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INSIDE

South Caspian Basin: Young, Cool, and Full of Promise

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ABSTRACT

The South Caspian Basin comprises a unique set of geologic parameters that rank it among the most prolific hydrocarbon regions of the world. Surrounded by compressional orogens, the basin has accumulated up to 25 km of sediment, with more than 10 km of this fill deposited in the last 6 m.y. This recent, rapid burial has resulted in such low temperature gradients that hydrocarbons are still being actively generated at depths between 8 and 12+ km. The anticlinal structures in the basin are large, and interpreted to be buckle folds overlying a regional detachment based on the analysis of regional 2-D seismic data. The combination of a prolific hydrocarbon system, large undrilled structures, and a favorable political climate for foreign investment has focused considerable industry attention on the potential of this basin.

INTRODUCTION

The South Caspian Basin lies within a belt of Tertiary to Holocene compression associated with the Alpine-Himalayan orogenic belt. The sedimentary fill of the South Caspian Basin, however, remains relatively undeformed compared to the adjacent Caucasus, Kopet Dag, and Elburz fold and thrust belts (Fig. 1). Deformation in the South Caspian Basin is expressed as a series of large folds that are commonly pierced by mud

Caspian Basin *continued on p. 2*

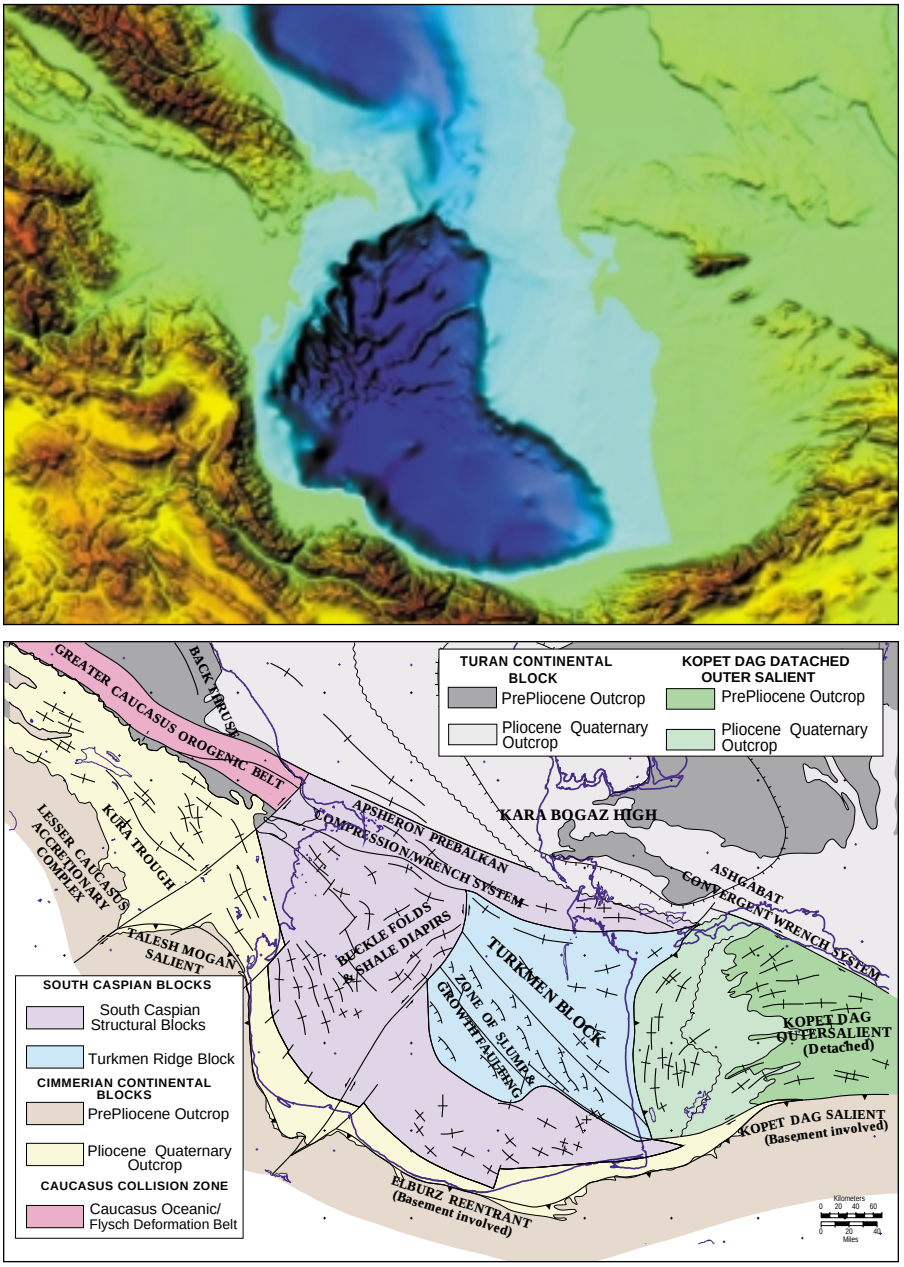

Figure 1. Upper: Merged bathymetry and digital topography of the South Caspian Sea and surrounding areas. The elongate subsea ridges present on the bathymetry are the sea floor expression of large, subsurface anticlinal folds (see Fig. 4). Lower: Structural elements of the South Caspian Sea and surrounding areas (modified from Philip et al., 1989, Berberian and King, 1981; Adamia et al., 1977; Nalivkin, 1976; Huber, 1978).

