Avenue, Madison, WI 53706, (608) 265-3021, fax 608-262-8353, E-Mail: haimson-@macc.wisc.edu.

NATO Advanced Study Institute on Feldspars and Their Reactions, June 29–July 10, 1993, Edinburgh, Scotland. Information: Ian Parsons, Dept. of Geology & Geophysics, University of Edinburgh, Edinburgh, EH9 3JW, UK, fax 44-31-668-3184.

July

Fluvial Sedimentology 5th International Conference, July 5–9, 1993, Brisbane, Australia. Information: Continuing Professional Education, The University of Queensland, Queensland 4072, Australia, phone +61-7-365 7100, fax +61-7-365 7099, telex UNIVQLD AA40315.

■ **Society for Industrial and Applied Mathematics,** Annual Meeting, July 12–16, 1993, Philadelphia, Pennsylvania. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org. *(Abstract deadline: February 5, 1993.)*

Geological and Landscape Conservation International Conference, July 17–24, 1993, Great Malvern, United Kingdom. Information: D. O'Halloran, JNCC, City Road, Peterborough, PE1 1JY, UK, phone 0733-62626, fax 0733-893 971.

Clays Control the Environment—10th International Clay Conference, July 18–23, 1993, Adelaide, Australia. Information: Conference Secretariat, Elliservice Convention Management, P.O. Box 753, Norwood, SA 5067, Australia, phone +61.8.332.4068, fax +61.8.364.1968.

August

Intraplate Volcanism International Workshop, The Polynesian Plume Province, August 1993, Tahiti, French Polynesia. Information: Workshop Tahiti 1993 Organization Committee, H.G. Barsczus, Centre Géologique et Géophysique, Case 060, Université de Montpellier II, 34095 Montpellier Cedex 5, France, phone 33-67-634-983, fax 33-67-523-908.

Geochemistry of the Earth Surface 3rd International Symposium, August 1–6, 1993, University Park, Pennsylvania. Information: Lee Kump, Dept. of Geosciences, Pennsylvania State University, 210 Deike Bldg., University Park, PA 16802, (814) 863-1274, fax 814-865-3191.

Belt Symposium III: Field Conference on New Geologic Perspectives of the Middle Proterozoic Belt-Purcell Basin, August 14–21, 1993, Whitefish, Montana. Information: Belt Symposium III, c/o Western Experience, Inc., 4881 Evening Sun Lane, Colorado Springs, CO 80917.

■ **Carboniferous to Jurassic Pangea: A Global View of Environments and Resources,** August 15–19, 1993, Calgary, Alberta, Canada. Cosponsored by the Canadian Society of Petroleum Geologists and the Global Sedimentary Geology Program. Information: Benoit Beauchamp or Ashton Embry, Geological Survey of Canada, 3303 33rd St. NW, Calgary, Alberta T2L 2A7, Canada, (403) 292-7126, fax 403-292-4961.

Mine Design International Congress, Mining into the 21st Century, August 23–26, 1993, Kingston, Ontario, Canada. Information: Peter Scott, Public Relations, ICMD/Relations publiques, CICM, Department of Mining Engineering/Département de génie minier, Queen's University/Université Queen's, Kingston, Ontario, Canada K7L 3N6, (613) 545-2212, fax 613-545-6597.

September

Coal Science 7th International Conference, September 12–18, 1993, Banff, Alberta, Canada. Information: David Brown, (403) 450-5200.

Fractography, Geological Society of London Thematic Meeting, September 13–14, 1993, London, United Kingdom. Information: M. S. Ameen, GeoScience Limited, Silwood Park, Buckhurst Road, Ascot SL5 7QW, UK, phone 0344 872220, fax 0344 872438.

WORLDTech I, International Congress on Mining Development, September 15–17, 1993, Philadelphia, Pennsylvania.. Information: Meetings Department, SME, P.O. Box 625002, Littleton, CO 80162, (303) 973-9550, fax 303-979-3461.

Andean Geodynamics 2nd International Symposium, September 21–23, 1993, Oxford, England. Information: P. Soler, ISAG 93, ORSTOM, CS1, 213 rue Lafayette, 75480 Paris Cedex 10, France, fax 33-1 48 03 08 29. *(Abstract deadline: April 1, 1993.)*

■ **International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) General Assembly,** Ancient Volcanism and Modern Analogues, September 25–October 1, 1993, Canberra, Australia. Information: IAVCEI General Assembly, Acts, GPO Box 2200, Canberra, ACT 2601, Australia, phone +61 6 2573299, fax +61 6 2573256.

Global Boundary Events (Interdisciplinary Conference of IGCP Project 293, Geochemical Marker Events in the Phanerozoic), September 27–29, 1993, Kielce, Poland. Information: Barbara Studencka, Muzeum Ziemi PAN, Al. Na Skarpie 20/26, 00-488 Warszawa, Poland, phone (4822) 217 391, fax (4822) 297-497; or Helmut H.J. Geldsetzer, Geological Survey of Canada, 3303 33rd St. N.W., Calgary, Alberta T2L 2A7, Canada, (403) 292-7155, fax 403-292-5377.

Meetings *continued on p. 27*

January *BULLETIN* and *GEOLOGY* Contents

Are you missing out? If you're not a *Bulletin* or *Geology* subscriber, you may miss the articles listed below. Subscribe today and receive all 1993 issues, even if you've already paid your 1993 dues. Call Membership Services today at 1-800-472-1988.

The Geological Society of America
BULLETIN
Volume 105, Number 1, January 1993

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JANUARY 1993

GSA ANNUAL MEETINGS

■ 1993

GSA Annual Meeting
Boston, Massachusetts
Hynes Convention Center
October 25–28

Chairman: James W. Skehan, S. J., Boston College

For information call the GSA Meetings Department, (303) 447-2020.

Geology and Health 1993 Program Theme

"Geology and Health" will be the scientific theme of the 1993 GSA Annual Meeting in Boston. The health of humanity requires adequate natural resources and a benign environment. Achieving these requirements will depend ever more heavily on advances in the geological sciences. The human family will need new insights, new techniques, and solutions to a wide range of local, regional, and global problems. The symposia and theme sessions devoted to *"Geology and Health"* at GSA 1993 will address these needs. A GSA-wide symposium concerned with major environmental and resource issues is planned. It will be followed by several specialized symposia dealing with the health effects of minerals and of anthropogenic changes in the composition of the atmosphere, soils, surface waters, and ground waters. These symposia and a number of related theme sessions will focus attention on some of the human dimensions of the geological sciences. The Boston Annual Meeting Committee hopes that these sessions will also supply answers to some vexing questions and solutions to important problems.

■ 1994

GSA Annual Meeting
Seattle, Washington
Washington State Convention and Trade Center
October 24–27

Chairman: Darrel S. Cowan, University of Washington

Call for Field Trip Proposals: Please contact the field trip chairman—Donald A. Swanson, Department of Geosciences, University of Washington, Seattle, WA 98195, (206) 543-1190.

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GSA SECTION MEETINGS

South-Central Section, Texas Christian University, Fort Worth, Texas, March 15–16, 1993. John A. Breyer, Department of Geology, P.O. Box 30798, Sid Richardson Building, Corner of Bowie and Cockrell, Texas Christian University, Ft. Worth, TX 76129-0001, (817) 921-7270. *Abstract deadline was November 20, 1992.*

Northeastern Section, Sheraton Inn Conference Center, Burlington, Vermont, March 22–24, 1993. Barry L. Doolan or Rolfe S. Stanley, Department of Geology, Perkins Geology Hall, University of Vermont, Burlington, VT 05405-0122, (802) 656-0247. *Abstract deadline was November 24, 1992.*

North-Central Section, University of Missouri, Rolla, Missouri, March 29–30, 1993. Richard D. Hagni, Department of Geology & Geophysics, 125 McNutt Hall, University of Missouri–Rolla, Rolla, MO 65401-0249, (314) 341-4616. *Abstract deadline was December 2, 1992.*

Southeastern Section, Florida State Conference Center, Tallahassee, Florida, April 1–2, 1993. James F. Tull, Department of Geology, B-160, Florida State University, Tallahassee, FL 32306-3026, (904) 644-1448. *Abstract deadline was December 7, 1992.*

Cordilleran and Rocky Mountain Sections, Reno Hilton (formerly Bally's Hotel), Reno, Nevada, May 19–21, 1993. Richard A. Schweickert, Department of Geological Sciences, Mackay School of Mines, University of Nevada–Reno, Reno, NV 89557-0138, (702) 784-6050; or Walter S. Snyder, Department of Geosciences, Boise State University, Boise, ID 83725, (208) 385-3645, fax 208-385-4061. *Abstract Deadline: January 26, 1993.*

Student Travel Grants for Section Meetings

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 students traveling to the 1993 GSA Annual Meeting in Boston in October and to the 1993 Section meetings. Contact your Section secretary for application procedures.

