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## Landers-Mojave Earthquake Line: A New Fault System?

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### ABSTRACT

The M 7.4 Landers earthquake of June 28, 1992, like most twentieth century California earthquakes, did *not* fall on the San Andreas fault. Instead, it is the latest of six M  $\geq 5$  earthquakes in the past 50 years whose epicenters and slip directions appear to define a 120-km-long alignment running approximately N15°  $\pm$  5°W across the central Mojave region. This previously unrecognized line, which we call the **Landers-Mojave** earthquake line, may be a geologically young, thoroughgoing fault system that cuts obliquely across numerous older but still active strike-slip faults. According to a simple kinematic and mechanical model of block rotation and new fault formation, these older faults may be gradually losing their ability to accommodate upper crustal deformation because they have become stresswise unfavorably oriented. The model and the debate it generated

Fault surface associated with the 1992 Landers (California) earthquake rupture along the Emerson fault, south of Galway Road.



about crustal stress, rotations, and the formation of new faults touch on several unresolved issues in tectonics, seismotectonics, crustal deformation, earthquake prediction, and structural geology.

### INTRODUCTION

Like most twentieth century larger California earthquakes, the 1992 M 6.1 Joshua Tree and the M 7.4 Landers events did *not* fall on the San Andreas fault. This highlights a puzzling aspect

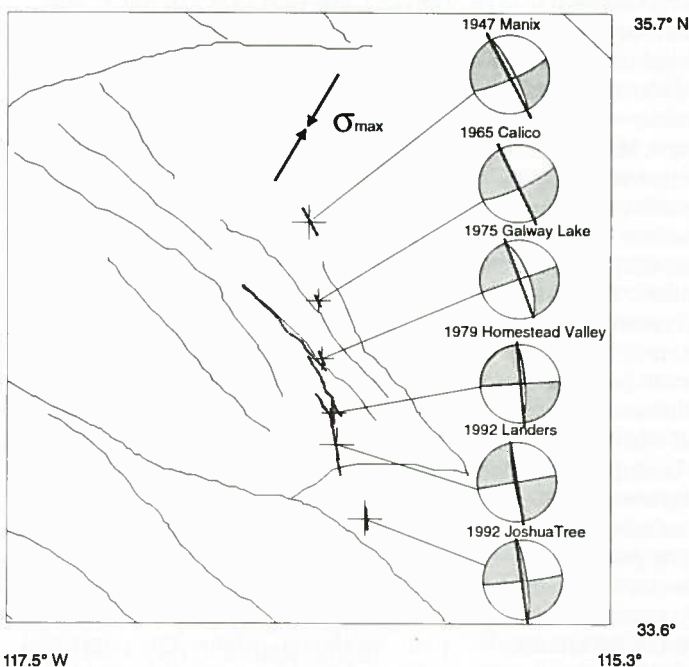
of California seismotectonics, especially because both events had pure strike-slip motion presumed to be typical for the San Andreas. In addition, the Landers earthquake surprised many for other reasons: (1) The southern part of the Landers and Joshua Tree earthquake ruptures define a line ~30 km long which has not before been recognized as a throughgoing and capable seismogenic fault (Ad Hoc Working Group Report, 1992). (2) The Landers 30° rupture kink (Fig. 1) is puzzling

because some earthquake models assume that seismic rupture stops at kinks, and does not propagate through them. (3) The southern Landers and Joshua Tree ruptures fell on a line that has had at least four previous earthquakes with similar rupture directions: the M 5.4 1975 Galway Lake, the M 5.3 1979 Homestead Valley, the M 5.2 1965 Calico, and the M 6.5 1947 Manix earthquakes (Fig. 1). We call this 120 km earthquake line the *Landers-Mojave* line.

### LANDERS-MOJAVE LINE

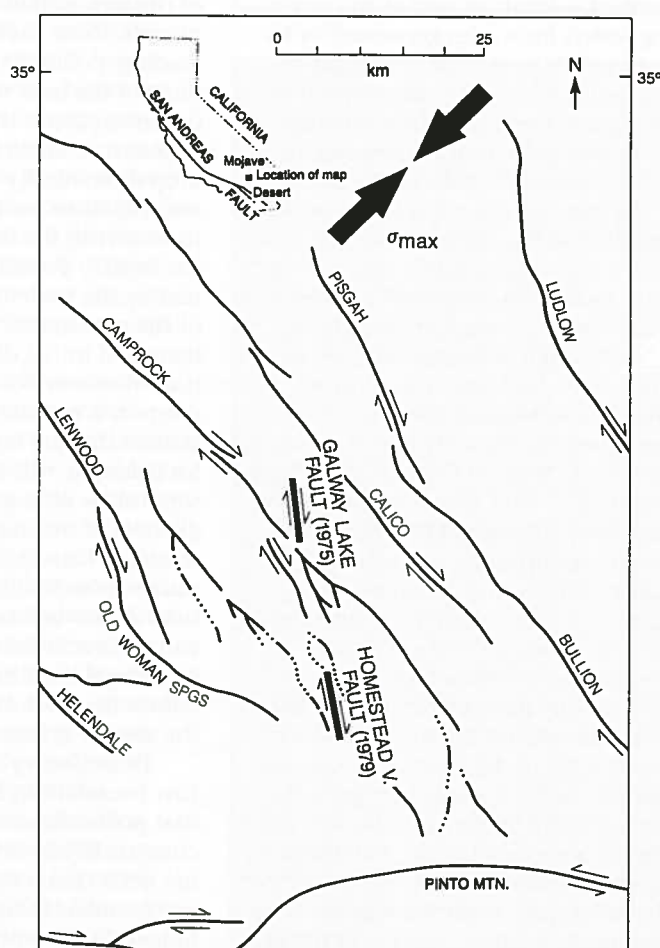
The Landers-Mojave line falls within a broad region of distributed deformation (commonly referred to as the eastern California shear zone (Dokka and Travis, 1990; Savage et al., 1990)), as inferred from geological and geodetic data. It is widely thought that distributed faulting is the main mechanism for this shearing. However, a fuller understanding of the *mechanics* of this distributed deformation in the Mojave remains elusive.

In 1989, we proposed, on the basis of an earlier kinematic and mechanical model for crustal deformation by fault sets (Ron et al., 1984; Nur et al., 1986, 1989) "that a new set of faults trending N-S may be in the process of formation" in the central Mojave region (Fig. 2). We thought that existing paleomagnetic, geological, and mechanical evidence at the time suggested that the well-developed northwest-oriented strike-slip faults in the central Mojave region had rotated counterclockwise or/and the stress had rotated clockwise (H. Ron, A. Nur, and A. Aydin, unpublished) so they are at present *mechanically* unfavorably oriented relative to the direction of maximum tectonic compression (Fig. 3). This direction at present is N10° to 30°E, and at an angle of 55° to 75° to the northwest-trending faults (for references see Stein et al., 1992; Zoback, 1991). Consequently, we suggested, a new fault system trending N15°W or so



**Figure 1.** Epicenters and fault-plane solutions of the six largest central Mojave earthquakes since 1947. Because the directions of these events (shown in red) approximately coincide with the alignment of their epicenters, it is proposed that this Landers-Mojave line may be a new or young fault. This fault crosscuts the older, well-documented and well-developed N45°W-trending central Mojave faults. At its kink, the Landers rupture was partitioned between these old faults and the Landers-Mojave direction.

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**Figure 2.** Reproduction of the Nur et al. (1989) figure showing the nearly fault-normal orientation of the Mojave compression of the older faults and its optimal orientation to the Homestead Valley and Galway Lake ruptures, suggesting the emergence of a new fault line and the gradual locking of the older faults.

**New Fault** continued on p. 256



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# IEE Annual Environmental Forum To Address Issues Related to Contamination of Boston Harbor and Massachusetts Bay

Fred A. Donath, Executive Director—GSA Institute for Environmental Education



Mindful of its charge to promote the "application of geology to the wise use of Earth," the GSA Institute for Environmental Education has selected the subject of contamination in a coastal marine environment for its second Annual Environmental Forum, to be presented Sunday, October 24, in Boston. IEE is joined in this effort by the GSA Geology and Public Policy Committee. The forum is entitled *A Crisis in Waste Management, Economic Vitality, and a Coastal Marine Environment: Boston Harbor and Massachusetts Bay*. Speakers and a panel will discuss various economic, scientific and technological, legal and regulatory, and societal considerations relevant to the subject.

Discharge into Boston Harbor of sewage sludge and effluent from more than 43 communities in the Greater Boston area has caused the harbor to be one of the most polluted in the nation. Additionally, low-level radioactive wastes and contaminated construction materials have been disposed of in Massachusetts Bay, and, to maintain Boston's transportation safety and economic viability, the harbor requires dredging. A major disposal site for past-dredged material is near a newly designated marine sanctuary. As part of a court-mandated plan to clean up the harbor, sludge is no longer discharged into it, and by 1995 sewage effluent will be discharged through a new 10-mile outfall pipe into Massachusetts Bay. The public has demanded cleanup of Boston Harbor, yet public concern is high over long-term impacts, and various groups challenge the wisdom of the solution. Boston Harbor and the adjacent Massachusetts Bay serve a variety of uses, including shipping, shipbuilding and repair, maritime support activities, fishing, recreation, tourism, education, and as the receiving waters for wastes generated by its residents. Scientists have worked to assess the effect of the new outfall in the face of the uncertainty inherent in a complex coastal marine system. Recent scientific studies have been undertaken to provide a better understanding of the fate and effect of contaminants in this system, and a long-term monitoring program is under way to document environmental change.

Although understanding of the impacts of discharges into Boston Harbor and Massachusetts Bay has improved significantly over the past five years, Michael Connor of the Massachusetts Water Resources Authority and Anne Aylward of the Massachusetts Port Authority, in the leadoff paper of the forum, point out that transfer of this information into the management process is difficult. Because no individual, no group, no governmental agency has overall responsibility for the harbor and bay, projects are undertaken in piecemeal fashion with haphazard progress. The management challenge is how to meet the harbor's commercial, navigational, tourism, and wastewater needs, and, at the same time, meet the region's environmental needs. Concerns of the general public over the significant costs of wastewater treatment and over the economic viability of the region demand that environmental managers address

these goals as cost-effectively as possible.

Keith Stolzenbach of the University of California, Los Angeles, and Gordon Wallace of the University of Massachusetts, Boston, discuss scientific studies of the transport and fate of contaminants which have provided information to support decisions affecting the environment of Boston Harbor and Massachusetts Bay. In the past decade there has been a dramatic increase in fundamental scientific investigations focused on environmental processes in Boston Harbor and Massachusetts Bay. These studies have addressed specific management questions such as acceptable levels of nutrient addition that will avoid nuisance algal blooms in localized areas (or long-term eutrophication on a baywide scale), controls on sources of pathogens and toxics necessary to prevent contamination of various marine resources, and disposal of contaminated sediments that must be moved for navigation or shoreline development. Physical oceanographic measurements have quantified water movement and determined residence times; chemical analyses of water column and sediment samples have documented inventories and rates of cycling of organic and inorganic constituents; and observations of live organisms have shed light on the processes governing the uptake of contaminants into the food chain.

Concern has been raised that relocating Boston's sewage outfall nine miles offshore will simply shift pollution from Boston Harbor to Massachusetts and Cape Cod bays. Richard Signell of the U.S. Geological Survey and Eric Adams of the Massachusetts Institute of Technology, in predicting the fate of the outfall discharge, discuss two independent computer simulations of the new outfall. Using different models, these show that for the same loading, pollutant concentrations over most of the bays will decrease slightly or remain about the same, whereas concentrations in Boston Harbor will drop dramatically. Moreover, the new site will allow water quality standards to be met in the immediate vicinity of the outfall, a condition that cannot be met by the present outfall. The nature of the new outfall will result in greatly increased initial dilution of the pollution. However, for certain pollutants, dilution is not the solution. Toxic substances that are bound with sediments, for example, will still be deposited in some areas of Massachusetts Bay, regardless of the initial or subsequent dilution. Thus, for many pollutants, source reduction is the only true solution. A new secondary treatment plant will remove some of these pollutants, but efforts must be maintained to reduce the level of pollutants entering the sewage system in the first place.

Peter Shelley of the Conservation Law Foundation, Boston, points out that pollution abatement in Massachusetts Bay over the past ten years has been characterized by extensive involvement of federal and state judges. The metropolitan Boston system, which is the single largest "point source" pollutant discharge into the bay, is a case in point. Frustrated by decades of bureaucratic inaction and

increasing systemic breakdowns in the treatment facilities, the City of Quincy and the Conservation Law Foundation—joined later by the U.S. Environmental Protection Agency—brought a series of successful lawsuits against the Metropolitan District Commission (MDC) in the early 1980s that established a judicially enforceable schedule for the reconstruction of the MDC's entire sewage system. The litigation also forced the creation of the politically and financially independent Massachusetts Water Resources Authority (MWRA). The fact that Metropolitan Boston is not the only municipal system discharging into Massachusetts Bay for which judicial action has been necessary to achieve compliance with water quality laws—several have required litigation—suggests that municipal compliance might always be a high-risk link in any pollution control strategy. Future pollution abatements may not lend themselves so readily to litigation. In addition to generic external inputs into Massachusetts Bay, "nonpoint" pollution from urban runoff, leaking septic systems, contaminated sediments, and discarded drums of toxic and radioactive wastes continue to present serious management problems. Moreover, the value of litigation will be increasingly limited by the lack of a set of long-term management goals and objectives. Massachusetts Bay requires a strategic plan that would provide such a context, not only for coordinating research and monitoring activities in the bay, but also for establishing regulatory priorities.

Cape Cod viewpoints on the Boston Harbor cleanup plan are presented by Mary Loebig of Stop the Outfall Pipe (STOP) and Susan Nickerson of the Association for the Preservation of Cape Cod (APCC). APCC and STOP are among the groups calling for strict compliance with state and federal regulations, investigation of alternative discharge sites, a minimum of full secondary treatment of all wastewater prior to a relocated discharge, stringent programs to reduce use of toxic substances, and other actions that could improve the potential for the project to deal with the sewage generation of the 43 communities and to minimize impacts to Boston Harbor and Massachusetts and Cape Cod bays. These groups have voiced grave concerns about the Massachusetts Water Resources Authority sewage treatment project, pointing out that conflicting opinions and interpretation of data by qualified scientists continue to raise significant doubts as to the environmental acceptability of the current plan. Moreover, intense rate-payer and other political pressures threaten to downscale an already environmentally debatable project. Numerous uncertainties remaining about potential impacts of the tunnel, which will carry the largest and most distant discharge of sewage effluent in the world, have left many organizations and individuals with disturbing scientific and philosophical questions.

The recent debate over the Boston Harbor cleanup has focused primarily

*continued on p. 255*



on the concerns of Cape Cod residents over the outfall and of metropolitan Boston area residents over the costs. What has been lacking is a strong constituency for a clean Boston Harbor, perhaps because even environmental groups have been split on the correct course to take. Robert Buchsbaum, of the Massachusetts Audubon Society North, presents a Boston viewpoint to the Boston Harbor cleanup plan. As a statewide organization, the Massachusetts Audubon Society has attempted to examine the issues in terms of what is best for the entire commonwealth, using the most up-to-date scientific information available. While acknowledging that some uncertainty does exist, the Society concludes that the ongoing cleanup effort will undoubtedly improve water quality in Boston Harbor while posing minimal risk to the resource of Massachusetts and Cape Cod bays. Its major concern is that the responsible agencies need to be firmly committed to a monitoring program that will permit changes to be made in the project in the unlikely event that harmful effects are found. The Audubon Society believes that, over the long term, nonpoint (diffuse) sources of pollution present a greater threat to nearshore coastal water quality than do point sources, once treatment facilities are upgraded.

John Teal of the Woods Hole Oceanographic Institution discusses biological alternatives and distributed treatment systems as alternatives to secondary treatment and ocean disposal. A variety of advanced, innovative wastewater systems that use wetland ecosystems have been developed. Those most suitable for urban settings are greenhouse-enclosed so as to operate year-round at high efficiency. Because these can be made attractive and not malodorous, they can be located close to the waste sources. Such an arrangement can save a substantial portion of the cost of the collection piping, which accounts for about half the cost of conventional, concentrated treatment systems. Facilities using managed ecosystems can also provide enhanced treatment, meeting drinking water standards, for a wide range of waste types.

Enhanced chemical treatment as an alternative to secondary treatment and ocean disposal is discussed by Susan Murcott of the Massachusetts Institute of Technology. When the Clean Water Act was passed in 1973, Congress elected to subsidize up to 75% of the compliance costs of the act. The nation overwhelmingly chose conventional primary treatment plus activated-sludge secondary treatment, a technology that was invented at the turn of the century. This federal subsidy preempted the market for new wastewater treatment technologies, and engineering consulting firms, state and federal regulators, environmental groups, and others have wittingly or unwittingly prevented deviation from this norm. Yet, new technologies are being developed in Europe and in Japan, as well as in some sectors of the United States. Murcott reviews several of the innovative wastewater technologies discussed in a recently released National Research Council report, and focuses in detail on chemically enhanced primary treatment (CEPT). CEPT has important water quality and cost-saving effects: it would permit a 50% reduction of the size of conventional secondary treatment at Deer Island, leaving space for the possibility of nutrient removal using European-designed aerated biofilters; it would

allow for the treatment of combined sewer overflows at the new wastewater treatment plant at Deer Island; and it would provide significant cost-savings for Massachusetts rate payers.