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IN THIS ISSUE

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June 21, 1996

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April 14, 1999

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Chicago, Illinois
May 1, 1999

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Ashland, Oregon

Kemble Widmer
Pennington, New Jersey
March 6, 1999

Caspian Basin *continued from p. 1*

diapirs and associated mud volcanoes, and which appear as linear physiographic features on the Caspian Sea floor (Fig. 1). Late Miocene–Pliocene uplift of the surrounding region isolated the basin, and made it a depocenter for the enormous volumes of sediment that were shed from both the nearby orogens and the Russian Platform. The resulting, rapid burial rates led to low temperature gradients that allowed hydrocarbon generation and preservation to great depths (Abrams and Narimanov, 1997).

The South Caspian region is also one of the world's oldest oil-producing regions. As early as the 4th century B.C., Alexander the Great is reported to have utilized these resources during his campaigns. Later in the 13th century, Marco Polo wrote of the oil seeps in the region around Baku (Yer-

WASHINGTON REPORT

Bruce F. Molnia, *bmolnia@erols.com*

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

Science and Creationism, a New View from the National Academy of Sciences

Scientists, like many others, are touched with awe at the order and complexity of nature. Indeed, many scientists are deeply religious. But science and religion occupy two separate realms of human experience. Demanding that they be combined detracts from the glory of each.

—National Academy of Sciences President Bruce Alberts

In late April, the National Academy of Sciences (NAS) released *Science and Creationism,* an updated revision of its 1984 statement on the topics of evolution and creationism theory. In the new *Science and Creationism,* the NAS states unequivocally that creationism has no place in any science curriculum at any level.

Science and Creationism accomplishes this in two ways. First, a strong scientific argument is presented that clearly describes the theory of evolution. Second, the differences between creationism, on one hand, and science and the theory of evolution, on the other, are described and contrasted. Briefly and clearly, the 35-page booklet explores the origin of life, the universe, and Earth, explains the current scientific understanding of biological evolution, discusses human evolution, and presents answers to seven frequently asked questions about evolution and creationism. These questions are: (1) What is evolution? (2) Isn't evolution just an inference? (3) Is evolution a fact or a theory? (4) Don't many famous scientists reject evolution? (5) If humans evolved from apes, why are there still apes? (6) Why can't we teach creation science in my school? and (7) If evolution is taught in schools, shouldn't creationism be given equal time?

Science and Creationism was issued to serve as a companion volume to *Teaching About Evolution and the Nature of Science,* a longer, more comprehensive review of evolution. The purpose of *Teaching About Evolution and the Nature of Science,* issued in 1998, is to provide educators and policy-makers with tools to help integrate lessons about the scientific theory with basic biology for children in kindergarten through grade 12. The guidebook was written by a group of scientists and educators who have been involved extensively in education and research on evolution. *Teaching About Evolution and the Nature of Science* does an effective job of: (1) summarizing the massive amount of scientific evidence in support of evolution and suggesting effective ways of teaching it; (2) explaining the nature of science and how it differs from other ways of knowing about the natural world; (3) providing eight sample activities that teachers can use to develop students' understanding of evolution and scientific inquiry; and (4) answering some of the most frequently asked questions about the scientific, legal, and educational issues surrounding the teaching of evolution.

Although teachers' organizations such as the National Science Teachers Association, the National Association of Biology Teachers, the National Science Education Leadership Association, and many others have rejected the science and pedagogy of creation science and have strongly discouraged its presentation in the public schools, many teachers are reluctant to teach evolution because of pressures from special-interest groups to downplay or eliminate it as part of the science curriculum. *Teaching About Evolution and the Nature of Science* attempts to deal with this issue.

Science and Creationism was prepared with a different purpose. Although it summarizes many key aspects of the theory of evolution, it also addresses and analyzes arguments and positions taken by various advocates of creation science by presenting analyses and interpretations of the arguments. *Science and Creationism* broadly and successfully presents a case for prohibiting the presentation of religious teachings about creationism in the classroom.

Science and Creationism concludes: "No body of beliefs that has its origin in doctrinal material rather than scientific observation, interpretation, and experimentation should be admissible as science in any science course. Incorporating the teaching of such doctrines into a science curriculum compromises the objectives of public education. Science has been greatly successful at explaining natural processes, and this has led not only to increased understanding of the universe, but also to major improvements in technology and public health and welfare. The growing role that science plays in modern life requires that science, and not religion, be taught in science classes."

The report was prepared by the Steering Committee on Science and Creationism, under the direction of the Office on Public Understanding of Science. The committee was chaired by Francisco J. Ayala from the University of California, Irvine. Earth science community members include: Ralph J. Cicerone, University of California, Irvine; G. Brent Dalrymple, Oregon State University; Stephen J. Gould, Harvard University; Donald Kennedy, Stanford University; George Rupp, Columbia University; and Steven M. Stanley, Johns Hopkins University. *Science and Creationism* is very attractive in presentation and authoritative in content. It should quickly become a standard reference, useful to anyone concerned about America's scientific literacy. Both *Science and Creationism* and *Teaching About Evolution and the Nature of Science* are available at the NAS Web site (www.nas.edu).■

gin, 1991). Azerbaijan has been producing oil commercially for more than 150 years, drilling the first oil well in 1848, 11 years before Colonel Drake's oil well in Pennsylvania. The industry's first offshore operations were undertaken in the south Caspian Sea in 1924 from wooden offshore platforms (Narimanov and Palaz, 1995).

In the Azerbaijan sector of the South Caspian Basin, approximately 11 billion oil-equivalent barrels of cumulative production have been reported from onshore and nearshore fields, with an additional 10 billion oil-equivalent barrels of proven, but undeveloped reserves (Narimanov and Palaz, 1995; George, 1993). Estimates for undiscovered offshore potential vary widely, but most indicate volumes that rival total production in the North Sea (Alekbarov, 1998). After the breakup of the Soviet Union, a significant area of the South Caspian was opened to western investment, with ensuing industry competition for access to exploration and development opportunities. Of an estimated 50 potential offshore structures, 13 Production Sharing Agreements have been signed with the Azeri government to date, with over $30 billion in planned foreign inves-

Caspian Basin *continued on p. 4*

Figure 2. Part of the South Caspian in the vicinity of Baku, Azerbaijan, showing some of the existing oil and gas fields and prospective offshore structures. Black represents discovered oil fields, gray represents discovered gas fields, and white represents structures with wells and/or signed exploration or production agreements with the Azerbaijan government.