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South-Central	Rena M. Bonem	(817) 755-2361
Northeastern	Kenneth N. Weaver ..	(410) 554-5503
Southeastern	Michael J. Neilson	(205) 934-2439

Topography *continued from p. 1*

lineaments for hundreds to thousands of kilometres across the flanks of the ridge. Transform-fault boundaries will be conditioned by, and will condition, accretionary processes, because the fault juxtaposes a barrier of aged lithosphere against the zero-age axis of the ridge segment (e.g., Fox and Gallo, 1984).

In contrast, ridge-axis discontinuities of the second and third order include a range of offset geometries (e.g., overlapping spreading centers along the East Pacific Rise; oblique relay zones along the Mid-Atlantic Ridge [Searle and Laughton, 1977]), and are small offsets of the opposing ridge segments in terms of both distance (less than a few tens of kilometres) and age (<~1 Ma) (Figs. 3A, 4, 5A, 5B). At second- and third-order discontinuities, structures indicative of a through-going zone of shear and rigid-plate-boundary behavior are not spatially sustained, suggesting that these offset geometries are not stable for long periods of time. These medium-order ridge-axis discontinuities are caused by differential asymmetric spreading, small changes in spreading direction, and variations in the process of melt generation (e.g., Lonsdale, 1989; Perram and Macdonald, 1990). The distinction between second- and third-order offsets is that the magnitude of a third-order offset is relatively small (less than a few kilometres), and there is little or no trace of third-order features off-axis (i.e., third-order segmentation is not long-lived, $<10^5$ yr).

The traces of second-order discontinuities are found as swaths of disturbed terrain flanking the ridge axis (called discordant zones), and generally do not trace small circles about the pole of opening (Figs. 4, 5A, 5B). Second-order segmentation patterns can follow one of at least two evolutionary paths: they migrate along-strike, leaving a V-shaped wake of abandoned ridge tips and basins; or they remain approximately in the same place, but oscillate back and forth along the ridge (Lonsdale, 1985; Macdonald et al., 1987; Wilson, 1990). It has been documented along the fast end of the accretionary spectrum (East Pacific Rise) that these discontinuities form abruptly, migrate rapidly along strike at variable velocities and directions, and are short-lived (less than a few million years) (Macdonald et al., 1988; Carbotte and Macdonald, 1992). Along-strike propagation speeds of up to 4000 mm/yr have been documented on the East Pacific Rise near lat 18°S (Cormier and Macdonald, 1991). Although less well constrained at the slow end of the accretionary spectrum (<40 mm/yr), second-order discontinuities appear to be longer lived (millions of years), propagate less rapidly, and exhibit a range of behavior in terms of spatial positioning (e.g., Sempere et al., 1990; Fox et al., 1991). They can remain fixed or they can migrate along strike, creating V-shaped patterns characterized by obliquely oriented ridges and basins. At all spreading rates, it is possible for one type of ridge-axis discontinuity to evolve into another by sustained asymmetric spreading of adjoining ridge segments (Perram and Macdonald, 1990; Grindlay et al., 1991). Characteristically, the terrain in close proximity to the discordant zones is highly magnetized, probably reflecting the eruption of highly fractionated basalts (e.g., Carbotte and Macdonald, 1992).

The different types of boundaries outlined above partition the mid-ocean ridge into segments of variable lengths (tens to hundreds of kilometres). Independent of length, most ridge segments have arched along-strike topographic profiles—i.e., a depth minimum is located approximately midway along the ridge segment, and depths increase toward the ends of the segment (Fig. 3B). Each ridge segment is characterized by its own distinctive along-strike profile in terms of relief and gradient from central high to segment ends, and depth of the central high. The extent to which axial depths increase from central high to segment ends ranges from tens to thousands of metres; the largest changes in relief are associated with ridge segments along more slowly accreting ridges (e.g., Mid-Atlantic Ridge). At fast-spreading ridges, which usually exhibit axial highs, the axial high increases steadily in cross-section area with increasing proximity to the elevated mid-sections of individual segments (Macdonald and Fox, 1988; Scheirer and Macdonald, 1993).

The scale of ridge segmentation discussed above is relatively easy to recognize because the ridge axis is clearly offset along strike. Recent high-resolution imaging and sampling of the ridge axis in some areas has defined morphologic, bathymetric, and geochemical changes along strike that suggest a finer, fourth-order scale of segmentation that is superimposed on the tens to hundreds of kilometres-long segmentation discussed above (Fig. 2) (e.g., Langmuir et al., 1986). The along-strike arch-shaped architecture is retained at this small scale, but the wavelength is on the order of kilometres, and the relief is low. Individual fault traces and volcanic structures along the axis commonly reflect these deviations in axial linearity by exhibiting right- or left-stepping (<1 km) en echelon patterns.

A host of geologic observations, including the regular undulation of the crest of the ridge, which correlates with its cross-section area (Scheirer and Macdonald, 1993), seismic evidence for an axial melt reservoir (e.g., Detrick et al., 1987; Vera et al., 1990; Harding et al., 1993; Toomey et al., 1990), geochemical anomalies, and the locations of discontinuities has led to the development of a magma supply model for ridge segmentation. In the magma supply model, the generation, transport, and distribution of melt from the upper mantle is enhanced beneath the shallow, swollen region of each segment and is depleted at the ends of each segment near overlapping spreading centers and other discontinuities (see Macdonald et al., [1991], Langmuir et al. [1986], Sinton and Detrick [1992], and Solomon and Toomey [1992] for reviews). As the plates spread apart, partial melting of mantle rocks occurs due to adiabatic decompression at depths of 30 to 60 km. The buoyant melt segregates from residual solid mantle and ascends to fill shallow magma chambers within the crust along the ridge axis. These melts locally swell the crustal magma reservoirs, and buoyant forces associated with the melt and a surrounding halo of hot, melt-impregnated low-density rock create a local shoaling of the ridge crest. Continuous injection of melt leads to local eruptions, migration of magma away from the locus of upwelling, and expansion of the axial magma chamber along strike. The laterally migrating magma loses hydraulic head with increasing distance from the center of magma replenishment; as a result, the depth of the ridge axis steadily increases along strike. As magma migrates