In the last formal presentation of the forum, Jerry Schubel and R. L. Swanson of the State University of New York, Stony Brook, present some national perspectives on waste treatment and ocean disposal. In spite of large expenditures, present wastewater management strategies in many coastal areas have failed to produce significant improvement in environmental and ecosystem quality, or in accommodation of multiple and conflicting uses by society. Moreover, little evidence exists that more of the same kinds of strategies would produce the desired results. They aver that a new paradigm is needed, such as integrated coastal management (ICM). ICM is an environmental quality-based approach rather than a technology-based approach. It begins with the identification of important ecosystem values and uses for a waterbody and the environmental qualities needed to sustain them. It then moves to an identification and ranking of the major threats to those uses and values throughout the zone of influence, and to an assessment of strategies to eliminate those threats—or at least to reduce the risks to acceptable levels. ICM focuses on real problems, not on perceived problems, and it monitors progress toward explicit goals. It is an interactive and iterative process in which accountability is ensured, but is difficult to apply because of scientific limitations. Technical decisions must be based upon the best scientific information, not on public perceptions and political pressures.

The formal presentations by these speakers will be followed by a panel discussion and questions from the audience.

#### Proposals Solicited for Third Annual Environmental Forum—Seattle

The Institute for Environmental Education, in cooperation with the GSA Committee on Geology and Public Policy, is soliciting proposals for the Third Annual Environmental Forum to be held in conjunction with the 1994 GSA Annual Meeting in Seattle. Proposals should include a summary of the proposed forum subject, perspectives to be represented (including names of speakers who might present these), and names of the person(s) who will serve as organizer(s) of the forum. Although prospective speakers need not be confirmed at the time the proposal is submitted, the proposed organizer(s) must be.

The IEE Annual Environmental Forum is intended to increase the awareness of geoscientists and the public of the role of geoscience in addressing environmental concerns. Although selection of the topic for the forum will take into consideration the geologic setting of the meeting place and environmental issues of particular interest there, the subject should have global significance. Speakers should be selected who will present public interest, legal, regulatory, management, and other viewpoints, as appropriate, in addition to the purely scientific.

Proposals should be submitted no later than November 15, 1993, to: Fred A. Donath, Executive Director, Institute for Environmental Education, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. ■

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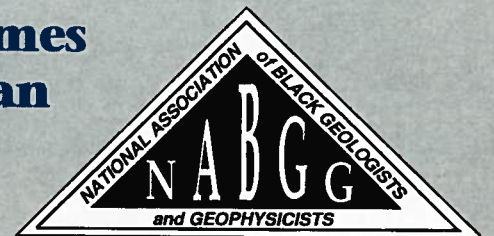
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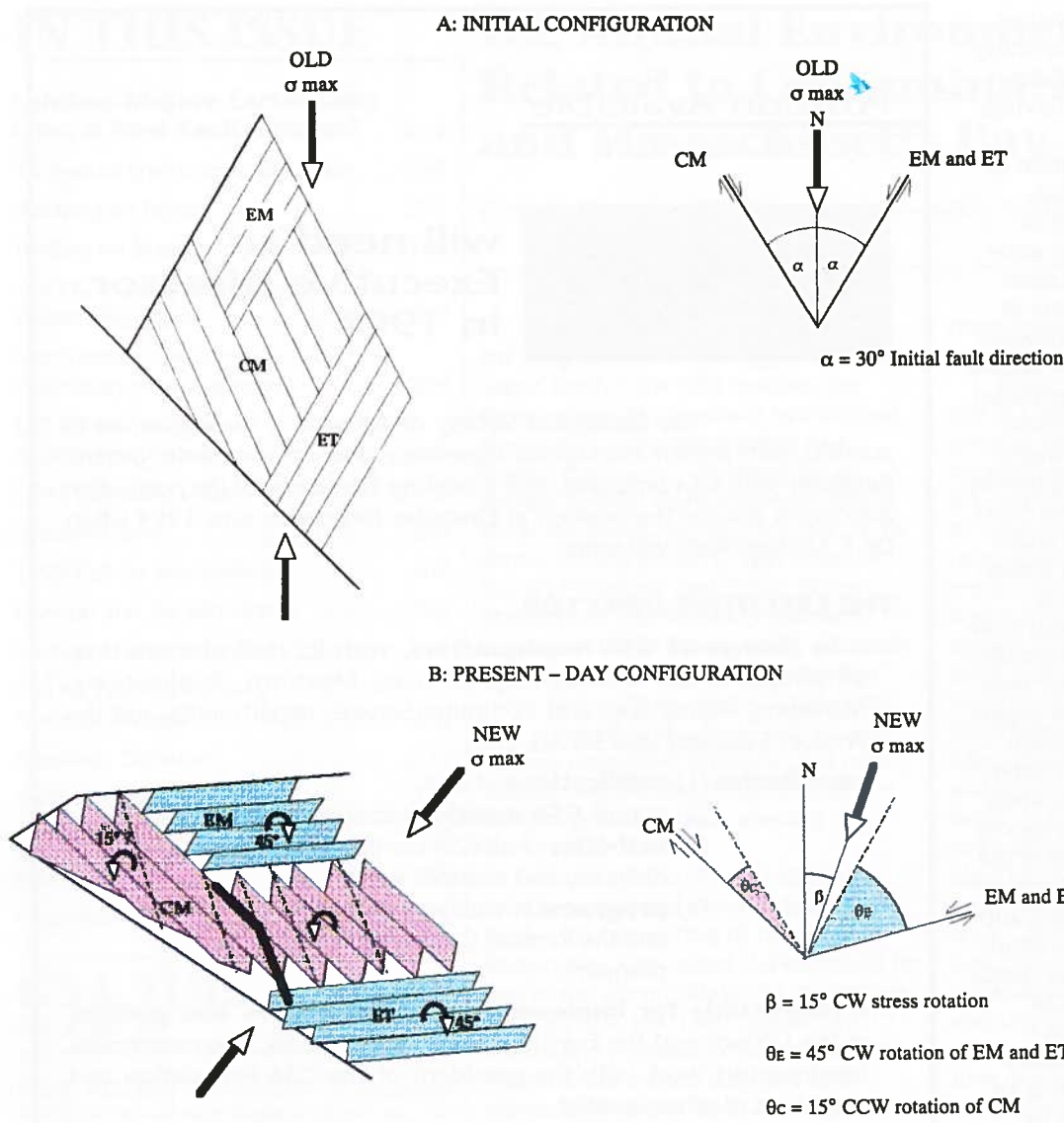


The National Association of Black Geologists and Geophysicists (NABGG) became GSA's thirteenth associated society on May 7, 1993, when the associated status was approved by the GSA Council.

Beginning with meetings in the kitchen of one of its founders, the NABGG was formally established in 1981 by a group of black geoscientists in the Houston-Dallas area to encourage students to take advantage of scholarship programs, to inform them of career opportunities in the fields of geology and geophysics, and to offer financial support to students pursuing geoscience degrees.

The Association currently has about 200 members. NABGG officers for 1993 are president Patricia M. Hall, Amoco Production Company, New Orleans, Louisiana; vice-president John W. Randall, Chevron USA, Bakersfield, California; secretary Charles E. Brown, U.S. Geological Survey, Reston, Virginia; and treasurer John T. Leftwich, Jr., Pennsylvania State University, University Park, Pennsylvania.



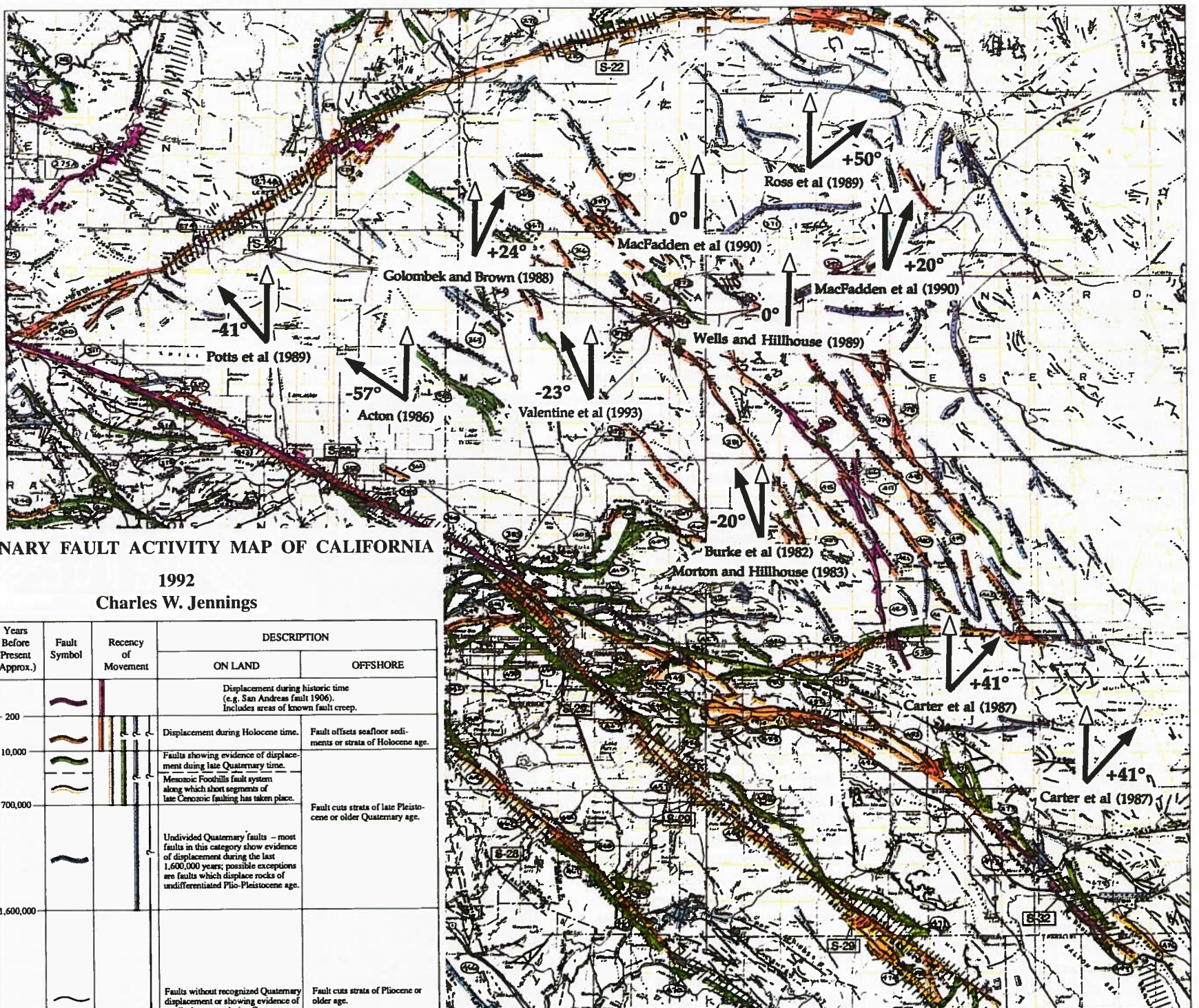


**Figure 3.** Block rotation in domains, stress-field rotation, and the formation of optimally oriented new faults in the Mojave region: A: In the initial configuration, the east Mojave (EM) and eastern Transverse Ranges (ET) domain faults are oriented  $\sigma = 30^\circ$  from the direction of the north-trending stress, and the central Mojave (CM) faults are oriented  $\sigma = 30^\circ$ . B: In the present-day configuration, paleomagnetic evidence and some structural data suggest a  $45^\circ$  or so clockwise rotation of blocks and faults in the EM and ETR domains, and possibly  $15^\circ$  or so counterclockwise rotation in the CM domain. These material rotations imply a stress field rotation  $\sigma = 15^\circ$ , into today's direction of  $N15^\circ W$ . Because the existing faults are so unfavorably oriented relative to the current stress, new ones should form (broken lines in the CM and the Landers [heavy line]), and the Landers-Mojave line may be such faults.

must develop to accommodate ongoing deformation. As we pointed out in 1989 the 1975 Galway Lake and the 1979 Homestead Valley earthquakes ruptured previously unmapped faults oriented roughly  $N15^\circ W$ , not the well-developed  $N45^\circ W$ -trending faults. The colinearity of these two ruptures suggests also that they may have occurred on a seismically single, unmapped fault 30 km long (Fig. 2). Although segments of this fault were identified in the field before 1992 (M. Rymer, personal communication), it was not recognized as a thoroughgoing, coherent and seismogenic fault.

The azimuth and sense of rupture of the Joshua Tree earthquake were similar to the 1975 and 1979 events (Fig. 1), and its epicenter fell roughly on the extension of their line to the south. Moreover, the Joshua Tree rupture apparently crosscuts the presumably young east-trending Pinto Mountain fault. This crosscutting relation prompted us to reconsider the 1947 M 6.5 Manix, with its  $N20^\circ W$  after-shock alignment (Richter, 1958), and the 1965 M 5.2 Calico earthquakes, over 100 km north of the Joshua Tree epicenter. The focal mechanisms of these earthquakes also seem consistent with right-lateral strike slip on unmapped  $-N15^\circ \pm 5^\circ W$ -trending faults, not on  $N45^\circ W$ -trending ones. Thus, the

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**Figure 4.** Rotation about vertical axes, as inferred from paleomagnetic declination anomalies in the Mojave region. Results show clockwise rotation in the eastern Mojave (where the associated faults are oriented east-west), and generally no or counterclockwise rotation in the central Mojave (where the faults are oriented  $N45^\circ W$ ). The relative rotation between the faults in the two domains is on the order of  $55^\circ$  to  $75^\circ$ .



## New Fault *continued*

line defined by the 1975, 1979, and 1992 (Joshua Tree) events (Fig. 1) is possibly an emerging thoroughgoing seismogenic fault ~120 km long.

The Landers earthquake can also be explained by our model. First, the southern part of its rupture, coincident in both the location and sense of slip with the previous N15°W ruptures, provides further evidence for a thoroughgoing fault. Second, the kink in the rupture is consistent with our mechanical model, because it suggests that slip can be partitioned during the transition from old, poorly oriented faults to new, optimally oriented ones (Fig. 3). In situ observations in fact reveal new rock fractures on some north-south segments of the Landers rupture (Ken Lajoie, personal communication), lending some direct support to the idea of new faulting.

## THE CONTROVERSY: STRESS, ROTATION, NEW FAULTS

The application of our model to the Mojave and Landers events has been sharply criticized for its three key aspects: stress, rotation, and new faults.

1. *Stress.* Two principal objections to the use of crustal stress to interpret active faulting were raised: (1) that it is immeasurable (can be inferred only indirectly from deformation measurements) and is spatially too heterogeneous; however, results from borehole breakouts and hydraulic fracturing provide clear evidence for systematic regional patterns of stress, especially principal stress directions (Zoback and Zoback, 1980); and (2) stress in the shallow brittle and weak continental crust is controlled by deformation of the ductile but strong middle crust, and merely reflects continuous deformation at depth (Jackson and Molnar, 1990). This is important in the context of the thin viscous sheet model for crustal (or lithospheric) deformation (England and McKenzie, 1982), which prohibits both clockwise and counterclockwise rotations in a single tectonic environment (Sonder et al., 1986). The opposing rotations of the Mojave domains suggest, therefore, that the thin viscous sheet model is inadequate here and that it is shallow faulting in the brittle crust that controls deformation of the deeper ductile regions (Zoback, 1991), not the other way around.

2. *Rotations and Paleomagnetism.* Although using paleomagnetic declination anomalies to infer rotations of crustal blocks about vertical axes is common practice, the mechanisms of these rotations remain uncertain. It is commonly assumed that rotations are controlled by the sense of shear in a given region. Thus, many have assumed that in the dextral San Andreas system, rotations must all be clockwise. However, paleomagnetic data indicate counterclockwise rotations in some areas of the western United States, notably the Mojave region (Fig. 4). For that region, about a dozen studies to date show clockwise rotations in the eastern Mojave and eastern Transverse Ranges (e.g., Carter et al., 1987) where faults are oriented east-west, and counterclockwise or no rotation in the central Mojave where active faults are oriented northwest (e.g., Morton and Hillhouse, 1983).

The evidence for counterclockwise rotations in Figure 4 has been dismissed by some as due to secular variations, unknown age of magnetization, hydrothermal effects, and unreliable or sparse sampling. However, it is essentially beyond dispute that a *relative*

rotation of 55° to 75°, between the eastern Transverse Ranges and eastern Mojave domains and the central Mojave has taken place during the past few million years, and that this rotation must be related to the direction of faults within these domains (Garfunkel, 1974; Luyendyk et al., 1980). Taking the initial angle between the eastern Transverse Ranges and eastern Mojave faults, and those in the central Mojave close to the optimal failure direction with N0°E compression at 3 Ma, the fault azimuths at that time were 30°E and 30°W, respectively. Taking a 45° clockwise rotation of the eastern Transverse Ranges and eastern Mojave blocks and a 15° counterclockwise rotation of the central Mojave blocks (Fig. 3) yields a present-day compression direction of 22.5°E, and a 17.5° clockwise stress rotation (similar in sense to the Basin and Range stress rotation; Zoback and Zoback, 1980).

3. *Formation of New Faults.* That new faults may be forming now has been our most controversial issue, termed "naive" by Greg Davis (personal communication) and "bizarre" by others. Some argue that the crust contains enough older faults, so that any deformation can be accommodated without new faults being required. Because dating slip on geological faults is usually difficult, some argue that it is hard to prove the formation of new ones, because they may be old faults that simply have not been recognized.