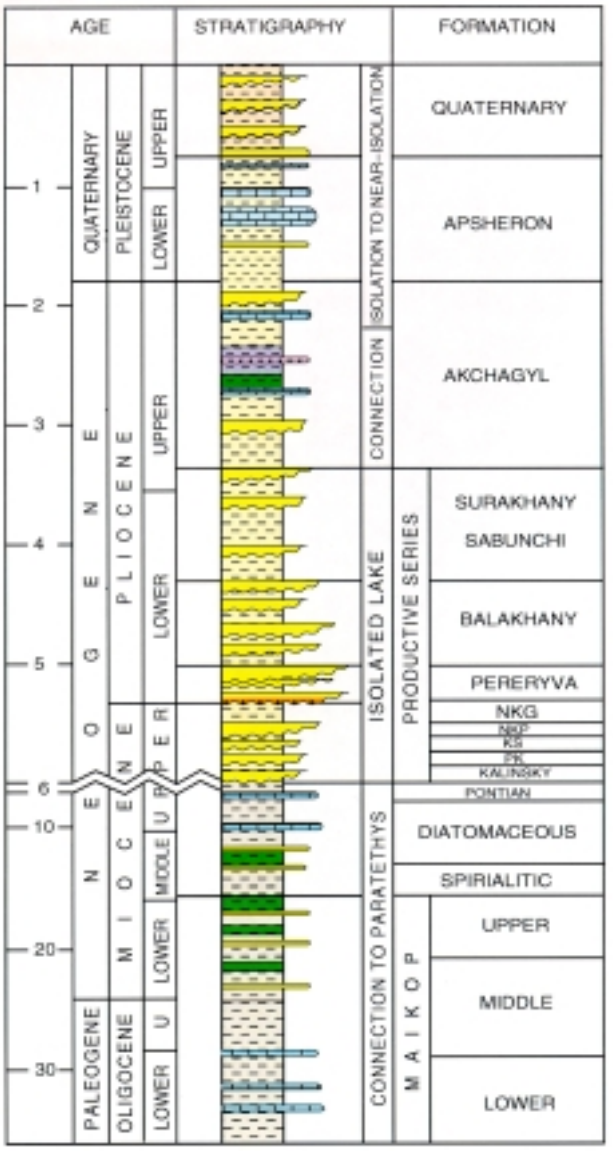


Figure 3. Schematic stratigraphic column for the central South Caspian Basin. Note the break in linear time scales at 6 Ma.

Caspian Basin *continued from p. 3*

ments (Fig. 2; Narimanov and Palaz, 1995; Alekbarov, 1998). Much of the remaining exploration potential lies in water depths between 300 and 700 m, and will require drilling to vertical depths of more than 6000 m.

TECTONIC AND DEPOSITIONAL OVERVIEW

Geophysical investigations of the crustal structure of the South Caspian Basin suggest it is underlain by oceanic to sub-oceanic crust (Rezanov and Chamo, 1969; Neprochnov et al., 1970; Priestley et al., 1994). Although most workers accept this interpretation, there is some debate as to the origin of the South Caspian Basin. Some of the proposed tectonic mechanisms include: a trapped remnant of early Mesozoic oceanic crust (Berberian, 1983), a Cretaceous to Paleogene strike-slip–related pull-apart basin (Apol'skiy, 1974), and a Middle to Late Jurassic marginal basin to the Tethys Ocean (Zonenshain and LePichon, 1986). In our opinion, regional geologic relationships and observations from seismic data best support a marginal basin origin. Regional geologic relationships that support back-arc extension include: Middle Jurassic ophiolitic assemblages and evidence for extension in the Caucasus (Adamia et al., 1977), Jurassic depositional systems that thicken northward from Iran (Rad, 1986), and evidence for Middle Jurassic extension in the Kopet Dag Mountains (Zonenshain and LePichon, 1986). Regional 2-D seismic surveys show rapid thinning of strata across extensional structures along the basin margins, consistent with an increase in crustal thickness in these areas (Shikalibeily and Grigoriants, 1980; Neprochnov et al., 1970).

Middle to Late Jurassic extension occurred behind a volcanic arc that stretched along the margin of southern Eurasia and the Tethys Ocean (Zonenshain and LePichon, 1986; Huber, 1978; Nalivkin, 1968). From the Jurassic through the Paleogene, the South Caspian marginal basin formed part of a larger seaway that reached from eastern Turkmenistan to the Black Sea (Vinogradov, 1968; Berberian and King, 1981). During this time, approximately 8 to 10 km of sediment accumulated in the basin.

In the late Paleogene, the Arabian and Eurasian plates began to collide (Zonenshain and LePichon, 1986). Subsequent regional uplift led to episodic marine restriction and the creation of euxinic conditions in the South Caspian Basin. Organic-rich calcareous and diatomaceous black shales of the Oligocene–lower Miocene Maikop Formation and the middle-upper Miocene Diatomaceous Series were deposited (Fig. 3). In the late Miocene, renewed tectonism caused the backarc seaway to be uplifted and exposed, isolating the deeper Black and Caspian Seas. The South Caspian Basin became an inland, freshwater lake (Kerimov et al., 1991), where river systems draining the Caucasus, Russian Platform, Kopet Dag-Tien Shan, and Elburz Highlands delivered large volumes of sediment. Nonmarine strata of the Productive Series were deposited at this time, which is the primary reservoir interval in the South Caspian Basin (Fig. 3).