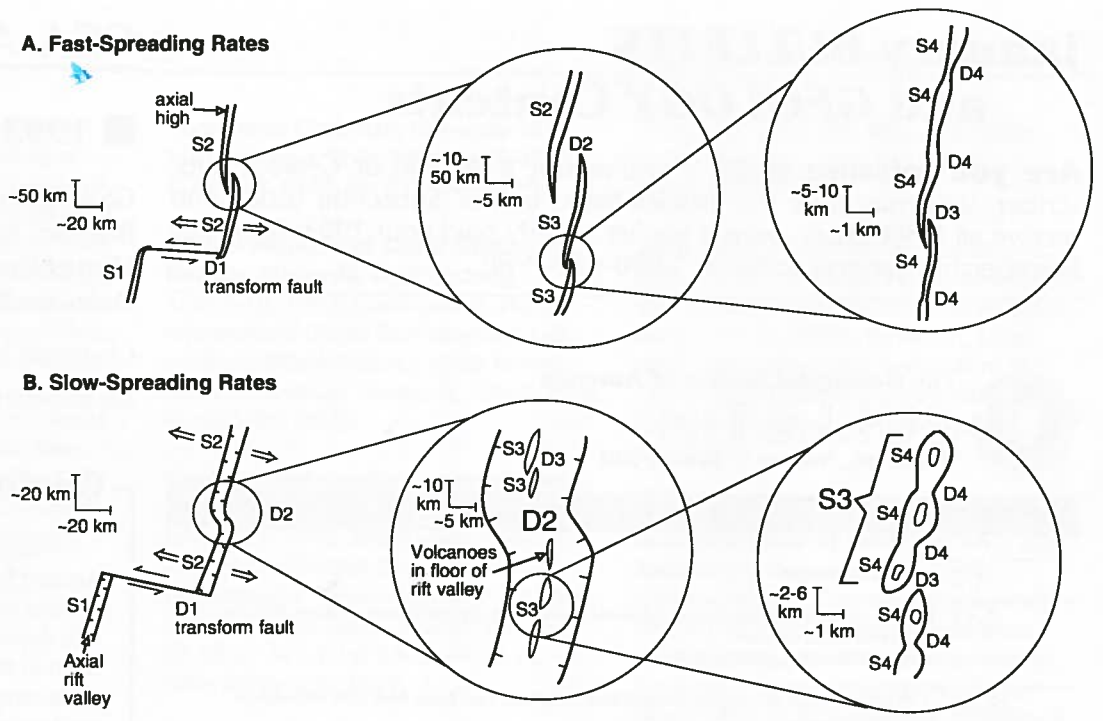


Figure 2. A proposed hierarchy of ridge-axis discontinuities of orders 1 through 4 for slow (bottom) and fast (top) spreading centers (after Macdonald et al., 1991). S1, 2, 3, 4 are ridge segments of order 1, 2, 3, 4, and D1, 2, 3, 4 are ridge-axis discontinuities of order 1, 2, 3, 4. Thus, a segment is first-order if it is bounded at both ends by first-order discontinuities, and second-, third-, or fourth-order if it is bounded at one (or both) end(s) by second-, third-, or fourth-order discontinuities. At both fast- and slow-spreading centers, first-order discontinuities are transform faults. Examples of second-order discontinuities are overlapping spreading centers on fast-spreading ridges and oblique shear zones on slow-spreading ridges. Third-order discontinuities are small overlapping spreading centers on fast-spreading ridges and intervolcano gaps on slow-spreading ridges. Fourth-order discontinuities are deviations from axial linearity (devals) resulting in slight bends or lateral offsets of the axis of less than 1 km on fast-spreading ridges and are intravolcano gaps on slow-spreading ridges. This four-tiered hierarchy of segmentation may really be a continuum. It has been established, for example, that fourth-order segments and discontinuities can grow to become third-, second-, and even first-order discontinuities and vice versa at both slow- and fast-spreading centers. Intermediate-rate spreading centers (40–90 mm/yr) tend to have the characteristics of slow-spreading segments and discontinuities when they are magmatically starved, and those of fast-spreading centers when magmatically robust. Even a fast-spreading center can have slow-spreading characteristics temporarily during periods of magma drought .

TABLE 1. CHARACTERISTICS OF RIDGE SEGMENTATION

	Order 1	Order 2	Order 3	Order 4
Segments				
Length (km)*	600 ±300 (400 ±200)	140 ±90 (50 ±30)	50 ±30 (15 ±10?)	14 ±8 (7 ±5?)
Longevity (yr)	>5 x 10^6	0.5–5 x 10^6 (0.5–10 x 10^6)	~10^4 – 10^5 (?)	~10^2 – 10^4 (?)
Discontinuities				
Offset (km)	>30	2–30	0.5–2.0	<1
Age (yr)†	>0.5 x 10^6 (>2 x 10^6)	<0.5 x 10^6 (<2 x 10^6)	~0	~0
Off-axis trace	Fracture zone	V-shaped discordant zone	None	None

Note: After Macdonald et al. (1991). Information for fast-spreading (>60 mm/yr) ridges, if it differs from that for slow-spreading ridges, is in parentheses.

*Errors are ±1σ.

†Of seafloor that is juxtaposed to the spreading axis at a discontinuity.

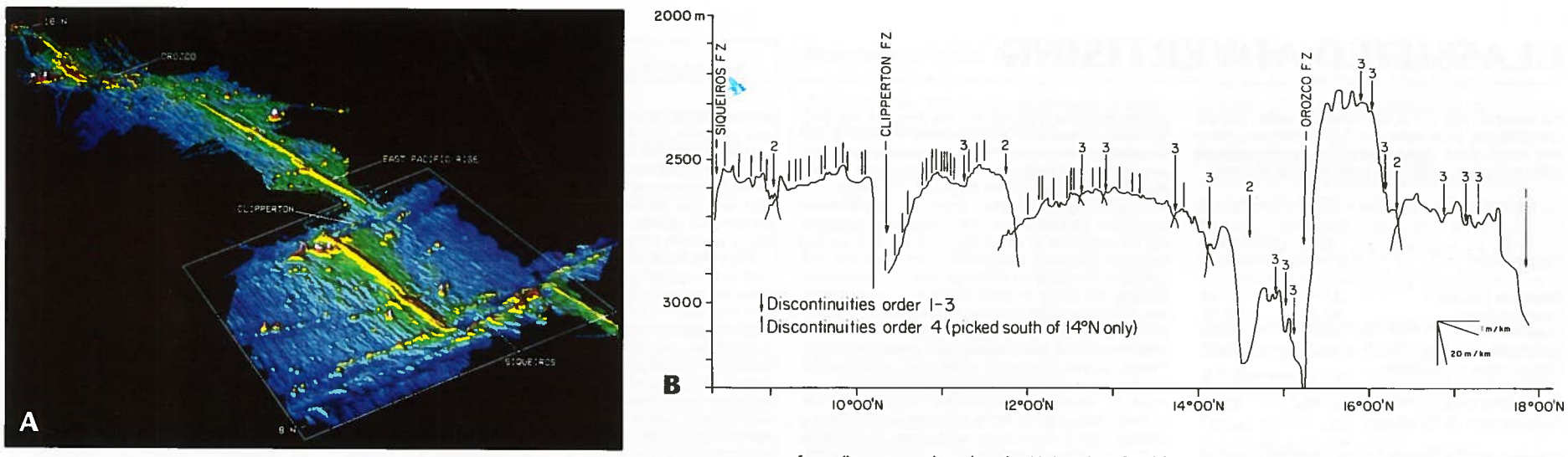
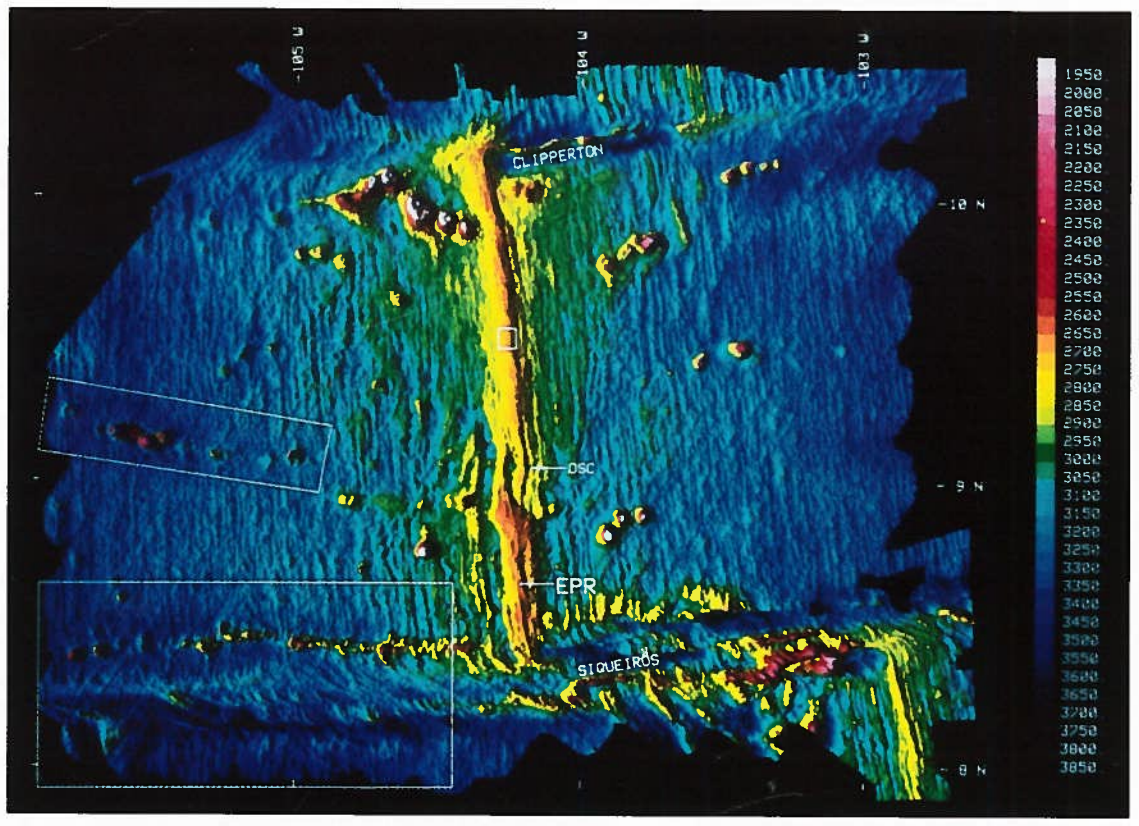


