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## Ocean Drilling and the Volcanic Record of Hotspots

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**Editor's Note:** The Ocean Drilling Program (ODP) is one of the largest and most ambitious international research projects in geology. Since 1969, it and its predecessors, the Deep Sea Drilling Project (DSDP) and the International Project of Ocean Drilling (IPOD), have addressed fundamental problems of ocean history and evolution by drilling almost 900 holes in the ocean bottom with the *GLOMAR Challenger* and, more recently, the *JOIDES Resolution*. This article is one of several that will summarize some of the more exciting recent discoveries of this important international project. The two photos symbolize the fact that in order to look at the along-strike nature of the exposure of basalts of the Deccan Traps, it is necessary to resort to drilling, as by the *JOIDES Resolution*.

—Eldridge M. Moores

**ABSTRACT**

Hotspots are stationary, upper mantle thermal anomalies that are maintained over tens to hundreds of million years by convective upwelling in the form of mantle plumes. Lithospheric plate motions over hotspots have produced linear, age-progressive volcanic trails, such as most island and seamount chains in the ocean basins. Ocean drilling along several major hotspot tracks has documented a direct and simple frame of reference for plate reconstructions. Comparison of the hotspot and paleomagnetic reference frames reveals several episodes of true polar wander; that is, motion of the entire Earth with respect to its spin axis. Many of the longer lived hotspot tracks began with rapid eruption of flood basalts, including continental provinces but also many of the huge oceanic plateaus. Several of these catastrophic volcanic events have been linked with mass extinctions observed in the fossil record. The long-term, fixed nature of hotspots and the initial large-volume flood-basalt events reflect two modes of whole-mantle convection.

**INTRODUCTION**

The location, flux, and compositional variability of basaltic volcanism on our planet can be largely explained by the plate-tectonic model. Mid-ocean-ridge basalts are produced by decompression melting of passively upwelling upper mantle (asthenosphere) at the edges of separating plates, while subduction of oceanic lithosphere delivers water and other volatiles into the mantle to stimulate melting, yielding volcanic arc basalts along collisional plate boundaries. Such plate-margin environments account for the vast majority of all basaltic magma production. A significant but volumetrically minor class of basaltic volcanism occurs within plates or crosses plate boundaries and is characterized by linear chains of volcanoes that grow older in the directions of plate motion. Familiar examples of this volcanic phenomenon are the young, parallel island chains of the Pacific basin (such as the Hawaiian Islands), the Yellowstone-Snake River Plain province, and the volcanic platform and ridge system centered on Iceland. The linear geometry and progressive age of volcanism within these provinces are thought to result from focused upper mantle zones of melting called hotspots (Wilson, 1963, 1965) that remain stationary as Earth's outer shell of lithospheric plates moves across them. The proposed locations of present hotspot volcanism are shown in Figure 1.

Morgan (1971, 1972) proposed that hotspots are maintained by unusually warm material rising from the lower mantle through upwardly convecting mantle plumes. These plumes, he speculated, constitute part of a long-lived, stable pattern of whole mantle convection. Once established, these conduits for heat and material transport from the lower mantle do not, Morgan suggested, move relative to one another. Because plumes arise from convection, it is popular to consider that they begin in the seismically defined thermal layer at the boundary between the core and mantle. Figure 1 shows that hotspots are not randomly distributed over the globe but are primarily a feature of the ocean basins and occur in two large clusters, one centered over the equatorial Pacific and the second running from the North Atlantic to the South Atlantic and western Indian oceans. Furthermore, hotspot locations correlate closely with positive departures from the average geoid (Crough and Jurdy, 1980) and with regions of slow seismic velocities ( $V_p$ ) in the lower mantle (Morelli and Dziewonski, 1987). These observations support Morgan's (1971, 1972) claim that hotspots are connected with mantle-wide upward convection. An important question is whether or not plumes are, in fact, fixed with respect to one another over geologically significant time scales.

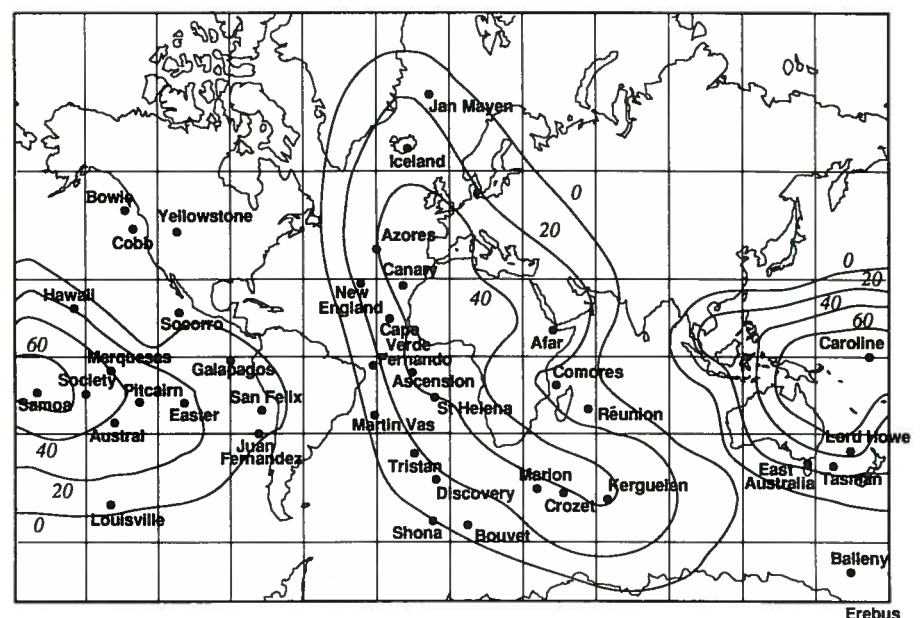
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Deccan flood basalt, western India. Photo by J. Mahoney



JOIDES Resolution, an ODP drilling ship. Photo provided by the Ocean Drilling Program



**Figure 1.** The global constellation of hotspots, which are upper mantle thermal anomalies that remain stationary and leave volcanic trails on the lithospheric plates. Hotspots are not randomly distributed but are concentrated in zones of high geoid residuals (contours, in metres, are from Crough and Jurdy, 1980). The pattern of hotspots also correlates with regions of slow  $V_p$  in the lower mantle (Morelli and Dziewonski, 1987), suggesting that hotspots are connected with mantle-wide upward convection.



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The answer to this has implications for the viscosity structure of the mantle and the scale and pattern of convection, as well as the idea that hotspot volcanism provides a useful reference frame for plate motions.

This paper reviews the contributions of the Ocean Drilling Program (ODP) to understanding of the dynamics and the compositional and thermal histories of mantle plumes, through sampling the volcanic record of long-lived hotspots. The products and effects of current hotspot activity can be studied in numerous young island chains, but long-term aspects of hotspot behavior can be investigated only by sampling the older, submerged volcanic trails of hotspots. Deep ocean drilling is the only way to penetrate commonly thick sediment cover to obtain representative volcanic products of the hotspot. Some of the more prominent older hotspot lineaments were sampled by the Deep Sea Drilling Program (DSDP) (Emperor Seamounts, Line Islands, Walvis Ridge-Rio Grande Rise, and New England Seamounts), and an early focus of ODP has been the complete volcanic history of two major Indian Ocean hotspots, Réunion and Kerguelen. Such extensive coverage has established the genetic connection between now active hotspots, island chains, seamount lineaments, and, in many instances, flood-basalt provinces. This density of sampling, coupled with biostratigraphic and radiometric age determinations, has strengthened the case for stationary mantle plumes over periods as long as 100 m.y. Compositional studies have traced the chemical variability in hotspot products with time, reflecting mixing of plume and upper mantle material.

### LIFE CYCLE OF HOTSPOTS

Much of what we know about hotspot volcanic chains has been learned at young island chains, Hawaii in particular. Yet these occurrences tell us only about the present activity of these thermal anomalies. How do mantle plumes start? What is the average life span of a hotspot? How do the composition and flux of volcanic material at a given hotspot change with time? To answer these questions requires sampling of volcanic lineaments that record the entire life cycle of hotspots. Two of these are in the



**Figure 2.** Computer-modeled hotspot tracks for the Indian Ocean basin, superimposed on the Réunion and Kerguelen volcanic lineaments. Black circles are current hotspot positions; heavy lines are predicted tracks (age of volcanism shown by ticks at 10-m.y. increments). Numbers are radiometric ages determined on basaltic rocks from island, submarine, and continental locations along the trends. The close correspondence between observed and modeled tracks supports the notion that hotspots are fixed and are maintained by deeply rooted mantle plumes. Flood basalts (stippled) mark the beginning of the two Indian Ocean hotspots investigated by ocean drilling.

Indian Ocean, those produced by the Réunion and the Kerguelen hotspots (Fig. 2), and they were the focus of four ODP drilling legs during 1987-1989.

The western (Réunion) province trends northeastward from the islands of Réunion and Mauritius, along the eastern limb of the Mascarene Plateau, then north along the Chagos-Maldives-Laccadive ridges to the Deccan continental flood basalts of central-western India. The eastern (Kerguelen) province includes the Kerguelen Archipelago, the Kerguelen Plateau, the Broken and Ninetyeast ridges, and the Rajmahal flood basalts. (Older and younger parts of both tracks have been separated by recent sea-floor spreading in the central Indian basin.) In addition to the subaerial exposures at islands and in India, deep drilling has recovered basalts beneath thick pelagic and shallow-water (carbonate and volcanoclastic) sedimentary deposits at six locations along the Réunion hotspot track and at six sites along the Kerguelen hotspot track; at an additional four sites on the Kerguelen Plateau, drilling reached basaltic basement.

Radiometric ages (<sup>40</sup>Ar-<sup>39</sup>Ar incremental heating experiments; Duncan and Hargraves, 1990; Duncan, 1991) define clear southward progressions in the age of volcanic activity along the two trends (Fig. 2). The contiguous, linear and parallel geometry of these lineaments, together with the age distribution of the volcanism, link each hotspot with the older elements of its trace. Both of these hotspots appear to have begun with massive outpourings of basaltic magmas over broad regions of the Indian subcontinent, but at different times. The earliest manifestation of the Réunion hotspot is the Deccan flood basalt province, with an estimated original volume of about 1.5 × 10<sup>6</sup> km<sup>3</sup>. On the basis of direct radiometric dating and magnetostratigraphic data, this entire sequence of lava flows is believed to have erupted extremely rapidly, within 1 m.y., at about 65 Ma (Duncan and Pyle, 1988; Courtillot et al., 1988;

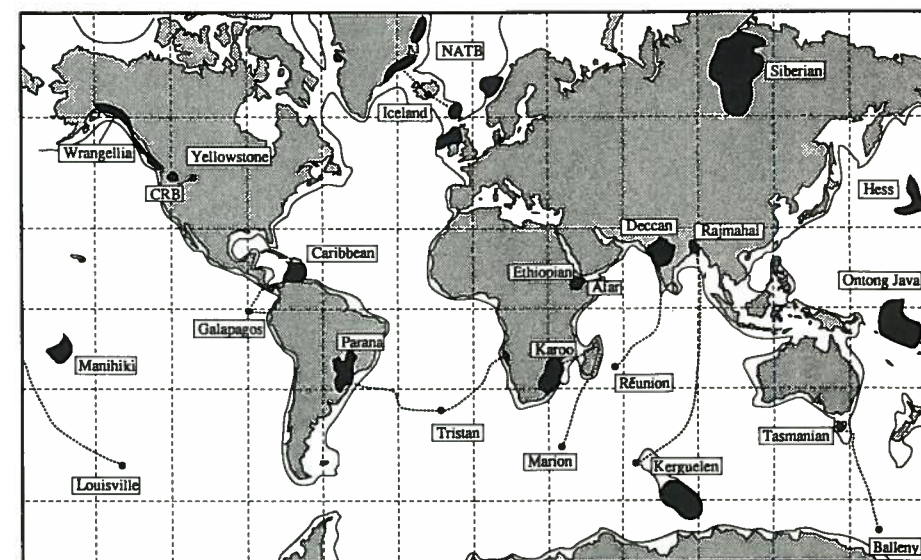
Baksi and Farrar, 1991). This catastrophic volcanic activity coincided with the Cretaceous/Tertiary boundary and probably contributed to climate change at that time through magma degassing (SO<sub>2</sub>, HCl, HF, CO<sub>2</sub>). The Kerguelen hotspot began similarly but earlier, with a flood basalt phase of activity at about 117 Ma. Plate reconstruction of the eastern Indian Ocean for this time places the contemporaneous southern Kerguelen Plateau adjacent to the Rajmahal basalts (Royer and Sandwell, 1989), indicating a volume several times larger than the Deccan province.

Other prominent hotspot tracks appear to have begun with flood-basalt events. The association of Mesozoic and younger flood basalts and hotspots (Morgan, 1972, 1981; Richards et al., 1989) is shown in Figure 3; the spatial and temporal relations are often more speculative than for the well-defined Réunion-Deccan and Kerguelen-Rajmahal pairs. One of the largest occurrences, the Siberian Traps, coincided with the largest known mass extinction event, that defining the Permian/Triassic boundary (Renne and Basu, 1991). This 250 Ma province, however, is not clearly connected to a now-active hotspot. Flood-basalt provinces are present along continental margins where they are associated with the early stages of continental rifting (White and McKenzie, 1989), but also interior to continents and in wholly oceanic settings. Table 1 compares the mantle plume volcanic production rates for flood-basalt and ocean-island phases of the hotspot life cycle. Initial eruption rates are between one and two orders of magnitude greater than for the subsequent "steady-state" mode.

These dynamic changes in the behavior of hotspots have been explained by the structure of diapirs produced in laboratory experiments, which are thought to mimic mantle plumes arising from deep mantle gravitational instabilities (Richards et al., 1989; Campbell and Griffiths, 1990). These experiments and theory show

**Table 1.** Comparison of Hotspot and Associated Flood Basalt Production Rates

Province and age (Ma) or hotspot	Original volume (km <sup>3</sup> )	Duration (m.y.)	Rate (km <sup>3</sup> per year)
Deccan (66±1)	>1,500,000	<1.0	>1.5
*Réunion	75,000	2.0	0.04
North Atlantic Tertiary (60±1)	>2,000,000	2.0	>1.0
*Iceland	3,500,000	15.	0.02
Parana-Etendeka (125±5)	1,500,000	2.0?	-0.75
*Tristan da Cunha	6,000	0.2	0.03
Karoo (early phase) (195±5)	2,000,000	2.0?	-1.0
*Marion-Prince Edward	10,000	0.5	0.02



**Figure 3.** Global distribution of flood basalt provinces erupted in the past 250 m.y. and associated hotspots (where known or guessed). These occur along continental margins, in continental interiors and in ocean basins; some, like Wrangellia, may be accreted oceanic plateaus. CRB are Columbia River basalts, and NATB are North Atlantic Tertiary basalts.



Bruce F. Molnia

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

## Potpourri

**Government Ethics and Scientific Societies.** On September 20, the comment period closed on a series of proposed guideline revisions that would change what is acceptable ethical conduct for federal employees. Entitled "Standards of Ethical Conduct for Employees of the Executive Branch," the new guidelines would, in essence prohibit federal employees from participating in the operational affairs of professional societies such as GSA. The Outside Activities section of the new guidelines would prohibit federal employees from using official on-the-job time to administer the internal affairs of professional societies or to conduct business affairs of the professional societies. In essence, this would eliminate federal employees serving as, for example, officers of GSA or editors of *GSA Today*. According to GSA President E-an Zen, the revised guidelines "could cause real problems for government scientists and could give young researchers one more reason not to work for the federal government." [See September *GSA Today*, p. 191, for Zen's notice about this.]

**Wetlands.** Last year's wetland is no longer this year's wetland. As much as 10% of the 100,000,000 acres in the U.S. previously defined as wetlands no longer meet the newest criteria of what constitutes a wetland. In 1988, George Bush, while campaigning for the Presidency, pledged a wetland protection policy of "no net loss." This position was strongly supported by the environmental and conservation communities. In early August, the administration's definition of what constitutes a wetland was changed to exclude several environments that had been previously included, and consequently previously protected from various types of development. Environmental Protection Agency Administrator William Reilly had attempted to maintain a broad interpretation of what constituted a wetland but was perceived by some members of the President's staff, some members of Congress, and several other Cabinet members as holding to an "anti-growth" position. The result of this new administration position is to remove certain environments, such as prairie potholes, from meeting the criteria for definition of wetlands.

**Space Station Freedom.** In mid-July, the Senate Appropriations Committee voted to approve full funding for the National Aeronautics and Space Administration's (NASA) Space Station Freedom project. What made this more than just a routine action on the part of the committee was that prior to the committee's vote, 14 scientific organizations and societies sent letters to members of the Senate opposing funding of Space Station Freedom. The letters stated that the excessive cost of the space station project (NASA stated a cost of \$30 billion) would drain substantial amounts of funding from the

support of science. The letters also asserted that the space station project would threaten "the vitality" of essential research programs and would jeopardize U.S. leadership in the world technology community. Among the 14 organizations that unsuccessfully attempted to influence the Senate were the Acoustical Society, the American Chemical Society, the American Crystallographic Association, the American Geophysical Union, the American Mathematical Society, the American Physical Society, the Optical Society of America, and Sigma Xi. (GSA was not one of the 14 organizations.) Committee chairwoman Barbara Mikulski's response to the plea from the scientific community was to suggest that they, the scientists, were misinformed and arguing from a position of vested interest.

Among the budgetary manipulations necessary to fully fund the space station, the committee recommended a cut in NSF's Antarctic program, a cut in the budget for housing for the elderly, and a \$50 million cut in NASA's Earth Observing System (EOS) project. For FY 1993, the Committee recommended a ceiling of \$2.25 billion for the space station project.

In May, the House Appropriations Subcommittee had voted to virtually eliminate the space station project from the FY 1992 budget. Lobbying by a vocal administration group, including Vice President Quayle, resulted in the resurrection of the project. Critics of Space Station Freedom have pointed out that the stated \$30 billion cost for the project is a gross understatement. Critics estimate that the full cost for the 30-year life of the project may run as high as \$180 billion.

**Global Warming Halted** (at least for the short term). A report in the *Washington Post* by William Booth quotes National Oceanic and Atmospheric Administration (NOAA) scientists as stating that the June 15 and 16 eruption of Mount Pinatubo introduced enough volcanic ash, dust, and gasses into the atmosphere to overcome the warming effects of greenhouse gas buildup, and to result in a cooling of Earth, at least for a few years. Described as the largest volcanic eruption of the century, Pinatubo's volcanic emissions may be two or three times more voluminous than those of the 1982 eruption of El Chichon. Based on analysis of polar-orbiting weather-satellite data, the NOAA scientists predict as much as a 4°F lowering of average temperatures in the tropics.

A concern raised by the environmental community is that any cooling, even a very temporary cooling related to atmospheric ash buildup, will be used to support the Bush Administration's lack of full acceptance of global warming and its potential consequences. The *Post* article quotes Michael Oppenheimer of the Environmental Defense Fund as stating, "The cooling is only temporary. It would be most foolish to use this hiatus in the warming trend as an excuse for inaction." ■

that plumes may start as lower viscosity (warmer) diapirs that grow from their supply through a trailing conduit as they rise through higher viscosity (cooler) mantle. The plume thus develops a large, spherical head and a long, narrow tail. On arrival at the base of the lithosphere, the plume head flattens and melts by decompression, producing enormous quantities of magma in a short period. These are the flood basalt events that have occurred on continents and in ocean basins and that signal the beginning of major hotspot tracks. Subsequent volcanism over the plume conduits (or "tails"), established by the initial plume upwelling, are the familiar tracks that connect flood basalts to currently active hotspots. Thus, an important prediction of this model is that oceanic plateaus, such as Ontong-Java, Kerguelen, and Manihiki, are flood basalt provinces equivalent to the continental examples. Only deep-sea drilling can sample these vast submarine features, although Richards et al. (1991) believe that some ancient oceanic plateaus have been accreted to continents, such as Wrangellia, southeast Alaska. (Is the ultimate fate of the flood basalt that began the Hawaiian hotspot an accreted terrane in Siberia?) Ocean drilling on the Ontong-Java plateau has recently been completed (ODP Leg 130) where flood-type basalt flows about 120 m.y. old are present at sites separated by more than 1500 km.

Following the formation of hotspots in flood-basalt volcanism, mantle plume flux along the Réunion and Kerguelen traces has been more or less constant, with no sign of waning activity. Some hotspots, notably the one that began with the Ontong-Java plateau and later formed the Louisville seamount chain, have disappeared, while others such as the Marquesas produce intermittent volcanic chains. On the basis of deep ocean drilling evidence for continuity of major hotspot tracks, it is clear that mantle plumes have lifetimes on the order of 120 m.y. or more.

## HOTSPOT REFERENCE FRAME

If the global constellation of mantle plumes forms a long-lived, stable pattern of convection of heat and material from the lower to the upper mantle, then the geographic orientations and age distributions of volcanic chains related to hotspots offer a very simple and direct record of the motion of lithospheric plates during the history of opening of most of the present ocean basins. Rates and directions of plate separation derived from the alternating normal and reversely magnetized stripes of seafloor parallel to spreading ridges measure past large-scale horizontal movements of pieces of Earth's surface relative to their neighbors. This is called a relative motion reference frame because the spreading ridges from which motion is measured are themselves moving over the mantle, albeit more slowly than plates. A third reference frame for plate motions is provided by Earth's magnetic field, which is assumed to have the shape (on average) of a dipole field aligned along the spin axis. Rocks that are magnetized in this field acquire a magnetic inclination (angle of the rock magnetic vector from horizontal) unique to their latitude. Thus, any trans-latitudinal (north-south) motion of lithospheric plates can be determined from the paleomagnetic reference frame; east-west motions cannot be measured by this method.

An essential question concerning hotspot volcanism, then, is whether or not mantle plumes are, in fact, fixed relative to one another and thus define an irregular, but rigid reference frame. Some amount of interplume (hotspot) motion might be expected because of viscous coupling between the base of the moving lithospheric plates and the upper mantle due to horizontal flow of the upper mantle away from spreading centers and toward subduction zones. If these perturbations are small or constant over long periods, then interplume drift may be significantly less than plate velocities, and hotspots with associated volcanic traces constitute a convenient and direct reference frame for reconstructing plate motions, independent of the paleomagnetic reference frame.