Continued compression in the late Pliocene led to renewed uplift in the region and the onset of major, widespread folding in the South Caspian Basin. The fact that the sedimentary fill of the basin is less deformed than the surrounding orogens has been attributed to the region being located in a tectonic "shadow" between the collisional loci of the Arabian and Indian plates (Burtman, 1989). Compressional deformation and structural growth continued through the Quaternary to Holocene and has been accompanied by shale diapirism and associated mud volcanism. Marine conditions were briefly reestablished in the late Pliocene in an event referred to as the "Akchagyl transgression" (Fig. 3). This was followed once again by isolation to near-isolation of the basin, and the deposition of Quaternary to Holocene sediments under conditions described as alternating freshwater and shallow brackish marine (Degens and Paluska, 1979).

SOUTH CASPIAN BASIN HYDROCARBON SYSTEM

Structural Style

Compressional deformation within the South Caspian Basin is expressed as numerous elongate anticlines (Figs. 1, 2, and 4). These structures generally trend northwest, with a few marked deviations from this trend that suggest some element of basement control on structural grain (Fig. 1). Based on the structural analysis of regional 2-D seismic data, the majority of the structures are interpreted to be large buckle folds overlying a regional ductile detachment zone at depth. In this interpretation, upper Miocene to Holocene sediments behaved in a relatively rigid fashion, deforming as folds by bedding-parallel flexural slip. The folds are relatively symmetrical, and lack a consistent sense of vergence as would be expected in either fault bend or fault propagation folds (Fig. 4). A buckle fold interpretation is also supported by low-angle reverse faults in the lower parts of the folds, and normal faults in the upper part. These two fault patterns are separated by an inferred neutral zone of essentially no extensional or compressional strains (Fig. 4).

Wall and Wiener (1998) used structural balancing to check the viability of the buckle fold interpretation. When the Miocene through Holocene sediments are progressively unfolded in the reconstruction, the structural level at which the strata are detached is at approximately 10–12 km, consistent with the interpreted location of the Maikop shale interval on seismic records. The detachment zone for these buckle folds is interpreted to have deformed by ductile flow within a mobile, overpressured, shale-rich zone. On the basis of the structural balancing and regional stratigraphic relationships, the detachment is placed within the Maikop shale, the primary source rock in the basin (Fig. 3). The Maikop interval is interpreted to occur at approximately 10–12 km on deep seismic records, and overpressured as a result of in situ hydrocarbon generation (Inan et al., 1997).

The timing for the onset of folding can be clearly determined from seismic data. Across most structures, there is a relatively constant sedimentary thickness to the top of the Surakhany Formation (Figs. 3 and 4). Above this interval, the sedimentary section displays marked thinning over the crest and onlap onto the flanks of the growing structures. The stratal thinning begins with deposition of the Akchagyl Formation (Figs. 3 and 4). Isotopic age dates reported from ash beds in the lower part of this formation indicate a time for onset of approximately 3.4 Ma (Chumakov et al., 1988).

Shale Diapirism and Mud Volcanoes

The South Caspian Basin is characterized by numerous onshore and offshore mud volcanoes fed by shale diapirs. Within the context of the buckle fold mechanism discussed above, the primary source for the shale diapirs is likely the ductilely deformed, overpressured Maikop shale. This interpretation is consistent with the occurrence of Oligocene-Miocene shales collected from mud volcano ejecta from onshore localities (Dadashev et al., 1995).

Mud volcanoes have been the subject of research by Azeri geoscientists for many years because of their association with

Caspian Basin *continued on p. 6*

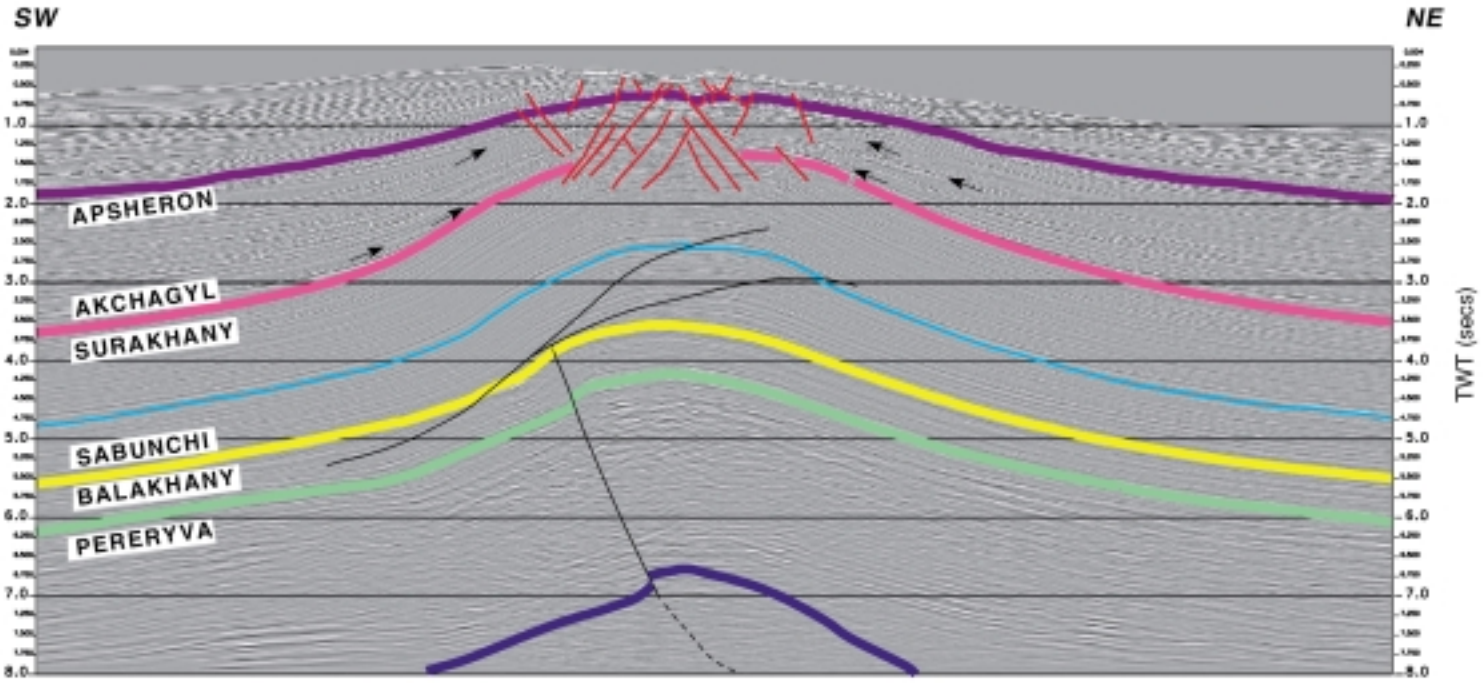
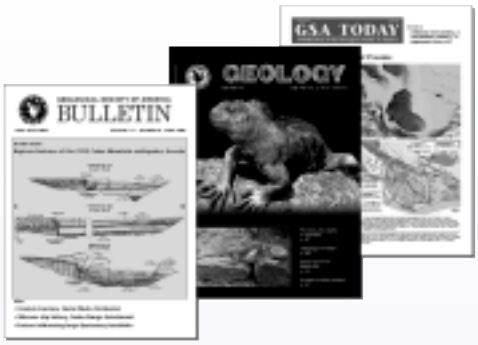