Figure 3. The fast-spreading East Pacific Rise at 8°–18°N. A: Shaded relief image; the view is toward the northeast. The white boxes show the locations of images in Figure 4 (foreground) and Figure 7 (see Fig. 4 for color depth scale). The image is of an area 1100 km long and about 350 km wide. The East Pacific Rise is the elevated north-south–trending region in the red-yellow depth range. The Siqueiros transform (foreground) is followed by the 9°N overlapping spreading centers, the Clipperton transform, the 11°45'N overlapping spreading center, and the Orozco transform (image produced at the University of California, Santa Barbara [UCSB] by S. P. Miller; based on data from Macdonald et al. [1993]). B: Axial depth profile of the East Pacific Rise at 8°–18°N taken from Macdonald et al. (1993). The numbers correspond to ridge axis discontinuities of orders 1 through 3. Fourth-order discontinuities (unlabeled vertical lines) are identified only south of 14°N, so the lack of fourth-order discontinuities north of 14°N indicates only that they have not been identified yet. In contrast to discontinuities of orders 1–3, fourth-order discontinuities have little or no axial depth anomaly.

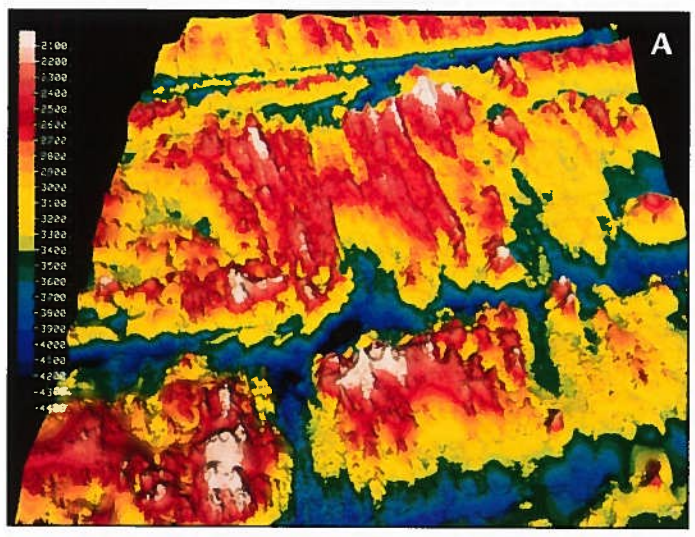
Figure 4. Sea Beam and SeaMARC II bathymetry merged in the Office of Naval Research East Pacific Rise Natural Laboratory (image produced at UCSB by S. P. Miller; based on data from Macdonald et al. [1993]). Subtle northeast-southwest grain is an artifact of SeaMARC II bathymetry parallel to the ship track. EPR is East Pacific Rise; OSC is 9°N overlapping spreading centers. Boxes show locations of side-scan sonar images of Figures 6A, 6B and 6C. There are no clear vestiges of the 300–400-m-high axial region of the East Pacific Rise on the rise flanks; as it cools, the shallow elevation disappears. Lineated north-south relief on the flank is produced by normal faulting (dip toward and away from the axis) and minor volcanism. On the ridge flanks adjacent to the 9°N overlapping spreading center, a V-shaped discordant zone indicates southward migration of the discontinuity at 52 mm/yr within the past ~1.0 m.y. The west-flank discordant zone comprises abandoned curvilinear ridge tips that reflect episodic clipping of the western ridge tip at the overlapping spreading center. The east-flank discordant zone consists of greater depths. Southward migration of the discontinuity has not been steady but has involved a series of episodic and dueling propagation events with rates ranging from <10 mm/yr to >500 mm/yr.

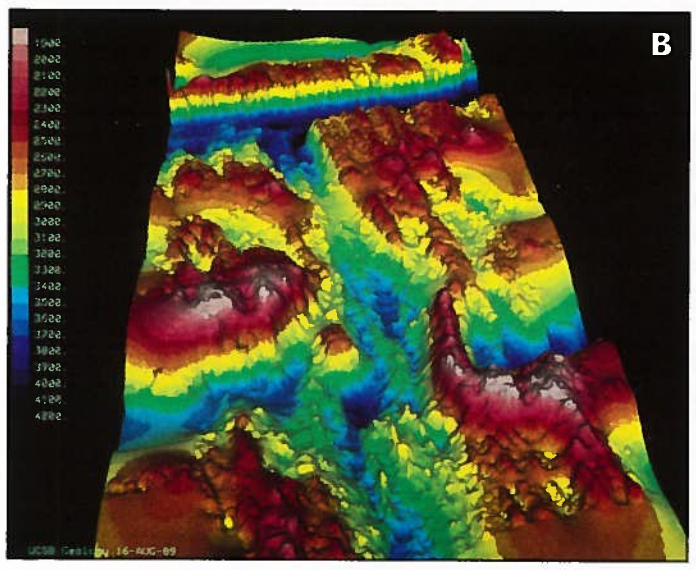


at depth along the ridge, continued extension fractures the overlying brittle carapace of frozen lava. Magmas then use these fractures as conduits to the seafloor, and volcanic eruptions follow the advancing crack front. The process outlined above occurs repeatedly as plate separation continues. In this magmatic model for a spreading center, ridge-axis discontinuities occur at the distal ends of magmatic pulses and define the ends of ridge segments (Figs. 3, 5A).

At slow-spreading ridges, seismic studies have not revealed a magma reservoir (Detrick et al., 1990). However, a similar pattern of segmented upwelling may still occur there, and very small pockets of melt or highly episodic magma chambers may be present (Smith and Cann, 1990). Large, bulls-eye–shaped gravity anomalies occur over ridge segments defined by second-order discontinuities on the Mid-Atlantic Ridge (Lin et al., 1990; Kuo and Forsyth, 1988; Blackman and Forsyth, 1991). Corrected to remove the gravitational effects of topography, these anomalies indicate that low-density upper mantle or thickened oceanic crust is present beneath the midsections of segments. Kuo and Forsyth (1988) proposed that these anomalies are best explained by a three-dimensional pattern of upwelling hot mantle material. The pattern of mantle upwelling may become less three-dimensional (Lin and Phipps Morgan, 1992), and magma migration within axial magma reservoirs may be more efficient at higher spreading rates (J. R. Cochran et al., unpublished).