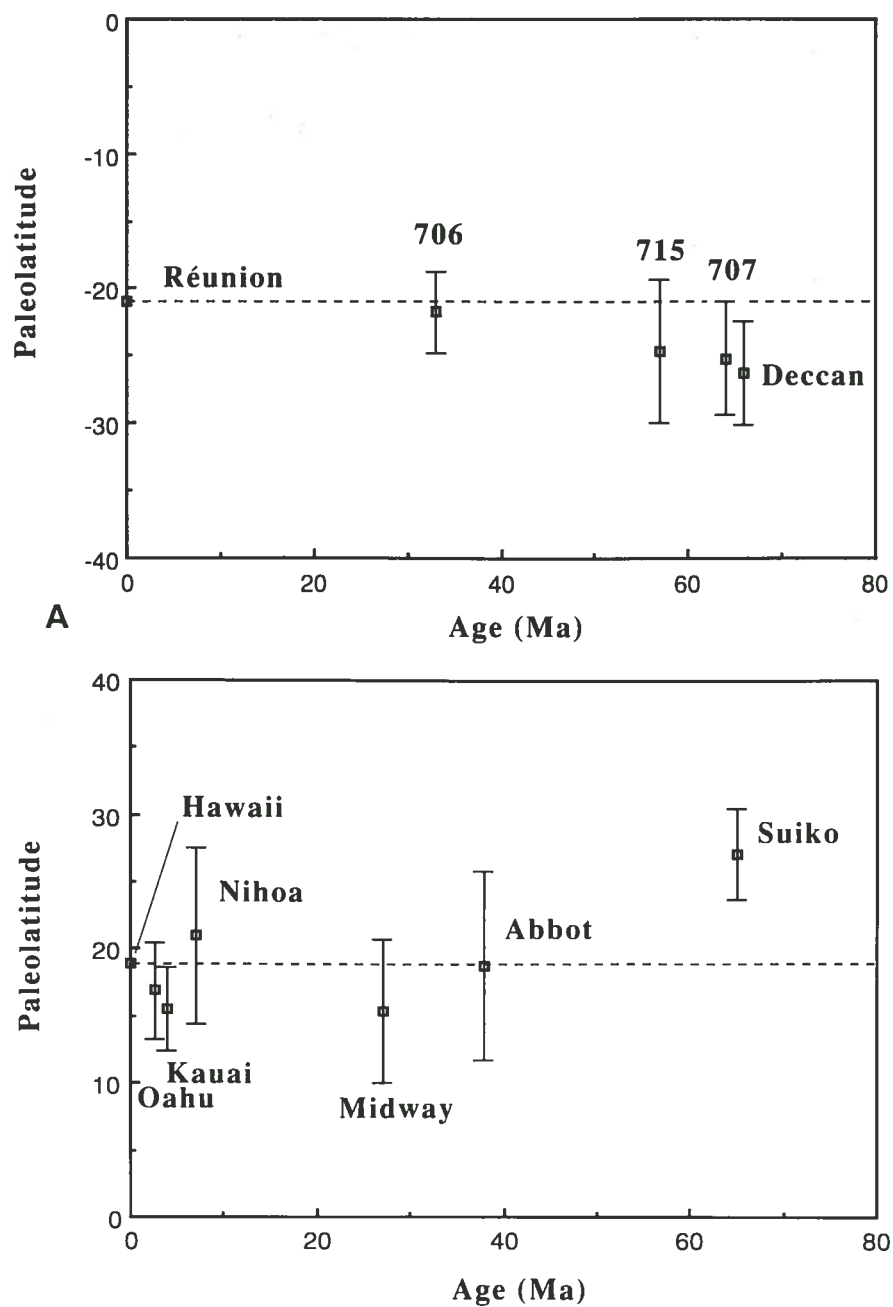
The magnitude of interplume motion can be assessed by comparing the geometry and age distribution of volcanism along hotspot tracks with reconstructions of past plate movements based on relative-motion data. If the motion of one plate over hotspots underlying it is determined from the orientation and age of volcanism along trails of islands, seamounts, and linear ridges, reconstructions of the past positions of neighboring plates relative to those hotspots can be calculated from sea-floor-spreading data. If hotspots underlying all plates are stationary, then the calculated motions of the neighboring plates should follow hotspot tracks observed on them. Any deviations of these predicted plate movements from actual hotspot tracks would then indicate the magnitude and direction of interplume drift. Figure 2 shows such computer-modeled hotspot tracks. In this example, the motion of the African plate has been described by a sequence of rotations over fixed hotspots that best fits the geometry and ages along sampled tracks, most notably the Walvis Ridge (O'Connor and Duncan, 1990). Modeled ages, shown in 10-m.y. increments, increase northeastward from 0 to 120 Ma, the approximate age of opening of the South Atlantic.

Addition of the relative plate motion between India and Africa and between Antarctica and Africa predicts the tracks that should be left by the Réunion and Kerguelen hotspots if these have remained fixed relative to the South Atlantic hotspots. As can be seen in Figure 2, there is a close match between predicted and observed volcanic trends, both in geometry and in age distribution. Hotspot tracks in eastern Australia and the Tasman Sea are similarly well matched (McDougall and Duncan, 1988). The success of this modeling, then, is strong support for the notion that hotspots maintain a fixed geometry over periods as long as 120 m.y. Molnar and Stock (1987), on the other hand, have found significant differences between observed and calculated tracks when comparing Atlantic and Pacific hotspots. Their analysis, however, assumes a single Antarctic plate from Late Cretaceous through Tertiary time, but all hotspots can be stationary if some relative motion between East and West Antarctica occurred during 80–40 Ma (Duncan, 1981).

The mantle reference frame for plate motions defined by hotspot tracks is independent of the paleomagnetic reference frame and has certain distinct advantages: It does not depend on the assumption of the geocentric axial dipole field (for which there is good evidence except during polarity reversals of the field), and it resolves

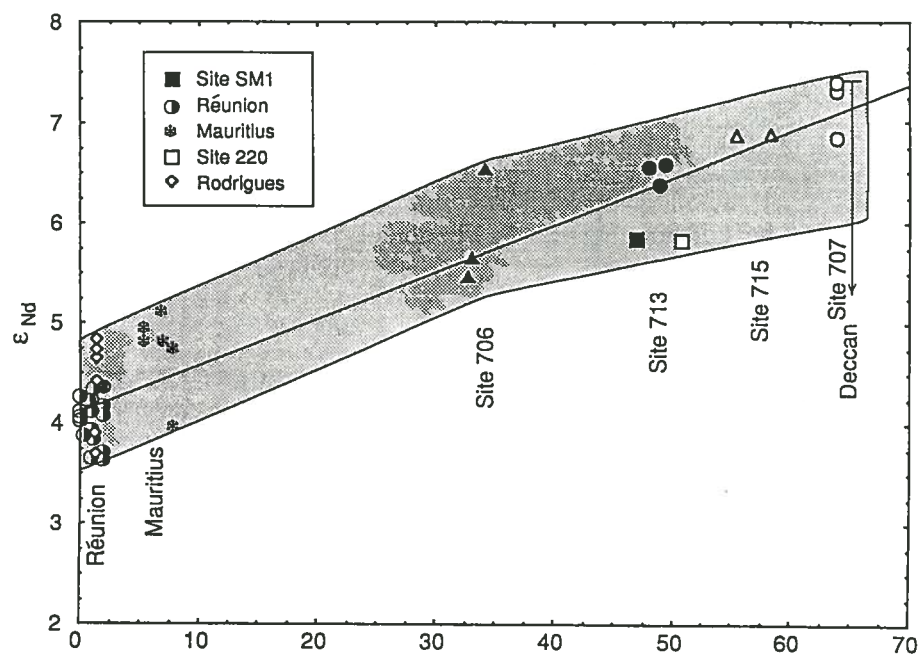
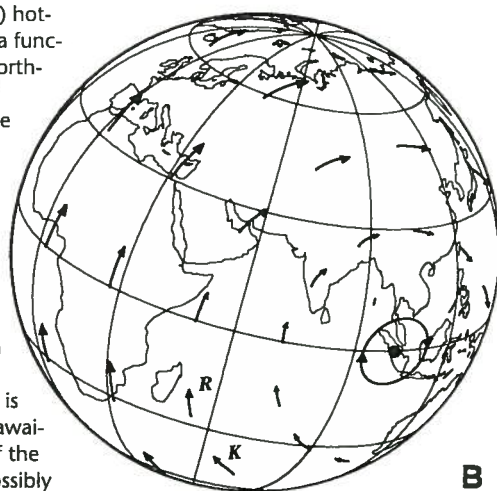
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**Figure 4.** A: Paleolatitudes of sample sites from the Réunion (above) and Hawaiian (below) hotspot tracks, with  $\alpha_{95}$  confidence limits, as a function of time. These data indicate a small northward motion of the Réunion hotspot ( $\sim 7^\circ$ ) concurrent with a southward motion of the Hawaiian hotspot ( $\sim 8^\circ$ ). The results are consistent with an episode of true polar wander; that is, motion of the entire Earth relative to its spin axis, as shown in B.

B: The early Tertiary true polar wander episode can be described by clockwise rotation ( $\sim 9^\circ$ ) of the Earth about a pole on the equator at about  $100^\circ\text{E}$ . The resulting northward motion of the Réunion hotspot is about  $7^\circ$ , and southward motion of the Hawaiian hotspot is about  $8^\circ$ . This adjustment of the Earth's principal moment of inertia was possibly caused by reorganization of plate motions in the early Tertiary.



**Figure 5.** Variation of  $^{143}\text{Nd}/^{144}\text{Nd}$  (shown as  $\epsilon_{\text{Nd}}$ ) of Réunion hotspot magmas as a function of time. The trend is from compositions similar to ocean-floor basalts in the early stages of hotspot activity (including the Deccan flood basalts) toward more plumelike ocean-island compositions.

## Ocean Drilling continued from p. 215

east-west plate motion, which is not detected in paleomagnetic studies. Several groups have used the mantle reference frame to determine the history of plate convergence across subduction zones, where the record of relative plate motion is largely destroyed (e.g., Engebretson et al., 1984). Continental tectonic and volcanic events in western North America are particularly well correlated with changes in the magnitude and direction of plate convergence predicted from the hotspot reference frame. This method eliminates the need to construct global circuits of plate motions that cross only spreading ridges and reduces the large uncertainties accumulated in combining sequences of rotation poles.

Also, differential motion between the mantle and the spin axis can in principle be determined by comparing plate motions recorded by the hotspot and paleomagnetic reference frames. Such motion has been termed *true polar wander* (distinguished from apparent polar wander of the magnetic [= spin] axis inferred from time sequences of paleomagnetic field directions for given plates). It is possible that redistribution of mass within Earth through processes such as mantle convection and plate motions may change the planet's moments of inertia sufficiently to cause a shift of the entire body relative to its spin axis (Goldreich and Toomre, 1969). This is, in fact, an old idea, suggested as an alternative to continental drift to explain paleoclimatic evidence for translatitudinal motion of Earth's surface (Irving, 1964). True polar wander, however, was largely ignored after it was demonstrated that separate continents had distinct apparent polar wander paths and that continental drift (plate motion) must have occurred. Could both motions occur simultaneously?

In the absence of true polar wander, mantle plumes do not move relative to the spin axis. Hence, every volcano generated along a given hotspot track would record the magnetic inclination, usually expressed as the paleolatitude, of the site of present hotspot activity. If measured paleolatitudes are constant along a hotspot track, then that hotspot has not moved with respect to the spin axis. On the contrary, a change in hotspot paleolatitude with time would indicate motion of the mantle (because plumes are stationary within the mantle) relative to the spin axis, which is true polar wander. (Note that the low viscosity of the fluid outer core allows the geomagnetic field to remain coupled with the spin axis.)

Paleolatitude data for core material recovered at three ODP Leg 115 sites, together with the paleolatitude of the Deccan flood basalts ( $-27.9^\circ \pm 2.4^\circ$ , Vandamme et al., 1991), indicate an  $\sim 7^\circ$  northward motion of the Réunion hotspot (Fig. 4A). This small amount of true polar wander is just barely significant at the  $\alpha_{95}$  confidence level of the paleomagnetic data. However, the direction and magnitude of this inferred mantle motion are consistent with other comparisons of the hotspot and paleomagnetic reference frames. Of particular interest are magnetic data from basalts recovered by DSDP drilling at Suiko seamount in the northern Hawaiian-Emperor chain that yielded a paleolatitude for the Hawaiian hotspot of  $27.1^\circ \pm 3.4^\circ$  (Kono, 1980), requiring  $\sim 8^\circ$  southward motion of this hotspot since 65 Ma. Paleolatitudes of younger sites along the Réunion and Hawaiian hotspot tracks are not significantly dif-

ferent from the present hotspot positions (Fig. 4A), indicating that the true polar wander occurred in early Tertiary time.

Hargraves and Duncan (1973) first noted the systematic northward motion of hotspots in the Atlantic region and simultaneous southward motion of hotspots in the Pacific region, relative to the geomagnetic pole, over the past  $\sim 50$  m.y. This observation was explained by a  $12^\circ$  clockwise rotation of the mantle about an equatorial axis emerging in the western Indian Ocean (Fig. 4B). Subsequent studies (summarized in Courtillot and Besse, 1987) have confirmed this surprising conclusion and have extended the history of true polar wander to 200 Ma. Intriguingly, the early Tertiary true polar wander event occurred within a period of global plate-motion reorganization, resulting in significantly more east-west collisional plate boundaries (Rona and Richardson, 1978). The abrupt change in direction of the Pacific plate, reflected in the Hawaiian-Emperor bend (43 Ma), and the "hard" collision of India and Africa-Arabia against Eurasia (45–50 Ma) occurred at this time. Courtillot and Besse (1987) concluded that these changes in subduction-zone location and activity perturbed the torque balance of the coupled upper mantle-lithosphere system, which produced the true polar wander.

## HOTSPOTS AS WINDOWS INTO MANTLE STRUCTURE

Because hotspots appear to be maintained by deep-seated mantle plumes, the composition of their volcanic products offers glimpses into the chemical structure of the mantle below the source region for ocean spreading ridge volcanism. It has been recognized since Gast's (1968) work that ocean island and sea-floor basalts are melted from distinct mantle reservoirs that have been separate for billions of years. Plumes deliver material from the lower mantle that is primordial or has been accumulating over billions of years of plate subduction (Zindler and Hart, 1986). A major objective of ODP Leg 115 basement drilling was to sample a time sequence of the volcanic products of Réunion hotspot activity to examine compositional changes from flood basalts to ocean-island volcanism. The seamount and island basalts of other similarly long-lived hotspots are characterized by a remarkable uniformity in composition (e.g., the Hawaiian-Emperor chain and the Louisville Ridge), but certain isotopic and trace element ratios indicate that subtle changes in the mantle source for melt production may occur with time. Compositions of basalts from the endpoints of the Deccan-Réunion chain (Cox and Hawkesworth, 1985; Fisk et al., 1989) show that there was a change in the mantle material supplied to the hotspot through Tertiary time.

Major element contents show that volcanic rocks all along the Réunion hotspot track are predominantly ocean-island tholeiites with variabilities controlled principally by low-pressure olivine and plagioclase fractionation. The abundance of incompatible elements (e.g., K, Ti, and Zr) in parental magmas, however, appears to increase with time, from Deccan to Réunion sites. Moreover, trace element abundance ratios that are generally insensitive to variations in partial melting and fractional crystallization (e.g., Ba/Ti, Nb/Y, and Zr/Nb) show systematic

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Forum is a monthly feature of *GSA Today* in which many sides of an issue or question of interest to the geological community are explored. Each Forum presentation consists of an informative, neutral introduction to the month's topic followed by two or more opposing views concerning the Forum topic. Selection of future Forum topics and participants is the responsibility of the Forum Editor. Suggestions for future Forum topics are welcome and should be sent to: Bruce F. Molnia, Forum Editor, U.S. Geological Survey, 917 National Center, Reston, VA 22092; (703) 648-4120; fax 703-648-4227.

## ISSUE: Programs for Ethnic Minorities in the Geosciences—Funding as a Pivotal Factor?

Last month, GSA FORUM addressed the question of why so few ethnic minority individuals were enrolling or employed in the geosciences. This month's FORUM expands the topic, addressing it from the perspectives of major industry and government funding organizations.

### INTRODUCTION:

*Marilyn J. Suiter, American Geological Institute, Washington, D.C.*

Few non-revenue-generating projects are able to operate without substantial financial support. The programs that currently work to increase the participation of underrepresented ethnic populations in geoscience have societal (and sometimes economic) importance, but rarely generate substantial revenues. Groups that operate such programs most frequently obtain funding support through grants and contributions.

The organizations providing that funding vary by sector, from federal and other governmental agencies, such as the U.S. Department of Energy and the National Science Foundation (NSF), to private sector, including geoscience-based industries, philanthropic foundations, professional societies, and individuals. The funds provided range from unrestricted contributions to grant projects in support of specific activities and/or outcomes.

Funding initiatives have strong impacts on the programs that address the underparticipation of ethnic minorities in the geosciences. In the process of selecting proposals to be funded, subsidizers also select the majority of programs that will function at all. Further, the funding organization provides guidelines that proposal writers must meet; in doing so, the shape of the program is further adjusted to match the objectives of that organization. The result is that the funders, by financial authority, play a leading role in the determination of which programs exist, what targets they affect, and how they operate.

The rationale for selecting programs varies widely. Federal agencies, by definition, serve national interests. Philanthropic foundations serve the mission(s) of their founders and/or their boards of directors. Industry generally works to preserve corporate interests, which may include benefits to the local community.

Other elements critical to selection may be based in the data provided by the proposal writer. Information that provides the reviewers with a quantitative perspective of a problem supports the author's premise that the issue to be resolved is important and that the proposal provides a solution.

However, it behooves the geoscience community to consider carefully how funders know which initiatives are most important. Certainly, one source of that knowledge is the provision of information by and opin-

ions of geoscientists. We also must evaluate the selection process. Just as concern has been expressed by many scientists about the selection process for grant awards for scientific research, the selection process for grants supporting human-resources development in science must be equally rigorous and equally fair.

This Forum provides a view of the funding perspectives of key supporters of programs on ethnic minorities in geoscience, and the rationale for their choices.

### PERSPECTIVE 1: Underparticipation in Science: A Federal View

*Darryl E. Chubin, Office of Technology Assessment, U.S. Congress, Washington, D.C.*

We are in the midst of an "American demographic revolution." As the nation's school-aged population becomes "minority majority," educators, parents, and political leaders must ask how our models of learning can change to reflect the diversity of students before us. This is not easy, even with good intentions and the will to effect change. It takes commitment, resources, and a rethinking of the institutions and practices that shape the aspirations of children—for better and for worse. This is the context for addressing one vital issue among many in education—the underparticipation of minority individuals in science.

Minority participation in science—whether measured by course-taking, college enrollment, baccalaureates earned in scientific fields, graduate study, or careers in scientific research or teaching—has chronically lagged behind that of the majority population. This obdurate truth has led to the recognition that without intervention at the national and local levels, minority participation in "things scientific" will not improve. Put another way, market forces alone will neither draw minority individuals to science nor retain them in the education "pipeline" through completion of advanced degrees. Only programs targeted to the learning needs of various students—including women and many white males who, too, are underserved by schools and the culture at large—will make a difference.

Of course, there is no single federal, or congressional, view on these matters. And there is no one program that satisfies the learning, counseling, and motivational needs of all students. But one lesson of federal agency, as well as school- and community-based

science, programs is this: what reduces the mystery and improves the interest and achievement of students in after-school, weekend, and summer activities targeted to one group tends to have positive effects on others. The key is individual attention to the whole child without the stigma of test, or track, or last year's performance. The baggage is left behind. The source of the "problem" is defined as the learning environment, not the learner.

In the decentralized U.S. system of education, we pay lip service to individual differences, but we sort and cull students according to what Shirley McBay, president of the Quality Education for Minorities Network (QEM), calls a "factory system model." Once identified as fast, slow, and somewhere in-between, students are discouraged and deflected from courses and careers that they are capable of pursuing. As a nation, we are wasting talent. Instead, we must remove preconceptions held by teachers and students alike about the role of innate talent. Aptitude is only one element of learning, and not the decisive one, at that. Discipline, industry, and resourcefulness are as important for becoming a scientist, and especially for increasing participation in scientific careers. Developing human resources is everybody's job. Federal policy is, at best, one catalyst.

### PERSPECTIVE 2: The Education and Human Resources Program of NSF's Division of Earth Sciences

*Arnold J. Silverman, National Science Foundation, Washington, D.C.*

The latest American Geological Institute (AGI) and National Science Foundation (NSF) data continue to show the abysmally poor representation of ethnic minority individuals in the geosciences. Federal support for research and education in the geosciences, in a democratic and pragmatic society, requires that the rapidly growing minority population of this country, a population that will provide a majority of the adult workers before the middle of the next century, be an active participant in publicly sponsored activity. The fact that to this date a combination of professional interest, unequal educational opportunity, and racial and gender prejudice has limited the number of minority individuals pursuing careers in the geosciences cannot be allowed to go unchallenged in the 1990s and beyond.

NSF and other federal agencies are determined to shift the status quo by offering new opportunities to recruit and retain minority individuals primarily through programs aimed at all institutions of higher education. NSF recognizes that modestly increasing the rate at which minority students with an interest in science make the transition from seniors in high school to freshmen in college and increasing the retention rate for science majors in the freshman and sophomore years to one equal to that of all students can easily triple the number of minority baccalaureate and Ph.D. graduates in science, to say nothing about increasing the size of the precollege pool interested in science.

We in the earth sciences at NSF will support such efforts through innovative minority-majority institutional alliances, increasing research experiences for minority undergraduates, and providing resources for bright, economically needy minority students to finish their studies. We must then expect an open market in employment,

based upon talent and potential contribution, to guide hiring practices.

### PERSPECTIVE 3: Exxon Corporation: Female and Minority Employment

*T. J. Volk, Exxon USA, Houston, Texas*

Exxon Corporation has more than 42,000 U.S. employees, of whom over 27% are females and 23% are ethnic minority individuals. Foremost among the resources of a premier company are the people who strive together in the attainment of its business objectives. Exxon values the diversity and international character of its work force. We want all employees to succeed, and we devote additional attention to women and minority individuals to ensure that barriers do not exist to their progress. In 1990, there was continued progress in the representation of women and minority individuals in Exxon's U.S. work force. At year end, women filled 10.5% of managerial positions, and minority individuals represented 11.6% of the managerial category. In professional assignments, minority individuals and women were represented in 12.8% and 21.7%, respectively, of the positions.

In the geosciences, females make up about 25% of university enrollments, and Exxon's domestic hiring experience is consistent with this. Perhaps the most significant obstacle to hiring ethnic minority individuals in the geosciences is their low level of enrollment, currently somewhat less than 5% in geoscience educational programs. Clearly, programs to encourage geoscience careers at the primary and secondary school levels are needed.

In 1990, in its efforts to actively identify and recruit talented women and minority individuals, Exxon made educational contributions of approximately \$920,000 at the precollege, college, and graduate school levels. A primary focus of these contributions was to promote engineering and science education at the high school and college levels.

During the fall of 1990, Exxon initiated a Minority Scholarship Program for students pursuing degrees in math- and science-based disciplines, particularly engineering and geoscience. Under this program, \$100,000 in scholarships was awarded to 15 minority students at ten universities around the country. In addition, Exxon provides annual direct financial support totaling \$28,000 for geology and geophysics minority scholarships and a variety of geoscience minority outreach programs involving selected high schools and universities. Complementing the above efforts, in 1990, the Exxon Education Foundation's minority-oriented grant payments totaled \$2,926,000. These payments were made in support of numerous organizations, programs, and projects from elementary school through graduate school.

### PERSPECTIVE 4: Personal Involvement: A Possible Solution to the Underrepresentation of Ethnic Minorities in the Geosciences

*Norman McIver, Shell Oil Company, Houston, Texas*

That ethnic minorities are underrepresented in the sciences, engineering, and math fields of employment is undisputed, and certainly the repre-

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sensation in the geosciences is at the low end of the spectrum. This has been the subject of numerous surveys and articles that clearly point out the existence and consequences of this growing problem to society. Many causes of this situation have also been enumerated—historical discrimination, inadequate precollege preparation for the sciences, and lack of interest or motivation. Here I focus on the importance of motivation.

Students may be motivated to select an education and career path by (1) personal guidance by a parent, friend, or teacher, (2) perception of the fame or fortune that a certain career will offer (usually based on role-model recognition), (3) a fundamental interest in the subject matter, or (4) a good match between one's inherent abilities and the required skills of the future career. It is clear from my observations of geologists in the workplace that only the motivation of interest and matched abilities will produce lasting satisfaction for both employee and employer. If that is true, the issue must then be how to discover ability and stimulate interest early enough in the educational process to make a difference.

Any effective, long-term solution should deal with precollege education, where basic values can be most easily established and where the basic skills of math are learned. Too commonly, the reaction to this problem is to seek additional funding and to propose yet another program. I suggest that funding is not the heart of the problem and may contribute little to the solution. Furthermore, there are many excellent programs that emphasize a combination of guidance, internship, and men-

toring. There is no question that financial aid is important, but it is not the key issue. In fact, financial assistance today is "begging" for qualified minority individuals to support.

However, I appeal to the community of geoscientists, particularly young people who have established successful careers, to get involved with organizations and programs that are reaching out to help in a personal way. Without personal involvement, no amount of funding by government or industry will make any significant difference.

I would encourage the membership of our major geological societies to seek out opportunities in their local communities to work with schools and undergraduate colleges, particularly where an ethnic minority population predominates. There are numerous organizations that would welcome a higher level of participation from companies and individuals, including INROADS, MESA, AGI's Minority Participation Program (Minority Geoscience Scholars), and local coalitions working to improve access of ethnic minority individuals to geoscience and other sciences.