Figure 4. Seismic line, approximately 23 km long, across a typical South Caspian structure. Note the crestal normal faults in the shallow section and the low-angle reverse faults in the lower part of the fold. These two fault regimes are separated by an inferred neutral surface within the lower Surakhany Formation. Also note the thinning and onlap of strata above the top Surakhany Formation (pink surface), indicating the onset of structural growth. Use of seismic data courtesy of Caspian Geophysical.

YOUR STRATEGIC PLAN IN ACTION

This series focuses on elements of GSA's Strategic Plan and its benefits to members. Look for specific examples of the Strategic Plan in action in future issues of GSA Today.



Publications Survey Aids Planning

Peg Lehr, *Director of Publications*

GSA publications should include field guides, conference proceedings, on-line journals, and articles on demand, according to responses to a recent member survey.

A sampling of 2,235 U.S. member subscribers to the *GSA Bulletin* and *Geology* and members who do not subscribe were mailed a four-page survey in January 1999. A total of 1,213 individuals responded. The survey consisted of 30 questions regarding the GSA publications *Bulletin, Geology,* and *GSA Today,* GSA's Web site, and potential products that GSA might develop. The survey is a strategy of Goal 1, Objective 2 of the GSA Strategic Plan: "To maintain the quality and increase the vitality of publications."

New Products

Respondents indicated that the top five choices for new products were field guides (57%), digital maps (56%), on-line, full-text journals (54%), conference proceedings (33%), niche publications (28%), and an article-on-demand service (26%). To develop those projects, GSA has

- Appointed a field guide editor and will publish the 1999 Annual Meeting field guides; these will be for sale in the GSA Bookstore and in the Registration area during the meeting, and through GSA headquarters after the meeting;
- Begun to create an action plan for placing the *Bulletin* and *Geology* on-line by 2001;
- Begun to investigate an article-on-demand service so members can create their own "virtual libraries" from GSA journals that will be published on-line in full text format.

Bulletin

Respondents indicated that the usefulness of the *Bulletin* in their professional work has remained the same over the past two years (61%), and 39% find it very useful or useful. Some (35%) said that they want synthesis articles on particular areas of research; others voted for multidisciplinary thematic issues (20%), shorter articles (10%), and commentaries from noted researchers (9%). A large majority of respondents (75% for *Bulletin;* 77% for *Geology*) indicated that they save or file publications for future reference.

Of the responses, 69% indicated that readers were very satisfied or satisfied with the *Bulletin,* 22% were somewhat satisfied, and 9% were not satisfied. A review of the responses shows a correlation between "not satisfied" and perception of "relevance." A majority of the 9% who were not satisfied said that relevance of *Bulletin* articles to their work is low.

Caspian Basin *continued from p. 5*

anticlines, and therefore hydrocarbon traps (e.g., Dadashev et al., 1995). Mud volcanoes range in size from tens of centimeters high to many kilometers wide with hundreds of meters of relief (Fig. 5).

Caspian mud volcanoes have been known for spectacular eruptions that have sent 50-m-wide columns of flame more than 200 m into the air (Dadashev et al., 1995). More than 1,000 years ago, the Caspian region was known as "the land of eternal fires" because of burning oil and gas seeps and mud volcano eruptions (George, 1993), and the "pillars of fire" are said to have been worshipped by the Zoroastrians (Yergin, 1991). The gases associated with the volcanoes are mostly hydrocarbons, 82% to 98% of the total gases being methane (Dadashev et al.,

Figure 5. Mud volcano outcrop near Baku, Azerbaijan. Note shield volcano morphology and person in distance for scale.

Respondents were asked to rank 10 components of publication—relevance, credibility, timeliness, quality, prestige of journal, length of papers, time from acceptance to publication, layout and design, technical contents, color illustrations. For the *Bulletin,* prestige and quality rated very high with respondents; relevance to their work and time from acceptance to publication rated low.

Respondents said that they use the table of contents as their primary guide and that the focus for both *Bulletin* and *Geology* is right on target.

Geology

Usefulness of *Geology* in their professional work has remained the same over the past two years for 63% of the respondents, and 59% find it very useful or useful. Respondents said that they want synthesis articles on particular areas of research (22%), multidisciplinary thematic issues (22%), and commentaries from noted researchers (16%), as well as opinion articles (11%). The inclusion of commentaries and opinion articles in responses indicates that readers are interested in adding a more dynamic element to the publications, enhancing the current "reporting" structure of the journals.