However, it cannot be disputed that faults must form at some time, and that long and coherent faults capable of generating larger earthquakes must organize sometimes out of a multitude of shorter faults. Furthermore, systematic crosscutting relations between faults provide compelling evidence that some are younger than others—e.g., the cutting of the young Pinto Mountain fault by the Joshua Tree and Landers rupture. In fact we believe (in contrast with some of our critics) that the *mechanics* of fault and fault set formation is a crucial subject for research, without which no sensible and rigorous interpretation of past and present crustal deformation by faulting will ever be possible.

## CONCLUSION

The kinematic and mechanical considerations discussed above, and our attempt to analyze active faulting in the central Mojave with the only model proposed so far that can explain the main Landers and Mojave observations, touch on several important seismotectonic, crustal deformation, and structural geology problems (and controversies).

1. How do new faults form or become organized?
2. Why and how is crustal deformation accommodated in so many regions by distributed faulting in domains?
3. How can we hope to predict earthquakes if we cannot even identify in advance the faults on which they can occur?
4. Is the Landers earthquake a characteristic one?
5. Is the deformation of the brittle crust, including block rotations, passively controlled by the ductile deformation at depth, or is the former controlling the latter?
6. Can the incorporation of fault sets in domains, conjugate domains, rotations, and the formation of new faults and fault sets lead to an advancement of faulting theory (which has remained, at least in our textbooks,

*New Fault continued on p. 258*

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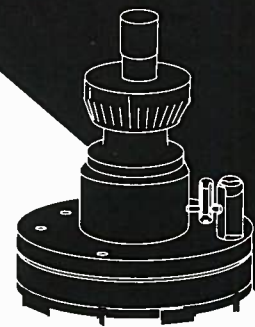
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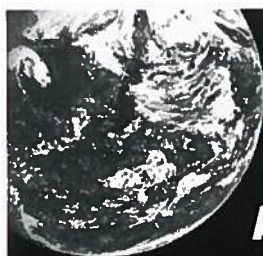
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**New Fault** continued from p. 257

unchanged for 40 years or more) by providing explanations for crosscutting fault sets, oblique slip, and mixed-mode deformation, for example?

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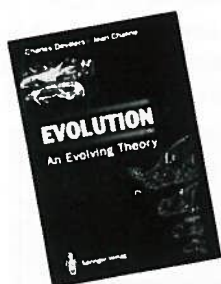
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## Federal Science Program and Budget Development

The executive and legislative branches of the federal government directly influence our nation's science policies and achievements through the development and execution of science programs and budgets. This month's Washington Report explores structural, personnel, and procedural aspects of science program and budget planning for one U.S. government bureau, the U.S. Geological Survey (USGS). The USGS (FY 1993 enacted budget of about \$577 million), while not having as large a budget as NASA or several other federal science organizations, is the lead federal agency in many areas of earth-science research such as earthquake hazards, hydrology, continental scientific drilling, and topographic and geologic mapping. The bureau is unique in the federal government, pursuing a wide range of applied and basic research in carrying out "Earth science in the public service." Nevertheless, USGS program and budget planning serves as a good example for illustrating how the federal government develops its science objectives and implements its science policy. Through an interview with Bonnie McGregor, Assistant Chief Geologist of the USGS Geologic Division (GD), currently serving as Acting Associate Director, we will take a guided tour through the existing federal budget process. Prior to August 16, when McGregor assumed the role of Acting Associate Director, she was in charge of managing and coordinating GD budget and program activities. She had both day-to-day operational budget and program responsibilities and long-range policy planning duties with regard to science activities.

• *GSA Today:* How are science programs and budgets linked in the executive branch? To an outsider reading newspaper headlines, the two often seem very disjointed.

• *McGregor:* Actually, federal science programs and budgets are very much connected in the executive branch. The initiation and implementation of federal science programs are inextricably linked to formulating the President's budget each fiscal year. Agency programs serve to integrate national needs, political concerns, and scientific capabilities.

• *GSA Today:* Are most federal science programs about the same size? Is there a general consistency in levels of effort or scope?

• *McGregor:* Not really. Although programs are typically the lowest level identified in the federal budget, they can vary greatly in size (personnel and dollars) as well as in degree of programmatic detail.

• *GSA Today:* What are some examples of federal science programs?

• *McGregor:* For FY 1993, some of the larger USGS programs, in terms of directly appropriated dollars and staff, include Earthquake Hazards Reduction

(\$50 million; 450 staff), Cartographic Data and Map Revision (\$42 million; 770 staff), and National Water Quality Assessment (\$38 million; 320 staff). Smaller USGS programs in FY 1993 include Side-Looking Airborne Radar (\$0.5 million; no staff), World Energy Resource Assessment (\$0.8 million; 6 staff), and Coordination of National Water Data Activities (\$1 million; 10 staff).

• *GSA Today:* You qualified the program numbers by saying "directly appropriated." What other resources do these programs have?

• *McGregor:* While most USGS programs are directly supported by annual congressional appropriations, many receive additional funds and staffing support from other sources, such as federal and state agencies, either on a matching basis or as reimbursements for work performed. About half of the funding for the USGS Water Resources Division comes from outside sources, mostly as matching funds in State cooperative programs. One USGS program, Astrogeology, is almost entirely funded by NASA. In FY 1992, more than 30% of all USGS funding came from reimbursable work rather than direct appropriations.

• *GSA Today:* What factors other than sources and sizes of resources affect program and budget planning?

• *McGregor:* Another major ingredient is organizational structure. The structure of the executive branch exerts a strong influence on planning science programs and budgets. Some federal science organizations, such as NASA and EPA, are independent organizations of the executive branch, whereas bureaus such as the USGS are within cabinet-level departments such as the Department of the Interior (DOI). Organizational structures internal to the USGS and the DOI provide a framework for and avenues for the two-way flow of program and budget data. While programs fund science in the federal government, organizational structures define how that science will be accomplished.

• *GSA Today:* Does this influence of structure over program and budget planning extend to within the bureaus themselves?

• *McGregor:* Absolutely. Each of the three USGS program divisions—Geologic, National Mapping, and Water Resources—is responsible for conducting its own science activities and developing long-range plans for their program areas. Structural units within the USGS program divisions have developed along different lines according to their particular operational needs. The Geologic Division, for example, is composed of topically focused offices (e.g., Mineral Resources, Regional Geology) within which are regionally or discipline-oriented branches (e.g., Alaskan Geology, Isotope Geology). Projects, the actual working level of the Geo-

logic Division, are conducted within the Branches by teams of scientists. Many USGS projects are funded by multiple programs.

• *GSA Today:* How are other groups above the Divisions organized and how do they affect USGS science planning and budgeting?

• *McGregor:* The USGS Director's Program Office coordinates the planning and development of all USGS programs and budgets. The USGS Director approves all program initiatives and reports directly to the DOI Assistant Secretary for Water and Science, who also oversees the Bureau of Mines and the Bureau of Reclamation. Within DOI, the Assistant Secretary for Policy, Management, and Budget has broad oversight responsibilities on behalf of the Secretary for all program and budget activities.

• *GSA Today:* Are there other executive-branch groups that influence USGS science planning and budgeting?

• *McGregor:* Yes, several other groups within the executive office of the President impact the planning of federal science programs and budgets. The Office of Management and Budget (OMB) has primary responsibilities to advise and assist the President in preparing the overall federal budget, in broadly supervising and controlling budget execution, and in developing and maintaining efficient government. For instance, cabinet-level administrators such as the Secretary of the Interior report to the President through OMB on budget matters. The Office of Science and Technology Policy under the President's science advisor, John Gibbons, serves as a source of scientific, engineering, and technological analyses and judgments for the President with respect to major scientific policies, plans, and programs of the federal

by people with experience in their areas of programmatic responsibility. In OMB, a technical background is a selection criterion for analysts who review the budgets and programs of science agencies such as DOE and NASA. Technical expertise is not a major criterion for OMB analysts who oversee DOI bureaus since DOI is primarily a land-management agency. The directorship of OMB is also a political appointment.

• *GSA Today:* What are the mechanisms by which the personnel of these organizations interact in the development of science programs and budgets?

• *McGregor:* Line and staff managers of the various executive branch bureaus and agencies interact through an intricate program and budget planning process. Part of the complexity is caused by the overlap of the planning process for one fiscal year with that of both the previous and (eventually) the following fiscal years. For instance, at press time, a final budget for fiscal year 1994 has not been signed into law; in the meantime, program planning for fiscal year 1995 is well underway within the bureaus and agencies. An annual overlap in the planning process is common to most organizations but is particularly prevalent in the federal government due to the basic system of checks and balances between the executive and legislative branches and because of the numerous iterations of appeals and resubmittals built into the system.

• *GSA Today:* How is the budget planning process started?

• *McGregor:* Although OMB and departmental guidance is given early in the planning process concerning broad target areas of interest and target funding levels, a bottom-up process is generally initiated by the bureaus in developing science program and budget

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### ***The procedures, structures, and people involved in the development of programs and budgets for federal science activities ensure that the end product represents the best possible compromise ... in light of the ... political, economic, and scientific constraints.***

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government and government-wide crosscutting programs such as Global Change.

• *GSA Today:* What kinds of personnel factors affect science program and budget planning?

• *McGregor:* Program and budget planning and development are deeply affected by the backgrounds and perspectives of the various participants in each organization at many levels. The program divisions within the USGS are composed of and led by hydrologists, geologists, cartographers, and other technical personnel. The Director's Program Office contains a blend of program and budget analysts with varying degrees of technical experience in the activities and operations of the program divisions. The position of USGS Director is a Presidential appointment requiring Senate confirmation. Traditionally the directorship has been treated as a nonpolitical post and held by a geoscientist selected by the Secretary of the Interior, usually from a slate of candidates compiled by the National Academy of Sciences.

DOI program and budget analysts have a broad array of managerial and administrative experiences with lesser emphases on science or technical backgrounds. The positions of DOI Secretary and Assistant Secretaries are political appointments, requiring Senate confirmation, that are generally held

plans. The baseline for program and budget planning each new fiscal year is the President's budget for the prior year's activities and funding, which are sometimes adjusted for increases or decreases in fixed costs such as rent and salaries. Activities above the baseline, either new or expanded programs, are proposed through program initiatives.

• *GSA Today:* What are the general steps in the process?

• *McGregor:* In the USGS, program initiatives with budgets are developed within the program divisions and are internally reviewed on the basis of technical merit, societal value, support of the DOI and administration needs, and the capabilities of the division to conduct the work. These initiatives are submitted to the director's office, where they are reviewed and, if approved, ranked by the director in priority order.

The package of prioritized USGS initiatives is submitted to the DOI Assistant Secretary for Water and Science for further review and modification before being delivered to the DOI Assistant Secretary for Policy, Management, and Budget, who critiques all of the DOI bureau initiatives and makes recommendations to the Secretary. The overall DOI package, as approved by the secretary, is submitted to OMB for

**Budget** continued on p. 260



its review and approval. OMB then combines its recommendations for all executive agencies into a single package known, once approved, as the President's budget.

• *GSA Today*: What you've described seems fairly static and lengthy—a serial flow of information with “go/no go” decisions at each level.

• *McGregor*: The process, in fact, is incredibly dynamic. Appeals of higher level decisions can be made along each step of the process. Appeals can be made on the basis of different program and budget priorities, which may result in the redistribution of proposed budget increases or decreases among programs. Total dollar levels assigned to programs administered by individual divisions, bureaus, and departments may also be appealed. Once the various iterations of submittals and appeals have been completed, the President's budget is submitted to Congress and the public.

The President's budget consists of several parts: “Departmental Highlights” with accompanying news releases for the news media, the “Budget Appendix” prepared by OMB for all members of Congress, and individual bureau justifications for specific congressional appropriations committees. The bureau justifications contain program-by-program information describing the base program, recent accomplishments, current and proposed activities, workload or performance measures, and summaries of proposed changes in the program.

• *GSA Today*: So far, we've talked about the executive branch. What about the legislative branch? What role does it play in science planning and budgeting?

• *McGregor*: It plays an integral part in the process. According to the U.S. Constitution, no money may be “drawn from the Treasury, but in consequence of appropriations by law.” The legislative branch, therefore, annually passes appropriations bills that, once signed into law by the President, allow the executive branch to operate.

• *GSA Today*: How is the legislative branch organized with regard to science planning and budget activities?

• *McGregor*: The legislative branch is composed of Congress as well as the Government Accounting Office, the Library of Congress, the Congressional Budget Office, the Government Printing Office, and several other agencies. The Senate and the House of Representatives have a number of standing committees, including ones on appropriations and budget. The House also has standing authorizing committees on Natural Resources; Energy and Commerce; and Science, Space, and Technology. Other Senate standing committees include Commerce, Science, and Transportation as well as Energy and Natural Resources. Most of the work of Congress is done by committee.

• *GSA Today*: How are the appropriations committees organized? How do they function?

• *McGregor*: The appropriations committees of both the House and Senate are divided into a number of subcommittees. The House and the Senate Appropriations Subcommittees for Interior and Related Agencies annually review the USGS budget, hold hearings, prepare reports for the full committees, and prepare appropriations bills for passage by Congress.

• *GSA Today*: What is the composition of the appropriations committees?

• *McGregor*: Of the 100 U.S. Senators, 29 currently sit on the Senate

Committee on Appropriations, and 15 of those sit on the Senate Appropriations Subcommittee on Interior and Related Agencies, both chaired by Senator Byrd (D-W.Va.). The full Senate Appropriations Committee is supported by a staff of 19, the senior members of which have backgrounds in public and business administration and accounting and have wide experience in the executive and legislative branches. The Senate Appropriations Subcommittee for Interior and Related Agencies is similarly supported by a staff of six.

Of the 435 U.S. Representatives, 59 sit on the House Committee on Appropriations, and 11 of those sit on the House Appropriations Subcommittee on Interior and Related Agencies chaired by Representative Yates (D-Ill.). The full House Appropriations Committee is supported by a staff of 23 with an additional investigative staff of 12. The House Appropriations Subcommittee on Interior and Related Agencies is also supported by a staff of six, who include a former chemist and budget analyst and a former employee of the DOI.

• *GSA Today*: What is the general process in the legislative branch for science program and budget planning?

• *McGregor*: At any time during the year, members of the House and Senate may request briefings, study plans, or other materials on specific aspects of science programs. Once the President's Budget has been presented to Congress, however, the appropriations subcommittees begin to review and analyze all bureau-level budget justifications on a program-by-program basis. The appropriations subcommittees hold public budget hearings where bureau witnesses testify as to the proposed budget and its impacts. Members of the appropriations subcommittees and other members of Congress submit questions for the bureau to answer before, during, and after the public hearings, and they submit requests concerning the capabilities of the bureaus to perform various activities.

Once the appropriations subcommittees have received and analyzed the program and budget information, they “mark-up” legislative bills concerning the level of funding and program activities of the federal bureaus and agencies. The bills, accompanied by reports that provide details concerning the language and intent of the bills, are forwarded for consideration to the full appropriations committees and then to the full House or Senate, as appropriate. The House and Senate bills are introduced on their respective floors and, after any debate or amendments from the floor, are eventually passed. These appropriations bills, as first passed by the House and the Senate, are usually very similar to each other but are rarely identical. Differences between the House and Senate versions are generally resolved in conference. Once the conferees have penned a joint bill thought to be acceptable to both sides of Congress, the bill is introduced on the floor of the House and then the Senate and, once passed, is sent to the President to be signed into law.

• *GSA Today*: So the end product of the entire process is the enacted budget?

• *McGregor*: Right. The series of appropriations bills that the President signs into law as the enacted budget provide a final guide to the program plans of the federal government for the following year. The bills may contain specific dollar amounts tied to general language concerning program plans—for example, \$1,828,000 to conduct the geomagnetism program of the USGS for FY 1992—in which case the details concerning the proposed program

## Trading on Science

Margaret Goud Collins, 1992–1993 Congressional Science Fellow

Scientists are in general curious people. The quality serves one well in Washington. A geologist on Capitol Hill may find a way to apply a scientific background to issues as obvious as reform of mining law, or as remote as the development of environmental technologies. The critical point for a Science Fellow is to approach the Congressional agenda with an open mind.

That, at least, is my explanation to myself of my focus on the issue of trade and the environment during my Fellowship year. I feel fortunate that my curiosity landed me at the center of

perhaps the most hotly debated and precedent-setting environmental issue of the year: the negotiations on the environmental side agreements to the North American Free Trade Agreement (NAFTA).

### WHY TRADE?

I came to Washington hoping to work on international environmental issues, though the connection to trade had never crossed my mind. I have

Trading continued on p. 261

## Geology and Public Policy— Boston Annual Meeting

Tuesday, October 26, Hynes Convention Center, Room 102

**Geoscience Legislation in Congress Forum** (12:00–1:30 p.m.)

Many science policy experts believe that the end of the Cold War may be as significant as the end of World War II with regard to national science and technology policy. The forum will provide an overview of recent and pending geoscience legislation and will include topics by the following speakers:

*Future of the National Science Foundation*

James F. Hays, National Science Foundation

*Implementing the National Geologic Mapping Act of 1992*

Charles J. Mankin, Oklahoma State Geologist

*Mining Law Reform*

Keith R. Knoblock, American Mining Congress

*Clean Water Act and Other Environmental Legislation*

Margaret Goud Collins,

U.S. Senate Committee on Environment and Public Works

*Collecting Fossils on Federal Lands*

John Pojeta, Jr., U.S. Geological Survey

**Earth Scientists on Capitol Hill** (1:30–2:30 p.m.)

GSA's seventh Congressional Science Fellow Margaret Goud Collins has worked on the Senate Committee on Environment and Public Works for the last year where she was involved in international environmental issues, including aspects of the North American Free Trade Agreement. At this open session Goud Collins will report about her experiences on the Hill, and the Geology and Public Policy committee members will comment on the value of science-government interaction and how scientists can provide expertise to Congress.

plans and activities contained in the budget justification are implicitly accepted as the final word.