### **PERSPECTIVE 5: ARCO's Outreach Programs for Precollege Students: A Long-Term Approach to Recruitment and Retention**

*James E. Geitgey, ARCO Oil and Gas Company, Dallas, Texas*

The rapidly evolving demographics of our society dictate that the underrepresentation of members of minority groups in the sciences gener-

ally, and the geosciences specifically, must be viewed as a business concern, not simply as a social issue. To ensure that our future personnel needs in the scientific and technical arenas are met, we must be able to attract and retain a greater percentage of this growing segment of our population to these disciplines.

Given the realization that we cannot focus only on those few minority students already enrolled in college—i.e., those ready to exit the "pipeline"—ARCO Oil and Gas Company has expanded its efforts to attract precollege students to the sciences and help prepare them academically.

Initial efforts to influence occur through ARCO's Exploration Outreach Program. This is a coordinated effort by a group of volunteer geoscientists in five different ARCO offices. These volunteers help local schools with a variety of activities that emphasize the promotion of the sciences as an interesting and enjoyable subject that the students might consider as a college major and career option.

A second area to which we have devoted considerable energy is in supporting internships for underrepresented minority students. ARCO's Summer Internship Program supports talented minority students, as young as graduating high school seniors, who express an interest in pursuing the geosciences in college. The summer experiences are designed to expose students to the type of work that geoscience professionals perform in the petroleum industry, and to do so early enough that the experience can be factored into their decision when selecting a college major. We have found that such summer assignments, when appropriately structured, are an excel-

lent means of generating interest in the geosciences among students who, for the most part, had very little true understanding of what geoscientists do.

The students in our intern program come to us from a variety of sources. We have for some years recruited through the INROADS program, a national organization with affiliates in many metropolitan areas. Currently, ARCO is in its second year of support for a unique cooperative effort between Ft. Valley State College, a historically black college in Georgia, and the University of Oklahoma, a program through which we recruit interns. In addition, this year ARCO has established two scholarship/internships targeted at graduating high school seniors interested in geology. Additional students have come to us through job fairs, magnet schools, and local special programs.

While internships help to pique interest in the geosciences, we have found that scholarship support is an important factor that influences a student's decision regarding a college major. Therefore, we support a variety of organizations that provide scholarships. The minority scholarship program administered through the American Geological Institute plays a critical role in this area.

ARCO believes that we must continue to expend more and more of our efforts at the precollege level. Unfortunately, declining interest in the sciences in the overall student population and the impending crisis that will result from such a dearth of interest will be exacerbated by the current underrepresentation of minority groups in that area. We must take a long-term approach to solving this problem. ■

## **AGI Increases 1991-1992 Scholarships**

The value and number of scholarships awarded through the Minority Participation Program of the American Geological Institute have increased significantly for 1991-1992. The total value of the awards is \$261,750, an 18% increase over the 1990-1991 total of \$221,000. The total number of scholarships granted is 94, up from 80 given in 1990-1991. The average amount of the scholarships has also increased, from \$1020 in 1989-1990 to \$2785 in 1991-1992.

The scholarships, designed to encourage underrepresented minorities to pursue careers in the geosciences, are given annually to Black, Hispanic, and Native American undergraduate and graduate geoscience students. Recipients are judged on academic achievement, financial need, and their potential for future success in the geoscience profession. The national Science Foundation has played a major role in providing grant support for the scholarship program. AGI member societies (including GSA) contribute to the program through dues payments, and individual members contribute as well.

### **Scholarship recipients for the Minority Participation Program are:**

Claudia J. Alexander (University of Michigan), Jose O. Aponte (Temple University), Vicki L. Batson (Centenary College), Elise B. Bekele (Cornell University), Troy B. Beserra (University of New Mexico), Stephanie S. Brazziel (Fort Valley State College), Armando Burciaga (University of California, Los Angeles), Danita A. Byrd (Western Michigan University), Matthew B. Carr (Old Dominion University), Christopher Carrisalez (California State University), Robert W. Carter (Virginia State University), David A. Castillo (Stanford University), Derek H. Clayton (Monmouth College), Henry P. Cortacans (Rutgers University), Erik E. Cortes (Rutgers University), Heidi M. Cruz (Amherst College), Cesar I. Delgado (University of Puerto Rico), Jennifer R. Diaz (Ball State University), Diana F. Elder (Northern Arizona University), Sonia I. Fernandez (University of Iowa), Andrea L. Foster (Indiana University—Bloomington), Henry K. Gabaldon (University of New Mexico), Cindy L. Gillespie (Texas Christian University), Ruben A. Giral (Lock Haven University), Carol K. Glendon (University of Hawaii), Raymond J. Gomez, Jr. (University of Alaska), David A. Gonzales (University of Kansas), Stanley Grant III (California Institute of Technology), Darius C. Greenidge (University of Pittsburgh), Marsha M. Grey (University of Hawaii), Cheryl D. Gullett (University of South Carolina), Patricia M. Hall (University of New Orleans), Robert L. Harris (Purdue University), Mandel J. Harvey (Radford University), Kim M. Howard (University of New Orleans), Bernard E. Hubbard (Cornell University), Andrew C. Humphrey (University of Michigan), Pamela E. Kennedy (University of Oregon), Marvin K. Knight (University of New Orleans), Derrick J. Lampkin (Ohio State University), Lewis A. Land (University of Oklahoma), John T. Leftwich, Jr. (Pennsylvania State University), Tanya N. Leggett (Pennsylvania State University), James A. Lopez (Indiana University/Purdue University—Indianapolis), Carrie Manfrino-Kievman (University of Miami), Jorge G. Martinez (Northeast Louisiana University), Linda J. Martinez (University of California, Santa Barbara), Ralph Matos (Kutztown University), Katherine A. Milla (Florida State University), Carlos A. Mortera-Gutierrez (Texas A&M University), Ivette M. Munoz (University of Puerto Rico), Kasele T. Myers (Frostburg State University), Lisa M. Naranjo (Colorado School of Mines), Donna J. O'Neal-Bolner (George Mason University), Ian M. Palao (Florida State University), Elise F. Parkin (Pomona College), Claudine D. Perrault (Miami-Dade Community College), Debra L. Piette (University of Wisconsin—Green Bay), Kathryn L. Pryor (Fort Valley State University), Aurora Pun (University of New Mexico), Carlos E. Ramos (University of Puerto Rico), Robert G. Reina (Texas A&I University), Pedro A. Restrepo (University of Arizona), George Reyes (Harvard University), Kenneth D. Ridgway (University of Rochester), Anthony D. Robinson (Wittenburg University), Raymond J. Roessel (University of Arizona), Michael J. Romero (New Mexico Institute of Mining & Technology), Hector M. Ruiz (University of Iowa), Teresa I. Sanchez (Texas A&M University), Nicole D. Scott (College of William and Mary), John M. Seeley (Texas A&I University), Pamela J. Seney (Centenary College), Milka A. Skewes (University of Colorado), Chad C. Soliz (Colorado School of Mines), Lillian Soto (University of Puerto Rico), Russell E. Stands (Colorado School of Mines), Judith A. L. Stoope (University of New Mexico), Danny J. Tadgerson (Lake Superior State University), Raymond Torres (University of California, Berkeley), Kirk D. Trujillo (Colorado School of Mines), Andrew D. Valdez (University of Washington), Aaron A. Velasco (University of California, Santa Cruz), Tonya M. Washington (University of Colorado), Kelli D. Weaver (Ohio Wesleyan University), Tina M. Wells (University of Arizona), Andrea M. West (New Mexico State University), Anthony J. Wilburn (Pomona College), Teresa Ann Williams (California State University, Hayward), Darryl K. Willis (Louisiana State University), Bruce M. Wilson (Temple University), Paula Zermeno (Amherst College). ■

## **Radcliffe Institute Offers Post-Ph.D. Scholarship for Women**

The Mary Ingraham Bunting Institute of Radcliffe College is a multidisciplinary center for advanced studies that sponsors women scientists, scholars, writers, and artists through year-long, residence fellowships. Funded by the Office of Naval Research, the 1992-1993 Science Scholars Fellowship program will provide eight fellowships to women who have held a Ph.D. for at least two years in one of the following fields: astronomy, molecular and cellular biology, biochemistry, cognitive and neural sciences, computer science, electrical engineering, aerospace and mechanical engineering, geology, materials science, mathematics, physics, naval architecture and ocean engineering, and oceanography. Science fellows will receive a minimum stipend of \$29,000 plus a research allowance and, when necessary, may affiliate with any laboratory in the greater Boston area.

Women interested in applying should contact the Bunting Institute for application materials at 34 Concord Avenue, Cambridge, MA 02138; telephone (617) 495-8212. The deadline for applications is October 15, 1991.



decreases from north to south, indicating increasing influence of plume material. White et al. (1990) have determined the isotopic compositions (Sr, Nd, and Pb) of the drilled basalts, which are distinct from both Réunion and Deccan basalts. There is a clear trend toward higher  $^{87}\text{Sr}/^{86}\text{Sr}$  and  $^{206}\text{Pb}/^{204}\text{Pb}$  and lower  $\epsilon_{\text{Nd}}$  with time (e.g., Fig. 5). This pattern is correlated with both a change from near-ridge to intraplate hotspot setting and a dramatic drop in magma production rate (from flood basalts to discrete volcanic centers).

There may be several causes for the temporal variations in basalt compositions produced from the Réunion hotspot: (1) the plate-tectonic environment in which the magmas erupted; (2) the effects of decreasing degrees of partial melting of plume material, which is heterogeneous on a small scale; and (3) changes in the composition of the plume itself. White et al. (1990) concluded that although decreasing degrees of partial melting may increase the proportions of incompatible elements and "enriched" isotopic ratios in hotspot magmas derived from compositionally heterogeneous plume material, the most plausible explanation for the observed geochemical variations is decreasing entrainment of asthenosphere by the rising plume. In the diapir model for plume initiation and flood basalt volcanism (Richards et al., 1989), the hot, low-viscosity, deeper mantle plume material will warm and entrain the upper mantle material through which it rises (Griffiths, 1986). Extensive examination of the Deccan basalts has shown that these magmas were a blend of plume (represented by Réunion basalt compositions) and Indian Ocean upper mantle (source for spreading ridge magmas), variably contaminated with continental lithosphere (e.g., Mahoney, 1988). The sheer size of the Deccan flood basalt event argues that a substantial region of the upper mantle beneath western India was involved in melting. Once the plume head had melted, the established plume conduit (tail) did not foster the same degree of entrainment of surrounding mantle, and the hotspot trail then formed from a much smaller scale of melting that involved progressively less upper mantle influence.

## FUTURE DRILLING TARGETS

Deep ocean drilling along older, submerged parts of long-lived hotspot tracks has provided evidence that the array of hotspots is stable within useful time scales and provides a direct reference frame for plate motions. A small but apparently significant early Tertiary episode of true polar wander can be resolved through comparison of hotspot and paleomagnetic reference frames. Several major hotspots have burst into life with flood-basalt volcanism, most likely the initiation of mantle plumes. Compositional changes in the volcanic products of hotspots reflect the variable mixing of deep and shallow mantle and, occasionally, lithosphere contributions to melting. It is clear that hotspot traces provide a rich source of constraints on the dynamical, compositional, and thermal histories of the mantle; deep ocean drilling is an important aspect of investigating the temporal variations in hotspot activity.

Further study of hotspot-mantle plume phenomena is underway and

planned for ODP drilling in the near future. The Kerguelen and Ontong-Java ocean plateaus were the focus of separate recent drilling legs. While analytical work is ongoing, it appears that these are oceanic equivalents of the continental flood-basalt provinces. Only a few hundred metres of the flow sequence has been sampled, so the full time and compositional range of volcanism will not be known soon. Future drilling in the North Atlantic will investigate the timing of continental rifting and volcanism surrounding the birth of the Iceland hotspot. A remarkable peak in mantle plume activity in Early to middle Cretaceous time will be examined by drilling into seamount chains in the western Pacific. This volcanism coincides with faster rates of sea-floor spreading, higher sea level, and higher atmospheric  $\text{CO}_2$  than today, and a long period of uniform geomagnetic field polarity. Drilling will aim at establishing a precise time scale for the volcanism and its relation to the extreme Cretaceous climatic conditions. Drilling is also planned for one of the northernmost (and oldest) of the Emperor seamounts, to extend our picture of the compositional variability of the Hawaiian hotspot. A better constraint on the timing of true polar wander is also expected.

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## ORE DEPOSITS AND EXPLORATION POTENTIAL OF THE SOVIET UNION

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# The International Division: A Report on Activities

Brian J. Skinner  
President, International Division

The GSA Council was in a bold and experimental frame of mind when it established the International Division on May 6, 1989. Unlike each of the other divisions, the International Division was not perceived to be a vehicle for specialists to gather within the confines of a larger organization. Rather, the International Division was seen as a vehicle for outreach. The purpose of this division, Council stated, is "to provide a forum for and to coordinate meetings, symposia, conferences, and lecture tours on the geology of regions outside of North America, a focal point for exchange of views by North American geologists working overseas, an organization to raise funds for visits of foreign colleagues, a clearing center of distribution of American journals and books to underfunded overseas institutions, and, in the process, of strengthening cooperation with overseas geoscientific societies to help raise funds for projects such as volunteer training courses, assistance in effective English translations, and international exchanges of professors, other geoscientists, and students."

Many GSA members support the goals of the International Division—about 250 have already joined. The division has had a slow start, but it now has several activities underway, more in the planning stage, and an expanding list of good suggestions that need a broad base of support in order to come to fruition. It is time for the International Division's first report.

The activities of the division fall into several categories.

**Symposia.** The division's first symposium will be presented at the Annual Meeting in San Diego. The topic is "Geology of the Pacific Rim," recognizing, in part, that the 29th International Geological Congress will be held in Kyoto, Japan, in August 1992. Con-

vened and chaired by division Vice-President Bruce Hanshaw, the symposium will include speakers from around the Pacific rim. We look forward to a large turnout on the afternoon of Tuesday, October 22.

The second symposium will be held at the time of the 1992 South-Central Section meeting in Houston, Texas. Titled "Comparison of North American and Eastern European Folded Belts," the symposium will be convened by A. W. Bally and M. A. Scheupbach and will, we hope, have several speakers from eastern Europe.

Our third symposium, which is still in the formative stages, will be cosponsored with the Engineering Geology Division. Planned for the 1992 GSA Annual Meeting, this symposium will focus on engineering geology aspects of geologic hazards in Central and South America, partly in recognition of the 500th anniversary of the opening of those regions by the voyages of Columbus.

**Field Trips.** The International Division's first field trip will be offered in conjunction with the 1992 GSA Annual Meeting in Cincinnati. The trip, "Geology of Columbus' Landfall," will visit San Salvador and adjacent islands and will be led by Mark Boardman of Miami University (Ohio), Cindy Carney (Wright State University), and Don Gerace (Director, Bahamian Field Station on San Salvador). The trip will, of course, have a strong orientation toward sedimentary processes, but it will also focus on Columbus-oriented archaeology.

**Student Activities.** A major purpose of the International Division is the strengthening of contacts with foreign geologists. By making contacts early in the careers of geologists—that is, while they are students—division members

hope that life-long bonds will develop. The division's most active committee, the Student Committee, has 20 hard-working members and is chaired by James W. Skehan, Department of Geology and Geophysics, Weston Observatory, Boston College, Boston, MA 02193, phone (617) 552-8300.

The Student Committee's first major activity is the GEOPALS Program, in which GSA members are invited to sponsor foreign geology students in North America as student members of GSA. GSA sponsors will also be encouraged to communicate with their GEOPALS, taking interest in their professional development and seeking to assure that they benefit from their studies in North America. GSA members or foreign students who wish to participate in GEOPALS should write or phone Jim Skehan at Boston College (address and phone number above).

**Nominating Committee.** The officers of the International Division are a president and two vice-presidents (all to be elected annually) and a secretary-treasurer (to be elected biennially). This year's nominating committee is Robin Brett (Chairman), Bruce Molnia, and John Reinemund.

**Annual Business Meeting.** Please show your support for and interest in the activities of the International Division by coming to our brief annual business meeting. We need your help, your ideas, and your membership in the division.

The meeting will be during the Society's Annual Meeting in San Diego on Monday, October 21, at 6 p.m., just before the alumni receptions. The meeting will be in the Green Room, San Diego Marriott.

## Information About Our Affiliates

**AGID.** One of the directives of the GSA Council when they established the International Division was that "the division will accomplish its activities in cooperation with and in support of the Association of Geoscientists for International Development (AGID), an associated society of The Geological

Society of America, Inc." The symposia we have planned will all be cosponsored by AGID.

AGID is a remarkable and highly effective organization that deserves to be much better known than it is. It is a nongovernmental organization founded and led largely by geoscientists from developing countries. The organization is dedicated to serving as an international network to connect geoscientists in developing countries with colleagues in developed countries. Funded largely by member subscriptions and grants from the Canadian International Development Agency, AGID sponsors and cosponsors seminars and workshops related to sustainable water, mineral, and energy resource development, assessment and mitigation of geologic hazards, and environmental protection. AGID has published books and pamphlets summarizing the results of these seminars and regularly publishes a newsletter of international geoscience activities.

Wang Sijing, Director of the Institute of Geology, Academia Sinica, Beijing, China, is president of AGID. Jon L. Rau, Secretary-Treasurer, is located at AGID Headquarters, c/o Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand. AGID has regional vice-presidents for West Africa, East Africa, Central-South America, Asia, and Europe-North America. Sandra M. Barr, Department of Geology, Acadia University, Wolfville, Nova Scotia BOP 1X0, Canada, is the vice-president for Europe-North America. Memberships in AGID are \$5 per year for earth scientists from developing countries, and \$15 per year for other scientists. Membership forms can be obtained from Sandra Barr or from Bill Greenwood, U.S. Geological Survey, M.S. 911, Reston, VA 22090.

## Project Pangea

An International Research Workshop, to plan research initiatives for the second project of the Global Sedimentary Geology Program, Project PANGAEA, will be held from May 24 to May 29, 1992, at the University of Kansas in Lawrence. (For further information see page 224.) ■

## Earthwatch Offers Grants for Labor-intensive Field Research

Earthwatch, a private non-profit organization, fosters scholarly research by offering capital, labor, and greater visibility to the scientific community. The membership consists of individuals who want to learn more about scientific problems and to share in the excitement of solving them, thereby providing a bridge between scholarly research and public education. Several of these research programs have reached millions of citizens by coverage from international media programs such as *Nova*, *National Geographic Explorer*, *BBC Chronicle*, *Discover*, and *Smithsonian World*. The Center for Field Research receives, reviews, and recommends research proposals for Earthwatch support. The center is interested in raising its level of support to the earth sciences community.

Earthwatch funds are primarily derived from the contributions of participating volunteers selected from Earthwatch's 75,000 members; therefore, nonspecialist volunteers must be integrated into the research design. Volunteers are enthusiastic, well-educated people who can be trained for a variety of tasks in a relatively short time.

The labor-intensive field research that Earthwatch supported in the 1990-1991 grants program includes:

- Eruptive mechanism of Mt. Etna Volcano, Italy
- Glacier hydrology and sediment transport, Switzerland

- Geophysical structure, petrology, and geochemistry of the Taranaki volcanoes, New Zealand
- Biogeochemistry of Lake Naivasha, Kenya
- Geochemistry of Lake Baikal, USSR
- Glacial and Pleistocene geology of Mount Olympus, Greece
- Post-Eocene volcanism in central Sonora, Mexico
- Excavations of the Hot Springs mammoth site, South Dakota
- Late Cretaceous Pautut Flora from West Greenland
- Postglacial environmental history of Guernsey, Channel Islands, UK
- Mississippian fossil fishes of the Bear Gulch Limestone, Montana

Preliminary proposals may be made by telephone or by a detailed letter to the Center for Field Research. Upon favorable review, full proposals will be invited for submittal 12 months before the proposed fielding date of the project. Full proposals will be peer-reviewed. Proposals will be considered from scholars of any nationality, covering any geographic region.

For further information contact: David S. Silverberg, Program Director, Center for Field Research, 680 Mount Auburn Street, P.O. Box 403, Watertown, MA 02272; (617) 926-8200; fax 617-926-8532.



Edward E. Geary

## Building a Better Yellow Brick Road

As the world changes so do our perceptions of it. If the movie version of *The Wizard of Oz* were made today, melting of the wicked witch would probably contaminate the local water supply with toxic PCEs (polychlorinated evils), the Tin Man would be buying foreign oil to keep himself going, Dorothy's ruby slippers and the Emerald City would have already been sold to pay the interest on Oz's national debt, and that beautiful poppy field would now be sprouting thistles in addition to flowers. It is also likely that there would be too few Lollipop Grown-ups around who have the interest, understanding, or proper training to deal with these problems.

Although I am sure that many Munchkins would become melancholy contemplating their once beautiful, now thistle-filled poppy field, many other Munchkins might think that the difference between thistles and poppies is not really all that great. Likewise, although many earth scientists grow a bit worried contemplating the current state of our science education system, there are many other scientists who haven't visited the precollege education field for years and haven't seen the thistles that have bloomed. For example, in today's typical 9th grade earth science classroom, the "earth science" teacher is more likely to be a biologist than an earth scientist, the textbook is probably out of date (except for the chapter on Creationism), the yearly budget for laboratory supplies has been spent on pencils and paper, and the students have already learned that earth science is not the science to take if they plan on going to college. Even a brainless scarecrow will tell you that few if any of the students who choose to take these earth science courses will become the scientists and engineers of tomorrow, nor will many of them even understand why science is important to their lives. Disturbingly, it is exactly these students who will make up a majority of our population in the year 2010, and it is from their ranks that many of our new scientists and engineers must emerge.

Who should we blame for this situation? The schools who always seem to be facing financial crises?, the teachers who are not confident or comfortable teaching a subject in which they have little or no formal training?, the students who think science is boring and have been told that they can't do science anyway?, the parents who are working multiple jobs just to make ends meet?, or ourselves for being too busy with our own work to help? Certainly, there are many areas where blame could be laid, but rather than spend our time and energy pointing fingers and creating destructive tornadoes, we need to put our efforts toward building and following a better Yellow Brick Road.

Fortunately, if it is taught well, earth science is ideally suited to excite and interest all students in science. From earthquakes and floods to the price of gasoline and the quality of drinking water, it is exciting and relatively easy to demonstrate how earth processes affect all of our lives directly

and dramatically. Furthermore, GSA members are uniquely equipped to help change how earth science is perceived and taught in precollege science classrooms. However, like the shy Cowardly Lion, many of us are a bit scared to enter the mysterious precollege education forest. I can assure you that many precollege science teachers are equally scared by the prospect of meeting lions, tigers, or geoscientists.

The Partners for Excellence program, recently developed by GSA, is designed to help all of us overcome our fears and hesitations, and take an

active role in improving the science education system. Partnering can take on many forms, from a simple telephone conversation with a teacher from your children's school, to giving a classroom presentation or leading a field trip, to mentoring a group of students from the inner city. The key to Partnering is that you work with the teacher(s) from your community to design the type of educational interaction that best suits your skills and the teacher's needs. You may even end up as part of a group of professional earth scientists working with a group of

teachers from several schools in your area, or you may be the sole resource agent for one teacher and one school.

For those of you interested in learning more about the Partners for Excellence Program, the new GSA Education Division will be hosting a special informational session on Partnering to be held Monday, October 21, from 12:00 to 1:00 p.m. in Room 8 of the San Diego Convention Center. Come, bring your lunch and bring a friend, but please, no lions, tigers, or bears. ■

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**Foundation Booth—A Place to Visit**

The Foundation's booth, #746, in the exhibit area at the San Diego Annual Meeting of GSA is a place that you will want to visit during the three-day period that the exhibits are open. As always, one or more of the Foundation's Trustees will be present at the booth, an always popular opportunity to discuss the affairs of the Society, the science, and matters of worldly interest with these senior, well-known GSA members.