Editor's Note: This is the first part of a two-part article. ■





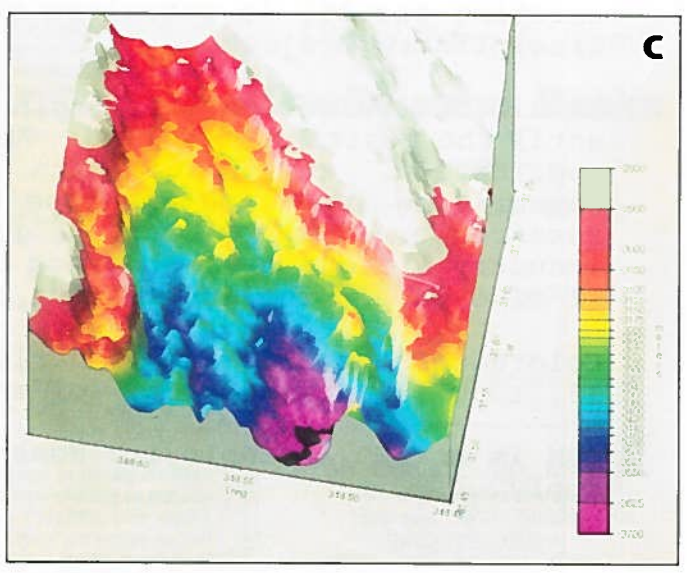


Figure 5. A: A shaded relief image of slow-spreading southern Mid-Atlantic Ridge (31°–34°S) looking northeast. The Meteor transform is in the foreground, then the 33°30'S second-order discontinuity; the Cox transform is in the background. An axial rift valley marks the spreading axis; it shoals to 200 m deep along 20% of the length of the segment shown but does not disappear. (Produced at UCSB by Charles Weiland, using data from Fox et al. [1991].) B: A shaded relief image with the Cox transform in the background and the 31°20'S second-order discontinuity in the foreground (a 12 km right-lateral jog of the axial rift valley). The view is toward the south. (Produced at UCSB by Suzanne Carbotte, using data from Grindlay et al. [1991].) C: Blow-up map of the neovolcanic zone within the axial rift valley from B (10 m contour interval). Note the many small conical volcanoes similar to those observed in the North Atlantic (Smith and Cann, 1990). (Produced at UCSB by Charles Weiland, using data from Fox et al. [1991].)

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Positions Open

ENVIRONMENTAL GEOLOGIST
University of Nebraska-Lincoln

A tenure-track Assistant Professor appointment in Environmental Geology is available beginning August 1993. A Ph.D. in Geology or related field and a commitment to research and teaching are required. We seek a candidate with interests in Tertiary and Quaternary paleoenvironmental reconstructions. The successful candidate should enhance current departmental strengths in climate history of continental interiors and high latitudes, and/or environmental aspects of hydrogeology. The successful candidate will be expected to establish an externally funded research program and teach undergraduate and graduate students in Geology and Environmental Studies. An ability to teach courses in geomorphology, and experience in modern depositional systems, glacial geology, environmental geochemistry, or other aspects of global change will be an advantage. Please submit a letter of application, statement of teaching and research interests and experience, curriculum vitae, publications list, and the names/addresses of three referees to: Dr. Nancy Lindsley-Griffin, Department of Geology, 214 Bessey Hall, University of Nebraska, Lincoln, NE 68588-0340. The closing date for applications is March 1, 1993. The University of Nebraska-Lincoln is committed to a pluralistic campus community through Affirmative Action and Equal Opportunity and is responsive to the needs of dual career couples. We assure reasonable accommodations under the Americans with Disabilities Act, contact Christy Horn at (402) 472-3417.

POST-DOCTORAL AND RESEARCH POSITIONS
Basin Analysis Group
Department of Geosciences
Penn State University

Post-Doctoral Scientist in Paleoceanographic Modelling. This individual will collaborate with paleoclimatologists, sedimentologists, and geochemists in an ongoing NSF-funded program studying the origins of anoxia in ancient epeiric seas. The ideal candidate would have experience using 3-D turbulent coastal ocean numerical models and an understanding of chemical oceanography. Responsibilities include implementing a numerical model of tracer geochemistry, nutrients, and oxygen into a circulation model and applying the resulting coupled model to an ancient epeiric sea using a Cray™ YMP at the Penn State Earth System Science Center. Opportunity also exists for independent research initiatives (in association with Drs. Michael Arthur, Lee Kump, and Rudy Slingerland). Salary: $27,000 to $32,000 US; Duration: 1 year with possibility for 1 year renewal.

Post-Doctoral Scientist in Hydro-Stratigraphy. This individual will participate in an interdisciplinary team focused on integrating the study of stratigraphy and fluid flow in Neogene Gulf Coast strata. The ideal candidate would have experience in sequence stratigraphy, seismic stratigraphy, wireline logging, fluid-flow through porous media, and use of Unix™-based workstations. However, applicants with demonstrated excellence in independent research in any of these fields will be considered. Above all, enthusiasm for research linking fluid flow and sedimentation is a prerequisite. Responsibilities will include: 2- and 3-D seismic and wireline analysis on a Landmark™ workstation, the interpretation of pressure and temperature data from wireline logs, and the interpretation of fluid-flow based on these data. Opportunity also exists for independent research initiatives. (In association with Dr. Peter Flemings). Salary: $27,000 to $32,000 US; Duration: 1 year with 1 year renewal.

Scientific Analyst/Database Manager. The successful individual will participate in an interdisciplinary team focused on integrating the study of stratigraphy with fluid-flow in Neogene Gulf Coast strata. Responsibilities include operating logging, seismic analysis, and mapping software and developing and managing large datasets. Applicants must have a BS/MS in a physical science or computer science and several years experience in a Unix environment. Salary: $25,000 to $35,000 US; Duration 1 year with 1 year renewal.

Applications should include a curriculum vitae, statement of interest, and the names of three potential references sent directly to: Prof. M. Arthur, Head, Department of Geosciences, 503 Deike Bldg., Penn State University, University Park, PA 16802. Further particulars may be obtained from: fleming@geosc.psu.edu or sling@geosc.psu.edu. Candidate selections will begin January 1st, 1993. The Pennsylvania State University is an equal opportunity employer.

SOLID EARTH GEOPHYSICIST
University of Colorado

The Department of Geological Sciences and the Cooperative Institute for research in Environmental Sciences (CIRES) are recruiting for a tenure-track faculty position in solid earth geophysics. Candidates from all fields of solid earth geophysics will be considered. Preference will be given to applicants whose research closely complements ongoing work at CU-Boulder, particularly that related to observational seismology and the physics of earthquake processes. The appointment entails full participation in the Department of Geological Sciences' undergraduate and graduate teaching program (including offerings in the appointee's specialty), supervision of graduate students, and the direction of an active research program. Preference will be given to candidates at the Assistant Professor level, but exceptional candidates at all levels will be considered.

Applicants should submit a current curriculum vitae, a transcript, a summary of current and proposed research, and arrange to have at least three letters of recommendation sent to the CIRES Geophysicist Search Committee, Campus Box 216, University of Colorado, Boulder, CO 80309-0216. The deadline for applications is February 26, 1993. It is the applicant's responsibility to see that the letters of reference arrive before the deadline.

The University of Colorado at Boulder has a strong institutional commitment to the principle of diversity. In that spirit, we are particularly interested in receiving applications from a broad spectrum of people, including women, members of ethnic minorities, and disabled individuals.

THE CHARLES BOETTCHER DISTINGUISHED CHAIR IN PETROLEUM GEOLOGY

The Department of Geology and Geological Engineering at the Colorado School of Mines invites applications for the Charles Boettcher Distinguished Chair in Petroleum Geology. This recently established endowed chair will be filled by a nationally or internationally recognized petroleum geologist who will establish and maintain a vigorous long term balanced program of teaching, research and technology development in the integrated discipline of petroleum geology. The chair holder will teach undergraduate and graduate courses, supervise graduate student research, develop an externally funded research program, establish and maintain industry liaison, and act as an ambassador for CSM's petroleum-related programs.