Rating their overall satisfaction with *Geology,* 87% indicated that they were very satisfied or satisfied, 11% were somewhat satisfied, and 2% were not satisfied. Respondents rated *Geology* excellent in prestige, timeliness, layout and design, and length of papers.

GSA Today

The Society's monthly news publication was rated very useful or useful by 60% of the respondents, somewhat useful by 30%, and of little or no use by 9%. Respondents were adamant that *GSA Today* should continue the one-per-month science articles (94%) and that the publication be continued as a member benefit (84%). They also want both provocative, untested ideas and reviews of new topics.

Respondents said that they want (in descending order of choice) geoscience news, synthesis articles, commentary, book reviews, advertising, editorials, integrated systems science articles, opinion articles, shorter articles, more color, and longer articles. The inclusion of geoscience news far outstripped other activities. A majority of respondents checked multiple answers. Several respondents indicated that they believe *GSA Today* should be a news and general interest vehicle rather than a headquarters news vehicle.

Respondents were polled about the development of more product advertisements in *GSA Today,* and 71% approved of the idea, particularly if more advertising would help subsidize larger issues or reduce the amount of money allocated from dues to pay for issues of *GSA Today.*

Web Usage

Of the respondents who had visited the GSA Web site, 63% found it very useful or useful, 26% found it somewhat useful, and 11% did not find it useful. Most respondents had not ordered GSA products on the Web site, although 29% indicated that they have purchased products via other Web sites.

What's Next

GSA's headquarters staff will use the results of the survey to develop new publications and other products for the membership and to enhance current publications. Changes in existing publications—e.g., a new table of contents for the *Bulletin* beginning with the July 1999 issue, and more frequent book reviews in *GSA Today*—are aimed at making GSA publications more relevant, accessible, and timely. ■

1995). A physical model for the mechanism of eruption has been proposed by Ivanov and Guliev (1988). In their model, ascending gas, traveling at twice the speed of sound, has the potential to suddenly compress when it encounters restrictions in its path, and therefore heat adiabatically. If the gas reaches a temperature of 537 °C, it will ignite and produce a potentially spectacular eruption. Large volumes of mud, breccia, and rock fragments are also associated with mud volcano eruptions, and several islands and shoals in the South Caspian Basin owe their origin to the accumulation of this erupted material.

Source Rocks

Organic-rich rocks of the Oligocene to lower Miocene Maikopian Series and the middle–upper Miocene Diatomaceous Suite constitute the principal oil-prone source rocks in the basin (Korchagina et al., 1988; Bailey et al., 1996). Based on analyses of samples from outcrop, core, and mud-volcano ejecta, Maikop source facies have total organic carbon contents up to 10%, hydrogen indices of 150–500 mg hydrocarbons/g organic carbon, and a predominance of marine algal organic matter (Guliev and Feizullayev, 1996; Abrams and Narimanov, 1997). Paleogeographic reconstructions of Oligocene and Miocene depositional environments indicate that source rock quality and organic richness should increase from more proximal onshore localities in the west to more distal, basinal settings in the area of the present-day South Caspian Basin. The ubiquitous nature of this source facies throughout much of the coastal and offshore regions of the South Caspian Basin is evidenced by prolific seepage of black oil. In their study of onshore seeps, Inan et al. (1997) correlated the geochemical signature of these oils with the Maikop source facies. Although the Maikop source facies has not been penetrated in the offshore, geochemical analyses of offshore oil seeps also can be correlated to the organic facies of the Maikop.

Burial History and Hydrocarbon Generation

The timing of oil and gas generation in the South Caspian Basin is greatly influenced by late Miocene–Holocene burial rates (up to 1.3 km/m.y.) and the resulting low temperature gradients of 14–16 °C/km (Bagir-Zadeh et al., 1988; Lubimova et al., 1974; Guliev et al., 1991; Bagirov et al., 1997). One-dimensional basin modeling based on the techniques of Lopatin (1971) indicates that the Neogene-Quaternary sedimentary succession is thermally immature for kerogen to oil conversion down to 6–8 km (Guliev et al., 1991). Given the low temperature gradient, the top of the oil window is interpreted to be near a depth of 8 km for Type II kerogens, and the base of the oil window and onset of gas generation is estimated at 13–14 km (Fig. 6; Bagirov et al., 1997). Basin modeling also suggests that the bulk of the oil was generated from Pliocene to