In the past there have been gifts awarded at the booth to GSA contributors, and 1991 is no exception. All those who have contributed to the Foundation this year will be eligible to participate in a drawing for some very interesting gifts, so mail your contribution to Boulder to arrive by October 10, or better still, make a contribution right at the booth, using a check, cash, or credit card. Gifts of \$100 entitle the contributor to membership in the Second Century Club, and the Foundation will present a small gift of appreciation to each Second Century Club member who visits the booth.

SAGE posters will be on sale by the Foundation. The proceeds over cost will be applied directly to the SAGE Fund, in support of this very popular and growing GSA program.

October 1991 is the 60th anniversary of GSA Council's official acceptance of the \$3.9 million bequest from R.A.F. Penrose, Jr. A display at the booth will commemorate this milestone in GSA history.

Finally, GSA's Institute for Environmental Education has begun operation, under the guidance of its executive director, Fred A. Donath, also a Foundation Trustee. Donath will be at the booth to talk about the very interesting programs that are being structured for this new GSA initiative in the environmental area.

**Have You Written a Will?**

Surprisingly, the majority of Americans die without having written a will. Does the absence of a will really make a difference? For most people the answer probably will be yes.

If you do not have a will, the state in which you live will essentially write one for you. Under state laws of descent and distribution, your property will be disposed of according to the mandates of the state. Your personal wishes will not enter into the matter.

The problem can be easily remedied, for most people at very little expense, by having an attorney prepare a will. Individuals may also write their own wills, called holographic wills, legal in nearly all states. A properly drawn will is important for the future of the people you love, and for the charitable causes about which you care and in which you sincerely believe.

If you wish to learn more about wills or if you wish to revise your existing will (a periodic review is important) we have a booklet that you will find of interest. The title is *Planning Your Bequests*, and we shall be happy to send you a copy if you will call the Foundation office at (303) 447-2020 or write us (you can use the accompanying coupon).

**Gifts in Memory of Doris M. Curtis**

GSA's 103rd President, Doris M. Curtis, died on May 23, 1991, during her term of office. This untimely event has deeply affected GSA members and earth scientists everywhere. Doris's popularity was widespread, and she pioneered many new directions for geology, not the least of which was her tenure as GSA President after an unbroken chain of 102 men.

The GSA Foundation is receiving memorial gifts for Doris Curtis which will be used to benefit groups and causes dear to her—women, public awareness, minorities, and education. Contributions may be sent to Boulder or made in person at the Foundation's booth #746 in San Diego. ■

**Donors to the Foundation, July 1991**

- |  |   |
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| <b>Century Challenge</b><br>Steven Esling  | <b>Minority</b><br>Marilyn J. Suiter<br>Thomas P. Thayer*   |
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June 30, 1991
- George W. Bain**  
Amherst, Massachusetts  
June 11, 1991
- Maurice Krafft**  
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# The Kiwi Geotrip

Comments by Ken Hamblin, Brigham Young University, as a trip participant on the three-week GSA GeoTrip to New Zealand, March 3–23, 1991. Scientific Organizers: Douglas S. Coombs, University of Otago, Dunedin, and Jarg Pettinga, University of Canterbury, Christchurch.

The GeoTrip to New Zealand was a journey to the far side of the world; strange, exotic, and full of wonder. Indeed, for most participants, crossing the equator was like a trip through the looking glass. In New Zealand the laws of nature seem to be repealed. Constellations are upside down, the sun traverses the sky in a deranged pattern, and although everyone speaks English, you can't understand them. The geology also seems to defy logic (Fig. 1). Paleontologists discover metamorphic facies, ignimbrites are not welded tuffs, and slow geologic processes occur at an incredible speed. So exotic is the geology of New Zealand that my "real world" experience could not be relied upon for a rational explanation of what I was seeing. In the North Island, the Pacific plate is being subducted westward under the Australian plate. In the South Island, the Australian plate is being subducted eastward under the Pacific plate. (Or is it the other way around??) In a word, the trip was one of the most exciting, interesting, and pleasant trips I have ever experienced. It was "hands on" experience with a type of geology I had never seen before. Here are some of the highlights.

From Auckland to Rotorua, to Taupo, and to Tongariro the landscape is dominated by volcanism. It controls the geomorphology, the drainage, and the geologic history of the island. The fascinating thing is that the volcanic activity here has a style of its own; half was between that of an island arc and the Cascade Range of North America. I was particularly fascinated by the ignimbrite sequence of the Taupo section and the details of eruptions the local geologists have worked out. We studied the results of the 1886 Tarawera eruption, including the 17 km fissures, a Maori village buried by an associated mudflow, and the formation of new lakes, which unfortunately buried the world-famous terrace deposits formed by earlier geyser activity.

The Rangitikei Valley contains the most clearly defined and most extensive sequence of upper Quaternary river terraces in New Zealand—and, as far as I'm concerned, in the entire world. What a magnificent sight! Fourteen sets can be easily distinguished. (I took 4 rolls of pictures, but still couldn't capture the scene).

As a clear document of recurrent movement on the major faults and the degree of Holocene tectonic activity in

New Zealand, the faulted river terraces are hard to beat. We studied excellent examples on both the North and South Islands. The superb sequence of offset terraces in the Wairarapa Plains preserved a remarkable record of dominantly dextral transcurrent movement through the Holocene, the last being formed during the 1855 earthquake. On the South Island a similar sequence of river terraces documents recurrent movement along the Hope fault system. What is impressive is the incredibly clear record of tectonics in action.

The splendor of the geomorphology and scenery of the Southern Alps was a most pleasant bonus to the trip. We hiked up to the Franz Josef Glacier (some took a helicopter ride through a dense overcast and saw the glacial fields basking in the sun above). We took a boat trip up the fiord of Milford Sound and later spent a day at Mt. Cook with such activities as scenic flights, landings on the Tasman glaciers, and hiking in alpine meadows. A bit of Switzerland in the land down under.

For me, and many others, an unsuspected highlight of our trip was our traverse across the sequence of metamorphic rocks from Franz Josef to Queenstown, seeing the area where F. J. Turner studied metamorphic facies. Although I never did see pumpellyite, I did, after all these years, get my first real glimpse of metamorphic facies.

If a single thing had to be selected as the highlight of the trip, certainly the overthrust of the Alpine fault at Gaunt Creek would be a strong contender for No. 1. Here schist, mylonite, and cataclastites of the Pacific plate are thrust over Quaternary gravels deposited by the present drainage on the Australian plate—all completely exposed in the steep cliffs in the valley of Gaunt Creek. At least 100 m of displacement has occurred since the deposition of the gravels in the past 10,000 years.

Add to these highlights the evidence we saw of accreted terrain, the cultural stops, including lunch at a sheep station with demonstrations of shearing and the work of sheep dogs, the albatross, penguins, kiwis, glow worms, and skeletons of the giant moa.

The success of the trip was the result of excellent planning and the tremendous amount of time and effort contributed by the leaders. They prepared a detailed guidebook especially for this trip and conducted the tour in

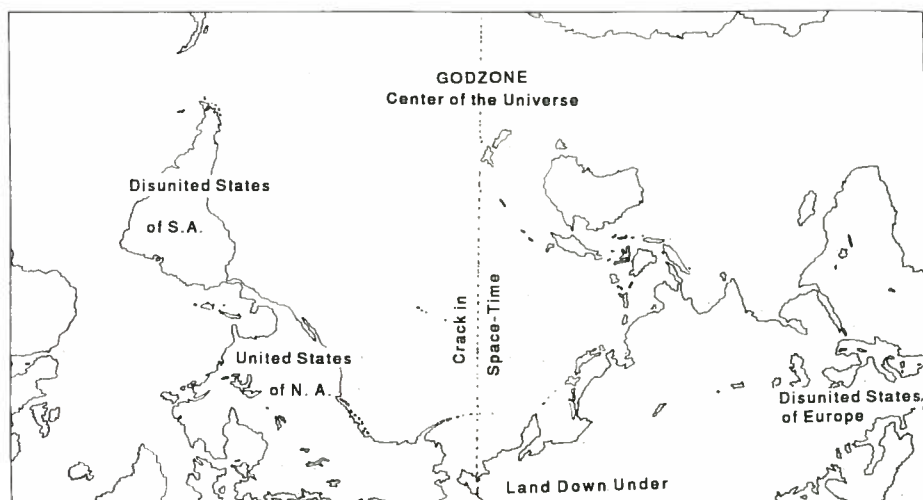
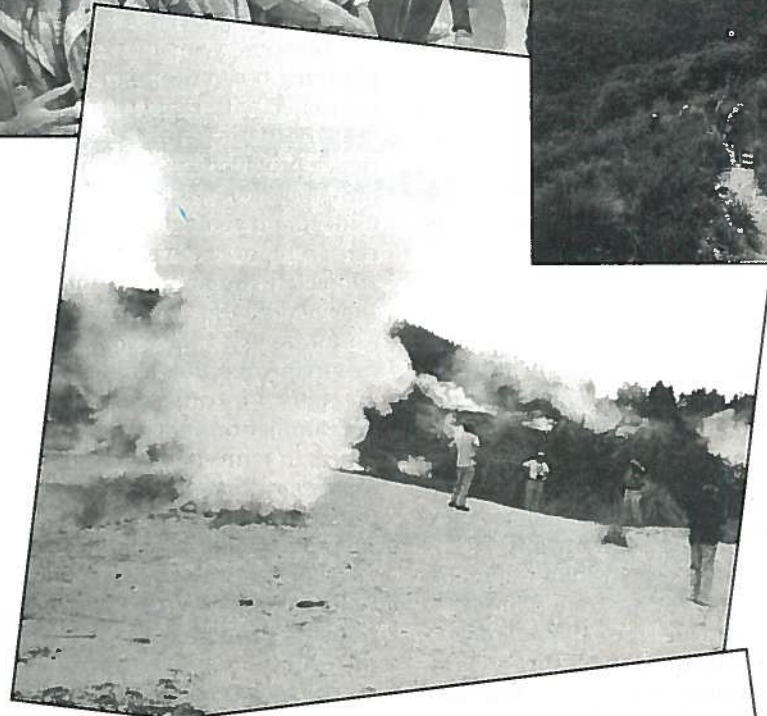
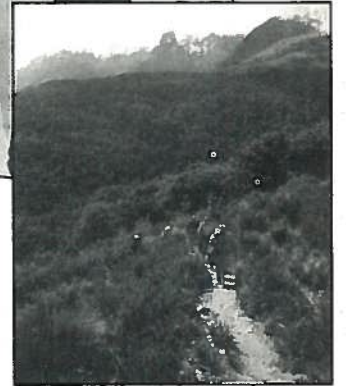


Figure 1. The world as seen by New Zealanders.



an extremely efficient and highly professional manner. More than 17 New Zealand scientists were involved, and we sincerely thank them all. We could never have appreciated the great geology of New Zealand without their help. We especially applaud the leaders who guided the tour: Douglas Coombs, Vincent Neall, Richard Norris, Jarg Pettinga, and Peter Wood were great tour leaders. Our sincere thanks.

Another of the real pleasures of this trip was the association with a variety of people from the United States, Canada, and Germany. All had a keen interest in geology, and all had an interesting, broad background of experiences to share.

Perhaps the only criticism I could make about the trip is that most of the participants were over "39" years old.

Just as the saying goes "it's a shame to waste youth on the young," it was sort of a shame to "waste" such a great trip on the old. A trip such as this could have even greater value for younger geologists. It would greatly enrich their background of field experience, expand their personal experience with field geology to a global scale, and provide them with professional contacts in other countries. Perhaps GSA should consider revitalizing in a new format the old NSF practice of supporting international field conferences targeted for young professors. I can't think of anything that could upgrade education in the geological sciences more than to give our younger professors field experiences in other parts of the world, to be shared, of course with all the over "39"ers. ■



# On Repair of a Brick Wall

Charles W. Welby

Chairman-Elect, GSA Engineering Geology Division  
Department of Marine, Earth, and Atmospheric Sciences  
North Carolina State University  
Raleigh, NC 27695

While rebuilding a brick wall in my backyard last spring, I began thinking about R. Gordon Gastil's call in the March issue of *GSA Today* for members of GSA to become more sensitive environmentally and for the geologic community to usher in a new era of environmental geology. I was wondering what the differences and similarities are between the science and practice of engineering geology and what is done in the name of environmental geology. It would seem that both are concerned with the use of geologic principles to avoid environmental problems, to minimize the effects of natural hazards on human affairs, and to correct problems inherited from the past.

In response to Gastil's comments, GSA headquarters and Gastil received a number of letters. Some praised his tocsin; others took umbrage with some of his comments about engineering geologists and his implication that engineering geology and environmental geology are different beasts, responsible to different masters. But are they?

What are the relationships between engineering geology and environmental geology (a term that has come into vogue since 1970). Somewhere on one of my bookshelves is at least one publication with "urban geology" in the title and which discusses matters that are today viewed by many as environmental geology. Engineering geology as a discipline has a long and distinguished history of responsiveness to human needs and concern for what are today considered environmental matters. Within the context of the GSA Annual Meeting programs, the Engineering Geology Division has had the responsibility for review of abstracts on which environmental geology is checked as the discipline of choice. This fact suggests that over the years those responsible for program development have recognized that what appear to be differences between the two are perhaps more semantic than real.

The brick wall illustrates this lack of a clear demarcation. The wall was designed to keep the mud from small mass-wasting events from spreading across a patio, down a driveway to a storm sewer, and then eventually to a stream. Upon reaching the stream the mud would add incrementally to the deterioration of the stream. The wall itself is an engineered structure; the most obvious geological concepts related directly to the wall are the forces from gravitational movement of the soil behind it and the pore pressure against the wall when the soil is saturated. It was not well engineered originally and fell over after about 20 years.

An understanding of where to put the weep holes and the support blocks in the wall requires some geological observation and judgment. But is the sediment-control function of the wall an engineering geology problem, or is it an environmental geology problem? I view it as an engineering geology problem, for an understanding of sediment transport and the way geologic processes may be used to mitigate the problem have been included in the

engineering geology discipline for some time. At the same time, in today's society it can be seen as an environmental geology problem, because the mud it holds back would otherwise end up in the stream.

Clearly, proper design of the wall is an engineering problem, but is it a civil engineering problem or an environmental engineering problem?

For some years I was on a county planning board dealing with problems associated with rapid (frenzied?) development in once-rural areas. This experience provided an opportunity to bring public attention to the need to understand geologic constraints on certain types of development and to appreciate the need for protection of sites of potential aggregate resources for future use. I was described by a local newspaper reporter as an "environmentalist," by others as "too much development-oriented," and by still others in terms better left to Chaucer's *Canterbury Tales*. Part of my public responsibility was to see that ordinances developed to "protect the environment" or to "manage land use" were realistic in terms of geologic principles and geologic facts about the county.

What was being done within the social and legal constraints was to insist that the physical geologic relations and processes be addressed by development so that the environmental impact would be minimized. The bottom line is that geologic observations, conclusions, and recommendations that have been viewed within the geologic community as in the realm of engineering geology were being applied to minimize future public expenditures and to minimize off-site effects. Although traditionally such applications of geologic principles have been viewed as engineering geology, in today's society we must acknowledge that some perceive them as environmental geology (as suggested by the reporter's classification).

In an attempt to determine what one GSA Joint Program Technical Committee may have seen as a dichotomy between environmental geology and engineering geology, I reviewed the titles for both environmental geology and engineering geology sessions at the 1990 Annual Meeting in Dallas. About one-half of the environmental geology papers presented there could have as appropriately been placed in a session entitled Engineering Geology. The other half I grouped as environmental geology because the titles suggested some discussion of a direct impact on humans or application to regulatory matters. In a broader view, they too could have been placed logically into an engineering geology session. Whether one would want to group the engineering geology papers as environmental geology papers depends upon one's perspective. Certainly most dealt, indirectly at least, with geologic problems having an impact or potential impact on humans and their institutions.

Two undergraduate courses I teach are entitled Engineering Geology and

Environmental Geology, respectively. The former draws civil engineering and geology majors; the latter draws students from a broad spectrum of majors, particularly soil science and landscape design, but also engineering and geology. Engineering Geology is the more technical and quantitative course; the Environmental Geology course addresses many of the same topics but with less emphasis upon detailed analysis of materials and processes and more upon the geologic information required to make reasoned and rational decisions. In both, there is discussion of the need for responsibility for one's decisions. Both courses deal with consequences, with looking at surficial and near-surficial geologic processes and the need to consider a project's effects upon both the physical environment and the biologic realm. In the early days of the Environmental Geology course it was team-taught. Each instructor had a "message" about the environment. As the realization set in that the course had to deal mostly with questions of physical and chemical geologic processes and to a certain extent with the political framework of our society, and less with the emotionalism and popularity of the environmental movement, faculty interest waned, and the course became my sole responsibility. These two courses are cited to provide a perspective with regard to engineering geology and environmental geology. The Engineering Geology course focuses on techniques and associated measurements that can be used to protect the biological realm and to assure maximum environmental protection. Less time is spent with placing projects within a social and legal context. The Environmental Geology course, on the other hand, looks at what can be done to maximize environmental protection and the need for careful consideration of geologic factors and their quantification. It sets the understanding within the social, institutional, and political framework, and it attracts some students initially because of the word "environmental" in its title. The student audiences and their needs control the differences in the courses more than does the subject matter itself.

At the 1991 Annual Meeting in San Diego, the Engineering Geology Division symposium is entitled GeoRisk Assessment. The organizers intend to provide a venue where use of geologic information in assessing risk to the biologic realm, humans included, from geologic processes or from human alteration of the geologic environment can be discussed. In my view, use and evaluation of geologic factors in risk assessment is properly included within the engineering geology discipline, but at the same time I recognize that others might choose to use the term "environmental geology" in this context. Certainly, the actual methodology of risk assessment is not to be construed as engineering or environmental geology.

The Engineering Geology Division expects to be an active participant and to play a significant role in development of the programs of GSA's new Institute for Environmental Education. Things that will be of interest to the institute are already of interest to most of the division members. I hope that members of GSA who are working in what they perceive as environmental geology will take the opportunity to become active members of the Engineering Geology Division. The dues are modest, the scientific agenda is exciting, and the division wants and needs your participation.

Returning to the brick wall, 30 or so years ago it would have been seen as simply a retaining wall to hold back the hillside and control the mud coming onto the patio. But times and ideas change. Today it can be seen as a symbol of our increased awareness of environmental problems and of how even small-scale geologic processes play a role in our everyday lives. The mud stays behind the wall and so need not be washed off the patio (water conservation); the mud does not reach the storm sewer and stream and therefore does not degrade the stream. If there are control ponds for urban runoff pollution in the city's stream system, holding back the mud reduces the need for tax monies to pay for future cleaning of the pond. Is it engineering geology or environmental geology that is applied here? Labels aside, as Popeye says, "I yam what I yam." The dichotomy between engineering geology and environmental geology is more imagined than real. In any event, the brick wall also provides a place to grow cucumbers, and, as a home-builder friend noted, it has a lot of character. ■

## Project PANGEA Workshop Planned

An International Research Workshop, to plan initiatives for Project PANGEA, will be held May 24-29, 1992 at the University of Kansas, Lawrence. This workshop is contingent on funding. The principal objectives of Project PANGEA are to examine the global sedimentary record and sediment variability from the base of the Pennsylvanian (Upper Carboniferous) through the end of the Middle Jurassic. This time interval offers special opportunities to understand global processes and both their magnitude and temporal variations during a time of accretion, zenith, and breakup of a major supercontinent. Its sediments preserve evidence of a broad range of climatic changes including glacial to desert, Milankovitch rhythms, development and demise of carbonate platforms and reefs, evaporites, and phosphorites, and includes two major extinction events at the boundaries between the Permian and Triassic and the Triassic and Jurassic.

Co-covenantors of the workshop are George deV. Klein, Dept. of Geology, University of Illinois, 245 Natural History Bldg., 1301 West Green Street, Urbana, IL 61801-2999; (217) 333-2076, fax 217-244-4996; and Benoit Beauchamp, Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, 3303 33rd St. NW, Calgary, Alberta T2L 2A7, Canada; (403) 292-7190, fax 403-292-5377. For registration information and details, write to: Project PANGEA, P.O. Box 5061, Station A, Champaign, IL 61825-5061.



## Call for Nominations for 1992 Young Scientist Award (Donath Medal)

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

**For the year 1992, only those candidates born on or after January 1, 1957, are eligible for con-**

**sideration.** In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1992 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 1992 Young Scientist Award must be received at GSA headquarters by **February 1, 1992**. The form for submitting the name of a candidate for the Young Scientist Award is attached below.

Recipients to date:

1989 . . . . . *Mark Cloos*

1990 . . . . . *Leigh H. Royden*

1991 . . . . . *Brian P. Wernicke*

*For a complete listing of past recipients of the Penrose Medal, Day Medal, Young Scientist Award, and Honorary Fellowship, please see p. 239*

### THE GEOLOGICAL SOCIETY OF AMERICA Nomination for 1992 Donath Medal (Young Scientist Award)

**DEADLINE:** Please return this form to headquarters by *February 1, 1992*

**NAME OF CANDIDATE:**

**ADDRESS:**

**BIOGRAPHICAL INFORMATION:** (similar to that found in *American Men and Women of Science, Who's Who in America*)

Date of birth: \_\_\_\_\_  
(For the year 1992, only those candidates born on or after January 1, 1957, are eligible for consideration.)

**SUMMARY OF SCIENTIFIC CONTRIBUTIONS TO GEOLOGY:** (not more than 200 words)

1992 DONATH MEDAL (YOUNG SCIENTIST AWARD)



## Call for Nominations for Distinguished Service Award

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

Council. This award will be presented during the Annual Meeting of the Society. 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 1992 is March 1, 1992.**

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*

### Help Direct GSA's Efforts

The GSA Committee on Nominations requests that each nomination be accompanied by a letter of recommendation (in the name of the nominator). Nominations for 1993 officers and directors must be received no later than **FEBRUARY 15, 1992**. Please send nominations and supporting information to Geological Society of America, P.O. Box 9140,

SELECTED BIBLIOGRAPHY: (no more than 10 titles)

### 1992 DONATH MEDAL (YOUNG SCIENTISTS AWARD)

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:** Please return this form to headquarters by **February 1, 1992**.

### About the Donath Medal Fellowship

In this issue of *GSA Today*, you will find information on how to apply for the Donath Medal Fellowship. This award is given to young scientists who have made significant contributions to the field of geology. The program was established in 1969 by the Council of the Geological Society of America. Each year, five young scientists are selected to receive the award. The recipients are invited to attend the annual meeting of the Geological Society of America and to give a paper. The award is named in honor of Donath Armstrong, one of the first young scientists to receive the award. The program has been very successful and has helped many young scientists to advance in their careers. At present there are only a few recipients who have received the award. The Council of the Geological Society of America is pleased to announce that the membership of the Geological Society of America is growing and that the award is becoming more widely known. It is important that we continue to support young scientists and that we encourage them to apply for the award. The award is a great honor and a great opportunity for young scientists to advance in their careers. We encourage all young scientists to apply for the award. The award is a great honor and a great opportunity for young scientists to advance in their careers. We encourage all young scientists to apply for the award.



## Call for Nominations for 1992 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, 1992**. 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 outstand-

ing 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

*Nominations continued on p. 228*

## PENROSE MEDAL, DAY MEDAL, OR HONORARY FELLOWSHIP

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

DEADLINE: Please return this form to headquarters by *February 1, 1992*

NAME OF CANDIDATE:

ADDRESS:

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)

re

ests your help in compiling a list of GSA  
ouncilors of the Society. The committee  
d by basic data and a description of the qual-  
ommended (vice-president, treasurer, coun-

ors must be received at GSA headquarters

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r, CO 80301.

## Honorary Program

Today you will find a  
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the Geological Society  
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candidate for Honorary



**Nominations** continued from p. 227

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.

**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 have lived and worked outside of North America. The most noteworthy exceptions were astronauts.