Applicants must have been active, and demonstrated leadership, in one or more phases of exploration, evaluation, development, research and management in the petroleum industry in domestic and/or international settings. The person should have knowledge of the political, social and economic ramifications that must be considered in making investment decisions. Applicants must have a PhD degree and credentials that would qualify them for tenure.

The successful candidate will have demonstrated an enthusiasm for teaching; a record of scholarly excellence, creativity and leadership as demonstrated by research accomplishments, publications and patents; ability to integrate methods and tools of multiple disciplines in the solution of significant technical problems; and, intellectual vision and capacity to recognize future trends and needs of the petroleum industry. Preference may be given to applicants with perceived strength in one or more of the following: structural geology/tectonics/basin analysis, reservoir geology, stratigraphy/sedimentology, and paleontology as applied to petroleum exploration and production. Preference will be given to applicants who complement and add diversity of expertise to existing faculty in petroleum geology and who work well in cross disciplinary projects.

Candidates selection will begin February 28th, 1993, and continue until the position is filled. Applicants should submit a letter of application, curriculum vita and a clear mission statement summarizing immediate and long term career goals in teaching and research and their vision of resource acquisition and petroleum industry liaison to the address below. Include names and addresses of five people who are willing to serve as references.

Colorado School of Mines, Charles Boettcher Chair, Search #92-11-13, 1500 illinois Street, Golden, CO 80401.

CSM is an EEO/AA Employer. Women and minorities are encouraged to apply.

HYDROGEOLOGIST, SEDIMENTARY GEOLOGIST, PALEONTOLOGIST
California State University, Sacramento

The Geology Department seeks applications from hydrogeologists, sedimentologists/sedimentary petrologists, and paleontologists for two possible faculty positions at the assistant or associate professor level. The hydrogeology position requires a degree in, or a significant number of university courses in hydrogeology. Preference will be given to candidates who also possess expertise in one or more of the following fields: sedimentary petrology, paleontology, oceanography, stratigraphy, environmental geology, geoscience education, engineering geology. The other position is for a sedimentologist/sedimentary petrologist, or paleontologist. Preference will be given to candidates who also possess expertise in one or more of the following disciplines: hydrogeology, stratigraphy, oceanography, environmental geology, geoscience education, engineering geology. Doctoral degrees completed by August 23, 1993 are required for tenure-track appointment for both positions. Applicants in final stages of dissertation may be considered for lecturer positions with possibility of conversion to tenure track upon completion of degree. Appointment is contingent upon availability of funds. CSUS is committed to a quality undergraduate education and is looking for applicants that wish to involve undergraduates in their professional studies. A significant portion of the work load for both positions will be teaching general education courses. CSUS has a strong, field-oriented, undergraduate geology major in which the candidates are also expected to participate. The campus has an array of water wells that the hydrogeologist is expected to use in developing a ground water instruction program; interaction with an expanding community of ground water professionals in the Sacramento area is also expected. Review of applications will begin on February 15, 1993; open until filled. Submit application letter, curretn resume, and names of three referees to: Dr. Diane H. Carlson, Chair of Search Committee, Geology Department, California State University, Sacramento, CA 95819-6043. AA/EEO.

MINERALOGY / PETROLOGY
University of Wisconsin-Parkside

The Geology Department at the University of Wisconsin-Parkside has a tenure-track faculty vacancy to be filled at the assistant or associate professor level with duties to begin about September 1, 1993. The successful applicant will be expected to teach mineralogy and petrology and share the teaching load in introductory geology courses for both majors and general education students in an increasingly diverse student body. The person we are looking for also should have advanced training and teaching interests in one or more of the following areas: environmental geology, hydrogeology, or structural geology. A productive research program, involving undergraduate students, in the candidate's specialty area is required. We seek applicants with a Ph.D. in geology (or its equivalent from a foreign institution) in-hand; however, applications will be accepted from those who will finish their degree no later than one year following acceptance of the position. The University of Wisconsin-Parkside is an affirmative action/equal opportunity employer and actively seeks applications from all qualified persons. Under a court approved settlement agreement and Wisconsin Statutes, we are required to provide a list of all nominees and applicants who have not requested in writing that their identity not be revealed. Persons agreeing to be final candidates will have their identity revealed as a final candidate. If you are interested in this position, send resume, transcripts, and three letters of recommendation as soon as possible to: Professor Gerald A. Fowler, Geology Department, University of Wisconsin-Parkside, 900 Wood Road, P.O. Box 2000, Kenosha, Wisconsin 53141-2000. To be considered, applications must be received on or before February 1, 1993. Initial screening of applicants will begin on January 15, 1993.

USGS SUPERVISORY GEOLOGIST / GEOCHEMIST GM-15

The U.S. Geological Survey's Geological Division, Office of Energy and Marine Geology, Branch of Coal Geology, Office of the Chief in Reston, Virginia, seeks candidates for the full-time position of Assistant Branch Chief for the Western Section of the Branch in Lakewood, Colorado. Candidates should have a strong background in current field and laboratory research for a broad area of the geosciences, with special emphasis on coal, other energy related fields, i.e., oil and gas; coal; uranium; etc.; or minerals. The position offered is for a full-time, permanent employee in the civil service who will serve the first four years as Assistant Branch Chief at the GM-15 level with a starting salary range of $68,829 to $86,589. At the end of the four year position the incumbent will be assigned to an equivalent position in either research, operations, or management.

The Assistant Branch Chief for the Western Section, Branch of Coal Geology, collaborates with the Branch Chief in planning, execution, and review of the scientific and technical programs of the Western Section of the Branch, including the formulation and implementation of new projects and the review and modification of ongoing projects. Participants with Branch Chief in preparing budget request documentation and allocation of funds to projects. Shares with the Branch Chief the entire range of personnel management including selection, hiring, performance evaluation, allocation of personnel to projects and program elements, and handling of personnel problems. Works also as an independent scientist and as an advisor in formulating and conducting research efforts in assessment of coal resources and in support of basic research and technical methods.

Applicants should submit an application for Federal Employment (SF-171, available in any Federal Personnel Office), a detailed resume, including education, experience, and bibliography may be submitted initially; however, candidates will be required to file the SF-171 form to receive full consideration, and a narrative addressing the following essential knowledge, skills, and abilities: (1) Knowledge of current laboratory and/or field, coal quality, coal resources, and /or other fossil-fuel, or minerals assessment research in the U.S.; (2) Ability to establish goals and priorities for scientific research programs in coal geology; (3) Ability to develop and execute a scientific program budget; (4) Ability to supervise personnel; (5) Ability to manage facilities, space, and equipment; (6) Skill in written and oral communication. In addition, interested applicants should submit a letter highlighting the applicant's past accomplishments, current pursuits, anticipated research direction, and a list of three or more persons from whom we may solicit references. Applicants must be U.S. citizens.

Applications must reference recruitment bulletin or vacancy announcement H-92-241 and be received at the following address by January 29, 1993.

Mail Stop 215, U.S. Geological Survey, Personnel Office, 12201 Sunrise Valley Drive, Reston, Virginia 22092.

THE U.S. GEOLOGICAL SURVEY IS AN EQUAL OPPORTUNITY EMPLOYER.

FACULTY POSITION
North Carolina State University

The Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University invites applications for a tenure-track teaching/research position in the area of geomorphology and/or surficial processes at the assistant or associate professor level beginning August 1993. Applicants should be able to conduct quantitative, fundable research that relates to the broader topics of environmental geology and global change. We encourage applications from those with teaching and research interests that incorporate geophysics, hydrogeology, geochemistry, remote sensing, or tectonics. The Dept. of MEAS includes 35 faculty members in three disciplines, and offers opportunities to interact with specialists in sedimentary processes, petrology, stable and radioactive isotopes, geodesy, tectonics, and marine and atmospheric sciences. Teaching responsibilities at both undergraduate and graduate levels.