Caspian Basin *continued on p. 8*

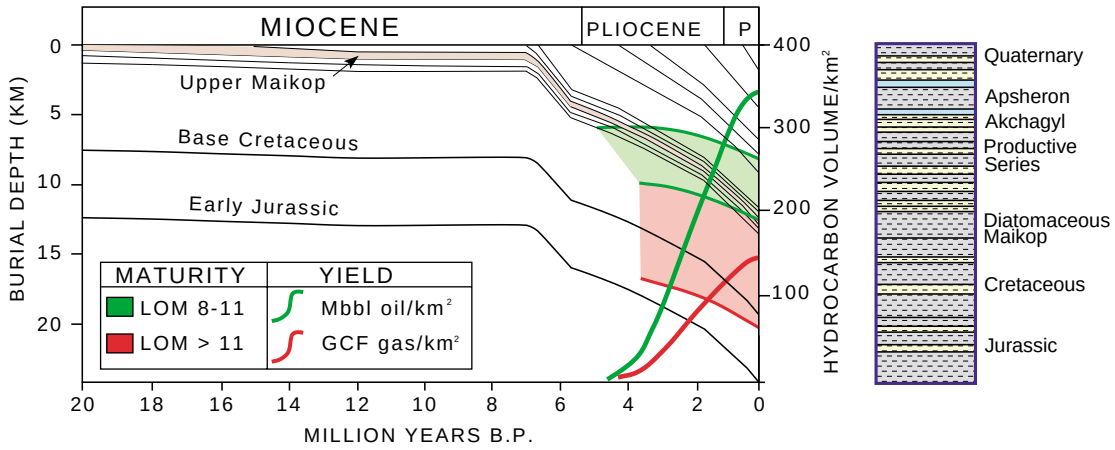


Figure 6. Burial history, hydrocarbon yields, and level of organic maturity (LOM) for an off-structure location in the central South Caspian Basin. The great depth for onset of hydrocarbon generation is due to the basin's low temperature gradients (~15 °C/km). Significant oil and gas yields from the Maikop began as recently as 4 Ma. LOM 8 and 11 correspond to a vitrinite reflectance equivalent of 0.55% and 1.1%, respectively.

Caspian Basin *continued from p. 7*

Quatenary time (Fig. 6; Narimanov, 1993), which is optimal timing relative to the onset of trap formation. The prolific present-day hydrocarbon seepage attests to active yields from the source rock and/or leakage from existing hydrocarbon traps.

Reservoir

Reservoirs in the upper Miocene–Pliocene Productive Series contain the vast majority of discovered hydrocarbons in the South Caspian Basin (Fig. 3). On the basis of outcrop studies, these strata are interpreted to have been deposited in nonmarine environments ranging from fluvial to lacustrine delta (Reynolds et al., 1998). From an exploration perspective, the most attractive reservoir targets occur in the lower Productive Series within amalgamated fluvial channel complexes of the Pereryva and lower Balakhany formations (Fig. 3). These reservoirs are mapped at depths between 4 and 7 km in undrilled offshore prospects. Fluvial deposits in the lower Productive Series below the Pereryva provide additional targets (Fig. 3).

The onset of Productive Series deposition represents a marked drop in relative base level. Reynolds et al. (1998) estimated that base level fell somewhere between 600 and 1500 m, and correlated the drop with the Messinian sea-level fall in the Mediterranean. In the late Miocene–Pliocene, the South Caspian Basin was a relatively small, isolated lake (Kerimov et al., 1991). Sediments were transported into the basin from the north by the paleo-Volga, from the west by the paleo-Kura, and from the east by the paleo-Uzboy river systems. North of the Apsheron Arch, in the central Caspian, the base-level drop caused the paleo-Volga River to incise a deep canyon that was subsequently onlapped by Productive Series strata (Kerimov et al., 1991; Mamedov, 1991).

As in all basins, sequence architecture and stratal stacking patterns reflect the interplay of tectonics, base-level changes, and sediment supply. For the South Caspian Basin, these factors consisted of subsidence, episodic uplift of surrounding orogens, lake-level changes, and sediment supply from the three river systems mentioned above. In addition, glacially induced climate changes are interpreted to have played an important role in controlling lake level and sediment supply and, consequently, reservoir distribution (Kerimov et al., 1991).

CONCLUSIONS

A combination of a unique geologic development, a prolific hydrocarbon system, and a benchmark chapter in the history of petroleum exploration characterizes the South Caspian Basin. In much of the region, the political climate for foreign investment is very favorable and, consequently, exploration activities that include the acquisition of 3-D seismic surveys and exploration drilling proceeds apace. With all of this focused interest and resulting activity, we should know soon whether the South Caspian Basin will live up to its promise.

ACKNOWLEDGMENTS

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Caspian Basin *continued on p. 9*

Caspian Basin *continued from p. 8*

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Each month, *GSA Today* features a short science article on current topics of general interest. For guidelines on submitting an article, contact either *GSA Today* Science Editor:

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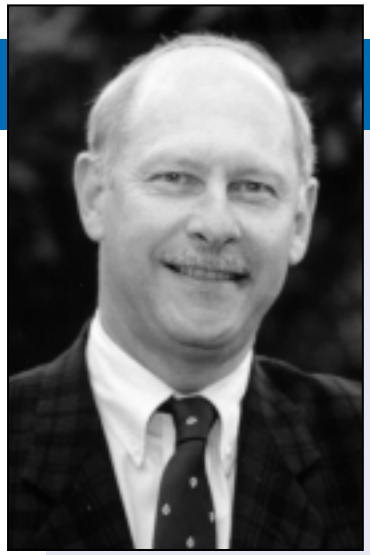


Captain of GSA Enterprise Retires

Five years and one strategic plan after taking the helm at GSA headquarters, Donald M. Davidson, Jr. has retired from the executive director position, effective June 30, 1999.

Davidson came to GSA headquarters from an administrative position at Northern Illinois University. He vied with several other candidates for the GSA executive director post. His successor is Sara S. Foland, chosen in May by the GSA Council.

Davidson said that his original goals for the directorship included growth of the membership, development of a straightforward business approach to running GSA, and fostering of a team-oriented atmosphere at headquarters, with emphasis on member service. In assessing progress in these areas, he noted that the membership of GSA has grown 7%; that effective budgeting and budget-monitoring processes are now in place; and that the headquarters staff cooperate with each other more closely than previously and have recently received high member-service ratings in a survey by the Council on Engineering and Scientific Society Executives. Davidson is particularly pleased that GSA now has a strategic plan, a map for the future.

Commenting on Davidson's contributions, 1998 GSA President Victor Baker said, "Don came to GSA at a pivotal time in its history. This was a period of transition, especially at headquarters, from practices that had served the Society in the past, but were becoming incompatible with the complexity of the operation in the 1990s. Don brought about an organization of headquarters that now allows it to implement that other major accomplishment of his regime: the strategic plan. The plan has engaged both the membership and headquarters in a new partnership. The progress of the future will be built upon the sound structure made possible during Don's tenure."