Most Honorary Fellows have been elected toward the evenings of their careers, after lifetimes 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. In choosing candidates for the Penrose

and Day Medals, **scientific achievements should be considered rather than contributions in teaching, administration, and service.**

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, 1992.**

The form for submitting the name of a candidate for any one of the awards is on page 227.

Recipients of the awards to date are listed on p. 239. ■

SELECTED BIBLIOGRAPHY: (no more than 20 titles)

A nomination 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:** Please return this form to headquarters by **February 1, 1992.**

PENROSE MEDAL, DAY MEDAL, OR HONORARY FELLOWSHIP



## CORDILLERAN SECTION, GSA 88th Annual Meeting

Eugene, Oregon  
May 11-13, 1992

The Cordilleran Section of the Geological Society of America will meet jointly with the Pacific Coast Section of the Paleontological Society of America at the Hilton Hotel & Conference Center in Eugene. The meeting is being hosted by the Department of Geological Sciences, University of Oregon.

### ENVIRONMENT

The meeting will be held at the Hilton Hotel & Conference Center on 6th Avenue in downtown Eugene. The meeting site is centrally located with easy access to numerous restaurants, a variety of lodging options, the Willamette River and its adjacent jogging trails, and the University of Oregon campus. Eugene is located in the Willamette Valley, nestled between the beautiful Oregon coast to the west and the snow-capped High Cascades to the east. The weather in mid-May should be spring-like with average high temperatures in the upper 60s and overnight lows in the 40s. The area receives an average of two inches of rain during the month of May. Travel to Eugene is relatively easy; Interstate 5 passes through the city, and the Eugene Airport is serviced by American, United, Horizon, and Alaska Airlines.

### CALL FOR PAPERS

Papers are invited for presentation in oral technical sessions, symposia, theme sessions, and poster sessions. Papers dealing with all aspects of the Cordilleran region of North America, as well as those of general geologic interest, will be considered for presentation and discussion. Technical sessions will allow 15 minutes for presentation and 5 minutes for discussion. Symposia may allow equivalent or longer times for presentation at the option of the conveners and symposium coordinators.

### FIELD TRIPS

Both premeeting and postmeeting field trips are planned. For details, contact the respective field trip leaders. General questions should be addressed to Gregory J. Retallack, Field Trip Coordinator, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-4558. Preregistration forms will be available in the Final Announcement in the February 1992 issue of *GSA Today*.

### Premeeting

1. **Tectonostratigraphy, Metamorphism, and Magmatism of the Mesozoic Belts of the Klamath Mountains.** May 9-10. M. A. Kays, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-4578.
2. **Sedimentology, Stratigraphy, and Tectonic Setting of an Eocene Subduction Complex and Overlying Forearc Basin Sequence, Southern Oregon Coast Range.** May 9-10. J. Black and A. Niem, Department of Geosciences, Oregon State University, Corvallis, OR 97331-5503, (505) 737-1233.
3. **Middle Tertiary Rocky Coast Paleoenvironments and Tephrites in the Oregon Western Cascades.** May 10. W. N. Orr, Department of Geological

Sciences, University of Oregon, Eugene, OR 97403, (503) 346-4577.

4. **Mid-Tertiary Paleosols and Paleoclimatic Changes in the High Desert of Central Oregon.** May 8-10. G. J. Retallack, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-4558.
  5. **Active Faulting in South-Central Oregon.** May 9-10. Ray Weldon, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (505) 346-4584.
  6. **Landslides in the Portland Metropolitan Area.** May 10. S. Burns, Department of Geology, Portland State University, Portland, OR 97207, (503) 725-3389.
- Postmeeting**
7. **Lower Paleozoic Tectonics of the Yreka and Trinity Terranes.** May 14-15. T. Wallin, Department of Geosciences, University of Nevada, Las Vegas, NV 89154-4010, (707) 739-1092.
  8. **The Josephine Ophiolite.** May 14-15. G. Harper (SUNY, Albany), c/o Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-6000.
  9. **Depositional Processes and Facies Geometry of Neogene Continental Volcaniclastics, Deschutes Basin, Central Oregon.** May 13-15. G. A. Smith, Department of Geology, University of New Mexico, Albuquerque, NM 87131, (505) 277-2348.
  10. **Quaternary Soils and Fluvial Landscapes of the Southern Willamette Valley, Oregon.** May 14. P. McDowell, Department of Geography, University of Oregon, Eugene, OR 97403, (503) 346-4567.

### SYMPOSIA

The following symposia will include both invited papers and selected volunteered papers. Prospective authors are encouraged to contact the respective conveners. General questions should be addressed to Jack M. Rice, Symposium Coordinator, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-3005 (direct) or 346-4573 (department).

1. **Tectonostratigraphy, Metamorphism, and Magmatism in Mesozoic Belts of the Klamath Mountains.** M. Allan Kays and Greg Harper, Department of Geological Sciences, University of Oregon, Eugene, OR, 97403, (503) 346-4578 (Kays) or (503) 346-6000 (Harper).
2. **The Second Symposium on the Regional Geology of the State of Washington.** Eric Cheney, Department of Geological Sciences, University of Washington, AJ-20, Seattle, WA 98195, (206) 543-3836; Ray Lasmanis,

Washington Division of Geology & Earth Resources, Mail Stop PY-12, Olympia, WA 98504, (206) 459-6372.

3. **Petrologic and Tectonic Evolution of Cordilleran Blueschist Terranes.** Brian Patrick, Department of Geological Sciences, University of California, Santa Barbara, CA 93106, (805) 893-4530.
4. **Mesozoic Batholiths of the Cordilleran Orogen.** J. Lawford Anderson, Department of Geological Sciences, University of Southern California, Los Angeles, CA 90089, (213) 740-6727.
5. **Seismotectonics of the Pacific Northwest.** George Priest, Oregon Department of Geology and Mineral Industries, 910 State Office Building, 1400 SW 5th Ave., Portland, OR 97201, (503) 229-5580; Craig S. Weaver, USGS, Geophysics Program AK-50, University of Washington, Seattle, WA 98195, (206) 442-0627.
6. **Paleontological Society Symposium, Neogene Paleoclimatic and Paleoenvironmental Change in the Pacific Northwest.** Andrew Cohen, Department of Geosciences, University of Arizona, Tucson, AZ 85721, (602) 621-4691.
7. **Geological and Tectonic Evolution of Southwestern Alaska.** Stephen Box, U.S. Geological Survey, U.S. Courthouse, Room 656, W. 920 Riverside Ave., Spokane, WA 99201, (509) 353-2467.
8. **From Spreading Center to Subduction Zone: Magmatic Processes in the Pacific Northwest.** Katherine Cashman, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-4323; Donald A. Swanson, USGS/AJ-20, Department of Geological Sciences, University of Washington, Seattle, WA 98195, (206) 543-1094; John R. Delaney, School of Oceanography, University of Washington, Seattle, WA 98195, (206) 543-4830.
9. **Mineralization Associated with Fault Processes.** Norm Brown, Department of Geological Sciences and Institute for Crustal Studies, University of California, Santa Barbara, CA 93106, (805) 963-2548.
10. **Magmatism Along the Northern Margin of the Basin and Range Province.** Anita Grunder, Department of Geosciences, Oregon State University, Corvallis, OR 97331-5503, (503) 737-1249.

### ABSTRACTS

Abstracts are limited to about 250 words and must be submitted camera-ready on the official 1992 GSA abstracts form, available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-8850.

### ABSTRACTS DEADLINE: JANUARY 21, 1992

An original and five copies are required for each abstract. Authors of symposium papers should send their abstracts directly to the appropriate convener (see lists above). Other abstracts should be sent to Jack M. Rice, Technical Program Chairman, Department of Geological Sciences, Eugene, OR 97403.

Abstracts will be reviewed for informative content and format, appropriate geographic coverage (Cordilleran region), and originality. Only one volunteered paper may be presented by each individual, although a person may also co-author papers

presented by others and may present additional papers invited for symposia.

### PROJECTION EQUIPMENT

All slides must be 2" x 2" and fit standard 35 mm carousel trays. Two projectors and two screens will be available for all oral sessions. Overhead projectors will *not* be available. Please bring loaded carousel trays, if possible.

### POSTER SESSIONS

Poster sessions will be located adjacent to the exhibit area. If you wish to take advantage of this highly effective means of communication, please indicate your preference for a poster session on the GSA abstract form.

### EXHIBITS

Exhibits will be located in the main foyer of the Conference Center. The cost of standard booths will be \$300 for commercial exhibitors and \$150 for educational and nonprofit institutions. For further information and space reservations, please contact A. Dana Johnston, Meeting Chairman, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-5588.

### STUDENT SUPPORT

The GSA Cordilleran Section has funds available for grants to support GSA Student Associates of the Cordilleran Section who are presenting papers at the meeting. Students are strongly encouraged to apply for these grants, and we anticipate that most students who qualify will be funded to some degree. Send applications to Cordilleran Section Secretary Bruce A. Blackerby, Department of Geology, California State University, Fresno, CA 93740, (209) 278-2955 (direct) or 278-3086 (department). Applications should include certification that the student is presenting a paper and is a GSA Student Associate of the Cordilleran Section. *All letters must be received by March 15, 1992.*

### SPECIAL EVENTS

After-hours events will include a no-host welcoming party for all registrants on Sunday evening. The annual luncheon for the Pacific Coast Section of the Paleontological Society of America will be held Tuesday at noon.

### GUEST PROGRAM

A raft trip on the McKenzie River and tours of Willamette Valley Wineries and the central Oregon coast may be offered if there is sufficient interest.

### ACCOMMODATIONS

A block of rooms at the Hilton Hotel, site of the meeting, has been reserved for attendees. A special reduced rate of \$70 (single) or \$80 (double) has been arranged. A variety of less expensive (\$30-\$50) housing options is also available within one mile of the meeting site. Specific information and reservation forms will be provided in the February 1992 issue of *GSA Today*.

### DETAILED INFORMATION

Information concerning registration, accommodations, and activities will appear in the February 1992 *GSA Today* and as part of the Cordilleran Section *Abstracts with Programs* for 1992. Preliminary questions and suggestions should be addressed to A. Dana Johnston, Meeting Chairman, Department of Geological Sciences, University of Oregon, Eugene, OR 97403, (503) 346-5588. ■



## **NORTH-CENTRAL SECTION, GSA 26th Annual Meeting**

**Iowa City, Iowa  
April 30–May 1, 1992**

The North-Central Section of the Geological Society of America will meet in Iowa City at the University of Iowa Memorial Union. The meeting will be hosted by the Geological Survey Bureau of the Iowa Department of Natural Resources and the University of Iowa Department of Geology. Several associated societies will be meeting in conjunction with the GSA North-Central Section: the Pander Society, the North-Central Section of the Paleontological Society, the Great Lakes Section of SEPM, the Central Section of the National Association of Geology Teachers, the Midwest Section of the National Association of Earth Science Teachers, and the Geological Society of Iowa.

### **CALL FOR PAPERS**

Technical sessions will include all topics listed on the GSA abstracts form. Papers, poster sessions, and symposia on these and other subject areas (including symposia listed below) are solicited. Special sessions focused on specific themes or subjects will be arranged by the local program committee after review of the abstracts. The time allotted for the oral presentations will be 15 minutes followed by 5 minutes for discussion. Following on the success of the symposium for consulting geologists at last year's North-Central GSA meeting, the 1992 meeting will include a symposium of special interest to environmental consultants.

To further GSA's focus on geoscience education, a special symposium is planned to address the topic of what every geoscientist should know about earth science in our schools. Elementary, junior high, high school, junior college, college, and university teachers of earth science or general science and professional geologists are encouraged to attend and participate.

### **REGISTRATION**

Preregistration will be by mail. On-site registration will take place on Wednesday, April 30, from 5:00 to 9:00 p.m. in the Iowa Memorial Union. Registration will continue daily from 8:00 a.m. to 5:00 p.m. for the duration of the meeting. Preregistration fees will be \$40 for professional GSA members or members of affiliated societies and \$10 for GSA Student Associates. For those not affiliated with GSA, preregistration fees will be \$45 for professionals and \$15 for students. On-site registration will be \$10 more for professionals and students. Please take advantage of the lower pre-registration fees.

**PREREGISTRATION DEADLINE:  
MARCH 31, 1992**

### **SYMPOSIA**

The following symposia have been organized. Authors are encouraged to contact the individual symposium organizers for information.

1. **Hydrogeology of Fine-Grained Tills.** George R. Hallberg, Iowa DNR—Geological Survey Bureau; William W. Simpkins, Iowa State University; D. Roger Bruner, Iowa DNR—Geological Survey Bureau, (319) 335-1592.
2. **Paleozoic Sequence Stratigraphy (Great Lakes Section, SEPM).** Brian J. Witzke, Iowa DNR—Geological Survey Bureau, (319) 335-1590; Jed Day, Illinois State University.
3. **Diagenetic Analysis of Transgressive-Regressive Events (Great Lakes Section, SEPM).** Luis A. Gonzalez, University of

Iowa, (319) 335-0567; Greg A. Ludvigson, Iowa DNR—Geological Survey Bureau.

4. **New Developments in Mid-continent Precambrian Research.** Raymond R. Anderson, Iowa DNR—Geological Survey Bureau, (319) 335-1589.
5. **Conditions in the Midcontinent During the Last Glacial Maximum, 21,000–16,500 R.C.Y.B.P.** Timothy J. Kemmis, (319) 335-1587, and E. Arthur Bettis III, Iowa DNR—Geological Survey Bureau.
6. **What Should Every Geoscientist Know About Earth Science in Our Schools?** (with apologies to Pete Palmer) (National Association of Geology Teachers; National Earth Science Teachers Association; Earth Science Teaching Section, Iowa Academy of Science). Jan Wielert, West High School, Iowa City, IA, (319) 339-6817.
7. **Experimentation as a Tool for Paleontological Study** (North-Central Section, Paleontological Society). Lawrence A. Wiedman, Monmouth College, (309) 457-2353.
8. **Innovative Methods of Teaching Concepts in Earth History** (North-Central Section, Paleontological Society). Lawrence A. Wiedman, Monmouth College, (309) 457-2353.
9. **Recent Advances in Sandstone Petrology and Sedimentology.** Robert L. Brenner, University of Iowa, (319) 335-1829; Robert H. Dott, Jr., University of Wisconsin.
10. **Consultant's Symposium: Interdisciplinary Environmental Consulting.** Curtis M. Hudak, Foth & Van Dyke, (612) 942-0396.

### **FIELD TRIPS**

Field trip coordinators are Brian F. Glenister, University of Iowa, (319) 335-1829; Robert D. Libra, Iowa DNR—Geological Survey Bureau, (319) 335-1585.

### **Premeeting**

1. **Silurian Depositional and Carbonate Mound Facies, Jones and Cedar Counties, Iowa.** Brian J. Witzke, Iowa DNR—Geological Survey Bureau, (319) 335-1590.
2. **Holocene–Late Wisconsinan Paleocology and Archeological Geology of East-Central Iowa.** Richard G. Baker, University of Iowa, (319) 335-1827; E. Arthur Bettis III, Iowa DNR—Geological Survey Bureau.

### **During the Meeting**

3. **Quaternary Geology of Conklin or Klein Quarries.** E. Arthur Bettis III, (319) 335-1587; Timothy J. Kemmis, Iowa DNR—Geological Survey Bureau.
4. **Walking Tour of the Geology of the University of Iowa Campus.** Brian J. Witzke, Iowa DNR—Geological Survey Bureau, (319) 335-1590.

### **Postmeeting**

5. **Cyclic Sedimentation of Pennsylvanian Rocks, Winterset, Iowa, Area** (overnight). Philip H. Heckel, University of Iowa, (319) 335-1804; John Pope, Des Moines, Iowa.
6. **Environmental Geology of the Big Springs Ground-water Basin, Northeast Iowa** (overnight). Robert D. Libra, (319) 335-1585; George R. Hallberg, Iowa DNR—Geological Survey Bureau.
7. **The Stratigraphy, Paleontology, Depositional, and Diagenetic History of the Middle-Upper Devonian Cedar Valley Group of Central and Eastern Iowa.** Jed Day, Illinois State University, (309) 438-8676; Bill J. Bunker, Iowa DNR—Geological Survey Bureau.

**ADDITIONALLY**, core workshops are planned to examine Cambrian rocks of the Iowa subsurface and cores of the Manson impact structure. The workshops will be held at the Iowa DNR—Geological Survey Bureau, Oakdale Research Facility at times to be announced.

### **POSTER SESSIONS**

We strongly encourage student and professional members to take advantage of this highly effective means of communication. Please indicate Poster Session on the GSA abstracts form. Each poster booth will provide three 4' x 4' boards arranged at table height. Poster sessions will be scheduled in the same room as the exhibits and will be available for viewing for one-half day.

### **ABSTRACTS**

Abstracts must be submitted camera-ready on official 1992 GSA abstracts forms in accordance with instructions on the forms. Abstracts forms are available from: Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-8850, and from GSA Campus Representatives at most college and university campuses.

**ABSTRACTS DEADLINE:  
DECEMBER 30, 1991**

Send one original and five copies to: Greg A. Ludvigson, Program and Abstracts Co-chair, Iowa DNR—Geological Survey Bureau, 123 North Capitol Street, Iowa City, IA 52242-1379, (319) 335-1761.

All abstracts will be reviewed for informative content, correct structure, reliability of data, appropriate geographic coverage, and originality. Authors will be notified of acceptance well in advance of the meeting.

### **STUDENT PAPERS AND TRAVEL ASSISTANCE**

The North-Central Section of GSA will award \$50 for each of the eight best papers whose principal author and presenter is a graduate or undergraduate student. Abstracts submitted for these awards should be clearly indicated. In addition, awards for travel assistance will be made to students

who are members of the GSA North-Central Section as of January 1992. To receive a travel grant, the student must present a paper (oral or poster) of which he or she is the author or co-author at the meeting. Applications for travel assistance awards may be obtained by writing the General Chairman. *Applications must be received by February 7, 1992.*

### **PROJECTION EQUIPMENT**

Two standard 35 mm carousel projectors will be provided for 2" x 2" slides only in each meeting room. Please bring your own loaded carousel trays identified with your name, session, and speaker number. A speaker-ready room equipped with projectors will be available for review and practice.

### **BUSINESS MEETING**

The GSA North-Central Section Management Board will hold its business meeting with breakfast at the North Room of the Iowa Memorial Union on April 30, 1992, at 7:00 a.m.

### **EXHIBITS**

Exhibits of educational and commercial organizations will be on display in the Triangle Ballroom in the Iowa Memorial Union, in proximity to the area for poster sessions. Exhibit space must be reserved by February 1, 1992. For further information, contact: Julia Golden, Exhibits Chair, Department of Geology, University of Iowa, Iowa City, IA 52242, (319) 335-1822.

### **SOCIAL EVENTS**

A welcoming reception will be held on the evening of Wednesday, April 29, in the Iowa Memorial Union from 5:00 to 9:00 p.m. On Thursday evening, April 30, the annual banquet of the North-Central Section will be held at the Main Lounge of the Iowa Memorial Union at 7:00 p.m., preceded by a social hour beginning at 6:00 p.m. on the Memorial Union Sunporch. Eugene Shoemaker (USGS) will speak at the banquet; his topic will be the Cretaceous-Tertiary boundary.

The Great Lakes Section of SEPM and the North-Central Section of the Paleontological Society will hold a joint luncheon on Thursday, April 30, at 12:00 noon in the South Room of the Iowa Memorial Union, and on Friday, May 1, the National Association of Geology Teachers and the North-Central GSA Education Committee will hold a joint luncheon in the Iowa Memorial Union at 12:00 noon. The North-Central GSA Campus Representatives will hold a breakfast on Friday, May 1, in the Iowa Memorial Union at 7:00 a.m.

### **HOUSING**

Hotel accommodations will be available at the University of Iowa Memorial Union and at hotels and motels in the Iowa City–Coralville area. Numerous restaurants within walking distance of the Iowa Memorial Union offer a variety of foods.

### **TRAVEL ARRANGEMENTS**

Iowa City and the University of Iowa campus are easily accessible by automobile via Interstate 80, Exit 244 (Dubuque Street). The Iowa Memorial Union is located on the east bank of the Iowa River on Madison Street near the center of the city. Hotels are available off Interstate 80 Exits 240, 242, and 246. The Iowa City area is served by the Cedar Rapids Municipal Airport, located just west of Interstate 35, about 15 miles northwest of Iowa City. Airport limousines are available from the airport to Iowa City hotels and motels.



## DETAILED INFORMATION

All sessions, registration, and the banquet will be held at the University of Iowa Memorial Union. Special arrangements can be made for lunches and/or special meetings by contacting the North-Central GSA General Chair. Information concerning registration, hotel accommodations, and other activities will appear in a future issue of *GSA Today* and in the North-Central Section *Abstracts with Programs* for 1992. Symposia and field trips listed for this meeting are tentative; further suggestions are always appreciated. Inquiries, additional information, requests, or suggestions should be directed to: Raymond R. Anderson, General Chair, Iowa DNR—Geological Survey Bureau, 123 North Capitol Street, Iowa City, IA 52242-1379, (319) 335-1589, or Holmes A. Semken, Jr., Co-General Chair, Department of Geology, University of Iowa, Iowa City, IA 52242, (319) 335-1820. ■

## GSA Division News

Divisions will be presenting awards to the following individuals at the 1991 Annual Meeting in San Diego in recognition of their service to the Division and/or contributions to the geological sciences.

**Engineering Geology Division**  
*F. Beach Leighton,*  
Distinguished Practice Award  
*Christopher C. Mathewson,*  
Meritorious Service Award

**Hydrogeology Division**  
Distinguished Service Award  
*Claire B. Davidson*  
*Keros Cartwright*  
*William E. Wilson*

**Structural Geology and Tectonics Division**  
*Terry L. Pavlis,* Best Paper Award

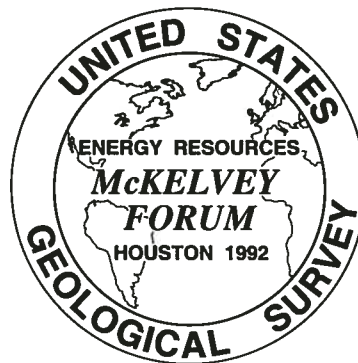
For a listing of other award recipients to be honored at the San Diego meeting, see page 149 of the July 1991 issue of *GSA Today*.

## Japan's Mount Unzen Eruption Claims Lives of GSA Members

GSA Members Harry Glicken and Maurice Krafft were killed in the June eruption of Mount Unzen, in southern Japan.

Glicken, who worked for the U.S. Geological Survey until 1989, had devoted his life to the study of volcanoes, including Mount St. Helens, Washington, where he almost died in the 1980 eruption.

Mount Unzen is one of 19 active volcanoes in Japan listed as dangerous and kept under constant surveillance. Glicken and Krafft and his wife, Katia, of Cernay, France, were in Japan studying the volcano. ■



## U.S. Geological Survey 8th Annual V.E. McKelvey Forum on Energy Resources

30 Oral Presentations  
53 Poster Presentations

- Gulf Coast reservoirs
- Basin evolution
- Paleoclimate & rhythms
- Sequence stratigraphy
- Source rocks
- Oil field growth
- Fractured reservoirs
- Computer applications
- Diagenetic studies
- Coal & coalbed methane

**Short Course: "Recent Advances in Plate Tectonics and Continental Crustal Evolution"**  
by Warren Hamilton

Houston, Texas  
February 18-20, 1992

**Technical Program**  
Christine Turner, USGS  
(303) 236-1561

**Registration Information**  
Jan W. Kernan, BAI, Inc.  
(301) 588-4177

# Springer for Geology

Stop by and see us at the GSA meeting (booths 502-504). Orders placed at the meeting receive a 15% discount.