• *GSA Today*: Are the enacted Appropriations Bill and the President's Budget Justification the only two sources of words concerning the final suite of activities determined by the process?

• *McGregor*: No. The House, Senate, and conference reports that accompany the appropriations bills may also contain specific dollar amounts tied to specific program plans. For example, within the USGS Coastal and Wetland Processes Program, an additional \$300,000 in fiscal year 1992 to establish a cooperative erosion research and monitoring program for the South Carolina coast. The specific activity listed in the report is added to the program's slate of activities as detailed in the budget justification. Bureaus may also be directed by language in the reports to perform certain activities within available funds, which may require changes in planned activities and reprogramming of funds in order to accomplish the work.

• *GSA Today*: How does the USGS view the process?

• *McGregor*: All-in-all, despite its complexity, the process works. Beyond the necessity of working within the established system to secure budgetary support each year, interactions during

program and budget planning provide important opportunities for the USGS to educate and inform decision makers at all levels in the federal government about the importance of earth-science information in addressing critical issues facing society, issues such as competing uses of land; conflicting environmental policies; identifying and mitigating natural hazards; and managing our nation's water, energy, and mineral resources. Program and budget planning provide challenges for USGS scientists to constantly evaluate the impact of their research and to communicate that impact to nontechnical audiences.

The enacted appropriations legislation represents the culmination of the program and budget planning process of the federal government. Through interactions within and between the executive and legislative branches, the federal operations are reviewed, the federal budget is formulated, and the slate of federal program activities determined. The procedures, structures, and people involved in the development of programs and budgets for federal science activities ensure that the end product represents the best possible compromise for our nation in light of the overriding political, economic, and scientific constraints. ■



lived and worked in developing countries, and I am convinced that a necessary (though not sufficient) component for long-term environmental progress in any nation is a strong, indigenous scientific and engineering community. Much environmental activism, here and abroad, focuses on passing laws, or ensuring access to information, or preserving undeveloped land. All these are important. But for both economic and environmental progress, a nation must have the technical capacity to understand its natural systems, to manage its development so that environmental damage is minimized, and to train a new generation of people with technical expertise. Otherwise, legislation is useless and preservation is only temporary.

When I began my Fellowship, I looked for opportunities to influence American environmental aid programs. I wanted to see if their goals could be fashioned to incorporate more scientific cooperation between U.S. and developing-country scientists.

Through the interview process, I learned that while reform of the U.S. aid program was planned, it was unlikely to move forward quickly. However, environment was becoming an important issue in trade agreements, and important negotiations were underway. Some environmental groups and members of Congress were trying to change the rules governing international trade so that they promote environmentally sound economic growth, rather than economic growth alone.

Since trade is universally popular, but foreign aid is not, I reasoned that making the trade-environment link would be a more sustainable way of promoting global environmental progress. And the need to make sure that science was a part of the equation was as important for environmental trade policy as for environmental aid.

Senator Max Baucus offered me the opportunity to work on the environment and trade issue. When President Clinton began an unprecedented negotiation of NAFTA side agreements on environment and labor, the strength of the environmental side agreement became, for many, the condition of their support for the agreement. This major economic agreement among Mexico, Canada, and the United States thus depended on these environmental negotiations, which raised the stakes on the issue. Because Senator Baucus is chairman of both the Committee on Environment and Public Works and the Finance Committee's Subcommittee on International Trade, he was very involved in the debate on the environmental side agreements—and so was I.

### THE TRADE-ENVIRONMENT CONNECTION

To explain the issue, I must begin with a brief background on international trade. Trade agreements traditionally have had one primary purpose: lower tariffs in order to promote more international trade and, therefore, greater economic growth in all trading countries. Since the Tokyo Round of negotiations of the General Agreement on Tariffs, and Trade (GATT) was completed in 1979, the scope of trade agreements has broadened to control some nontariff barriers to trade such as, for example, product standards that unfairly discriminate against imported goods. An example of an allowable standard is automobile airbags, since they are equally required on imported and domestic vehicles.

The environmental community was awakened to the link between trade agreements and their domestic policy battles in 1991. A GATT panel ruled that tuna import restrictions mandated by the U.S. Marine Mammal Protection Act were an unacceptable restriction of trade, and must be removed. The GATT ruling outraged

environmentalists and led to concern that trade agreements could limit the nation's ability to pass and enforce environmental measures.

### NAFTA AND ENVIRONMENT

NAFTA is a step beyond GATT, in that it commits the United States, Mexico, and Canada to gradually lift all tariffs and barriers to trade between the three countries. The environmental issues raised by the prospect of the United States entering a free-trade agreement with a developing country fall into three categories:

- First, that the agreement will open to challenge our federal, state, or local environmental laws as barriers to trade;
- Second, that lax environmental enforcement in Mexico will entice American companies to move there to escape high costs of environmental compliance in the United States, or at the very least that Mexican companies will have an unfair cost advantage vis à vis American competitors;
- Third, that economic growth without environmental safeguards will worsen Mexico's already gloomy environmental conditions, including the water and air contamination in the border region with the United States.

### NAFTA'S SIDE AGREEMENTS

President Clinton, in a campaign speech, promised to negotiate side agreements that would ease those concerns. In late August the agreements were completed. They contain procedures for lodging complaints that environmental laws are not being enforced, for investigation of complaints, and for a backup system

of fines and trade sanctions for persistent, unresolved problems. My part in their development included hundreds of discussions with environmental groups, trade negotiators, business people, and other Congressional staffers, in helping to formulate how the environmental issue should be handled. This fall, NAFTA will be submitted to Congress for approval, and we will see whether it was all for naught.

### LESSONS FOR A SCIENTIST

Was I successful in raising the issue of the need to improve Mexico's science and engineering capacity as part of an environmental program? In a negotiated document like a trade pact, it's hard to claim influence. But I was pleased to see how receptive many people are to the issue, once it is raised. On the other hand, it is clearly not at the top of many people's priority list. Lawyers are concerned about legal implications; advocacy groups clamor for openness; economists look for incentives. The moral is simple: if you as a scientist think it's appropriate to introduce science into an issue, don't count on anyone else to do it for you, but you may find support once you enter the fight. ■

*Margaret Goud Collins has completed her term as the GSA Congressional Science Fellow for 1992-1993. She served on the staff of the Senate Committee on Environment and Public Works. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, which supported 47% of the program with a \$23,000 grant under Assistance Award No. 1434-92-G-2251. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.*



The Geological Society of America

## Congressional Science Fellowship 1994-1995



The Geological Society of America is accepting applications for the 1994-1995 Congressional Science Fellowship. The Fellow selected will spend a year (September 1994-August 1995) 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 postdoctoral to mid-career earth scientists. 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 15, 1994

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Registration and housing information appeared in the June issue of *GSA Today*.

Technical Program Schedule appeared in the September issue of *GSA Today*.

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## CHARGING INTO THE FUTURE

### 1993 GSA ANNUAL MEETING

Boston, Massachusetts - October 25-28

John B. Hynes Convention Center - Boston Marriott Copley Place

## The Great Flood of '93

**Wednesday, October 27, 5:45 to 7:30 p.m.**  
**Hynes Convention Center, Ballroom B.**

*Cosponsored by GSA Divisions: Archaeological Geology, Engineering Geology, Hydrogeology, and Quaternary Geology and Geomorphology.*

The most important hydrogeologic event in historic times occurred this spring and summer on the Mississippi-Missouri river drainage in the agricultural heartland of the United States. We have a rare opportunity to view video and remote sensing imagery of the affected floodplain. Flood waters rose above the previous historic flood level of 1973 for more than three weeks, creating one of the most significant tests of engineering design assumptions and climatological effects modeling known to scientists and engineers.

We will be opening with a presentation of the historical effects of large flooding on the Mississippi River, showing a video presentation developed by the U.S. Army Corps of Engineers, discussing a Quaternary overview of climatic factors that contributed to this event,\* and addressing the human impacts of the event due to highway network interruptions and costs.

Co-conveners: Rhea L. Graham, Engineering Geology Division and Stephen G. Wells, Quaternary Geology and Geomorphology Division. Speakers expected are: James Knox, University of Wisconsin; Wayne Wendland, University of Illinois; Nick Melsher, U.S. Geological Survey; Roy Trent, Federal Highway Administration; Joseph Kissane, Mark Alvey, and Gary Dyhouse, all of the Engineering Branch of the U.S. Army Corps of Engineers, St. Louis District.

\* *learning about U.S. Geological Survey efforts to disseminate monitoring information.*



## 1993 GSA Annual Meeting Contributors and Sponsors

For the Boston Annual Meeting, GSA has received generous contributions to both the general meeting fund and to specific events. GSA is most appreciative of this support and thanks the following companies. Companies with bold listing have contributed \$500 or more to the meeting. Those in uppercase have contributed \$1000 or more.

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## GSA and Boston College Host Top Seniors

GSA and Boston College will be sponsoring a group of top undergraduate seniors during the Annual Meeting. This program, now in its third year, has been a great success with the invited students and faculty of sponsoring universities. Arrangements have been made by GSA to fund housing and registration fees for these select Top Seniors. Boston College will serve as host to these seniors by providing a local field trip and other activities. Travel expenses will be paid for by the student's university.

The program exposes the best and brightest of the seniors to the broad range of career opportunities in geology. The students get a chance to meet with professionals in various fields and to learn about the latest research. By necessity, this program has been carried out by invitation only. The first 34 schools to respond to the invitation have sent Top Seniors to Boston. A list of these schools is below.

Appalachian State University ■ Edinboro University of Pennsylvania ■ Indiana University ■ Lawrence University ■ Miami University ■ Michigan State University ■ Old Dominion University ■ Pennsylvania State University ■ Purdue University ■ Rensselaer Polytechnic Institute ■ Rider College ■ Rutgers, The State University, New Brunswick ■ Southeast Missouri State University ■ Saint Louis University ■ SUNY, College at Buffalo ■ SUNY, College at New Paltz ■ SUNY, College at Oneonta ■ Texas A&M University ■ University of Alabama ■ University of Arkansas at Little Rock ■ University of California, Santa Barbara ■ University of Colorado at Denver ■ University of Florida ■ University of Illinois at Urbana-Champaign ■ University of Kentucky ■ University of New Orleans ■ University of North Carolina at Wilmington ■ University of Pennsylvania ■ University of Tennessee, Knoxville ■ University of Texas at Dallas ■ University of Texas at San Antonio ■ University of Wisconsin—Eau Claire ■ Vanderbilt University ■ Washington State University

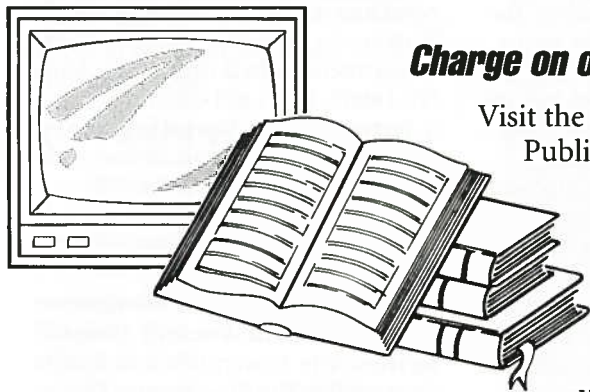




# 1993 Combined Publishers' Display

## GSA ANNUAL MEETING

Boston, Massachusetts ■ October 25–28



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## STUDENT TRAVEL GRANTS

The GSA Foundation will award matching grants up to a total of \$3500 each to the six GSA Sections. The money, when combined with equal funds from the Sections, will be used to assist GSA Student Associates traveling to the 1993 GSA Annual Meeting in Boston in October and to the 1994 Section meetings. Contact your Section Secretary for application procedures.

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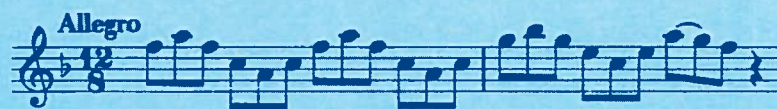
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# Bravo Boston GSA Chorale

Tuesday, October 26, 8:00 p.m.

Jordan Recital Hall, New England Conservatory of Music



**Come and see  
one hundred singing geologists and friends  
perform Mozart's Requiem  
with a professional orchestra.**

As happened to many who attended the 1988 Denver GSA meeting, with the stellar performance by the GSA Centennial Orchestra of geologists, you won't want to say for years to come, "I heard about the Bravo Boston GSA Chorale, but I missed it."

This will be a spectacular evening at beautiful Jordan Hall on the campus of the New England Conservatory of Music, an easy ten minute walk from the Hynes Convention Center and surrounding hotels. Jordan is one of the best classical recording halls—the setting is hardwood, the acoustics are exquisite, and the seats are comfortable, arched in a handsome two-tier horse-shoe pattern with no obstructed views anywhere.

The conductor, John Finney, is well known in the Boston musical community. Maestro Finney has recorded on several international labels and is director of the University Chorale at Boston College and associate conductor of the famous Handel and Haydn Society.

In addition to the feature performance of Mozart's Requiem by the Bravo Boston GSA Chorale, several other popular pieces with your geological colleagues as accomplished soloists will also be performed.

### PROGRAM

**Sonata in D major** Purcell  
**Trumpet Tune**

Robert Hazen, *trumpet*

**Concerto in G minor for Two Cellos** Vivaldi  
Tom Hoisch and Holly Stein, *cellos*

— Intermission —

**Requiem in D minor** Mozart  
Bravo Boston GSA Chorale

A limited number of tickets remain for this not-to-be missed extravaganza. Purchase your tickets on site at the Hynes Convention Center in Boston early in the week. **IF** you are a last-minute singer (there are still a few openings in the Chorale) ... **OR ... IF** you have signed up to sing and have not received your August 12 information letter, call Holly Stein immediately at (703) 648-5326.



## NORTHEASTERN SECTION, GSA 29th Annual Meeting

**Binghamton, New York  
March 28-30, 1994**

The State University of New York at Binghamton, the Paleontological Research Institution of Ithaca, New York, and the New York State Geological Survey, Albany, will host the Northeastern Section of the Geological Society of America meeting at the Holiday Inn Arena in Binghamton, New York. The Eastern Section of SEPM, the Northeastern Section of the Paleontological Society (NE-PS), the Eastern and New England Sections of the National Association of Geology Teachers (ES-NAGT), and the Association for Women Geoscientists will be meeting with GSA's Northeastern Section. The meeting will be conducted from 8:00 a.m., Monday, March 27, to 5:00 p.m., Wednesday, March 30. Field trips and short courses will be held on Saturday, March 26, Sunday, March 27, and Wednesday, March 30.

### DETAILED INFORMATION

Information concerning registration, travel, accommodations, and activities will appear in the December 1993 issue of *GSA Today* and as part of the GSA Northeastern Section *Abstracts with Programs* for 1994. Requests for additional information or suggestions should be addressed to the General Chairman, H. Richard Naslund, to the Registration Coordinator, James E. Sorauf, or to the Abstracts Coordinator, Herman E. Roberson, all at  
Department of Geological Sciences  
and Environmental Studies  
State University of New York  
Binghamton, NY 13902-6000  
(607) 777-2264 or fax 607-777-2288  
E-mail: GEOMAIL@BINGVAXA

### LOCATION

Binghamton is located just north of the New York-Pennsylvania border at the confluence of the Susquehanna and Chenango rivers. The area is situated physiographically at the northern edge of the Appalachian plateau, the eastern edge of the Catskill Mountains, and the southern edge of the Finger Lakes District. The metropolitan area of approximately 200,000 is served by interstate routes 81 and 88, and state highway 17, providing excellent highway access from the entire Northeastern Section and from southeastern Canada. A modern airport with convenient shuttle service to downtown Binghamton is located north of town. Temperatures during March range from

the 30s to the 60s (°F); rain, snow, or sunshine can be expected.

### CALL FOR PAPERS

Papers are invited from students and professionals for presentation at oral and poster theme sessions and in general sessions. The format for the oral sessions will include 15 minutes for presentation and five minutes for discussion. Two projectors and two screens will be provided in each of the oral sessions. All slides must fit into a standard 35 mm carousel tray. The format for the poster sessions will include three hours of display time, with two hours specified during which the authors should be present for discussion. Each poster booth will include three 4' by 8' tack boards. Electrical outlets for poster sessions will not be available unless specifically requested in advance. Papers of regional interest to geologists in northeastern North America, as well as those of general interest to professionals, teachers, and the general public will be considered for oral or poster presentation.

### SYMPOSIA AND THEME SESSIONS

The following symposia and theme sessions have been proposed for the Binghamton meeting. Symposia generally include invited papers and selected volunteered papers, while theme sessions are generally composed entirely of volunteered papers. Additional symposia or theme sessions may be added. If insufficient papers are received for a proposed symposium or theme session, submitted papers will be considered for regular oral or poster sessions.

### Symposia

- 1. Northeast Hydrologic Problems: An Industrial Perspective.** Robert Demicco, Peter Demicco, and Brent Waters. c/o Robert Demicco, Department of Geological Sciences, State University of New York, Binghamton, NY 13902-6000, (607) 777-2604.
- 2. What Can Clays Tell Us?: The Application of Clay Mineralogy to Geologic Investigations (in the Northeast).** Michele Hluchy and Jeff Walker. c/o Michele Hluchy, Geology Department, Alfred University, Alfred, NY 14802, (607) 871-2203.
- 3. Intraspecific Variation.** (Sponsored by the Northeastern Section of the Paleontological Society) Robert Titus, Department of Geology, Hartwick College, Oneonta, NY 13820, (607) 432-4200.
- 4. Geochemistry and Movement of Modern and Ancient Crustal Brines.** Tim Lowenstein and Robert Darling. c/o Tim Lowenstein, Department of Geological Sciences, State University of New York, Binghamton, NY 13902-6000, (607) 777-2604.