Send vita, teaching and research plans, and the names of 3 references before January 31 to: Dr. R. V. Fodor, Dept. of MEAS, Box 8208, North Carolina State University, Raleigh, NC 27695. NCSU is an equal opportunity/affirmative action employer. We particularly encourage female and minority-group scientists to apply.

ENVIRONMENTAL GEOLOGIST/HYDROLOGIST
University of the South

Applications are invited for a three-year entry level appointment, potentially convertible to tenure-track, beginning in August 1993. Applicants should be able to teach a field-oriented hydrology course, a physical geology course, and at least two of the following: soils, meteorology, GIS, physical geography, and introductory environmental science. Other courses may be considered, depending on the applicant's skills and interests. We seek a broadly educated scientist committed to teaching within an undergraduate liberal arts program. Applicants should have a doctorate or be in the final stages of degree completion.

The University of the South has a distinguished liberal arts program in which excellence in teaching is emphasized and research with students is encouraged. The Department of Forestry and Geology offers degrees in both Natural Resources and Geology.

Review of applications will begin February 1, 1993. Applicants should send a curriculum vitae, undergraduate and graduate transcripts, three letters of recommendation, and a statement of teaching interests and experience to: Donald B. Potter, Department of Forestry and Geology, The University of the South, Sewanee, Tennessee 37375; (615) 598-1479. EOE.

Services & Supplies

FOR SALE. 19 vols. AAPG Memoirs (1962–1986), $150.00; 11 vols. AAPG Spec. Publ. (1929–1962), $50.00; 26 vols. GSA Treatise on Invertebrate Paleontology (C through W), $80.00; 1700 Reprints on Conodonts (filed and sorted), $850.00. Buyer pays shipping. Lists available. Samuel P. Ellison, Jr., 5948 Highland Hills Dr., Austin, Texas 78731-4059, Tel. 512-453-2480.

Opportunities for Students

Tolman Geoscience Fellowships. The Department of Earth and Planetary Sciences, Washington University, St. Louis, announces competitive graduate fellowships in honor of Carl F. Tolman, geologist and former Chancellor of the University. The Tolman Fellowships provide 2 years of support for students pursuing a Ph.D. degree in geology, geochemistry, or geophysics. Stipends for the 1993-1994 academic year are $12,000 for 9 months, and include a waiver of Graduate School tuition. The Tolman Fellowships complement our existing fellowships and assistantships, which include McDonnell Center for the Space Sciences Fellowships for students in the planetary sciences, as well as teaching and research assistantships.

For application forms or more information, contact: Prof. Douglas Wiens, Department of Earth and Planetary Sciences, Washington University, Campus Box 1169, 1 Brookings Drive, St. Louis, MO 63130, phone (314) 935-5610.

Summer Research Program for Undergraduates at Columbia University's Lamont-Doherty Geological Observatory. Eight students will be selected to participate in 10-week long research program using Ocean Drilling Program (ODP) cores, well-logs and seismic profiles. Current sophomore and junior science majors who are citizens or permanent residents of the U.S. are eligible. Students will receive $2,200 stipend and housing. Some money is available to defray cost of travel between home institution and Lamont. Program is sponsored by JOI-US Science Support Program associated with ODP. Application deadline is March 1, 1993. For further information contact: Dr. Suzanne O'Connell, Program Coordinator, Dept. of Earth and Environmental Sciences, Wesleyan University, Middletown, CT 06457, Tel. (203) 347-9411 ext. 2044, Fax (203) 343-3903.

Complex Systems at the Earth's Surface. Opportunities exist of graduate research into the fundamental nature of landforms and of the processes which create them at the Scripps Institution of Oceanography, University of California, San Diego.

A combination of computer simulation, theory and field observations are used to address general questions regarding self-organization, pattern formation and nonlinear dynamics, as well as specific mechanical processes operating on coastal and arid landforms. Current applications include beach cusps, ripples, dunes, alluvial fans, patterned ground, landslides and sediment transport. Facilities include Silicon Graphics workstations, the Mojave Desert, and a research beach. Quantitative background in physics or related field is preferred.

For more information regarding this program and application to Scripps/UCSD, please send a resume, undergraduate transcripts, names, addresses, and phone numbers of 3 references and a statement of interest to Prof. Brad Werner, Complex Systems Laboratory, Center for Coastal Studies 0209, Scripps Institution of Oceanography, La Jolla, California 92093-0209. (619) 534-0583. UCSD is an EO/AA employer.

Wright State University — Geophysics Fellowships. The Department of Geological Sciences at Wright State University offers applied geophysics fellowships in the Master of Science program. The Department is well equipped for a wide range of geophysical research. Fellowships begin fall 1993. Tuition will be waived for successful applicants and additional summer research assistance is available. The fellowships and other geophysical research are funded by British Petroleum, Amoco, Arco, Conoco, Marathon, Mobil, and Unocal. Completed applications should be submitted to Wright State University, Department of Geological Sciences, Dayton, Ohio 45435, by March 1, 1993. Contact Dr. Ben Richard or Dr. Paul Wolfe at (513) 873-3455 for additional information.

1993 Ocean Drilling Summer Research Program for Undergraduates at the University of Hawaii. The Shcool of Ocean and Earth Science and Technology (SOEST) at the University of Hawaii is accepting applications for its 1993 Ocean Drilling Summer Research Program. SOEST will host this eight week program at the University of Hawaii's Manoa campus in Honolulu from June 6 to July 31. Student participants will engage in faculty-directed research, lectures and field trips relating to the science of the Ocean Drilling Program. Successful applicants will receive: (1) travel expenses to and from Hawaii, (2) room and board for the duration of the program, (3) travel funds to visit the active Kilauea volcano, and (4) a student stipend of $2,000. Citizens or permanent residents of the U.S. and its territories are eligible. A minimum GPA of 3.0 is required. The application deadline is March 1, 1993.

For applications contact: Dr. Craig R. Glenn, ODSRPU Coordinator, University of Hawaii, Department of Geology & Geophysics, Honolulu, HI 96822, Tel. 808-956-2200.

Meetings *continued from p. 22*

Accelerator Mass Spectrometry 6th International Conference, September 27–October 1, 1993, Canberra and Sydney, Australia. Information: AMS-6, ACTS, GPO Box 2200, Canberra ACT 2601, Australia, phone 61-6-249 8105, fax 61-6-257 3256.

October

Basin Inversion International Conference, October 4–9, 1993, Oxford, England. Information: Peter Buchanan, CogniSeis Development, Stanley House, Kelvin Way, Crawley, West Sussex, RH10 2SX, UK. (*Abstract deadline: April 1993*).

Society for Organic Petrology 10th Annual Meeting, October 9–13, 1993, Norman, Oklahoma. Information: Brian Cardott, Oklahoma Geological Survey, 100 E. Boyd St., Rm. N-131, Norman, OK 73019-0628, (405) 325-3031, fax 405-325-7069.

■ **IAMG '93 (International Association for Mathematical Geology),** October 10–15, 1993, Prague, Czechoslovakia. Local Chairman: Vaclav Nemec, K. Rybinickum 17, Praha 1–Strasnice, Czechoslovakia; Technical Program Committee cochairmen—North and South America: John C. Davis, Kansas Geological Survey, University of Kansas, Lawrence, KS 66047, (913) 864-3965, fax 913-864-5317, E-mail: john_davis.-moore_hall@msmail.kgs.ukans.edu; Europe, Africa, and Asia: Jan Harff, Institute for Baltic Sea Research, Seestr. 15, 0-2530 Warnemuende, Germany, phone 49 381 58.261, fax 49 381 58.336, E-mail: harff@geologie.io-warnemuende.dbp.de.