## Cycles and Events in Stratigraphy

Edited by G. Einsele, W. Ricken, and A. Sellacher, University of Tübingen, Germany  
This book describes a large variety of marine bedding features, including gravity mass flows, siliceous sediments, phosphorites, shallow water carbonates, and glacio-marine cycles. It also covers stratification phenomena in land and sea lacustrine sediments, coal cycles, and tephra layers. Scales range from annual varves to larger, mainly sea-level controlled sedimentary sequences. Such secondary effects as biological response and feedback mechanisms, trace fossil tiering, and diagenetic overprinting are also presented. Finally, special techniques in timing and correlating cyclic and event bedding phenomena are discussed. This book is ideal for graduate students and researchers in geology, sedimentology, stratigraphy, and paleontology.  
1991/approx. 1040 pp., 461 illus./Hardcover \$79.00/ISBN 0-387-52784-2

Available in both hardcover and softcover!

## Mechanics in Structural Geology

By M. Brian Bayly, Rensselaer Polytechnic Institute, Troy, NY  
*Mechanics in Structural Geology* is a highly readable textbook for students and a reference book for all geoscientists interested in structural geology. Bayly's concise text, plus numerous question and answer sets, guide the reader through the concepts of structural mechanics. Although the text is both conceptually and mathematically rigorous, the topics are presented in a style that is easily grasped.  
1991/approx. 400 pp., 230 illus./Hardcover \$59.00 ISBN 0-387-97615-9  
Softcover \$39.00 ISBN 0-387-97652-3

## Seismic Facies and Sedimentary Processes of Submarine Fans and Turbidite Systems

Edited by P. Weimer, University of Colorado, Boulder, CO; and M.H. Link, Mobil R&D Corporation, Dallas, TX, USA  
Understanding submarine fan and turbidite systems has been a major quest of geologists and geophysicists for decades. Historically important as reservoirs of vast quantities of hydrocarbons, recent advances in technology have dramatically improved our ability to examine these sand and mud bodies. Unfortunately, this proliferation of data has made it difficult for geoscientists to examine all aspects of these important systems. The authors have addressed this problem by compiling twenty-three key papers that discuss current examination techniques and review the important geological and geophysical characteristics of both ancient and modern fan and turbidite systems.  
1991/456 pp., 403 illus./Hardcover \$89.00/ISBN 0-387-97469-5  
(*Frontiers in Sedimentary Geology*)

## Volcanoes of the Central Andes

By Shanaka L. De Silva, Indiana State University, Terre Haute, IN; and Peter W. Francis, Lunar and Planetary Institute, Houston, TX  
This colorful catalog of Andean volcanoes uses Landsat Thematic Mapper images, ground photographs, topographic maps, and results of earlier studies to provide the first comprehensive description of one of the world's most important active volcanic provinces (44 volcanoes are characterized). This book provides an invaluable data base for all those interested in the central Andes, not only volcanologists.  
1991/216 pp., 219 illus./Hardcover \$89.00/ISBN 0-387-53706-6

## Sea Levels, Land Levels, and Tide Gauges

By K.O. Emery and D.G. Aubrey, both of the Woods Hole Oceanographic Institute, Coastal Research Center, Woods Hole, MA, USA  
In *Sea Levels, Land Levels, and Tide Gauges*, authors Emery and Aubrey suggest that tidal gauges should not be used unquestioningly as a benchmark for measuring eustatic sea-level changes. Tectonism, subsidence, ocean current variability, and human activity can and do affect the accuracy of these records.  
Understanding the reasons for changes in sea levels is essential for the proper development of coastal regions. The results of this study provide guiding data for scientific, engineering, and policy solutions to coastal flooding. The ideas presented in this book are directly relevant to the debate surrounding global climate changes.  
1991/237 pp., 113 illus./Hardcover \$59.00/ISBN 0-387-97449-0

Available soon...

## Encyclopedia of Marine Sciences

Edited by J.G. Baretta-Bekker, E.K. Duursma, and B.R. Kuipers, Netherlands Institute for Sea Research, Denburg, The Netherlands  
This encyclopedia defines 3,000 concepts, methods, and other keywords in marine geology, biology, chemistry, and physical oceanography. Its brief explanations and illustrations make this book a handy reference for scientists, instructors, and students interested in marine and oceanic systems.  
1991/approx. 250 pp., 127 illus./Hardcover \$35.00 (tent.)/ISBN 0-387-54501-8

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## **ROCKY MOUNTAIN SECTION, GSA 45th Annual Meeting**

**Ogden, Utah  
May 13-15, 1992\***

The Rocky Mountain Section of the Geological Society of America and the Rocky Mountain Section of the Paleontological Society of America will meet jointly in Ogden, Utah, May 13-15, 1992. The meeting is sponsored by the Department of Geology, Weber State University.

### **ENVIRONMENT**

The meeting will be held at the Ogden Park Hotel in downtown Ogden. Fine restaurants and interesting shops are located only a short walk from the hotel along historic 25th Street. The Ogden City Mall is within one block of the hotel. The weather in early May will likely be pleasant, with spring-like mild temperatures. Situated at the boundary of the Basin and Range and Middle Rocky Mountain physiographic provinces, the Ogden area has a variety of geologic features that range in age from Precambrian to Holocene and vary from the igneous and metamorphic rocks of the Farmington Canyon Complex to the pluvial deposits of Lake Bonneville. Although the meeting site is adjacent to the Wasatch fault, the probability of movement on the fault during the course of the meeting is small. This abundant variety of geologic features makes northern Utah an ideal classroom for students and professionals alike, as J. W. Powell, G. M. Wheeler, G. K. Gilbert, W. M. Davis, and A. J. Eardley discovered.

### **CALL FOR PAPERS**

Papers are invited for technical sessions, symposia, and poster presentations. The technical sessions will provide 15 minutes for presentation and 5 minutes for discussion. Symposia conveners may assign more time to invited key speakers. Papers of regional interest to geologists in the Rocky Mountain and Great Basin areas and papers of general interest will be considered for the program. Poster presentations are encouraged. Please note that abstracts for symposia should be submitted directly to the appropriate convener.

To further GSA's focus on geoscience education, a special symposium is planned on resources available to geoscience teachers, with presentations and demonstrations by individuals from universities, public schools, state geological surveys, and museums. Two field trips of particular interest to teachers have been planned, including a Friday afternoon trip in the Ogden area and a Saturday trip in the Brigham City-Logan area. Elementary, junior high, high school, junior college, and college and university teachers of earth science or general science are encouraged to attend.

### **REGISTRATION**

Preregistration will be by mail. Forms will accompany the Final Announcement in the February 1992 issue of *GSA Today*. On-site registration will take place on Tuesday, May 12, 1992, from 3:00 to 8:00 p.m. and will continue daily from 7:45 a.m. to 5:00 p.m. through May 15. For lower registration fees and to assist the local

committee in planning, please **pre-register by April 15, 1992.**

### **FIELD TRIPS**

Both premeeting and postmeeting field trips will be offered. Unless otherwise noted, all field trips begin and end in Ogden. For details about particular field trips, contact the field trip leaders listed or James R. Wilson, Field Trip Coordinator, Department of Geology, Weber State University, Ogden, UT 84408-2507.

#### **Premeeting**

1. **Quaternary Volcanism, Tectonics, and Sedimentation in the Idaho National Engineering Laboratory Area** (2 days, Monday and Tuesday; beginning and ending in Idaho Falls, transportation available to Ogden on Tuesday evening). William R. Hackett, (208) 526-6963, and Richard P. Smith, EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID 83415.
2. **Structure and Fabric of Metamorphic Terrains in the Eastern Great Basin: Implications for Mesozoic Crustal Shortening and Extension** (4 days, Saturday-Tuesday). Phyllis A. Camilleri, Dept. of Geology & Geophysics, University of Wyoming, P.O. Box 3006, Laramie, WY 82071, (307) 766-2914; David M. Miller, USGS; Arthur N. Snoke, University of Wyoming; Michael L. Wells, Colgate University.
3. **Extraordinary Synorogenic and Anoxic Deposits Amidst Sequence Cycles of the Late Devonian-Early Mississippian Carbonate Shelf, Lakeside Mountains and Stansbury Range, Utah** (2 days, Monday and Tuesday). K. M. Nichols, (303) 236-5799, and N. J. Silberling, (303) 236-5660, USGS, Denver; P. H. Cashman and J. H. Trexler, Jr., University of Nevada, Reno.
4. **Quaternary Geology and Geologic Hazards of Tooele and Northern Rush Valleys, Utah** (1 day, Tuesday). Barry J. Solomon, Utah Geological Survey, 2363 S. Foothill Dr., Salt Lake City, UT 84108, (801) 467-7970.
5. **Geologic Evolution of Antelope Island, Utah: Multiple Episodes of Deformation and Metamorphism** (2 days, Monday and Tuesday; beginning and ending in Salt Lake City; transportation to Ogden will be available on Tuesday evening after the field trip). Grant C. Willis, (801) 467-7970, Hellmut H. Doelling and Mark E. Jensen, Utah Geological Survey, 2363 S. Foothill Dr., Salt Lake City, UT 84108; W. Adolph Yonkee, Weber State University.

6. **Engineering Geology and Geologic Hazards of the Ogden Area** (1 day, Monday). Mike Lowe, Utah Geological Survey, 2363 S. Foothill Dr., Salt Lake City, UT 84108, (801) 467-7970.
7. **Geology, Geochemistry, and Mineral Deposits of the Oquirrh Mountains** (1 day, Tuesday). Paula N. Wilson, Dept. of Geology, Weber State University, Ogden, UT 84408-2507, (801) 544-4611; Ricardo Presnell, Kennecott.
8. **Mesozoic Paleontology and Paleoenvironments of Northeastern Utah** (2 days, Monday and Tuesday). David Gillette, State Paleontologist, Utah Historical Society, 300 Rio Grande, Salt Lake City, UT 84101-1182, (801) 533-5755.

#### **During Meeting**

9. **Geology of the Wasatch Front and Lake Bonneville** (half-day, Friday afternoon). James R. Wilson, Weber State University, Ogden, UT 84408-2507, (801) 626-6208.

#### **Postmeeting**

10. **Miocene Monzonitic Eruptive Centers and Associated Megabreccias, "Iron Axis" Province, Southwestern Utah** (3 days, Saturday-Monday; beginning and ending in Cedar City). Richard Blank, (303) 236-1341, Peter D. Rowley, and David Hacker, USGS, MS 964, Box 25046, Denver, CO 80225.
11. **Geology for Earth Science Teachers: Processes and Principles along the Wasatch Front** (1 day, Saturday; beginning in Ogden or Logan and ending in Ogden or Logan). Don Feisinger, (801) 750-1273, Susanne Janecke, and Peter Kolesar, Dept. of Geology, Utah State University, Logan, UT 84322-4505.
12. **Tectonics of the Sevier Orogenic Belt in the Northern Wasatch Range, Utah** (1 day, Saturday). Adolph Yonkee, (801) 626-7419, Dept. of Geology, Weber State University, Ogden, UT 84408-2507; Jim Evans, Utah State University.
13. **Late Proterozoic Stratigraphy and Tectonics, Northern Utah and Southeastern Idaho** (1 day, Saturday). Paul Link, Dept. of Geology, Idaho State University, Pocatello, ID 83209-8072, (208) 236-3365.

### **SYMPOSIA**

The following symposia are planned. Please note that abstracts for symposia should be submitted directly to individual conveners.

1. **Cretaceous and Tertiary Basin Evolution in the Eastern Great Basin**. Christopher J. Potter and Russell F. Dubiel. Send abstracts to Christopher J. Potter, U.S. Geological Survey, Box 25046, MS 919, Federal Center, Denver, CO 80225.
2. **Paleozoic Biochronology and Sequence Stratigraphy of the Eastern Great Basin, Utah and Nevada**. Michael E. Taylor and Thomas W. Henry. Send abstracts to Michael E. Taylor or Thomas Henry, U.S. Geological Survey, Box 25046, MS 919, Federal Center, Denver, CO 80225.
3. **Mesozoic Metamorphism and Tectonics of the Eastern Great Basin**. Phyllis Camilleri and David M. Miller. Send ab-

stracts to David M. Miller, U.S. Geological Survey, 345 Middlefield Road, MS-975, Menlo Park, CA 94025.

4. **Quaternary Cave Paleontology, Stratigraphy, and Taphonomy**. Michael E. Nelson and James Mead. Send abstracts to Michael E. Nelson, Division of Sciences, Northeast Missouri State University, Kirksville, MO 63501.
5. **Early Mesozoic Paleogeology, Colorado Plateau**. David Gillette. Send abstracts to David Gillette, State Paleontologist, Utah Historical Society, 300 Rio Grande, Salt Lake City, UT 84101-1182.
6. **Upper Paleozoic Continental Margin, Paleogeography and Tectonics**. Walter S. Snyder and Claude Spinosa. Send abstracts to Walter S. Snyder, Dept. of Geology and Geophysics, Boise State University, Boise, ID 83725.
7. **Geology, Geochemistry, and Mineral Deposits of the Oquirrh Mountains, Utah**. Paula N. Wilson and Ricardo Presnell. Send abstracts to Paula N. Wilson, Dept. of Geology, Weber State University, Ogden, UT 84408-2507.

### **POSTER SESSIONS**

We strongly encourage students and professional members to take advantage of this highly effective means of communication. Please indicate Poster Session on the GSA abstracts form. Poster sessions will be scheduled adjacent to the exhibits and will be available for viewing for one-half day.

### **ABSTRACTS**

Abstracts are limited to about 250 words and must be submitted camera-ready on the official 1992 GSA abstracts form, available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301; (303) 447-8850. Send one original and five copies of abstracts to be considered for technical sessions and poster sessions to GSA Technical Program Co-Chairs, Dept. of Geology, Weber State University, Ogden, UT 84408-2507.

**ABSTRACTS DEADLINE:  
JANUARY 29, 1992**

### **PROJECTION EQUIPMENT**

Projection equipment will be provided for 2" x 2" slides and a standard 35 mm carousel tray. Please bring your own carousel tray identified with your name, session, and speaker number. A speaker ready room equipped with projectors will be available for review and practice. Two projectors and two screens will be provided for each session.

### **EXHIBITS**

Exhibits representing education, research, and industry will be displayed at the meeting site. For further information, contact Exhibits Coordinator, GSA Section Meeting, Dept. of Geology, Weber State University, Ogden, UT 84408-2507.

### **STUDENT SUPPORT**

The GSA Rocky Mountain Section has funds available for grants to GSA Student Associates who are presenting a paper at the meeting and are attending or have graduated from a college or university within the boundaries of the section no later than one month prior to the meeting. Students are encouraged to apply for these grants. Most students who qualify will be funded to some degree. Additional funds are available to support car pools that

\*NOTE: Dates have been changed from those previously published.



include one or more students who will be presenting papers. Send applications to Kenneth E. Kolm, Rocky Mountain Section Secretary, Dept. of Geology and Geological Sciences, Colorado School of Mines, Golden, CO 80401; (303) 273-3651. *Applications must be submitted by March 1, 1992.* They should include the student's GSA membership number, the title of his/her paper/poster, and a budget.

The Paleontological Society will award a prize to the presenter of the best student paper on a paleontological topic. Papers can be co-written with a nonstudent, but the student must be both the presenter and the senior (primary) author. To be eligible, the speaker must either be currently enrolled in a graduate or undergraduate program or have completed such a program no more than one month prior to the meeting.

### SPECIAL EVENTS AND ACTIVITIES

Everyone is invited to socialize at Tuesday evening's welcoming party in the poolside area at the Ogden Park Hotel from 7 to 9 p.m. Hors d'oeuvres and a no-host bar will be provided. The GSA Rocky Mountain Section

Management Board will meet for breakfast in the Ogden Park Hotel on May 14, 1992, at 7 a.m. The GSA Rocky Mountain Section business meeting will be held on Thursday May 14, 1992, in the Ogden Park Hotel, at 12 noon.

### HOUSING

A large block of rooms at the Ogden Park Hotel, site of the meeting, has been reserved for attendees at a special reduced rate. Additional housing is available at other motels and hotels in Ogden, several of which are within walking distance of the meeting site.

### DETAILED INFORMATION

Information concerning registration, accommodations, and activities will appear in a future issue of *GSA Today* and as a part of the Rocky Mountain Section *Abstracts with Programs* for 1992. Symposia and field trips listed for this meeting are tentative; further suggestions are appreciated. Inquiries, additional information, special requests, or suggestions should be addressed to the General Chair: Sidney Ash, Dept. of Geology, Weber State University, Ogden, UT 84408-2507. ■

## 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 1942.

**Francis Birch**  
Cambridge,  
Massachusetts

**John Clark**  
Bursa, Turkey

**George M. Furnival**  
Alberta, Canada

**E. N. Goddard**  
Portage, Michigan

**H. D. MacGinitie**  
Oakville, California

**Ralph L. Miller**  
Bethesda, Maryland

**Stuart A. Northrop**  
Albuquerque, New Mexico

**Joe Webb Peoples**  
Middle Haddam,  
Connecticut

**Fred B. Phleger**  
La Jolla, California

**Harold W. Scott**  
Urbana, Illinois

**John W. Vanderwilt**  
Sun City, California

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## The Geological Society of America

# Congressional Science Fellowship 1992-1993



The Geological Society of America is accepting applications for the 1992-1993 Congressional Science Fellowship. The Fellow selected will spend a year (September 1992-August 1993) in the office of an individual member of Congress or a congressional committee. The program provides an opportunity to gain a better understanding of science and technology issues facing Congress and to advise on a wide range of scientific issues as they pertain to public policy questions. The American Association for the Advancement of Science conducts an orientation program and assists the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

### Criteria

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

### Award

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

### 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, 1992**

## The Geological Society of America

# Research Grants Program 1992



The primary role of the Research Grants Program is to provide partial support for research by graduate students who are candidates for the M.S. or Ph.D. degree at universities in the United States, Canada, Mexico, and Central America. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program. Eligibility is not restricted to

GSA members. New application forms for the current year and detailed requirements are available each fall in the geology departments of colleges and universities offering graduate degrees in earth sciences. Forms are mailed annually to GSA Campus Representatives and department secretaries and chairmen in the United States and Canada. They are also available upon request from the Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, Colorado 80301. *Please use only the 1992 application and appraisal forms.*

Confidential evaluations from two faculty members are required from candidates for the M.S. or Ph.D. degree and must accompany applications submitted. PLEASE USE THE "APPRAISAL OF APPLICANT" FORMS, WHICH ACCOMPANY THE 1992 APPLICATION FORMS. Application forms will not be accepted by facsimile.

The Geological Society of America awarded \$278,500 in grants in 1991. The grants went to 240 students doing research for advanced degrees. The average amount awarded was \$1161. The largest grants were \$2000, but there is no predetermined maximum amount.

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

**ALL APPLICATIONS MUST BE SUBMITTED ON THE 1992 FORMS AND POSTMARKED BY FEBRUARY 15, 1992**



**GSA Penrose Conferences****October 1991**

**Development and Evolution of Foreland Basins**, October 6–11, 1991, Oñana, Spain. Information: James H. Meyers, Dept. of Geology, Winona State University, Winona, MN 55987; (507) 457-5266 (dir.), (507) 457-5000 (dept.); fax 507-457-5586; Douglas W. Burbank, Dept. of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0740; Lee J. Suttner, Dept. of Geology, Indiana University, Bloomington, IN 47405; Cai Puigdefabregas, Dept. de Política Territorial, Servei Geològic de Catalunya, Diputació, 92, Se, 08015 Barcelona, Spain.

**March 1992**

**Continental Tectonics and Magmatism of the Jurassic North American Cordillera**, March 28–April 3, 1992, Lake Havasu City, Arizona. Information: David M. Miller, U.S. Geological Survey, 345 Middlefield Road, MS-975, Menlo Park, CA 94025; (415) 329-4923; fax 415-329-4936; or Richard M. Tosdal (same address); (415) 329-5423.

**May 1992**

**The Origin and Evolution of the Coast Mountains, British Columbia, Yukon, and Alaska**, May 16–21, 1992 (tentative), Whistler, British Columbia. Information: George E. Gehrels, Dept. of Geosciences, University of Arizona, Tucson, AZ 85721; (602) 621-6026; fax 602-621-2672; Maria Luisa Crawford, Dept. of Geology, Bryn Mawr College, Bryn Mawr, PA 19010; (215) 526-5111; fax 215-526-5086; James W.H. Monger, Geological Survey of Canada, 100 West Pender Street, Vancouver, BC V6B 1R8, Canada; (604) 666-6743 or 0529; fax 604-666-1124.

**Other Meetings****October**

**Seismic Anisotropy in the Mantle and Geodynamics of Orogenic Belts**, October 1–3, 1991, Montpellier, France. Information: Alain Vauchez, Laboratoire de Tectonophysique, Place Eugène Bataillon, 34095 Montpellier Cedex 05, France; phone 61-14-3602; fax 67-14-3603; telex 490944.

**Clay Minerals Society 28th Annual Meeting**, October 5–10, 1991, Houston, Texas. Information: Dave Pevear, Program Services/CM, 91, Lunar and Planetary Institute, 3303 NASA Rd. 1, Houston, TX 77058-4399; (713) 965-4452; fax 713-966-6115.

**Geothermal Resources Council Annual Meeting**, October 6–9, 1991, Sparks, Nevada. Information: Grace Mata, Geothermal Resources Council, P.O. Box 1350, Davis, CA 95617-1350; (916) 758-2360.

**Fifth International Congress on Pacific Neogene Stratigraphy and IGCP 246**, October 6–10, 1991, Shizuoka, Japan. Information: V-CPNS-IGCP246 Organizing Committee, Geoscience Institute, Faculty of Science, Shizuoka University, Shizuoka 422, Japan; fax 81-542-37-9895.

**Federation of Analytical Chemistry and Spectroscopy Societies and Pacific Conference on Chemistry and Spectroscopy**, October 6–11, 1991, Anaheim, California. Information: FACSS, P.O. Box 278, Manhattan, KS 66502-0003; (301) 846-4797.

**36th Annual Midwest Ground Water Conference**, October 9–11, 1991, Indianapolis, Indiana. Information: William J. Steen, Indiana Department of Natural Resources, Division of Water, 2475 Directors Row, Indianapolis, IN 46241; (317) 232-4164.

**New Mexico Geological Society 42nd Fall Field Conference: Sierra Blanca Basin-Ruidoso Region**, October 9–12, 1991, Ruidoso, New Mexico. Information: Neil Whitehead III, New Mexico Bureau of Mines and Mineral Resources, Campus Station, Socorro, NM 87801; (505) 835-5752; fax 505-835-6333.

**Rocky Mountain Friends of the Pleistocene Annual Field Trip**, October 11–13, 1991, Lake Bonneville, Utah. Information: Richard Van Horn, U.S. Geological Survey, Box 25046, MS 966, Denver, CO 80225.

**Tri-State (Illinois, Wisconsin, Iowa) Geological Field Conference**, October 11–13, 1991, Charleston, Illinois. Information: Kaylin Johns, School of Adult and Continuing Education, Eastern Illinois University, Charleston, IL 61920.

**Eastern Section, Seismological Society of America**, October 14–16, 1991, Memphis, Tennessee. Information: Arch Johnston, CERL, Memphis State University, Memphis, TN 38152; (901) 678-2007; fax 901-323-2857; E-mail essa@bilbo.memst.edu.

**International Symposium on Debris Flow and Flood Disaster Protection**, October 14–20, 1991, Emeishan City, Sichuan Province, China. Information: Tong Yuling, International Research and Training Centre on Erosion and Sedimentation (IRTCS), P.O. Box 366, Beijing, China 100044; phone 8413372; telex 22786 ITCS CN; fax 8412539.

**American Institute of Professional Geologists Annual Meeting**, October 16–19, 1991, Gatlinburg, Tennessee. Information: Lawrence I. Benson, ERC/EDGE, P.O. Box 22879, Knoxville, TN 37933-0879; (615) 966-9761; fax 615-966-4155.

**New York State Geological Association 63rd Annual Field Conference**, October 18–20, 1991, Oneonta, New York. Information: James R. Ebert, Department of Earth Sciences, State University of New York, Oneonta, NY 13820-4015; (607) 431-3065; fax 607-431-2107.