### Theme Sessions:

- 1. Use of Computer Graphics for Geologic Instruction.** William J. Brennan, Department of Geological Sciences, SUNY at Geneseo, Geneseo, NY 14454, (716) 245-5291.
- 2. Mesozoic Magmatism.** H. Richard Naslund, Department of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-4313.
- 3. Undergraduate Research** (a poster session sponsored by the Geology Division of the Council on

*Northeastern continued on p. 265*

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### Hydrology and Water Management in the Humid Tropics

Hydrological Research Issues and Strategies  
for Water Management  
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Maynard M. Hufschmidt,  
and John S. Gladwell  
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### The Jurassic of the Circum-Pacific

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Undergraduate Research). Barbara Tewksbury, Department of Geology, Hamilton College, Clinton, NY 13323, (315) 859-4713.

**4. Advances in Earth Science Education, K-12.** Sponsored by the Northeastern and New England Sections of NAGT.

**5. Recent Advances in the Geology of the Adirondack Mountains.** Robert Badger, Department of Geology, SUNY at Potsdam, Potsdam, NY 13676, (315) 267-2286.

### ABSTRACTS

Abstracts are limited to about 250 words and must be submitted on the official 1994 GSA abstract form, available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020.

Send one original and five copies of abstracts to be considered to: H. Richard Naslund, Department of Geological Sciences, State University of New York, Binghamton, NY 13902-6000, (607) 777-4313. Authors who think that a paper might be suitable for inclusion in a symposium or theme session should send an extra copy of the abstract to the appropriate contact person.

Abstracts will be reviewed for content, originality, and format. Only one volunteered paper may be presented by each individual, although a person may also be a coauthor on papers presented by others. Additional papers may be presented by an individual if they are invited for a symposium.

Abstracts are due by December 2, 1993.

### SHORT COURSE

One short course has been proposed for the Binghamton meeting. This course will be on Sunday, March 27, on the campus of the State University of New York at Binghamton. Preregistration is required.

**Emerging Software Technologies and Their Applications in Geology.** Cornelia Yoder, Department of Geology, Syracuse University, Syracuse, NY 13244, (315) 443-2672.

### FIELD TRIPS

Proposed field trips for the Binghamton meeting are listed below. Additional trips may be added at a later date. The actual trips run will depend on weather and enrollment. All trips will depart from and return to the Holiday Inn Arena, Binghamton, New York.

**Devonian Sedimentary Environments in New York State.** Saturday, March 26 to Sunday, March 27. Leader: John S. Bridge.  
**Geomorphology and Environmental Geology in the Binghamton Area.** Sunday, March 27. Leader: Marie Morisawa.

**Local Geology in the Binghamton Area.** Wednesday, March 30. Leaders: SUNY Binghamton staff.

### EXHIBITS

Exhibit space will be available at the Holiday Inn Arena, and snacks and refreshments will be available for exhibit visitors. Exhibit booths (8' by 10'), framed with drapes and containing a table and chairs, will be available for exhibitors wishing to present exhibits during the entire meeting, from 8:00 a.m., Monday, March 27, to noon Wednesday, March 30. Reduced rates will be available for educational or nonprofit groups or institutions.

Three special half-day *Theme Exhibit Sessions* are planned for (1) graduate programs in the Geological Sciences, (2) state geological surveys, and (3) environmental consulting companies. These special theme exhibit sessions are designed to encourage participation by groups that might not wish to have an exhibit run during the entire meeting, and to provide a time and place for exhibit visitors to examine a variety of groups or programs with similar interests. During these special exhibit sessions, tables and chairs will be available in a central area without booths at a reduced exhibit price. Exhibitors renting a booth for the entire meeting will be provided with a table and chairs at the appropriate special theme exhibit sessions at no additional cost. For further information and space reservations, contact: Department of Geological Sciences, State University of New York, Binghamton, NY 13902-6000, (607) 777-4313; fax 607-777-2288; or E-mail: GEOMAIL@BING-VAXA.

### SPECIAL EVENTS

#### Breakfast

Association for Women Geoscientists

#### Luncheons

Paleontological Society NE Section Luncheon

NAGT Business Meeting and Luncheon

#### Receptions

Welcome Reception, 6-10 p.m., Sunday, March 27.

GSA Northeastern Section Reception and Banquet, Tuesday, March 29.

#### Other Events

GSA Northeastern Section Management and Board Meeting  
5 km Fun Run

#### Guest Activities

The Binghamton area offers a wide variety of activities that may be of interest to guests, including the Roberson Museum and Science Center, the Discovery Center (a hands-on children's museum), the Ross Park Zoo, the Kopernik Observatory, and the Anderson Center for the Arts. There are a large number of additional museums and attractions within a 1-2 hour drive of the Binghamton area, including the Corning Museum of Glass, Watkins Glen Park, wineries of the Finger Lakes region, the Baseball Hall of Fame in Cooperstown, and the Tioga Central Railroad & Museum. A representative of the Binghamton area Chamber of Commerce will be available at the convention center to assist you with your sightseeing plans.

### EARTH SCIENCE EDUCATION

Special activities are planned for K-12 earth science educators. A special poster session, "New Advances in Earth Science Education K-12", is planned, as well as a field trip to the Kopernik Observatory and Science Center in Vestal, New York, and a local geology field trip for K-12 earth science educators. To encourage attendance of pre-college earth science teachers, on-site registration fees will be reduced for K-12 school teachers in public and private schools.

### REGISTRATION

Anyone wishing to attend oral sessions, poster sessions, or exhibits must register for the meeting. Please check the December 1993 issue of *GSA Today* and *GSA Northeastern Section Abstracts with Programs* for 1994 for student and professional registration fees and for registration forms. A reduced one-day registration fee will be available for

### CALL FOR NOMINATIONS

## 1994 John C. Frye Environmental Geology Award

In cooperation with the American Association of State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a \$1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund.

The 1994 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in Seattle. Members of the selection committee are Chairman Frank E. Kottlowski, New Mexico Bureau of Mines and Mineral Resources; John P. Kempton, Illinois Geological Survey; and Diane L. Conrad, Vermont Division of Geology and Mineral Resources.

### CRITERIA FOR NOMINATION

Nominations can be made by anyone, based on the following criteria:

- (1) paper must be selected from GSA or state geological survey publications,
- (2) paper must be selected from those published during the preceding three full calendar years,
- (3) nomination must include a paragraph stating the pertinence of the paper,
- (4) **nominations must be sent to Executive Director, GSA, P.O. Box 9140, Boulder, CO 80301. Deadline: March 31, 1994.**

### BASIS FOR SELECTION

Each nominated paper will be judged on the uniqueness or significance as a model of its type of work and report and its overall worthiness for the award. In addition, nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers).

### 1993 AWARD RECIPIENT NAMED

The 1993 award will be presented at the GSA Annual Meeting in Boston to Robert F. Walters, Walters Drilling Company and Adjunct Senior Scientist of Kansas Geological Survey, for his paper *Gorham Oil Field, Russell County, Kansas*, Bulletin 228 (1991), Kansas Geological Survey. The report describes environmental impacts of the birth, development, and decline of a large oil field, as well as the successful mitigation efforts.

Visit the

## GSA Bookstore

at all 1994 Section Meetings

those unable to attend more than one day of the conference. To encourage attendance of precollege earth science teachers, on-site registration fees will be reduced for K-12 school teachers in public and private schools. Guests who wish to attend only luncheons, dinners, receptions, and guest activities may register at a greatly reduced fee.

**Preregistration deadline: March 4, 1994.**

### HOUSING

A large block of rooms has been reserved for meeting participants and their guests at the Holiday Inn Arena convention facility. The Holiday Inn Arena is conveniently located in downtown Binghamton, with easy access from I-81. All of the meeting exhibits will be located within the hotel building, and stores, travel agencies, and restaurants are within easy walking distance. Parking is available on site. For conference planning and to take advantage of attractive conference room rates, it is important to reserve your room before February 27, 1994. Guaranteed rates are \$65 single, \$70 double, \$80 triple, or \$90 for four persons. ■

### Geological Software for Research · Analysis · Illustration Presentation · Recreation · Education

We offer a growing collection of affordable, high quality geological software tools:

**GeoSymbol:** geological symbol set (\$75, IBM or Macintosh);

**Parallax 3D:** easy 3D shape illustration (\$99);

**Quake!**: earthquake simulation, with computer source code in BASIC & Pascal (book only, \$9.95; book+MSDOS disk, \$19.95);

**RockFill:** 66 CorelDRAW fill patterns (\$50);

**SpheriStat:** stereonet analysis and plotting (professional \$85, student \$45).

#### New releases:

**GMM/Geological Map Maker for Windows 3.1:** Turn your field measurements into structural maps and import them into Windows 3.1 programs, \$199.

**MetPet, version 2.0:** Plot metamorphic mineral compositions and calculate mineral reactions, \$150.

Prices in US dollars. Contact us for ordering information and Canadian prices.

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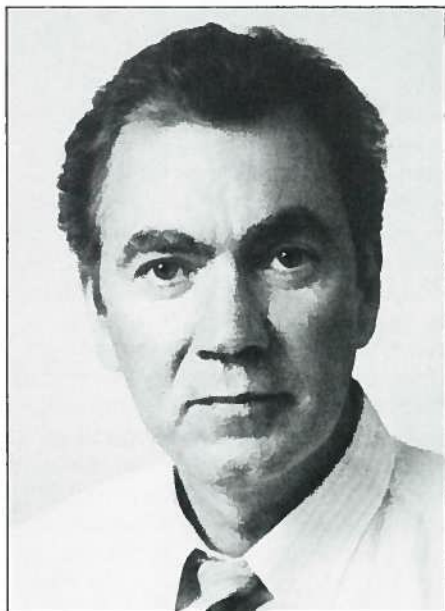


# 1993 Honorary Fellows Named

Lee Gladish

The achievements of three preeminent geoscientists will be recognized at the 1993 GSA Annual Meeting in October. GSA Council members, at their meeting last May, voted to confer Honorary Fellowship upon the three, who individually are known internationally for their expertise in such diverse areas as the geology of Iceland, the birth and evolution of southern South America, the geochemistry of the Lesser Antilles, and the petrology of lunar rocks. They are Kristján Sæmundsson, Sellfos, Iceland; Victor A. Ramos, Buenos Aires, Argentina; and George Malcolm Brown, Oxfordshire, United Kingdom.

GSA Honorary Fellowships are awarded to outstanding geologists who have distinguished themselves internationally through their geological work or have rendered special service to the Society. Most Honorary Fellows live outside North America.



## Kristján Sæmundsson

On the practical side, Sæmundsson's work has had a tremendous impact on his nation of Iceland. His field studies of structure and stratigraphy over vast regions of Iceland, augmented by fine-scale mapping, have helped develop new geologic methods for well siting and geothermal field development that provide services vital to the economic welfare and quality of life of his country. He has long played a key role in the National Geothermal Program, a program that has been responsible for the siting of boreholes throughout Iceland, for the discovery and development of low-temperature geothermal areas for heating and agricultural purposes. More than 85% of the population in Iceland now utilizes geothermal energy for heating and

domestic hot water, while geothermal electricity supplements hydro in such a way that coal- or petroleum-powered plants are unnecessary. Sæmundsson cannot go into a grocery store in Sellfos without being recognized and lauded by those he has helped to locate and develop geothermal wells.

On the academic side, Sæmundsson is recognized internationally as the expert on Icelandic geology. This is substantiated by his authorship of the bedrock Geologic Map of Iceland (1:500,000); the 1:250,000 geologic maps of southwest, south, and northeast Iceland; his 1979 summary paper of the geology of Iceland; and his 1986 summary paper on subaerial volcanism in the western North Atlantic. In addition, he was instrumental in providing the geological "ground truth" for much of the magnetostratigraphy in Iceland, a critical locale in the development of the paleomagnetic time scale. His most recent paper, on the geology of the Thingvallavatn area, is an elegant exposition with impressive photographs and illustrations of the geology of a subaerial segment of the Mid-Atlantic Ridge.

Born in Iceland and educated in West Germany, Sæmundsson is currently chief geologist and head, Geology Section of Geothermal Division, National Energy Authority of Iceland. Concurrently, he serves as an instructor at the University of Iceland and as a consultant and adviser to Vikir-Orkint Ltd. for Kenya

To submit a nomination for Honorary Fellowship, use the criteria and form on page 267. Nomination materials must be received at GSA headquarters by February 1, 1994.

## GSA Division News

Divisions will be recognizing the following individuals at the 1993 Annual Meeting in Boston for their service to the Division and/or contributions to the geological sciences.

### Coal Geology Division

Edwin R. Landis, Distinguished Service Award  
Alexander R. Cameron, Distinguished Service Award  
James C. Cobb, Distinguished Service Award

### Engineering Geology Division

Don U. Deere, Distinguished Practice Award

### Hydrogeology Division

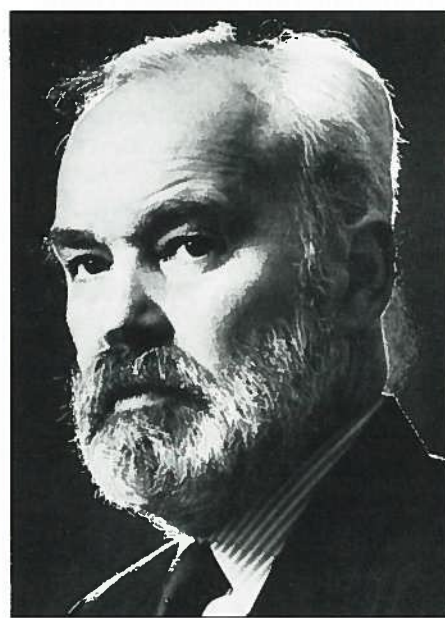
Paul R. Seaber, Distinguished Service Award  
David A. Stephenson, Distinguished Service Award  
Fred M. Phillips, 1994 Birdsall Distinguished Lecturer

### Quaternary Geology and Geomorphology Division

Victor K. Prest, Distinguished Career Award

For a listing of other award recipients to be honored at the Boston meeting, see page 175 of the July 1993 issue of *GSA Today*.

Power Company and the United Nations University Geothermal Training Programme. In recent years he has also served as an expert on geothermal resource evaluation and training in Turkey, Greece, and Djibouti.



## Victor A. Ramos

One of Victor Ramos's North American colleagues states "...several factors have contributed to Ramos's highly productive career. These include a real love of the earth sciences, a never-ending curiosity about how the earth works, a broad range of scientific interests, an incredible memory, and a quick mind. He is a walking encyclopedia on all aspects of South American geology. These characteristics have made him one of the outstanding synthesizers of both pre-Andean and Andean events." Many geologists from throughout the world would agree.

Although primarily a structural geologist and regional mapper, Ramos has collaborated on projects and published more than 150 papers on topics ranging from paleontology to geophysics

to geochemistry. His publications have been of immense significance in placing the geology and tectonics of his region in a modern context. It is difficult to find a paper on Argentine or Andean geology that does not reference his work. He was an early convert to the theory of plate tectonics and was instrumental in introducing the concepts in Argentina. At the same time, he has been a leader in interpreting Andean geology in plate-tectonic terms. He was also an early convert to the terranes concept, and his papers on the Chilena terrane in 1986 and on Latin American terranes in 1988 are widely recognized and quoted.

He has made innumerable original data contributions through his own regional mapping, a program he currently conducts with his students from the University of Buenos Aires, where he serves as professor and chairman of the Department of Geological Sciences. He has been the recipient of awards from OAS and UNESCO for remote sensing studies, from the Circum-Pacific Council of Hydrocarbon and Mineral Resources for comparative studies of the Andes, from ORSTOM (French overseas geological research organization) for seismotectonics of the Andes, and from the Guggenheim Foundation for comparative studies of the Andes and North American mountain chains. His current research involves the structural geology of the Andean fold and thrust belt of the Aconcagua region of Chile-Argentina.

Born in Argentina, Ramos earned his bachelor's and doctoral degrees at the University of Buenos Aires and his master's degree at the International Training Centre for Aerial Survey, Delft, Netherlands.



## George Malcolm Brown

If one were to use the British tendency for understatement, one might say that Sir Malcolm Brown performed useful petrological and geochemical studies. However, it is no understatement to say that he has made major contributions to interpretation of genetic relations among all the major groups of igneous rocks, including the lunar rocks he studied for years as a NASA principal investigator.

He is a pioneer in studying gravitational differentiation of layered igneous intrusions and its effect on mineral and chemical fractionation patterns. Early in his career he worked extensively in the Brito-Icelandic Tertiary volcanic province, bringing new interpretations to the geology of the Skaergaard complex in Greenland and to the ultramafic intrusions of the island of Mull; these

works in a sense defined his main focus of interest. Brown was a major investigator in pyroxene phase equilibria and its use in geothermometry and geobarometry. He did a major study on the genesis of volcanic rocks from 15 islands of the Lesser Antilles, cooperating with seismologists to understand the relation between subduction and explosive volcanism and processing 1500 new rock analyses to better understand partial melting and magma-chamber fractionation processes. He used this information to understand the genesis of the different andesite magma types. He performed petrological and geochemical studies to understand the mineralogy, petrology, and genesis of the different lunar magma-types. His contributions to understanding of pyroxene phase relations arose from petrologic studies of rocks he sampled in the field, and also included experimental and analytical work at the Geophysical Laboratory of the Carnegie Institution in Washington, D.C. In almost every branch of igneous petrology—from granites to mantle rocks—by means of field work, analytical techniques, and phase equilibria studies, Malcolm Brown has made significant contributions.