■ **Federation of Analytical Chemistry and Spectroscopy Societies (FACSS) 20th Annual Meeting,** October 17–22, 1993, Detroit, Michigan. Information: FACSS, P.O. Box 278, Manhattan, KS 66502, (301) 846-4797. *(Abstract deadline: February 1, 1993.)*

■ **New Developments in Geothermal Measurements in Boreholes,** sponsored by GeoForschungsZentrum Potsdam, Geothermal Association of Germany, IUGG International Heat Flow Commission, Internationl Association for Mathematical Geology, and the Kansas Geological Survey at The University of Kansas, October 18–23, 1993, Klein Köris, Germany. Information: E. Hurtig, GFZ Potsdam, Talegrafenberg A45, 0-1561 Potsdam, Germany, phone 49.331.310.347, fax 49.331.310.610, E-mail: gth@gfz-potsdam.dbp.de.

■ **GSA Annual Meeting,** October 25–28, 1993, Boston, Massachusetts. Information: GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, fax 303-447-1133. *(Abstract deadline: July 7, 1993.)*

Asociación de Ingeniéros de Minas, Metalurgistas y Geólogos de México XX Convención, October 26–29, 1993, Acapulco, Guerrero, Mexico. Information: Fernel Arvizu Lara, AIMMGM, A.P. 4073, C.P. 06400 Mexico, D.F., Mexico.

November

International Circum-Pacific and Circum-Atlantic Terrane Conference VI, November 5–21, 1993, Guanajuato, Mexico. Information: Fernando Ortega-Gutiérrez, fax 52 (5) 548-0772; or David G. Howell, fax 415-353-3224.

■ **American Geophysical Union Fall Meeting,** December 6–10, 1993, San Francisco, California. Information: AGU–Meetings Department, 2000 Florida Avenue, N.W., Washington, DC 20009, (202) 462-6900, fax 202-328-0566, E-mail: dsolomon@kosmos.agu.org. *(Abstract deadline: September 9, 1993.)*

1994 Meetings

January

■ **Remote Sensing for Marine and Coastal Environments, 2nd Thematic Conference,** January 31–February 2, 1994, New Orleans, Louisiana. Information: Robert Rogers, ERIM, Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123.

April

■ **Transport and Reactive Processes in Aquifers—IAHR Symposium,** April 11–15, 1994, ETH-Zürich, Switzerland. Information: Th. Dracos or F. Stauffer, Institute of Hydromechanics and Water Resources Management (IHW), ETH-Hönggerberg, CH-8093 Zürich, Switzerland, phone (01)377 30 66 or (01)377 30 79, fax (01)371 22 83.

Send notices of meetings of general interest, in format above, to Editor, *GSA Today*, P.O. Box 9140, Boulder, CO 80301.

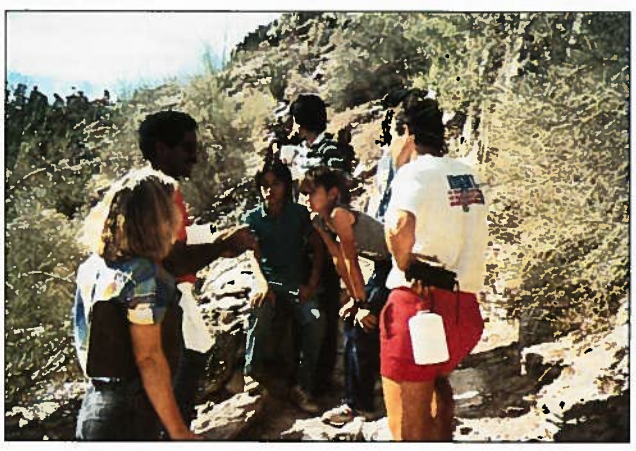
Minorities & Women *continued from p. 11*

cruitment efforts in the 1970s and the limited number of role models, the ad hoc status was a good mode from which to operate. Now, although more minority and women scientists are coming into the profession, the recruitment gap remains large. Continued and even greater commitment to affirmative-action principles is required. The Council and the committee are about to take greater steps.

Although Geoscience Day works well at the national level, we need to overcome our "silver bullet" modus operandi; i.e., we must develop a mechanism to ensure GSA's long-term involvement with the schools and students we have visited, and then expand this to other schools. Through Education Coordinator Ed Geary and the Partners program and with the Education Committee, we are establishing a network of volunteers to work with the schools in host cities of the annual meeting and regional and local GSA activities. This volunteer network will provide mentors to foster interest in the geosciences among students in local schools. Using the Boston and Seattle meetings as regional models, we hope to establish GSA geoscientists as event partners, local field-trip leaders, science fair liaisons, career-day speakers, and classroom visitors.

The Committee on Minorities and Women in the Geosciences is also developing an inward-focused program to inform and educate members of GSA and to pursue projects and programs for the benefit of ethnic minorities and women already in the profession. A workshop is planned for the 1993 Boston meeting to address issues of hiring, promotion, and career satisfaction for advanced students and professionals. The committee will also move from an information-only role to an advocacy role, not only facilitating the identification of promising minority and women students but also monitoring their recruitment and professional development within the disciplines.

GSA is a large and diverse professional organization, able to reach out directly to students, teachers, and professional earth scientists anywhere in the country, The numbers of minority and female professionals in GSA are growing, though perhaps discouragingly slowly. More role models are becoming available—role models who themselves had mentors and who have both the sensitivity and the experience needed in these outreach efforts. Geoscience Day participants view this effort as an opportunity to give something back to the system by serving as mentors and as an opportunity for professional and personal growth. We hope that geoscientists, within GSA or not, care enough about our profession to invest the time necessary to ensure its viability. We hope that they will recognize their responsibility to their fellow citizens not just to open the door to earth science, but to see that young people pass through that door and have their full and fair opportunity to contribute to the knowledge of the earth sciences, to advance professionally, and to be fulfilled. ■



Fostering interest and recruiting ethnic minorities and women into the geosciences has been the goal of the Geoscience Day program for nearly two decades. Students and group leaders participate in the 1991 Geoscience Day field trip during GSA San Diego Annual Meeting.

GSA Wants Photos

Gift Certificates given for photos we use.

GSA uses many color photos in its catalogs, meetings flyers, and other marketing materials. Our needs have outgrown our small resource library, so we are soliciting new photos.

Pictures should be of geologic subject matter, well composed, colorful, and unusual enough to grab the attention of other geologists—if it has scenic beauty, so much the better. Any topic, location, or subject matter is OK.

We prefer 35 mm slides; include prints of slides if you have them. Mark slides clearly for correct orientation. To each slide, attach a 15-word description and include your full name, address, and phone number. If you are not the photographer, include photographer's name and address, too.

All photos will be acknowledged and permission forms will be sent. Slides then will be placed in our data base for consideration whenever needs arise. We need to hold slides for a minimum of two years before returning them.

Each time one of your slides is used, you will receive a notice and a gift certificate good for $20 off the price of any GSA book, map, or transect. Send all slides to:

GSA Marketing (Slides)
Geological Society of America
P.O. Box 9140
Boulder, CO 80301-9140

The Geological Society of America

Research Grants Program 1993

The primary role of the Research Grants Program is to provide partial support for research by graduate students at universities in the United States, Canada, Mexico, and Central America. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program. Eligibility is not restricted to GSA members. New application forms are available each fall in the geology departments of colleges and universities offering graduate degrees in earth sciences. Forms are mailed annually to GSA Campus Representatives and department secretaries and chairpersons in the United States, Canada, and Mexico. They are also available upon request from the Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, Colorado 80301. *Please use only the 1993 application and appraisal forms.*

Confidential evaluations from two faculty members are required from candidates for the M.S. or Ph.D. degree and must accompany applications submitted. PLEASE USE THE "APPRAISAL OF APPLICANT" FORMS, WHICH ACCOMPANY THE 1993 APPLICATION FORMS. Application forms will not be accepted by facsimile.

The Geological Society of America awarded $315,769 in grants in 1992. The grants went to 248 students doing research for advanced degrees. The average amount awarded was $1273. The largest grant was $2500, but there is no predetermined maximum amount.

The Committee on Research Grants will meet in March to evaluate applications and award grants. In April, all applicants for grants will be informed of the committee's actions by the Executive Director of the Geological Society of America.

ALL APPLICATIONS MUST BE SUBMITTED ON THE 1993 FORMS AND POSTMARKED BY FEBRUARY 15, 1993

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