**International Symposium on Geological Hazards and Prevention**, October 20–25, 1991, Beijing, People's Republic of China. Information: Chu Zhanchang, Secretariat, Organizing Committee, International Symposium on Geological Hazards and Prevention, 64, Funei St., Beijing, People's Republic of China; phone 658561-410.

**Geological Society of America Annual Meeting**, October 21–24, 1991, San Diego, California. Information: GSA, Meetings Dept., P.O. Box 9140, Boulder, CO 80301; (303) 447-2020; fax 303-447-1133.

**Society of Vertebrate Paleontology 51st Annual Meeting**, October 24–26, 1991, San Diego, California. Information: Maureen Gibbons or Barbara Groeger, SDNHM-SVP 91, Department of Biology, San Diego State University, San Diego, CA 92182-0057; Maureen Gibbons:

(619) 594-5387; Barbara Groeger: (619) 594-5686; fax 619-594-5676.

**Brazilian Geophysical Society Second International Congress**, October 28–November 1, 1991, Salvador City, Bahia, Brazil. Information: Brazilian Geophysical Society—SBGf, Alberto Brum Novaes, Universidade Federal da Bahia/UFBA-PPPG, Rua Caetano Moura 123, Federação 40.210, Salvador BA, Brasil; phone 55-071-2370408.

**Arbuckle Group Core Workshop and Field Trip**, October 29–31, 1991, Norman, Oklahoma. Information: Kenneth S. Johnson, Oklahoma Geological Survey, University of Oklahoma, 100 East Boyd, Rm. N-131, Norman, OK 73019; (405) 325-3031.

**November**

**Geological Association of New Jersey 8th Annual Meeting and Field Trip**, November 1–2, 1991, King of Prussia, Pennsylvania. Information: Sue Halsey, 1 Heritage Court, West Trenton, NJ 08628; (609) 777-0339; fax 609-633-7950.

**Hydrology and Hydrogeology in the '90s: Issues, Strategies and Technologies**, November 3–7, 1991, Orlando, Florida. Information: AIH, 3416 University Ave. S.E., Minneapolis, MN 55414; (612) 379-1030.

**Carolina Geological Society 1991 Field Conference**, November 8–10, 1991, Murphy, North Carolina. Information: Stephen A. Kish, Dept. of Geology B-160, Florida State University, Tallahassee, FL 32306; (904) 644-2064.

**5th International Circum-Pacific Terrane Conference**, November 11–28, 1991, Santiago, Chile. Information: D. G. Howell, U.S. Geological Survey, MS 902, 345 Middlefield Rd., Menlo Park, CA 94025; (415) 329-5430.

**Eastern Oil Shale Symposium**, November 13–15, 1991, Lexington, Kentucky. Information: Geaunita H. Caylor, University of Kentucky/OISTL, 411 Breckinridge Hall, Lexington, KY 40506-0056; (606) 257-2820; fax 606-258-1049.

■ **Ore Deposits and Exploration Potential of the Soviet Union**, November 18–19, 1991, Golden, Colorado. Information: Poul Emsbo, Symposium chairman, CSM-SEG student chapter, Colorado School of Mines, Golden, CO 80401-1887; (303) 273-3859.

**Clean Seas 91, International Conference on Marine Pollution**, November 19–22, 1991, Valletta, Malta. Information: Lesley Ann Sandbach, Project Manager, Clean Seas 91, The Spearhead Group, Rowe House, 55-59 Fife Road, Kingston upon Thames, Surrey KT1 1TA, UK; phone 081 549 5831 (intl: +44-81-549-5831); telex 928042 SPEARS G; fax 081-541-5657 (intl: +44-81-541-5657).

**Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration**, November 20–22, 1991, Houston, Texas. Information: Petroleum Hydrocarbons Conference/National Water Well Association, P.O. Box 182039, Dept. #017, Columbus, OH 43218; (614) 761-1711.

**December**

**Paleozoic-Mesozoic Inversion Tectonics, Southern Africa**, December 2–6, 1991, Cape Town, South Africa.

Information: Maarten de Wit or Ian Ransome, Dept. of Geology, University of Cape Town, Rondebosch 7700, South Africa; phone 021-6502921/25; fax 021-6503783.

**IGCP 264 Remote Sensing Spectral Properties (5th Meeting)—Geological Applications of Remote Sensing with Emphasis on Spectral Properties**, December 2–12, 1991, Pune, India. Information: Melvin Podwysowski, Co-Chairman IGCP264, USGS, National Center, MS 913, Reston, VA 22092; fax 703-648-6057.

**Mining Indonesia '91**, December 4–7, 1991, Jakarta, Indonesia. Information: Eileen M. Lavine, Information Services, Inc., 4733 Bethesda Ave., #735, Bethesda, MD 20814; (301) 656-2942; fax 301-656-3179.

■ **American Geophysical Union Fall Meeting**, December 9–13, 1991, San Francisco, California. Information: 1991 Fall Meeting, American Geophysical Union, 2000 Florida Ave., N.W., Washington, DC 20009.

**1992****February**

**6th International Symposium on Landslides**, February 10–14, 1992, Christchurch, New Zealand. Information: ISL 1992 Secretariat, c/o Guthreys Pacific Ltd., P.O. Box 22-255, Christchurch, New Zealand; fax 643-790-175; telex NZ4243 Guthreys.

**U.S. Geological Survey 8th Annual McKelvey Forum on Energy Resources**, February 18–20, 1992, Houston, Texas. Information: Christine Turner, USGS, Box 25046 MS 939, Federal Center, Denver, CO 80225; (303) 236-1561.

**First South Asia Geological Congress—GEOSAS-I**, February 23–27, 1992, Islamabad, Pakistan. Information: Hilal A. Raza, GEOSAS-I Secretary General, Hydrocarbon Development Institute of Pakistan, P.O. Box 1308, Islamabad, Pakistan; phone 9251-823690 or 821417; telex 5516 HDIP PK; fax 9251-828773.

**GSA South-Central Section Meeting**, February 24–25, 1992, Houston, Texas. Information: Hans G. Avé Lallemand, Dept. of Geology and Geophysics, P.O. Box 1892, Rice University, Houston, TX 77251; (713) 527-4889.

**Society for Mining, Metallurgy, and Exploration Annual Meeting**, February 24–27, 1992, Phoenix, Arizona. Information: Meetings Department, SME, P.O. Box 625002, Littleton, CO 80162; (303) 973-9550; fax 303-979-3461.

**March**

**21st Computer Simulated Mineral Exploration Workshop**, March 3–30, 1992, Fontainebleau, France. Information: L. Zanone, Ecole des Mines de Paris, CGGM-IGM, 35, rue Saint-Honoré, 77305 Fontainebleau Cédex, France; phone (33 1) 64 69 49 30; telex 694 736 F; fax (33 1) 64 69 47 01.

**Circum-Pacific Council for Energy and Mineral Resources Symposium**, Sustainable Development: Energy and Mineral Resources and the Environmental Impact of Their Utilization in the Circum-Pacific Region, March 9–12, 1991, Bangkok, Thailand. Information: Mary Stewart,



Circum-Pacific Council, 5100 Westheimer, Suite 500, Houston, TX 77056; fax 713-622-5360.

**GSA Southeastern Section Meeting**, March 18–20, 1992, Winston-Salem, North Carolina. Information: Paul D. Fullager, Dept. of Geology, CB 3315 Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315; (919) 962-0677.

■ **AGU Chapman Conference on Climate, Volcanism, and Global Change**, March 23–27, 1992, Hilo, Hawaii. Information: Stephen Self, Dept. of Geology and Geophysics, University of Hawaii at Manoa, Honolulu, HI 96822; or Richard P. Turco, Dept. of Atmospheric Sciences, University of California, Los Angeles, CA 90024-1565.

**Second Conference on Earthquake Hazards in the Eastern San Francisco Bay Area**, March 25–28, 1992, Hayward, California. Information: Sue Ellen Hirschfeld, Dept. of Geological Sciences, California State University, Hayward, CA 94542; (415) 881-3486.

**GSA Northeastern Section Meeting**, March 26–28, 1992, Harrisburg, Pennsylvania. Information: Donald M. Hoskins, Pennsylvania Geological Survey, Dept. of Environmental Resources, P.O. Box 2357, Harrisburg, PA 17105; (717) 787-2169.

■ **Structural Styles in the Southern Midcontinent**, March 31–April 1, 1992, Norman, Oklahoma. Information: Kenneth S. Johnson, Oklahoma Geological Survey, University of Oklahoma, 100 East Boyd, Rm. N-131, Norman, OK 73019; (405) 325-3031.

#### April

**XVII General Assembly of the European Geophysical Society**, April 6–10, 1992, Edinburgh, Scotland. Information: EGS Office, Postfach 49, 3411 Katlenburg-Lindau, Germany; phone (49) 5556-1440; fax 49-5556-4709; telex 965564 zil d; E-mail SPAN: LINMPI::EGS; EARN: U0085@DGOGWGDS.

■ **1992 SEPM Permian Basin Section Annual Fieldtrip**, Paleokarst, Karst-related Diagenesis, and Reservoir Development: Examples from Ordovician-Devonian–Age Strata of West Texas and the Mid-Continent, April 9–11, 1992. Information: Magell Candelaria, Arco Oil & Gas Co., P.O. Box 1610, Midland, TX 79702; (915) 688-5254; fax 915-688-5756.

**American Association of Petroleum Geologists Southwest Section**, April 12–14, 1992, Midland, Texas. Information: West Texas Geological Society, P.O. Box 1595, Midland, TX 79702; (915) 683-1573. (*Abstracts deadline: December 1, 1991.*)

**1992 International High-Level Radioactive Waste Management Conference**, April 12–16, 1992, Las Vegas, Nevada. Information: James Tulenko, Attn: TRANSACTIONS Office, American Nuclear Society, 555 N. Kensington Avenue, La Grange Park, IL 60525.

**Fifth Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)**, April 26–29, 1992, Oakbrook, Illinois. Information: Mark Cramer, 11100 E. Dartmouth Ave., Suite 190, Aurora, CO 80014; (303) 752-4951. (*Abstracts deadline: November 1, 1991.*)

**GSA North-Central Section Meeting**, April 30–May 1, 1992, Iowa City, Iowa. Information: Raymond R. Anderson,

Iowa DNR, Geological Survey, University of Iowa, 123 N. Capital St., Iowa City, IA 52242; (319) 335-1575.

#### May

**First Canadian Symposium on Geotechnique and Natural Hazards**, May 6–9, 1992, Vancouver, British Columbia. Information: Organizing Secretary, Geohazards '92, 970 Burrard St., Vancouver, BC V6Z 1Y3, Canada; (604) 663-1651; fax 604-663-1940.

■ **Institute on Lake Superior Geology Annual Meeting**, May 7–9, 1992, Hurley, Wisconsin. Information: Albert B. Dickas, 203 Administration, University of Wisconsin–Superior, Superior, WI 54880; (715) 394-8311; fax 715-394-8107.

■ **Third Goldschmidt Conference**, May 8–10, 1992, Reston, Virginia. Information: Bruce R. Doe, U.S. Geological Survey, 923 National Center, Reston, VA 22092; (703) 648-6205; fax 703-648-6191.

**Lower Palaeozoic of Ibero-America (International Conference, IGCP-IUGS/UNESCO) and International Workshop: Natural Resources of the Circum-Gondwanan Lower Palaeozoic**, May 8–12, 1992, Mérida, Spain. Information: Juan Carlos Gutiérrez-Marco, Instituto de Geología Económica, Facultad de Ciencias Geológicas, 28040-Madrid, Spain; fax 34-1-5439162.

**GSA Cordilleran Section Meeting**, May 11–13, 1992, Eugene, Oregon. Information: A. Dana Johnston, Dept. of Geological Sciences, University of Oregon, Eugene, OR 97403-1272; (503) 346-5588.

**GSA Rocky Mountain Section Meeting**, May 13–15, 1992, Ogden, Utah. Information: Sidney R. Ash, Dept. of Geology, Weber State University, Ogden, UT 84408-2507; (801) 626-6908.

**Pan-American Current Research on Fluid Inclusions (PACROFI IV)**, May 22–24, 1992, Lake Arrowhead, California. Information: Michael A. McKibben, Department of Earth Sciences, University of California, Riverside, CA 92521-0423; (714) 787-3444; fax 714-787-4324. (*Abstracts deadline: March 1, 1992.*)

**The Euramerican Coal Province: Controls on Tropical Peat Accumulation in the Late Paleozoic**, May 24–27, 1992, Wolfville, Nova Scotia, Canada. Information: John H. Calder, Nova Scotia Dept. of Mines and Energy, P.O. Box 1087, Halifax, Nova Scotia B3J 2X1, Canada; (902) 424-5364; fax 902-424-0528; or Martin R. Gibling, Dept. of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada; (902) 494-2355.

**Project PANGAEA (GSGP) Research Workshop**, May 24–29, 1992, Lawrence, Kansas. Information: Project Pangea, P.O. Box 5061, Station A, Champaign, IL 61825-5061; (217) 333-2076.

**Geological Association of Canada/Mineralogical Association of Canada Joint Annual Meeting**, May 25–27, 1992, Wolfville, Nova Scotia, Canada. Information: Aubrey Fricker, General Secretary, Atlantic Geoscience Centre, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada; (902) 426-6759; fax 902-426-4465.

**Third International Conference on Engineering, Construction and Operations in Space**, May 31–June 4, 1992, Denver, Colorado. Information:

Stein Sture, SPACE 92 Technical Co-Chairman, Dept. of Civil, Environmental, & Architectural Engineering, University of Colorado, Boulder, CO 80309-0428; (303) 492-7651; fax 303-492-7317.

#### June

**33rd U.S. Symposium on Rock Mechanics**, June 8–10, 1992, Santa Fe, New Mexico. Information: Wolfgang R. Wawersik, Geomechanics Division 6232, Sandia National Laboratories, Albuquerque, NM 87185; (505) 844-4342; fax 505-844-7354.

**American Association of Petroleum Geologists Annual Meeting**, June 21–24, 1992, Calgary, Alberta, Canada. Information: George Eynon, General Chairman, Bow Valley Industries, Ltd., P.O. Box 6610, Postal Station D, Calgary, Alberta T2P 3R7, Canada; (403) 261-6100; or AAPG Convention Department, P.O. Box 979, Tulsa, OK 74101; (918) 584-2555.

**Interpraevent 1992—Protection of Habitat against Floods, Debris Flows and Avalanches**, June 29–July 3, 1992, Berne, Switzerland. Information: Interpraevent 1992, c/o Bundesamt für Wasserwirtschaft, Postfach 2743, CH-3001 Berne, Switzerland.

#### July

**7th International Symposium on Water-Rock Interaction**, July 13–22, 1992, Park City, Utah. Information: Yousif Kharaka, Secretary-General, U.S. Geological Survey, MS 427, 345 Middlefield Road, Menlo Park, CA 94025; (415) 329-4535; fax 415-329-5110.

**Society for Industrial and Applied Mathematics Annual Meeting**, July 19–24, 1992, Los Angeles, California. Information: SIAM Conference Department, 3600 University City Science Center, Philadelphia, PA 19104-2688; (215) 382-9800; fax 215-386-7999; E-mail siamconfs@wharton.upenn.edu. (*Abstracts deadline: January 6, 1992.*)

**International Committee for Coal Petrology 44th Meeting**, July 20–24, 1992, University Park, Pennsylvania. Information: Alan Davis, Penn State University, 205 Research Bldg. E, University Park, PA 16802; (814) 865-6544; fax 814-865-3573.

**Northeastern Science Foundation—History of Earth Sciences Society Meeting on the History of Geology**, July 29–August 1, 1992, Troy, New York. Information: Gerald M. Friedman, Northeastern Science Foundation, P.O. Box 746, Troy, NY 12181-0746; (518) 273-3247; fax 518-273-3249.

#### August

**29th International Geological Congress**, August 24–September 3, 1992, Kyoto, Japan. Information: Secretary General, IGC-92 Office, P.O. Box 65, Tsukuba, Ibaraki 305, Japan; phone 81-298-54-3627; fax 81-298-54-3629; telex 3652511 GSJ J.

**IAS/SEPM Research Conference on Carbonate Stratigraphic Sequences: Sequence Boundaries and Associated Facies** (Emphasis on Outcrop and Processes Studies), August 30–September 3, 1992, La Seu, Spain. Information: Toni Simo, Dept. Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St., Madison, WI 53706; (608) 262-5987; fax 608-262-0693; E-mail simo@geology.wisc.edu; or Mark Harris, Dept. Geosciences, University of Wisconsin, P.O. Box 413, Milwaukee, WI 53201; (414) 229-5452; or Evan Franseen, Kansas Geological Survey,

1930 Constant Ave., Lawrence, KS 66047; (913) 864-5317.

■ **International Conference on Large Meteorite Impacts and Planetary Evolution**, August 31–September 2, 1992, Sudbury, Ontario, Canada. Information: B. O. Dressler, Ontario Geological Survey, 77 Grenville St., 9th Floor, Toronto, Ontario M7A 1W4, Canada; (416) 965-7046; fax 416-324-4933.

#### September

**5th International Symposium on Seismic Reflection Profiling of the Continental Lithosphere**, September 6–12, 1992, Banff, Alberta, Canada. Information: R. M. Clowes, Lithoprobe Secretariat, 6339 Stores Road, University of British Columbia, Vancouver, BC V6T 1Z4, Canada; (604) 822-4202; fax 604-822-6958; or A. G. Green, Geological Survey of Canada, 1 Observatory Crescent, Ottawa, Ontario K1A 0Y3, Canada; fax 613-992-8836.

**International Symposium on the Geology of the Black Sea Region**, September 7–11, 1992, Ankara, Turkey. Information: ISGB Sekreterliği, MTA Genel Müdürlüğü, 06520 Ankara, Türkiye; phone (90)-(4)-223 69 27; fax 90-(4)-222 82 78. (*Abstracts deadline: March 1, 1992.*)

**Applications of Strain: From Microstructures to Mountain Belts**, September 8–12, 1992, Liscomb Mills, Nova Scotia, Canada. Information: Mark Brandon, Dept. of Geology and Geophysics, Yale University, P.O. Box 6666, New Haven, CT 06511-8130, (203) 432-3135; or Scott R. Paterson, Dept. of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0740; (213) 740-6130.

**The Transition from Basalt to Metabasalt: Environments, Processes, and Petrogenesis**, September 9–15, 1992, Davis, California. Information: Peter Schiffman, Dept. of Geology, University of California, Davis, CA 95616; (916) 752-3669; E-mail PSchiffman@UCDavis.edu.

**4th International Conference on Paleoclimatology**, September 21–25, 1992, Kiel, Germany. Information: ICP IV Organizing Committee c/o GEOMAR, Wischhofstrasse 1-3/Bldg. 4, D-2300 Kiel 14, Germany.

**23rd Annual Binghamton Geomorphology Symposium: Geomorphic Systems**, September 25–27, 1992, Oxford, Ohio. Information: Bill Renwick, Dept. of Geography, Miami University, Oxford, OH 45056; (513) 529-1362; E-mail BRENWICK@MIAMIU.BITNET, or Jonathan Phillips, Dept. of Geography, East Carolina University, Greenville, NC 27858; (919) 757-6082; E-mail GEPHILLI@ECUVM1.BITNET.

**American Institute of Professional Geologists Annual Meeting**, September 27–October 1, 1992, Lake Tahoe, Nevada. Information: Jon Price, AIPG, P.O. Box 665, Carson City, NV 89702; (702) 784-6691.

#### October

**Association of Engineering Geologists Annual Meeting**, October 3–9, 1992, Long Beach, California. Information: John Byer, Kovacs-Byer, Inc., 11430 Ventura Blvd., Studio City, CA 91604; (818) 980-0825.

**Fluid-Volcano Interactions**, October 4–9, 1992, Mount Hood, Oregon. Information: Steve Ingebritsen, U.S. Geologi-

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cal Survey, MS 439, 345 Middlefield Road, Menlo Park, CA 94025; (415) 329-4422; fax 415-329-4463; Bruce Christenson, Geothermal Research Centre, Private Bag 2000, Taupo, New Zealand; Craig Forster, Dept. of Geology and Geophysics, University of Utah, 719 W.C. Browning Building, Salt Lake City, UT 84112; Grant Heiken, Los Alamos National Laboratory, MS-D462, Los Alamos, NM 87545; Craig Manning, Dept. of Earth and Space Sciences, University of California, 405 Hilgard Avenue, Los Angeles, CA 90024.

**2nd International Congress on Energy, Environment and Technological Innovation**, October 12-16, 1992, Rome, Italy. Information: Secretaria CPA: Comisión de Promoción Académica, Facultad de Ingeniería, Universidad Central de Venezuela, Edif. Decanato, Caracas 1050, Venezuela; phone 58-2-6627538/7612; fax 58-2-6627327. (Abstracts deadline: October 31, 1991.)

**Geological Society of America Annual Meeting**, October 26-29, 1992, Cincinnati, Ohio. Information: GSA, Meetings Dept., P.O. Box 9140, Boulder, CO 80301; (303) 447-2020; fax 303-447-1133.

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

## Circum-Pacific Council for Energy and Mineral Resources Announces Symposium

The Circum-Pacific Council for Energy and Mineral Resources and the Geological Society of Malaysia, as co-sponsor, are convening a symposium on Tectonic Framework and Energy Resources of the Western Margin of the Pacific Basin on November 29- December 2, 1992, in Kuala Lumpur, Malaysia.

Copies of the First Circular and Call for Papers on this meeting may be obtained from

The Halbouty Center  
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The Council would appreciate it if you would make distribution of these circulars to your members and other interested colleagues.

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The Geological Society of America

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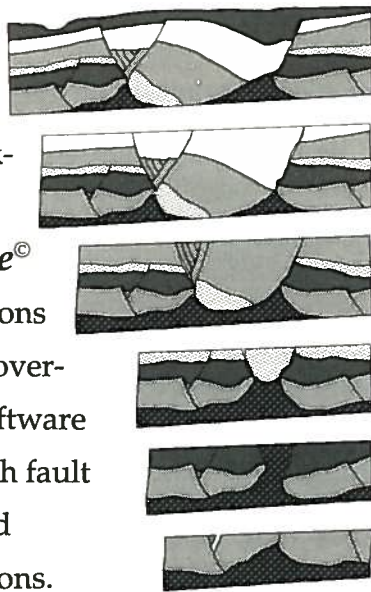
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## GSA ANNUAL MEETINGS

### ■ 1991

GSA Annual Meeting, San Diego, California  
October 21-24

See August *GSA Today* for housing, registration, and transportation information.

See September *GSA Today* for Technical Program information.

For general information: GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020.



### ■ 1992

GSA Annual Meeting, Cincinnati, Ohio  
October 26-29

#### Call for 1992 Short Course Proposals

Have you thought about giving a short course? The GSA Committee on Short Courses invites those interested in proposing a GSA sponsored or cosponsored short course to contact GSA headquarters for proposal guidelines.

Short courses may be conducted in conjunction with all GSA annual or section meetings, but we are particularly interested in identifying short courses to be offered during the 1992 Annual Meeting in Cincinnati or the 1993 Annual Meeting in Boston.

Proposals for the Cincinnati meeting must be received by *December 1, 1991*. Selection of courses will be made by February 1, 1992, leaving 8 months for preparing course manuals and making arrangements.

For proposal guidelines or information contact: Edna A. Collis, Short Course Coordinator, GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020.

### ■ FUTURE

Cincinnati . . . . .	October 26-29 . . . . .	1992
Boston . . . . .	October 25-28 . . . . .	1993
Seattle . . . . .	October 24-27 . . . . .	1994
New Orleans . . . . .	November 6-9 . . . . .	1995
Denver . . . . .	October 25-28 . . . . .	1996

For general information on technical program participation (1992 or beyond) contact: Sue Beggs, Meetings Manager, GSA headquarters.