Brown was a Fellow at the Geophysical Laboratory of the Carnegie Institution of Washington, D.C., in 1966–1967 and left to become professor and head of the Department of Geology at Durham University. He also taught at Oxford University. For more than a decade he served as director of the British Geological Survey, for which he was knighted by the Queen of England. ■



# About the Honorary Fellow Program

Below you will find a form to be used in nominating candidates for Honorary Fellowship in the Geological Society of America. Each year this honor is bestowed on non-North Americans who live and work outside of North America and have distinguished themselves in geological investigations or in notable service to the Society. Under exceptional circumstances, North Americans have been named Honorary Fellows. This amendment to the bylaws was made in 1969

when the Apollo II astronauts who first walked on the moon were elected.

The program was established by the GSA Council in 1909, and since then, except during a few war years, one or more Honorary Fellows have been elected annually. Most Honorary Fellows have been elected after many years of outstanding and internationally recognized contributions to the science. At present there are 59 living geologists who have received this honor.

The Council of the Society encourages the membership to submit names of qualified candidates for this honor. In preparing a nomination, it is imperative that the original research and scientific advances of the candidate be stressed. All supporting data, especially degrees received, publications, positions, etc., should also be verified by the nominator. Use the form below for nominating a candidate for Honorary Fellowship. ■

*For a complete listing of past recipients of the Penrose Medal, Day Medal, Young Scientist Award (Donath Medal), and Honorary Fellows, please see p. 270.*

See p. 268 for additional nomination procedures.

**PENROSE MEDAL, DAY MEDAL, OR HONORARY FELLOWSHIP**

## THE GEOLOGICAL SOCIETY OF AMERICA Nomination for Penrose Medal, Day Medal, or Honorary Fellowship (please circle one)

NAME OF CANDIDATE: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

Telephone: \_\_\_\_\_

**REQUIRED INFORMATION** (Please attach)

**BIOGRAPHICAL INFORMATION**

- Suggested sources: *American Men and Women of Science*
- Who's Who in America*
- GSA Service Record (obtainable from headquarters)
- Other \_\_\_\_\_

**SUMMARY OF SCIENTIFIC CONTRIBUTIONS TO GEOLOGY**

Not more than 200 words.

**SELECTED BIBLIOGRAPHY**

No more than 20 titles.

**LETTERS OF SUPPORT**

Nominations for any one of these three awards **MUST BE SUPPORTED** by signed letters from five (5) GSA Fellows or Members. The letters may be attached to this form or may be sent to the Executive Director separately. Supporting letters must discuss the original research and scientific advances of the candidates. Please also verify all other supporting data.

Name of person making the nomination: \_\_\_\_\_

Address: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

Letters of support will be submitted by:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

RETURN TO: Executive Director  
The Geological Society of America  
P.O. Box 9140  
Boulder, CO 80301  
(303) 447-2020

DEADLINE: Completed nomination materials must be received by **February 1, 1994**.



## GSA Division and Section Grants 1993

June Forstrom, GSA Research Grants Administrator

### DIVISION RESEARCH GRANTS

Seven of the 12 GSA divisions offer grants for outstanding student research. Divisions that do not currently offer grants are Archaeological Geology, Geoscience Education, History of Geology, International, and Planetary Geology.

#### Coal Geology Division

The Coal Geology Division presented its sixth annual Antoinette Lierman Medlin Scholarship Award in 1993 to Ken Saunders, Dalhousie University, for his proposal titled "Sedimentology of the Late Carboniferous Coal-bearing Hub Cyclothem, Sydney Mines Formation, Cape Breton Islands, Canada." The Division considers proposals from any full-time graduate student who is conducting research in coal geology.

#### Engineering Geology Division

The fourth annual Engineering Geology Division Anniversary Award for outstanding student research was presented this year to Susan S. Richards, a Ph.D. candidate at Kent State University. The title of her research project is "Relationships Between Clay Mineralogy and Engineering Properties of Clay Soils."

#### Geophysics Division

The Geophysics Division presented its sixth annual Allan V. Cox Student Research Award in 1993 for an outstanding student research proposal submitted to the GSA Research Grants Program. James C. Pickens, a Ph.D. candidate at the University of Massachusetts, Amherst, received the award for his research project titled "The Brunhes-Matuyama Transition of the Tatara-San Pedro Volcanic Complex, Chile."

#### Hydrogeology Division

The fourth annual awards for outstanding student research from the Hydrogeology Division were presented in 1993 to five students: Susan J. Altman, Pennsylvania State University, University Park, for "Transport of Nutrients in Groundwater Flowing Through Porous Media and Shallow Bedrock Beneath Farmland and Removal of Nutrients in the Riparian Zone"; Sandeep Burman, University of Minnesota, Minneapolis, for "Mathematical and Physical Scale Modelling for Determination of Ground Water Sensitivity to Surface Generated Contaminants"; Marc J. Hinton, University of Waterloo, for "The Role of Groundwater Flow on Stream Discharge and Chemistry in Glacial Till Watersheds"; Barbara J. Mahler, University of Texas, Austin, for "Sediment-Contaminant Transport in Karst Terrains"; and Piyush Srivastav, University of Nebraska, Lincoln, for "Wetlands' Impact on Water Quality in Sandhills of Nebraska."

#### Quaternary Geology and Geomorphology Division

The Quaternary Geology and Geomorphology Division awarded Mackin Grants to two students in 1993. Joseph M. Licciardi, M.S. degree candidate at Oregon State University, will study "Quaternary Aminostratigraphy of the Pluvial Lake Chewaucan Basin, Eastern Oregon." Joseph A. Mason, Ph.D. candidate at the University of Wisconsin, Madison, received the award for his project titled "Effects of Glacial-interglacial Climatic Change on Accumulation and Long-term Storage of Sediment in the Root River Basin, Southeastern Minnesota."

Thirty-nine Mackin Grants have been awarded since the Division made its first award in 1974.

#### Sedimentary Geology Division

The Sedimentary Geology Division presented its seventh annual award for an outstanding student research proposal submitted to the GSA Research Grants Program to Michael C. Pope, Ph.D. candidate at Virginia Polytechnic Institute and State University. The award was for his research project titled "Cyclic Sedimentary and Diagenetic Record during Ordovician Greenhouse to Icehouse Transition."

#### Structural Geology and Tectonics Division

The Structural Geology and Tectonics Division presented its eighth annual award for outstanding student research in 1993. The recipient is Jed Leigh Mosenfelder, M.S. degree candidate at Stanford University. His project title is "Emplacement History of the Oman Ophiolite."

### SECTION RESEARCH GRANTS

#### North-Central Section

The North-Central Section of GSA awarded grants to undergraduate students who attend a college or university within the North-Central Section geographic area. Recipients are Patricia Fay DuBois, Washington University, for "Mineralogic and Morphologic Study of Crinoids in the Arkansas Novaculite, Broken Bow, Oklahoma"; Mary McNeil, University of Akron, for "Post-depositional History of a Marine Limestone"; Thomas J. Needs, Jr., University of Akron, for "Comparison of Algal Carbonate and Aragonite Muds from Moonrock Pond, San Salvador Island, Bahamas"; Lisa Sack, University of Manitoba, for "The Paleolimnology and Paleohydrology of Little Manitou Lake, Saskatchewan"; Andrea K. Sykora, University of Wisconsin-River Falls, for "Jointing in Ordovician Rocks on Either Side of the Hudson-Afton Horst in Wisconsin and Minnesota"; and Mei Leng Wong, Western Michigan University, for "Detection of a Reef in Allegan County, Michigan, Using Gravity Methods."

Division and Section Grants continued on p. 272

## Call for Nominations for 1994 Penrose and Day Medals and Honorary Fellows

Nominations for GSA's Penrose and Day Medals and for Honorary Fellowships of the Society are due at headquarters by **February 1, 1994**. Members and Fellows of the Society are encouraged to participate in this important process by nominating candidates for these high honors.

#### Penrose Medal

The Penrose Medal was established in 1927 by R.A.F. Penrose, Jr., to be awarded in recognition of eminent research in pure geology, for outstanding original contributions or achievements that mark a major advance in the science of geology. The award is made only at the discretion of the Council. Nominees are selected by the Council, may or may not be members of the Society, and may be from any nation. Penrose's sole objective in making the gift was to encourage original work in purely scientific geology. **Scientific achievements should be considered rather than contributions in teaching, administration, or service. Mid-career scientists who have already made exceptional contributions should be given full consideration for the award.**

#### Day Medal

The Day Medal was established in 1948 by Arthur L. Day to be awarded annually, or less frequently, at the discretion of the Council, for outstanding distinction in contributing to geologic knowledge through the application of physics and chemistry to the solution of geologic problems. Day's intent was to recognize outstanding achievement and inspire further effort, rather than reward a distinguished career. **Scientific achievements should be considered rather than contributions in teaching, administration, and service.**

#### Honorary Fellows

Geologists who have distinguished themselves in geological investigations or in notable service to the Society may be elected as Honorary Fellows. In practice, nearly all candidates are non-North Americans who live and work outside of North America. The most noteworthy exceptions were astronauts.

Most Honorary Fellows have been elected after many years of outstanding and internationally recognized contributions to the science.

#### How To Nominate

To ensure thorough consideration by the respective committees, please submit for each candidate a brief biographical sketch, such as used in *American Men and Women of Science* and *Who's Who in America*, a summary of the candidate's scientific contributions to geology that qualify the individual for the award, and a selected bibliography of no more than 20 titles.

A nomination for any one of these three awards **MUST BE SUPPORTED** by signed letters from each of five (5) GSA Fellows or Members. The letters may be attached to this form or may be sent to the Executive Director separately. For Honorary Fellow nominations, please *verify degrees received, publications, positions held, etc.* The names of unsuccessful candidates proposed to the Council by the respective committees will remain for consideration by those committees for three years. **FOR THOSE STILL UNDER CONSIDERATION, IT IS RECOMMENDED THAT AN UPDATED LETTER OF RENOMINATION BE SENT TO THE EXECUTIVE DIRECTOR.**

The deadline for receipt of nominations at the office of the Executive Director is **February 1, 1994**.

Please use the form on page 267 for submitting the name of a candidate for any one of the awards.

Recipients of the awards to date are listed on p. 270. ■

## GSA 50-Year Fellows Honored

GSA annually honors those individuals who have attained their 50th year of membership in the Society. Each of the 50-year members listed below, all of whom are GSA Fellows, will receive a specially designed lapel pin and a certificate of recognition.

This list of 50-year Fellows includes all current members who joined the Society in 1944.

**John Eliot Allen**  
Portland, Oregon

**Robert L. Bates**  
Columbus, Ohio

**Frederick Betz, Jr.**  
Williamsburg, Virginia

**John W. Butler, Jr.**  
Coos Bay, Oregon

**Eugene Cameron**  
Madison, Wisconsin

**Charles S. Denny**  
New London, New Hampshire

**Parke A. Dickey**  
Owasso, Oklahoma

**John Van N. Dorr II**  
Bethesda, Maryland

**J. Wyatt Durham**  
Kensington, California

**Kenneth O. Emery**  
North Falmouth, Massachusetts

**John P. Gries**  
Rapid City, South Dakota

**Konrad B. Krauskopf**  
Stanford, California

**J. David Love**  
Laramie, Wyoming

**Robert L. Nichols**  
Seminole, Florida

**S. Spencer Nye**  
Brownsville, Texas

**E. F. Osborn**  
State College, Pennsylvania

**Benjamin M. Page**  
Stanford, California

**Lincoln R. Page**  
Melvin Village, New Hampshire

**Frederick H. Pough**  
Reno, Nevada

**Laurence L. Sloss**  
Evanston, Illinois



## Call for Nominations for 1994 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 \$15,000, was endowed by Dr. and Mrs. Fred A. Donath.

**For the year 1994, only those candidates born on or after January 1, 1959, are eligible for consideration.** In choosing candidates for the Young Scientist Award, scientific

achievement and age will be the sole criteria. Nominations for the 1994 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 1994 Young Scientist Award must be received at GSA headquarters by **February 1, 1994**. Use the form below for submitting the name of a candidate for the Young Scientist Award. ■

## Call for Nominations for 1994 GSA 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, 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. Letters of nomination and any

supporting information should be addressed to Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. ■

**Deadline for nominations for 1994 is March 1, 1994.**

Recipients to date:

1988 . . . . .	Campbell Craddock Robert D. Hatcher, Jr. Eldridge M. Moores William A. Thomas
1990 . . . . .	William B. Heroy, Jr.
1991 . . . . .	Dorothy M. Palmer
1992 . . . . .	A. R. (Pete) Palmer
1993 . . . . .	Michel T. Halbouty

1994 YOUNG SCIENTIST AWARD (DONATH MEDAL)

### THE GEOLOGICAL SOCIETY OF AMERICA Nomination for 1994 Young Scientist Award (Donath Medal)

NAME OF CANDIDATE: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

Date of birth: \_\_\_\_\_

For the year 1994, only those candidates born on or after January 1, 1959, are eligible for consideration.

**REQUIRED INFORMATION** (Please attach)

**BIOGRAPHICAL INFORMATION**

Provide in a format similar to that found in *American Men and Women of Science, Who's Who in America*.

**SUMMARY OF SCIENTIFIC CONTRIBUTIONS TO GEOLOGY**

Not more than 200 words.

**SELECTED BIBLIOGRAPHY**

No more than 10 titles.

**LETTERS OF SUPPORT**

Nominations for the Donath Medal **MUST BE SUPPORTED** by signed letters from five (5) scientists. The letters may be attached to this nomination form or may be sent to the Executive Director separately.

Name of person making the nomination: \_\_\_\_\_

Address: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

Letters of support will be submitted by:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

RETURN TO: Executive Director  
The Geological Society of America  
P.O. Box 9140  
Boulder, CO 80301  
(303) 447-2020

**DEADLINE:** Completed nomination materials must be received by **February 1, 1994**.



## Help Direct GSA's Future

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 1995 officers and councilors must be received at GSA headquarters no later than **FEBRUARY 15, 1994**.

Please send nominations and back-up material to Administrative Department, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

## GSA Medalists and Honorary Fellows

### Richard A.F. Penrose, Jr., Medalists

1927 Thomas Chrowder Chamberlin	1950 Morley Evans Wilson	1972 Wilmot H. Bradley
1928 Jakob Johannes Sederholm	1951 Pentti Eskola	1973 M. King Hubbert
1929 <i>No award given</i>	1952 George Gaylord Simpson	1974 William Maurice Ewing
1930 Francois Alfred Antoine Lacroix	1953 Esper S. Larsen, Jr.	1975 Francis J. Pettijohn
1931 William Morris Davis	1954 Arthur Francis Buddington	1976 Preston Cloud
1932 Edward Oscar Ulrich	1955 Maurice Gignoux	1977 Robert P. Sharp
1933 Waldemar Lindgren	1956 Arthur Holmes	1978 Robert M. Garrels
1934 Charles Schuchert	1957 Bruno Sander	1979 J Harlen Bretz
1935 Reginald Aldworth Daly	1958 James Gilluly	1980 Hollis D. Hedberg
1936 Arthur Philemon Coleman	1959 Adolf Knopf	1981 John Rodgers
1937 <i>No award given</i>	1960 Walter Herman Bucher	1982 Aaron C. Waters
1938 Andrew Cowper Lawson	1961 Philip Henry Kuenen	1983 G. Arthur Cooper
1939 William Berryman Scott	1962 Alfred Sherwood Romer	1984 Donald E. White
1940 Nelson Horatio Darton	1963 William Walden Rubey	1985 Rudolf Trümpy
1941 Norman Levi Bowen	1964 Donnel Foster Hewett	1986 Laurence L. Sloss
1942 Charles Kenneth Leith	1965 Philip Burke King	1987 Marland P. Billings
1943 <i>No award given</i>	1966 Harry H. Hess	1988 Robert S. Dietz
1944 Bailey Willis	1967 Herbert Harold Read	1989 Warren Bell Hamilton
1945 Felix Andries Vening-Meinesz	1968 J. Tuzo Wilson	1990 Norman D. Newell
1946 T. Wayland Vaughan	1969 Francis Birch	1991 William R. Dickinson
1947 Arthur Louis Day	1970 Ralph Alger Bagnold	1992 John Frederick Dewey
1948 Hans Cloos	1971 Marshall Kay	1993 Alfred G. Fischer
1949 Wendell P. Woodring		

### Arthur L. Day Medalists

1948 George W. Morey	1964 James Burleigh Thompson, Jr.	1979 Walter M. Elsasser
1949 William Maurice Ewing	1965 Walter H. Munk	1980 Henry G. Thode
1950 Francis Birch	1966 Robert M. Garrels	1981 Donald L. Turcotte
1951 Martin J. Buerger	1967 O. Frank Tuttle	1982 Eugene M. Shoemaker
1952 Sterling Hendricks	1968 Frederick J. Vine	1983 Harmon Craig
1953 John F. Schairer	1969 Harold C. Urey	1984 Wallace S. Broecker
1954 Marion King Hubbert	1970 Gerald J. Wasserburg	1985 Freeman Gilbert
1955 Earl Ingerson	1971 Hans P. Eugster	1986 E-an Zen
1956 Alfred O. C. Nier	1972 Frank Press	1987 Don L. Anderson
1957 Hugo Benioff	1973 David T. Griggs	1988 Claude J. Allègre
1958 John Verhoogen	1974 A. E. Ringwood	1989 Dan McKenzie
1959 Sir Edward C. Bullard	1975 Allan Cox	1990 William S. Fyfe
1960 Konrad B. Krauskopf	1976 Hans Ramberg	1991 Ian Carmichael
1961 Willard F. Libby	1977 Akiho Miyashiro	1992 Susan Werner Kieffer
1962 Hatten Schuyler Yoder	1978 Samuel Epstein	1993 Hugh P. Taylor, Jr.
1963 Keith Edward Bullen		

### Young Scientist Award (Donath Medalists)

1989 Mark Cloos	1991 Brian Philip Wernicke	1993 Michael Gurnis
1990 Leigh Handy Royden	1992 John Peter Grotzinger	

### Honorary Fellows

Neil Armstrong	Augusto Gansser	Wallace S. Pitcher	Harrison Hagan Schmitt
Jean A. Aubouin	David Headley Green	Jean Piveteau	Eugen Seibold
Krzysztof Ludwik Birkenmajer	Dorothy Hill	Isabella Premoli-Silva	Ahti J. Simonen
Roland Brinkmann	Kenneth J. Hsu	Desmond A. Pretorius	Boris Sergeevich Sokolov
George Malcolm Brown	Jiqing Huang	B. P. Radhakrishna	Richard L. Stanton
S. Warren Carey	Valdar Jaanusson	Hans Ramberg	Rashid A. Khan Tahirkheli
Maria Bianca Cita	Emilie Jäger	Victor A. Ramos	Bernard P. Tissot
Michael Collins	Ihsan Ketin	John G. Ramsay	Livio Trevisan
William Compston	Teiichi Kobayashi	Alfred Rittmann	Rudolf Trümpy
Douglas Saxon Coombs	Hans Laubscher	Alexander B. Ronov	Guangzhi Tu
Gabriel Dengo	Henno Martin	Rupert W. R. Rutland	Harry B. Whittington
Kingsley C. Dunham	Michael W. McElhinny	Kristjan Saemundsson	Alwyn Williams
Stanislaw Dzulynski	German K. Müller	Rushdi Said	Yang Zun-yi
Hans Fuchtbauer	Mervyn Silas Paterson	Hitoshi Sakai	Quido Zaruba
William S. Fyfe	Leo Y. Picard	Mircea Sandulescu	

See page 267 and 269 for 1994 nomination forms.