## GSA SECTION MEETINGS

### ■ 1992

South-Central Houston, Texas  
Rice University, February 24-25

Hans G. Avé Lallemand, Dept. of Geology and Geophysics, P.O. Box 1892, Rice University, Houston, TX 77251; (713) 527-4889

Southeastern, Winston-Salem, North Carolina  
Stouffer-Winston Plaza, March 18-20

Paul D. Fullagar, Dept. of Geology, CB 3315 Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315; (919) 962-0677

Northeastern, Harrisburg, Pennsylvania  
Harrisburg Hilton, March 26-28

Donald M. Hoskins, Pennsylvania Geological Survey, Dept. of Environmental Resources, P.O. Box 2357, Harrisburg, PA 17105; (717) 787-2169

North-Central, Iowa City, Iowa  
University of Iowa, April 30-May 1

Raymond R. Anderson, Iowa DNR, Geological Survey, University of Iowa, 123 N. Capital St., Iowa City, IA 52242; (319) 335-1575

Cordilleran, Eugene, Oregon  
Eugene Hilton Conference Center, May 11-13

A. Dana Johnston, Dept. of Geological Sciences, University of Oregon, Eugene, OR 97403-1272; (503) 346-5588

Rocky Mountain, Ogden, Utah  
Ogden Park Hotel, May 13-15 *Note date change*

Sidney R. Ash, Dept. of Geology, Weber State University, Ogden, UT 84408-2507; (801) 626-6908

#### Foundation to Fund Matching 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 students traveling to the 1992 GSA Annual Meeting in Cincinnati in October and to 1992 Section meetings.

Travel grants will be awarded and administered by the Sections, whose officers should be contacted for further information.

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#### Addendum

##### South-Central Section, GSA 26th Annual Meeting

Houston, Texas  
February 24-25, 1992

##### Symposium Addition:

Symposium #10. *Magellan to Venus*. V. L. Sharpton, Lunar and Planetary Institute, Houston, TX; E. R. Stofan, Jet Propulsion Laboratory, Pasadena, CA. Send abstracts to Buck Sharpton, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058.

Abstracts deadline: November 6, 1991.

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## We're Almost There!

Two more books are done. Burt Slemmons was here in August to go over the galley for *Neotectonics of North America*, and Amos Salvador was here in September to do the same for *The Gulf of Mexico basin*—the last chapter was received on August 19, thus completing the volume. The patient authors for these two volumes are listed below.

Bob Speed has spoken to all authors for the volume on *Phanerozoic Evolution of the North American Continental-ocean Transition*, and they all "promised" that their manuscripts would be written and into review in September. The final copy of the last chapter of *The Cordilleran Orogen: U.S.*, which needed only minor changes, was also expected in September, as soon as Bob Christiansen returned from field work. On the basis of that expectation, Mary Lou Zoback and Pete Lipman were to be in Boulder this month to go over the galley for that book (co-editor Clark Burchfiel may get back from China in time to help).

### More Kudos

Many thanks to the following 101 contributors to two more DNAG volumes. They bring the grand total of contributors so far to 1893. ■

### Neotectonics of North America

D. B. Slemmons, E. R. Engdahl, M. D. Zoback and D. D. Blackwell, eds.

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J. T. Andrews	L. M. Jones
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### Positions Open

**GEOCHEMISTRY AND ISOTOPE GEOLOGY**  
The Department of the Scripps Institution of Oceanography at the University of California, San Diego, invites applications for faculty positions (tenure track/tenured) in the geochemistry of the ocean, the solid earth, or the atmosphere. Rank and salary will be commensurate with qualifications and experience in accord with UC pay scales. Assistant Professor level applicants should show evidence of potential via letters of recommendation and a publication record appropriate for their experience; Associate and Full Professor level applicants should show evidence of excellence in research. Positions at all levels will involve graduate teaching and the research supervision of Ph.D. students. Candidates must hold the Ph.D. in an appropriate science at the time of appointment. Please send a letter of application, curriculum vitae including teaching experience, and names of three references to: UCSD, Chair, Geochemistry Search, Dept. of the Scripps Institution of Oceanography, 0208, 9500 Gilman Dr., La Jolla, CA 92093-0208, before October 31, 1991. UCSD is an Equal Opportunity/Affirmative Action Employer.

**GEOLOGY CHAIRPERSON**  
The University of Texas at Arlington, approximately 24,000 students, seeks applications and nominations for the position of Chairperson of the Department of Geology. Applicants should have demonstrated leadership ability, and a proven record of research, funding and teaching skills. The position is available September 1, 1992, salary will be competitive. Interested candidates should send a curriculum vita, statements of administrative accomplishments and philosophy, and the names, addresses and telephone numbers of four references to: Dr. Edmund D. Brodie, Jr., box 19498, U.T. Arlington, Arlington, Texas 76019-0498. Applications will be reviewed starting November 1, 1991. An Equal Opportunity/Affirmative Action Employer.

**UNIVERSITY OF WASHINGTON  
GEOLOGICAL SCIENCES**  
The Department of Geological Sciences invites applications for a tenure-track faculty position at the assistant professor level in one of the following fields:  
Experimental petrology. Applicants should have expertise in the fundamental properties of silicate minerals and melts at high temperatures and pressures; and in the application of experimental and theoretical techniques to the analysis of complex multi-component systems over the range of pressures and temperatures corresponding to the realm of magma genesis in the earth.

Physics of sediments and sedimentary processes. Applicants should have research interests in processes responsible for the physical characteristics of sediments and sedimentary rocks. Possible areas of expertise include but are not restricted to: sediment transport, bedform genesis, granular flow, sedimentation, debris-flow behavior, or consolidation of sediments.

Chemical or biological study of the stratigraphic record. Applicants should have research expertise in areas such as but not limited to: diagenesis, fluidrock interactions, geochemical cycles, biological events, or the interpretation of earth history based on the study of the stratigraphic record.

Applicants should send a statement of research and teaching interests, curriculum vitae, and names of four references to Chairman, Search Committee, Department of Geological Sciences, AJ-20, University of Washington, Seattle, WA 98195. Priority will be given to applications received before November 1, 1991.

The University of Washington is building a multicultural faculty and strongly encourages applications from female and minority candidates. Preference will be given to applicants who can serve well in an increasingly diverse University community. The University of Washington is an Affirmative Action, Equal Opportunity Employer.

**THE UNIVERSITY OF TEXAS AT DALLAS  
ASSISTANT PROFESSOR  
CARBONATE SEDIMENTOLOGIST**  
The Programs in Geosciences at The University of Texas at Dallas seek applications for a tenure-track position at the Assistant Professor level beginning September 1, 1992, in the general area of Carbonate Sedimentology/Petrology. Our goal is to complement

existing sedimentology expertise and to build an interactive group with existing strengths in clastic sedimentology, micropaleontology/stratigraphy, geochemistry, petrology, tectonics/structure and geophysics/seismology. We seek a dynamic and aggressive scientist who is also a competent and enthusiastic teacher. We are particularly, but not exclusively, interested in an individual who will assume supervision of the stable isotope mass spectrometry laboratory. Duties will involve teaching undergraduate and graduate courses in the area of carbonate sedimentology, supervision of M.S. and Ph.D. students and possible participation in summer field camp. The position requires a Ph.D. Salary is negotiable.

UTD is a relatively new (22 years old) urban university that was formed from the nucleus of a private research institution (Southwest Center for Advanced Studies). UTD is conveniently located near three major oil company research laboratories. Major facilities within the Programs in Geosciences include: a new Convex mini supercomputer with array processor, a new automated electron microprobe, a SEM, three solid-source mass spectrometers, a 1988 Finnigan MAT Delta E gas-source mass spectrometer (with off-line carbonate sample preparation system), an organic geochemistry laboratory, a new automatic x-ray diffractometer, two AA spectrophotometers and high pressure-high temperature apparatuses for experimental petrology and rock deformation.

Applicants should send a letter outlining specific research interests, a resume (indication of sex and ethnicity for Affirmative Action statistical purposes is requested but not required), and names of three references to: Academic Search No. 2002, The University of Texas at Dallas, P.O. Box 830688, Richardson, TX 75083-0688.

Interviews will begin at the National GSA Meeting in San Diego in October 1991 and will continue until the position is filled.

**DEPUTY DIRECTOR**  
The Earth Sciences and Resources Institute (ESRI) of the University of South Carolina has a newly created position open for a Deputy Director. ESRI is an autonomous research institute within the College of Science and Mathematics, reporting directly to the Dean. Approximately 20 full-time research scientists and a support staff of 35 are dedicated to exploration-oriented research in the international energy industry, and there is a rapidly developing environmental and geohydrology research group. ESRI also administers a graduate program leading to the degree of Master of Earth Resource Management (MERM); currently more than 40 candidates are in attendance. Research funds and student support are generated entirely by Institute staff; for fiscal year 1991/92, the budget exceeds \$2.5 million. The Deputy Director position will be funded from research revenues initially, but a tenure track reassignment subsequently may be possible. Responsibilities will be to assist the Director in program administration and to develop new and challenging areas of research, which could include environmental geology or geohydrology, as well as ESRI's traditional fields of hydrocarbon exploration and basin analysis. The successful applicant should have a PhD in earth sciences and a minimum of ten years of research experience beyond the doctorate, including some management responsibilities in petroleum geology and related fields such as environmental geology. Salary will be competitive and commensurate with experience. Candidates should send a resume, a statement of research interests/plans, details of administrative background, and the names of three references to: Prof. Paul G. Huray, Vice Provost for Research, The University of South Carolina, Columbia, SC 29208. Review of applications will begin immediately and continue until the position is filled. The University of South Carolina is an Equal Opportunity/Affirmative Action Employer.

**GEOCHEMISTRY  
California Institute of Technology  
Division of Geological and Planetary Sciences**  
Applications are invited for a 2-year postdoctoral fellowship to study experimentally the fractionations of oxygen, hydrogen, and carbon isotopes in magmatic systems. Applicants should have a background in stable isotope geochemistry and/or experimental petrology.

Send resume and names of three references to Professors E. M. Stolper/S. Epstein (170-25), Division of Geological and Planetary Sciences, Caltech, Pasadena, CA 91125.

Caltech is an equal opportunity employer. Women and minorities are encouraged to apply.

**POSTDOCTORAL POSITION  
TYNDALL AIR FORCE BASE, FLORIDA**  
A research position is available in the Subsurface Chemical Processes Research Group at the Tyndall Air Force Base (TAFB) in Panama City, Florida. TAFB is the lead Air Force agency for research, development, testing and evaluation for environmental quality technology.

The research is in modeling the transport of organic chemical contaminants in laboratory model systems and interpreting transport data from a large-scale natural gradient field transport study that is underway. Emphasis will be given to chemical heterogeneities and their effects on solute transport. Application of existing solute transport models to data sets and some ab initio modeling will be required. The opportunity will also exist to help design and execute in-house laboratory experiments to elucidate solute transport mechanisms. A background in physical sciences with emphasis in hydrogeology, geology, or hydrology is preferred. A degree within last 3 years and U.S. citizenship or permanent resident alien status is required.

For information about the research project contact Thomas Stauffer at (904) 283-6059. For application materials contact Postgraduate Research Program at TAFB, Science/Engineering Education Division, Oak

Ridge Associated Universities, P.O. Box 117, Oak Ridge, TN 37831-0117, (615) 576-3456.

### RESEARCH SCIENTIST ASSOCIATE I (Solid-Source Multicollector Mass Spectrometer Technician) The University of Texas

The Department of Geological Sciences invites applications for a full-time mass spectrometer technician. The individual will be responsible for day-to-day management of a laboratory that houses a Finnigan MAT 261 multicollector thermal ionization mass spectrometer. Specific duties will include assisting and collaborating with faculty in execution of research, training new users in mass spectrometer operation, routine instrument calibration and maintenance, trouble shooting, performing minor repairs, and when necessary, arranging repairs by specialists.

Minimum qualifications are a Bachelor's degree in geological sciences, chemistry, physics, or materials science. Competitive applicants should have computer programming skills and experience in solid-source mass spectrometry of radiogenic isotopic systems. An advanced degree in one of the above fields, familiarity with clean room protocol and experience in operating and maintaining a multicollector thermal ionization mass spectrometer are preferred.

Minimum salary is \$2019 per month with an excellent fringe benefit package. Higher salary is possible commensurate with education and experience. Funding for this position is subject to renewal August 1994. Application materials, including a resume and names, addresses, and phone numbers of three references, should be sent to Dr. Nicholas Walker, Technician Search Committee Chairman, Department of Geological Sciences, University of Texas, Austin, Texas 78713-7909. Applications will be accepted until October 31, 1991.

The University of Texas is an Equal Opportunity/Affirmative Action employer. Qualified minorities are encouraged to apply.

### BATES COLLEGE Lewiston, Maine Hydrogeologist, Assistant Professor

Applications are invited for an assistant professorship to begin in September 1992. The individual must possess a strong commitment to undergraduate education and research. The primary interest of the individual should be in hydrogeology. Other interests should include the application of geochemistry or geophysics to topics in hydrogeology. Candidates are expected to develop a program of research involving undergraduates. This is an entry-level, tenure-track position that requires the Ph.D. Women and minority group members are strongly encouraged to apply.

This appointment, a net addition to the geology faculty, is the fourth professorship in the department. It presents a significant opportunity for new curricular directions in geology, for liaisons with colleagues in the natural sciences, and for addressing student interest in environmental studies. Teaching responsibilities include three courses (an introductory course, and two upper-level courses) and supervision of senior thesis research during the regular academic year, and a five-week short term unit (April/May). The short term unit allows off-campus field study or intensive laboratory experiences.

Bates College is a liberal arts college in south-central Maine with a strong field-based and laboratory-supported program in geology. The geology department is housed in a new \$10 million science facility. There is ample space for teaching and research laboratories; the successful candidate will be expected to pursue outside support for specialized instrumentation. Dedicated laboratories currently support mineralogy, petrology, geochemistry, sedimentology, and SEM-EDS microscopy. The department has a substantial inventory of field equipment; geophysical field equipment for hydrogeologic studies include a six-channel signal-enhanced seismograph and an earth resistivity system. Access to on-campus mainframe and minicomputers and to national computer networks is through AT&T or Macintosh PCs provided in faculty offices and laboratories.

Applications should include a letter that discusses teaching and research, transcripts of all college work, and the names, addresses, and phone numbers of three referees from whom letters of recommendation may be solicited. The closing date is January 1, 1992. Application materials should be sent to: John W. Creasy, Chair, Department of Geology, Bates College, Lewiston, Maine 04240.

Bates College is an Equal Opportunity/Affirmative Action employer.

### STRUCTURAL GEOLOGIST NORTHERN ARIZONA UNIVERSITY

The Department of Geology at NAU invites applications for a tenure-track position in structural geology assistant professor level. Duties will include teaching at the introductory, senior and graduate levels. An active research program is expected of all faculty, and the candidate will be expected to demonstrate a record of scholarly activity. The Southwest offers extensive opportunities for structural geology research.

The Department is currently composed of seventeen active full-time faculty and two research associates, and offers vigorous B.S. programs in Geology and Environmental Sciences, and M.S. programs in Geology and Quaternary Studies. Regents approval has been granted for a Ph.D. program in Geology, and we are currently seeking approval to start this program in Fall 1992.

The position will start in August 1992, at which time the successful candidate will be expected to hold a Ph.D. degree. Position will remain open until filled, but review of applications will begin December 1, 1991. Applicants should send a letter of interest stating teaching and research plans, a curriculum vita, and names, addresses and telephone numbers of three references to Chair, Structural Geology Search Committee, Department of Geology, Box 6030, Northern Arizona University, Flagstaff, AZ 86011-6030.

Northern Arizona University is a committed equal opportunity/affirmative action institution. Minorities,



women, physically challenged persons, and veterans are encouraged to apply.

#### PROJECT GEOLOGIST

Will plan, logistically organize and execute field problems consisting of geological mapping, geochemical sampling, surveying, and drilling. Duties include: compilation of geoscientific data, reports preparation, mapping, drilling cores and cutting logs.

Requires: B.S. in Geology, two years experience in precious metals with one year being in the area of deposit exploration - primarily in veins, mapping and diamond core drilling. JOB SITE(S) Nevada, Oregon and Washington - requires travel. Salary \$32,000 to 35,000, basic 40 hour week. APPLY with written resume and letters of recommendation. PRESENT all prior employment with supervisor's name, address and telephone number. Two job openings. Send to: CAMBIOR USA, 230 South Rock Boulevard, Reno, Nevada 89502. NO PHONE CALLS ACCEPTED.

#### HYDROGEOLOGIST; ASSISTANT PROFESSOR WEST VIRGINIA UNIVERSITY

West Virginia University's Department of Geology and Geography invites applications for a tenure-track position at the assistant professor level with a specialty in hydrogeology, beginning August, 1992. Applicants with training and experience in modeling ground-water flow and chemical transport are preferred. The successful candidate will teach courses and develop a research program in the physical/quantitative aspects of fluid flow. This emphasis should complement our other hydrogeologist, who has strengths in chemical and environmental hydrogeology. Commitment to securing external funding and supervising graduate research is essential. The Ph.D. degree is required at time of appointment. Applicants should send cover letter, resume, graduate course transcripts, and addresses of three referees to: Dr. Alan C. Donaldson, Chairman, Department of Geology and Geography, West Virginia University, Morgantown, WV 26506. Review of candidates will begin on January 2, 1992 and continue until the appropriate candidate is found. West Virginia University is an affirmative-action/equal opportunity employer.

#### U.S. DEPARTMENT OF ENERGY YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE

The Yucca Mountain Site Characterization Project Office of the United States Department of Energy coordinates and manages the technical and programmatic investigations to determine whether or not the Yucca Mountain site in southern Nevada is suitable for development as a repository for high-level radioactive waste. This is a project of national importance, and is one of the most complex and challenging programs on which an earth scientist can work.

The Regulatory and Site Evaluation Division of the Yucca Mountain Site Characterization Project Office seeks outstanding candidates to review, administer, coordinate and direct studies in geology, hydrology, geophysics, geochemistry and performance assessment. Demonstrated professional competence in several of these areas is a plus.

Incumbents will regularly interact and communicate with regulatory and oversight bodies, and with the public. A knowledge of Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) regulations pertaining to the siting, development and operation of a high level waste repository will be essential to the conduct of your duties. The incumbent will not participate in scientific studies as a principal investigator.

Successful candidates will be experienced scientists with appropriate professional and academic background (M.S. or Ph.D. preferred) and experience or interest in management of complex, integrated technical programs.

Positions are available at our office in Las Vegas, Nevada at the GS-12/13 level (\$37,294-\$57,650 per year) depending on experience and qualifications. Reference announcement YMPO #1.

Candidates should submit an Application for Federal Employment (SF-171) by December 1, 1991, to U.S. Department of Energy, Nevada Operations Office, Federal Personnel Branch, P.O. Box 98518, Las Vegas, Nevada, 89193-8518. Information may be obtained by calling (702) 295-1487. U.S. Citizenship is required. [Equal Opportunity Employer].

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**LEATHER FIELD CASES.** Free brochure, SHERER CUSTOM SADDLES, INC., P.O. Box 385, Dept. GN, Franktown, CO 80116.

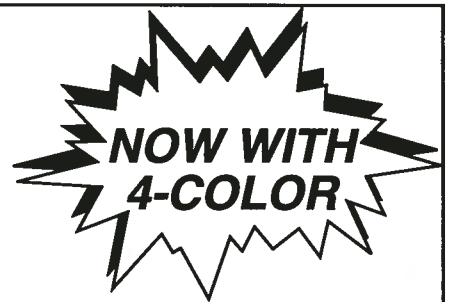
#### Opportunities for Students

The Earth Sciences and Resources Institute at the University of South Carolina is currently seeking Master's and PhD level graduate students to work with ESRI scientists in industry-sponsored geological studies in the USSR, South America, Czechoslovakia, and Africa. We seek self-motivated students with interests in sedimentology, stratigraphy, structural geology, tectonics or geophysics. Funded thesis research projects and teaching and research assistantships are available. The University of South Carolina is an equal opportunity/affirmative action employer.

Interested students are invited to submit a brief letter, unofficial transcripts and a statement of research interests to K. H. Fleischmann, Earth Sciences and Resources Institute, 901 Sumter St., Columbia, SC 29208. Phone: (803) 777-6484, Fax: (803) 777-6437.

We will be meeting and interviewing students at GSA in San Diego. If you are interested in interviewing at this time, please indicate this in your letter.

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

### Arthur L. Day Medalists

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

### Honorary Fellows

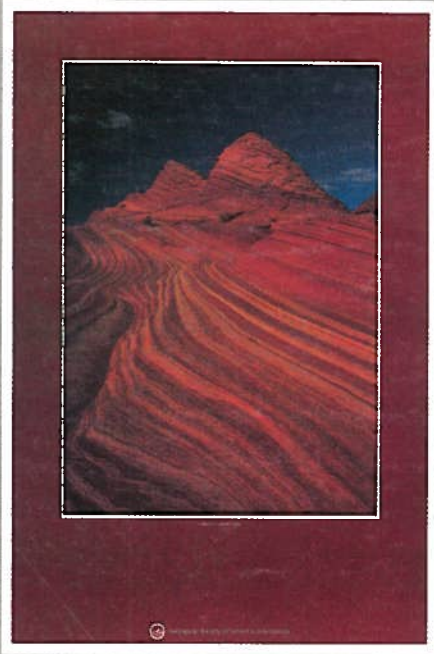
Neil Armstrong	Leo Y. Picard
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Hans Laubscher	Rudolf Trümpy
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### Young Scientist Award (Donath Medal)

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1990 Leigh Handy Royden
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See page 225 and 226 for 1992 nomination forms.





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## Cole Memorial Research Awards in Geomorphology and Micropaleontology

Through the generosity of W. Storrs Cole, two awards for support of research are offered through GSA. The Gladys W. Cole Memorial Research Award provides research support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. It is to be given to a GSA Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology. Funds cannot be used for work already accomplished, but recipients of a previous award may reapply if additional support is needed to complete their work. The amount of this award in 1992 will be \$6000.

The second award, the W. Storrs Cole Memorial Research Award, has been established to support research in invertebrate micropaleontology. This award will also carry a stipend of \$6000 and will be given each year to a GSA Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

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

All applications must be postmarked on or before February 15, 1992. Actions taken by the Committee on Research Grants will be reported to each applicant in early April.

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

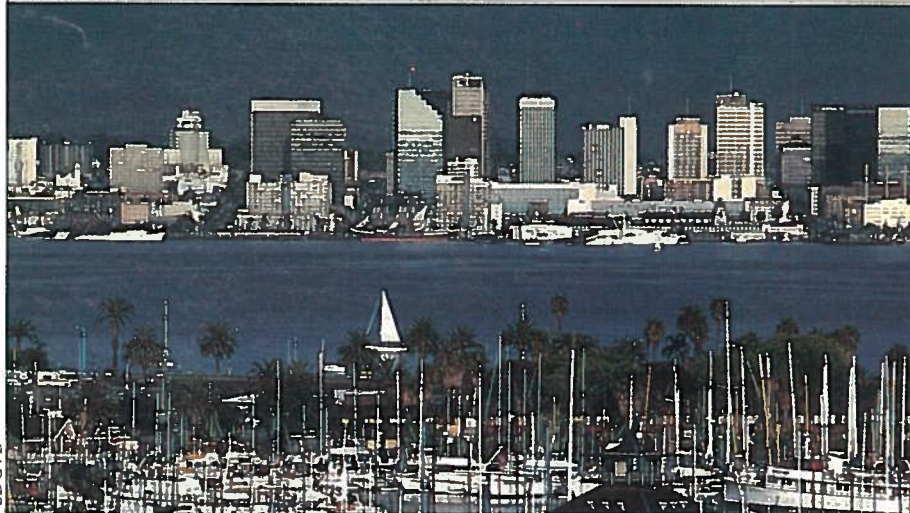


## 1991 GSA ANNUAL MEETING

October 21-24, 1991  
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### San Diego Convention Center Marriott Hotel & Marina

For Technical Program information see the September issue of *GSA Today*. For registration and housing information see the August issue of *GSA Today*. Contact: GSA Meetings Department, (303) 447-2020; GSA, P.O. Box 9140, Boulder, CO 80301.



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