## MEETINGS

### GSA Penrose Conferences

#### March 1994

**From the Inside and the Outside: Interdisciplinary Perspectives on the History of Earth Sciences**, March 19–21, 1994, San Diego, California. Information: Léo 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) 646-1420, fax 603-646-3922; Kenneth L. Taylor, Dept. of History of Science, University of Oklahoma, Norman, OK 73019-0315, (405) 325-2213, fax 405-325-2363.

#### April 1994

■ **Triple Junction Interactions at Plate Margins**, April 21–26, 1994, Eureka, California. Information: Virginia B. Sisson, Dept. of Geology and Geophysics, Rice University, P.O. Box 1892, Houston, TX 77251-1892, (713) 285-5234; Terry L. Pavlis, Dept. of Geology and Geophysics,

University of New Orleans, New Orleans, LA 70148, (504) 286-6797; David J. Prior, Dept. of Earth Sciences, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK.

#### June 1994

**Fractured Unlithified Aquitards: Origins and Transport Processes**, June 15–20, 1994, Racine, Wisconsin. Information: John A. Cherry, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada, (519) 885-1211, ext. 2892, fax 519-746-5644; David M. Mickelson, Dept. of Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St., Madison, WI 53706, (608) 262-7863, fax 608-262-0693; William W. Simpkins, Dept. of Geological and Atmospheric Sciences, 253 Science I, Iowa State University of Science and Technology, Ames, IA 50011, (515) 294-7814, fax 515-294-6049.

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### CALL FOR NOMINATIONS

## 1996 National Awards (Deadline: April 30, 1994)

Nominations for the national awards described below are being solicited for 1996. Each year GSA members have been invited to participate by recommending possible candidates.

Those who wish to make nominations are urged to do so by sending BACKGROUND INFORMATION and VITAE, and specifying the award for which the candidate is being submitted by **April 30, 1994**, to the GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, fax 303-447-1133. The nomination process is coordinated by AGI on behalf of its member societies, and a roster of candidates will be finalized by the AGI Member-Society Council at its Spring 1995 meeting for nomination to the respective offices sponsoring the national awards.

#### William T. Pecora Award

The Pecora Award, sponsored jointly by NASA and the Department of the Interior, is presented annually in recognition of outstanding contributions of individuals or groups toward the understanding of Earth by means of remote sensing.

The award recognizes contributions of those in the scientific and technical community as well as those involved in the practical application of remote sensing. Consideration will be given to sustained or single contributions of major importance to the art or science of the understanding of Earth through observations made from space.

#### National Medal of Science

The medal is awarded by the President to individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences."

There are now many younger American scientists and engineers who may be reaching a point where their contributions are worthy of recognition. The committee is giving increasing attention to these individuals as well as to those outstanding women and minority scientists who deserve recognition.

#### Vannevar Bush Award

The Vannevar Bush Award is presented from time to time to a person who, through public service activities in science and technology, has made an outstanding contribution toward the welfare of mankind and the nation.

The award is given to a senior statesman of science and technology and complements the NSF's Alan T. Waterman Award, which is given to a promising young scientist. The two awards are designed to encourage individuals to seek the highest levels of achievement in science, engineering, and service to humanity.

The nomination should be accompanied by a complete biography and a brief citation summarizing the nominee's scientific or technological contributions to our national welfare in promotion of the progress of science.

#### Alan T. Waterman Award

The Waterman Award is presented annually by the NSF and National Science Board to an outstanding young researcher in any field of science or engineering supported by NSF.

Candidates must be U.S. citizens or permanent residents and must be 35 years of age or younger, OR not more than five years beyond receipt of the Ph.D. degree by December 31 of the year in which nominated.

Candidates should have completed sufficient scientific or engineering research to have demonstrated, through personal accomplishments, outstanding capability and exceptional promise for significant future achievement.

**Remember:** BACKGROUND INFORMATION and VITAE of nominated candidates should be sent by **April 30, 1994**, to the GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301.



## 1993 Meetings

### October

■ **Pennsylvania Geologists 58th Annual Field Conference**, Geology of Southern Somerset County Region, October 1-2, 1993, Somerset, Pennsylvania. Information: Field Conference of PA Geologists, P.O. Box 1124, Harrisburg, PA 17108-1124, (717) 787-2379.

■ **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.

■ **Environmental Hydrology and Hydrogeology, Second USA/Hungary Joint Conference**, October 7-14, 1993, Budapest, Hungary. Information: AIH, 3416 University Ave. S.E., Minneapolis, MN 55414-3328, (612) 379-1030, fax 612-379-0169.

■ **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.

■ **Association of Engineering Geologists Annual Meeting**, October 9-15, 1993, San Antonio, Texas. Information: Association of Engineering Geologists, 323 Boston Post Rd., Suite 2D, Sudbury, MA 01776, (508) 443-4639.

■ **Geothermal Resources Council Annual Meeting**, October 10-13, 1993, Burlingame, California. Information: Geothermal Resources Council, P.O. Box 1350, Davis, CA 95617-1350, (916) 758-2360, fax 916-758-2839.

■ **International Association for Mathematical Geology**, October 10-15, 1993, Prague, Czechoslovakia. Local Chairman: Vaclav Nemeč, 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.

■ **Seismological Society of America, Eastern Section Meeting**, October 13-15, 1993, Weston, Massachusetts. Information: John E. Ebel, Weston Observatory, Dept. of Geology & Geophysics, Boston College, 381 Concord Road, Weston, MA 02193-1340, (617) 899-0950, fax 617-552-8388, E-mail: EBEL@BCVMS.BC.EDU.

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

■ **New Developments in Geothermal Measurements in Boreholes**, October 18-23, 1993, Klein Köris, Germany. Information: E. Hurtig, GFZ Potsdam, Telegrafenberg A45, 0-1561 Potsdam, Germany, phone 49-331-310-347, fax 49-331-310-610, E-mail: gth@gfz-potsdam.dbp.de.

■ **Gulf Coast Association of Geological Societies and Gulf Coast Section of SEPM 43rd Annual Convention**, October 20-22, 1993, Shreveport, Louisiana. Information: Roger Berg, Arkla Exploration Co., P.O. Box 21734, Shreveport, LA 71151, (318) 429-2713.

■ **Overthrusting into Foreland Basins: Sedimentological Consequences**, October 20-22, 1993, Troy, New York. Information: Gerald M. Friedman, Northeastern Science Foundation, Rensselaer Center of Applied Geology, 15 Third Street, P.O. Box 746, Troy, NY 12181-0746.

■ **Geological Society of America Annual Meeting**, October 25-28, 1993, Boston, Massachusetts. Information: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, fax 303-447-1133.

■ **World Energy Engineering 16th Congress**, October 26-28, 1993, Atlanta, Georgia. Information: Ruth M. Bennett, 4025 Pleasantdale Road, Suite 420, Atlanta, GA 30340, (404) 447-5083, fax 404-446-3969.

■ **Asociación de Ingenieros 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.

■ **Rocky Mountain Ground Water Conference**, October 27-29, 1993, Albuquerque, New Mexico. Information: Michael E. Campana, Dept. of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131-1116, (505) 277-3269, fax 505-277-8843.

■ **Geological Association of New Jersey, Precambrian Traverse of Northern New Jersey**, October 29-30, 1993. Information: John Marchisin, P.O. Box 5145, Trenton, NJ 08638, (201) 200-3162, fax 201-200-2298.

### November

■ **International Circum-Pacific and Circum-Atlantic Terrane Conference VI**, November 5-21, 1993, Guanajuato, Mexico. Information: Fernando Ortega-Gutiérrez, fax 52-5-550-6644 or -8432; or David G. Howell, fax 415-353-3224.

■ **24th Annual Underwater Mining Institute**, November 7-9, 1993, Estes Park, Colorado. Information: Karynne Chong Morgan, UMI Conference Coordinator, 811 Olomehani Street, Honolulu, HI 96813-5513, (808) 522-5611, fax 808-522-5618, Internet: morgan@uhunix.uhcc.hawaii.edu, CompuServe: MMTTC, 70673,534.

■ **Third International Congress of the Brazilian Geophysical Society**, November 7-11, 1993, Rio de Janeiro, Brazil. Information: SBGf-Divisão Centro-Sul, Secretaria do 3º CIBSGf, Av. Rio Branco 156, sala 2510, 20043-900 Rio de Janeiro, RJ, Brasil, phone 55-21-533-0064, fax 55-21-533-0064.

■ **Mineral Resources of Russia, International Symposium and Exhibition**, November 9-13, 1993, St. Petersburg, Russia. Information in the USA: (505) 291-9812. Information in Russia: Organizing Committee, P.O. Box 215, 199004, St. Petersburg, Russia, E-mail: vsg@sovamsu.sovusa.com., phone 7-812-218-9224, fax 7-812-355-7952.

■ **15th New Zealand Geothermal Workshop**, Long-term use of Geothermal Resources: Problems and Solutions, November 10-12, 1993, Auckland, New Zealand. Information: K. C. Lee, M. G. Dunstall, or S. F. Simmons, Geothermal Institute, University of Auckland, Private Bag 92019, Auckland, (649) 373-7599, ext. 8401, fax 649-373-7436.

■ **Basement and Basins of Eastern North America**, AAPG Hedberg Research Conference, November 10-13, 1993, Ann Arbor, Michigan. Information: AAPG Continuing Education Department, P.O. Box 979, Tulsa, OK 74101, (918) 584-2555, fax 918-584-0469.

■ **Developing a Science and Drilling Program for the Chicxulub Impact Crater**, November 13-14, 1993, Puerto Vallarta, Mexico. Information: Virgil L. Sharpton, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058, (713) 486-2111, fax 713-486-2162, E-mail (Internet): sharpton@lpi.jsc.nasa.gov.

■ **Eastern Oil Shale Symposium**, November 17-19, 1993, Lexington, Kentucky. Information: Geaunita H. Caylor, University of Kentucky/OISTL, 643 Maxwellton Court, Lexington, KY 40506-0350, (606) 257-2820, fax 606-258-1049.

### December

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

■ **World Organization of Volcano Observatories—IAVCEI Commission**, December 13-17, 1993, Guadeloupe Island, West Indies. Information: Catherine Netter, Observatoires Volcanologiques, IPGP, phone 33-1-44-27-24-00, fax 33-1-44-27-24-01.

## 1994 Meetings

### January

■ **Remote Sensing and GIS International Symposium**, January 27-28, 1994, location to be determined. Information: Vern Singhroy, Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, Ontario K1A 0Y7, Canada, (613) 947-1215, fax 613-947-1385; or Ivan Johnson, 7474 Upham Court, Arvada, CO 80003, (303) 425-5610; and Doug Nebert, Water Resources Division, USGS National Centre, MS 445, Reston, VA 22092, (703) 648-5691, fax 703-959-5691.

■ **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.

### February

■ **Geological Society of Australia Field Conference**, Deformation Processes in the Earth, February 6-11, 1994, Jindabyne, New South Wales, Australia. Information: Stephen Cox, RSES, ANU, Canberra, ACT 0200, Australia, phone 61 6 249 4076, fax 61 6 249 0738, E-mail: jdf152@cscgpo.anu.edu.au.

■ **New Developments Regarding the K/T Event and Other Catastrophes**

in **Earth History**, February 9-12, 1994, Houston, Texas. Logistical information: Litta Holley, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058-1113, (713) 486-2149, fax 713-486-2160, E-mail (Internet): holley@lpi.jsc.nasa.gov.; Technical information: Graham Ryder, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058, (713) 486-2141, fax 713-486-2162, E-mail (Internet): zryder@lpi.jsc.nasa.gov.

■ **Breakthroughs in Karst Geomicrobiology and Redox Geochemistry**, February 16-19, 1994, Colorado Springs, Colorado. Information: Arthur Palmer, Earth Sciences Dept., SUNY Oneonta, Oneonta, NY 13820-4015, (607) 436-3064, fax 607-436-2107.

■ **U.S. Geological Survey, 9th V. E. McKelvey Forum on Mineral Resources**, February 22-25, 1994, Tucson, Arizona. Information: Warren C. Day, U.S. Geological Survey, Box 25046, MS 905, Federal Center, Denver, CO 80025, (303) 236-5568, fax 303-236-5603.

### March

■ **International Convention on Global Exploration and Development**, March 6-9, 1994, Toronto, Ontario, Canada. Information: Rita Plaskett, Convention Manager, Suite

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## Short-Course Series

### Using EPA's New WhAEM Model for Wellhead Protection: Analysis of Time of Travel Capture Zones with the Analytical Element Method

Colorado School of Mines  
November 17-19, 1993

Instructors: O.D.L. Strack  
(Univ. of Minnesota),  
and H.M. Haitjema  
(Indiana Univ.)

The course, through lectures and computer sessions, will address the underlying principles and operation of WhAEM, and focus on the application of WhAEM to real world wellhead protection problems.

For more information  
contact the IGWMC.

international ground water modeling center  
**igwmc**

Institute for Ground-Water  
Research and Education  
Colorado School of Mines  
Golden, Colorado 80401-1887  
Phone: (303) 273-3103  
FAX: (303) 273-3278



### South-Central Section

The South-Central Section of GSA presented its sixth annual research awards to qualified graduate students in the section in 1993. Recipients are students who attend a college or university in the South-Central Section geographic area and have submitted applications to the GSA Research Grants Program. The awards presented this year went to Rudy Machorro Sagastume, University of Texas at El Paso, for "Comparative Study Between the Chuacús Group and Las Ovejas Group, Central Guatemala"; and James Roger Mayer, University of Texas at Austin, for "The Role of Fractures in Regional Groundwater Flow."

### Southeastern Section

GSA's Southeastern Section awarded research grants to 11 qualified students within the section. They are Keikki Bauert, University of North Carolina at Chapel Hill, for "Foredeep and Platform Petrology and Geochemistry of Middle Ordovician Limestones in the Appalachian Basin"; John J. Blandin, Old Dominion University, for "Depositional and Sequence Stratigraphic Analysis of the Miocene St. Marys Formation, Calvert County, Maryland"; Daniel A. Cenerelli, West Virginia University, for "Sediment Distribution in Four Debris-Flow Channels on North Fork Mountain, Eastern West Virginia"; Zi-Qiang Chen, Florida State University, for "The Quaternary Sea Level Fluctuations and Coastal Responses of Appalachee Bay, Northwest Florida: Evidences from Seismic Stratigraphy, Sedimentology, Paleontology, and Geochronology"; Kendall B. Fountain, University of Florida, for "Mineralogical and Geochemical Characterization of Plio-Pleistocene Kaolinite Deposits in North-Central Florida: Genetic Relationships Among Deposits in the Southeastern United States"; Ruben A. Giral, University of North Carolina, Chapel Hill, for "Early Structures in a Laramide-Style Uplift"; Patricia Ann Johnson, Appalachian State University, for "A Study of the Mars Hill Terrane in the Blue Ridge Belt, Western North Carolina"; Nicholas B. Kidd, Clemson University, for "Pyroxene and Chromite Crystallization in Diabase Dikes"; Pamela J. Seney, Auburn University, for "Petrology and Geochemistry of the Freetown Layered Complex, Sierra Leone, West Africa"; Thomas Lowell Stetler, University of North Carolina at Wilmington, for "Geologic Mapping and Structural Analysis in the Southern Half of the Spring Hope 7.5 Minute Quadrangle, Nash County, North Carolina"; Robert L. Tolliver, University of Tennessee, for "Population Dynamics and Extinction in Late Eocene Benthic Foraminifera from the Gulf Coastal Plain."

The remaining three sections—Northeastern, Rocky Mountain, and Cordilleran—do not currently offer research grants. ■

### Meetings continued from p. 271

1002, 74 Victoria Street, Toronto, Ontario M5C 2A5, Canada, (416) 362-1969, fax 416-362-0101.

**Geology and Exploration and Development Potential of Energy and Mineral Resources of Vietnam and Adjoining Regions**, March 14-17, 1994, Hanoi, Vietnam. Information: Mary Stewart, 5100 Westheimer, Suite 500, Houston, TX 77056, (713) 622-1130, fax 713-622-5360.

**GSA South-Central Section Meeting**, March 21-22, 1994, Little Rock, Arkansas. Information: Philip L. Kehler, Dept. of Earth Sciences, University of Arkansas, 2801 S. University Ave., Little Rock, AR 72204, (501) 569-3546, fax 501-569-8020. (Abstract deadline: November 30, 1993.)

**GSA Cordilleran Section Meeting**, March 21-23, 1994, San Bernardino, California. Information: Joan Fryxell, Dept. of Geological Sciences, California State University, 5500 University Parkway, San Bernardino, CA 92407-2397, (909) 880-5311, fax 909-880-7005. (Abstract deadline: November 29, 1993.)

**Seventh Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)**, March 27-31, 1994, Boston, Massachusetts. Information: EEGS, Mark Cramer, P.O. Box 4475,

Englewood, CO 80112, (303) 771-6101. (Abstract deadline: October 1, 1993.)

**GSA Northeastern Section Meeting**, March 28-30, 1994, Binghamton, New York. Information: H. Richard Naslund, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-4313, fax 607-777-2288. (Abstract deadline: December 2, 1993.)

### April

**GSA Southeastern Section Meeting**, April 7-8, 1994, Blacksburg, Virginia. Information: Lynn Glover, III, and Robert J. Tracy, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061-0420, Glover's direct (703) 231-6213, fax 703-231-3886, Tracy's direct (703) 231-5980. (Abstract deadline: December 1, 1993.)

**Toxic Substances and the Hydrologic Sciences**, April 10-13, 1994, Austin, Texas. Information: American Institute of Hydrology, 3416 University Ave. S.E., Minneapolis, MN 55414-3328, (612) 379-1030, fax 612-379-0169.

**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 41-1-377 30 66 or 41-1-377 30 79, fax 41-1-371 22 83.

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## GSAF UPDATE

Robert L. Fuchs

### Bequest Supports Institute for Environmental Education

The Foundation has received a \$10,000 bequest from the estate of Charles and Gladys Theis. The money will be used to fund activities of the Institute for Environmental Education.

Charles V. Theis was born in Kentucky in 1900 and studied at the University of Cincinnati, receiving a Ph.D. degree in 1929. His was the first doctorate in geology ever granted by that school. During his career he worked for the Kentucky Geological Survey, the U.S. Corps of Engineers, and the U.S. Geological Survey. He became a member and Fellow of GSA in 1936 and continued his membership in the

Society until his death in August 1987. Gladys Theis died in January 1993.

Charles Theis was one of the most prominent scientists in the early development of ground-water hydrology. His work in the 1930s in the plains of west Texas and New Mexico led to the "Theis equation," the transient ground-water formula from which one can project the time that will elapse before a pumping well reaches equilibrium. C.V. was recognized for his pioneering work in hydrogeology by the American Water Resources Association, which made him its first Honorary Member in 1970. In addition, he received the Distinguished Service Award from the Department of the Interior in 1958.

IEE Executive Director Fred Donath noted, "The present importance of hydrogeology as a specialty of the earth

sciences has been possible because of the original, creative work of geologists such as C.V. 50 and 60 years ago. As the demand for environmental studies has intensified, hydrogeology has evolved from the sound base that these early workers established. This gift from his estate to GSA and IEE is an additional legacy from a productive scientific career."

### Pooled Income Fund Growth Continues

The total value of the Foundation's Pooled Income Fund continues to increase. Following a gift from former GSA President Larry Sloss, the fund value was \$188,891 at the end of July.

As the name implies, the Pooled Income Fund combines gifts from a number of donors in a single investment fund, from which a share of the income is paid quarterly to each donor for life. At the death of the donor (and any designated beneficiary), that share of the fund is severed and becomes part

of the Foundation's endowment, to be used thereafter to finance GSA's programs such as SAGE, IEE, research grants, and publications. The donor may designate the ultimate use of her or his share and may easily make subsequent gifts from time to time to augment quarterly income. Another attribute of the fund is an income tax deduction in the year of the gift.

The Pooled Income Fund had an income return of 7.0% and a total return of 8.1% in 1992. This year in the first six months the income return was 5.7% and the total return was 14.8% (annualized).

Larry Sloss said that the Pooled Income Fund fits nicely into his and his wife's retirement situation. "Marion and I need to maintain an income stream, and the Pooled Income Fund enabled us to make a gift to GSA and actually increase our current income. This wasn't black magic—we transferred to the fund shares in a growth mutual fund that paid only a minimal dividend." ■



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#### Women in Science

Roger L. Duba  
Rudolf A. Gees\*  
Edward W. Hildreth\*



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■ **Mid-America Paleontology Society National Fossil Exposition: Dinosaurs**, April 15–17, 1994, Macomb, Illinois. Information: Marvin Houg, 3330 44th St. NE, Cedar Rapids, IA 52402, (319) 395-0577, or Karl A. Stuekerjuergen, RR1, Box 285, West Point, IA 52656, (319) 837-6690.

■ **Extractive Industry Geology**, April 17–20, 1994, Sheffield, England. Information: The Conference Office, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England, phone 44-71-580-3802, fax 44-71-436-5388.

■ **AAPG Hedberg Research Conference, Near-Surface Expressions of Hydrocarbon Migration**, April 24–27, 1994, Vancouver, British Columbia, Canada. Information: AAPG Continuing Education Department, P.O. Box 979, Tulsa, OK 74101, (918) 584-2555, fax 918-584-0469.

■ **European Association of Science Editors 5th General Assembly and Conference**, April 24–28, 1994, Budapest, Hungary. Information: EASE Secretariat, 49 Rosendale Way, London, NW1 0XB, UK, phone 44-71-388 9668, fax 44-71-383 3092.

■ **Third International Conference on the Abatement of Acidic Drainage**, April 25–29, 1994, Pittsburgh, Pennsylvania. Information: D. Lowan, U.S. Bureau of Mines, P.O. Box 18070, Pittsburgh, PA 15236, (412) 892-6708, fax 412-892-4067.

■ **GSA North-Central Section Meeting**, April 28–29, 1994, Kalamazoo, Michigan. Information: Alan Kehew, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5495, fax 616-387-5513. (Abstract deadline: January 4, 1994.)

#### May

■ **GSA Rocky Mountain Section Meeting**, May 4–6, 1994, Durango, Colorado. Information: Douglas Brew, Geology Dept., Ft. Lewis College, Durango, CO 81301, (303) 247-7254, fax 303-247-7310.

■ **Geologic Remote Sensing Tenth Thematic Conference**, May 9–12, 1994, San Antonio, Texas. Information: ERIM/Thematic Conferences, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123, Internet: wallman@vaxb.erim.org.

■ **Geological Association of Canada and Mineralogical Association of Canada Annual Meeting**, May 15–18, 1994, Waterloo, Ontario, Canada. Information: Alan V. Morgan, Dept. of Earth Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada, (519) 885-1211, ext. 3231, fax 519-746-7484.

■ **High-Level Radioactive Waste Management International Conference**, May 22–26, 1994, Las Vegas, Nevada. Information: Tom Sanders, Attn: Transactions Office, American Nuclear Society, 555 N. Kensington Avenue, La Grange Park, IL 60525.

■ **Glacial Cycles at High Latitudes**, May 29–June 1, 1994, Fjærland, Norway. Information: Berit H. Barkley, Dept. of Geology, P.O. Box 1047 Blindern, 0316 Oslo, Norway, 47-22-856691, fax 47-22-854215.

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#### June

■ **1st North American Rock Mechanics Symposium**, June 1–3, 1994, Austin, Texas. Information: NARM Symposium, Continuing Engineering Studies, Cockrell Hall 10.324, University of Texas, Austin, TX 78712; or Priscilla Nelson, (512) 471-5664, or Stephen Laubach, fax 512-471-0140.

■ **Geochronology, Cosmochronology, and Isotope Geology Eighth International Conference (ICOG-8)**, June 5–11, 1994, Berkeley, California. Information: Garniss H. Curtis, Institute of Human Origins–Geochronology Center, 2453 Ridge Road, Berkeley, CA 94709, (510) 845-4003, fax 510-845-9453.

■ **Fifth International Conference on Ground Penetrating Radar**, June 12–16, 1994, Kitchener, Ontario, Canada. Information: GPR '94, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario

N2L 3G1, Canada, (519) 885-1211, ext. 2892, fax 519-725-8720.

■ **First International Symposium on Protection and Development of Mountain Environment**, June 20–24, 1994, Ponte di Legno, Italy. Information: Man & Mountain '94, c/o Valdepur Service s.r.l., via Seradello 225, 25068 Serezzo (BS), Italy.

#### July

■ **FORAMS '94: International Symposium on Foraminifera**, July 5–9, 1994, Berkeley, California. Information: FORAMS '94, Museum of Paleontology, University of California, Berkeley, CA 94720, (510) 642-1821, fax 510-642-1822.

■ **Earthquake Engineering Fifth U.S. National Conference**, July 10–14, 1994, Chicago, Illinois. Information: Claudia Cook, Newmark Civil Engineering Laboratory, University of Illinois, 205 N. Mathews, Urbana, IL 61801-2397, (217) 333-0498.

■ **Basement Tectonics 11th International Conference**, July 25–29, 1994, Potsdam, Germany. Information: Onno Oncken, Conference Chairman, Geo-Forschungs Zentrum, Telegrafenberg, D-0-1561 Potsdam, Germany, phone 49-331-310601, fax 49-331-310306. (Abstract deadline: March 1, 1994.)

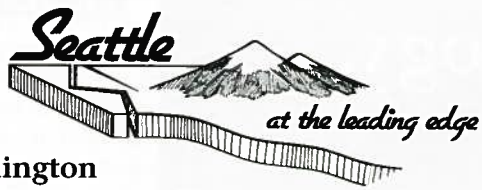
■ **Society for Industrial and Applied Mathematics Annual Meeting**, July 25–29, 1994, San Diego, California. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org. (Abstract deadline: January 24, 1994.)

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



# GSA ANNUAL MEETINGS

## 1994



Seattle, Washington  
Washington State Convention  
and Trade Center  
Seattle Sheraton Hotel  
October 24-27

**General Chairman: Darrel S. Cowan**

**Technical Program Chairman: Mark S. Ghiorso**  
Symposia and theme proposals due: January 3, 1994

**Field Trip Chairman: Donald A. Swanson**  
Field trip proposal deadline was May 15, 1993; however, a few trips may still be accepted. Call today if you are interested in leading a trip. First draft of guidebook copy will be due January 1, 1994.

These chairmen are located at the Dept. of Geosciences, University of Washington, Seattle, WA 98195, (206) 543-1190, fax 206-543-3836. Proposals go directly to them.

For information call the GSA Meetings Department, 1-800-472-1988 or (303) 447-2020.

### At the Leading Edge: 1994 Technical Program Theme

Geology *At the Leading Edge* will be the scientific theme of the 1994 GSA Annual Meeting in Seattle. The theme will draw emphasis both to the geographical position of Seattle, situated on the leading edge of a convergent plate margin, and to the application of "leading edge" theoretical approaches to and technological advances in the elucidation of geological problems. Theme sessions and symposium proposals are sought in all aspects of Pacific Rim and convergent margin geology, with particular emphasis on the utilization of new technology. The Seattle Program Committee will sponsor a GSA symposium titled "The Birth and Death of a Plate," which will include invited talks on topics such as arc volcanism, kinematics of plate motion, accretionary wedges, and evolution of ocean-ridge spreading centers. Speakers will illuminate these issues with results from remote sensing, geodesy, seismic imaging, experimental studies of geologic materials, and computational advances in modeling geologic systems. Theme sessions will have the option of being organized with more flexibility. One proposal is to lead off a theme session with an invited speaker who will review the subject of the theme and set the tone and organization of the abstracts in the remainder of the session. The Seattle Program Committee also proposes to have several less formal evening sessions aimed at bringing attendees up to date on new techniques such as GIS (Geographical Information Systems), GPS (Global Positioning System), and major nationally funded research projects such as the RIDGE initiative and the Continental Drilling Program. The 1994 GSA Annual Meeting in Seattle promises an exciting opportunity to discuss important geological questions in a nontraditional way. Plan to join us *At the Leading Edge*.

#### LAST CHANCE ...

### 1994 Continuing Education Course Proposals Due Now

The GSA Committee on Continuing Education (*formerly the Short Course Committee*) invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines.

Continuing Education courses may be conducted in conjunction with all GSA annual or section meetings. We are particularly interested in receiving proposals for the 1994 Annual Meeting in Seattle OR the 1995 Annual Meeting in New Orleans.

Selection of courses for 1994 will be made by February 1, 1994. For those planning ahead, we will also consider courses for 1995 at this time.

For proposal guidelines or information contact:  
Edna A. Collis,  
Continuing Education Coordinator,  
GSA headquarters, 1-800-472-1988, ext. 134.

## 1995

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

**General Chairman: William R. Craig, University of New Orleans**

**Technical Program Chairman: Laura Serpa, University of New Orleans**

**Call for Field Trip Proposals:** Please contact the Field Trip Chairmen listed below.

**Whitney Autin**  
Louisiana Geological Survey  
P.O. Box G, University Station  
Baton Rouge, LA 70893-4107  
(504) 388-5320

**Duncan Goldthwaite**  
4608 James Drive  
Metairie, LA 70003  
(504) 887-4377

For general information call the GSA Meetings Department, 1-800-472-1988 or (303) 447-2020.

## FUTURE

**Boston** ..... October 25-28 ..... 1993  
**Seattle** ..... October 24-27 ..... 1994  
**New Orleans** .... November 6-9 ..... 1995  
**Denver** ..... October 28-31 ..... 1996  
**Salt Lake City** .. October 20-23 ..... 1997

For general information on technical program participation (1993 or beyond) contact Sue Beggs, Meetings Manager, GSA headquarters.

## Section Meetings—1994

### South-Central Section

**University of Arkansas, Little Rock, Arkansas, March 21-22, 1994.** Philip L. Kehler, Department of Earth Sciences, University of Arkansas—Little Rock, 2801 S. University Ave., Little Rock, AR 72204, (501) 569-3546, fax 501-569-8020. *Abstract Deadline: November 30, 1993.*

### Cordilleran Section

**California State University, San Bernardino, California, March 21-23, 1994.** Joan E. Fryxell, Department of Geological Sciences, California State University, 5500 University Parkway, San Bernardino, CA 92407-2397, (909) 880-5311, fax 909-880-7005. *Abstract Deadline: November 29, 1993.*

### Northeastern Section

**SUNY at Binghamton, Binghamton, New York, March 28-30, 1994.** H. Richard Naslund, Department of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-4313, fax 607-777-2288. *Abstract Deadline: December 2, 1993.*

### Southeastern Section

**Virginia Polytechnic Institute and State University, Blacksburg, Virginia, April 7-8, 1994.** Lynn Glover, III, and Robert J. Tracy, Department of Geological Sciences, Virginia Tech, Blacksburg, VA 24061-0420, Glover's direct (703) 231-6213, Tracy's direct (703) 231-5980, fax 703-231-3886. *Abstract Deadline: December 1, 1993.*

### North-Central Section

**Western Michigan University, Kalamazoo, Michigan, April 28-29, 1994.** Alan Kehew, Department of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5495, fax 616-387-5513. *Abstract Deadline: January 6, 1994.*

### Rocky Mountain Section

**Fort Lewis College, Durango, Colorado, May 4-6, 1994.** Douglas Brew, Geology Department, Fort Lewis College, Durango, CO 81301, (303) 247-7254, fax 303-247-7310. *Abstract Deadline: January 13, 1994.*

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Please send \_\_\_\_\_ copies of the 1994 GSA Abstract form. I understand that the same form may be used for all 1994 GSA meetings—the six Section Meetings and the GSA Annual Meeting in Seattle.



# October BULLETIN and GEOLOGY Contents

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Applicants should possess the following credentials: 1) an earned Doctorate or the equivalent experience in exploration, mine geology, development, planning, production and management in the Mining Industry in senior professional or advisory consulting or executive positions, 2) a record of, or demonstrated interest in achieving excellence in teaching and research in the field of applied economic geology, and 3) expertise in mineral exploration, evaluation and development of mineral deposits, and a knowledge of the relevant political, social, environmental and economic factors that influence the application of geological science to industrial practice.

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The deadline for application is Monday, November 15, 1993. Please send letter of application, resume and names and addresses of three references to: Colorado School of Mines, Fogarty Chair Search #93-11-15, 1500 Illinois Street, Golden, CO 80401.

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

#### FACULTY POSITION - STABLE ISOTOPE GEOCHEMISTRY

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■ Early morning at Jenny Farm, Reading, Vermont. Photo by Paul Corkum.

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