Ed Geary, director of GSA education programs, echoed Baker's comment. "One of the chief accomplishments of Don's tenure at GSA is our new strategic plan," Geary said. "Starting from scratch and helping us through the tortuous first phase of development, Don brought together leadership, staff, and members to craft a document that will help to guide our efforts during the next decade."

Speaking from a headquarters staff perspective, Geary added, "During the past five years, Don has created a more open environment at GSA and encouraged us to communicate more broadly across departments. I think all of us are now more knowledgeable about GSA's mission, budget, and day-to-day operations."

Davidson said that he plans to stay active in geoscience associations, particularly the Society of Economic Geologists and GSA. He and his wife, Mary, will remain in the Boulder area.

Open Space, Smart Growth, Urban Sprawl

Kai Anderson, *GSA Congressional Science Fellow*

Discussions with friends and colleagues who live and work beyond the Washington, D.C., Beltway commonly lead to the question of how the impeachment trial of President Clinton affected my work as a Congressional Science Fellow. I compare the atmosphere on Capitol Hill during the impeachment process to a persistent but not impenetrable fog at San Francisco International Airport. Much as foggy conditions cause re-routings and flight delays, impeachment proceedings in the Senate chamber disrupted the legislative routine at the beginning of the 106th Congress.

My experience within the belly of the impeachment beast suggests that the common perception that the trial brought the Senate to a standstill is only partly true. The trial slowed the pace of Senate business, and legislative initiatives were placed in a temporary holding pattern as their authors waited for the impeachment fog to clear. However, during the trial, out of view of most of America, legislation concerning issues as disparate as open space conservation and education funding was being written, vetted, and rewritten. As soon as the trial ended, legislators introduced a flurry of bills in an effort to make up for real and perceived lost time.

Although the regular Senate business suffered an extended slowdown during the impeachment saga, the same was not true for my particular workload. At about the same time Kenneth Starr delivered his report to the House of Representatives, my mentor, Senator Lieberman's longtime environment and energy advisor, was promoted to a post as the minority staff director for the Government Affairs Committee. My supervisor's promotion caused an order of magnitude increase in the volume of paper landing on my desk and a similar increase in my portfolio of issues. The temporary but dramatic expansion of my responsibilities early in my fellowship year allowed me the opportunity to play a significant role in designing Senator Lieberman's environment and energy legislative agenda for 1999.

Paradoxes of Urban Sprawl

One issue that has captured the attention of some lawmakers is the relationship between open space conservation and urban sprawl. Issues such as urban sprawl, which reflect many interrelated problems, require multifaceted solutions. To comprehensively address urban sprawl, communities must understand the barriers to urban renewal and the incentives that drive migration to suburban areas. One key obstacle to urban redevelopment is the presence of polluted industrial sites called "brownfields." Developers are commonly loath to assume the regulatory risk and considerable expense associated with cleanup of such sites and choose instead to develop in cheaper, previously undeveloped "greenfields" on the outskirts of existing communities.

Greenfields development is only one of the forces that contributes to sprawl; migration to the suburbs reflects people's desire to live in a safe, healthy environment near open space and quality schools. For those who live in suburbs across the country, morning and evening commute times are on the rise as traffic congestion grows more pronounced, in part because more folks seek to realize the perceived advantages of suburban life. In many places, vigorous suburban development has led, ironically, to the disappearance of the open space so coveted by those who led the population migration away from urban centers. Bulldozers and construction projects have leapfrogged toward the countryside as development has spread outward from urban centers. This growth has stranded many suburbanites—an hour or more of stressful driving from their places of work—in subdivisions that lack the urban amenities they once traded for open space and a quieter lifestyle.

Where Are Those Wide Open Spaces?

Open space is increasingly a priority issue for Americans. In November 1998, voters passed more than 70% of state and local ballot initiatives designed to encourage smart growth and protect open space. Nationwide, the desire to protect open space and mitigate and avoid the negative impacts of urban sprawl are contributing to a groundswell of support for so-called smart growth practices.

Smart growth is seen by many people to be an antidote to the plague of unmitigated urban sprawl. Many things contribute to urban sprawl, and unraveling the direct relationship between cause and effect is challenging. The Senate Smart Growth Task Force (SGTF), in which my boss is participating, provides a forum for better delineating the effects that federal policies and programs have on urban sprawl. For example, the SGTF hosted a dialogue on how federal funding for transportation projects has impacted community development historically (for better and worse) and how future transportation funding might best be used to encourage smart growth practices and prevent urban sprawl.

Open space is one of the most obvious casualties of urban sprawl. Farmland and forests disappear as residential and commercial development radiate away from urban centers and crop up along roads and highways. In many cases, communities are hard pressed to raise the money necessary to purchase and protect urban and suburban green spaces for permanent conservation. This problem is compounded by the reality that the most successful open space conservation requires coordinated local and regional planning efforts. These observations suggest that the most productive federal efforts to mitigate urban sprawl may prove to be those that provide funds to help foster regional, state, and local collaborative planning and those that provide financial assistance for state and local acquisition and enhancement of open space.

Bills for Bills

The Land and Water Conservation Fund of 1964 (LWCF) represents a viable, though traditionally underappropriated, source of federal money dedicated to open space conservation. The fund is authorized to receive up to $900 million annually in royalty revenue from outer continental shelf oil and gas production. The purchase of the Headwaters Forest of Northern California is a recent example of LWCF open space acquisition. In practice, because the fund is subject to the annual appropriations process, it rarely receives full funding. Moreover, despite the widespread popularity of the fund, the portion of it allocated for use by state and local governments has been defunct for the past five years.

The presence of an authorized vehicle (the LWCF) and the bipartisan grassroots demand for both open space conservation and smart growth planning efforts provides a rare opportunity to create a permanently dedicated trust fund, exempt from the annual appropriations process, to support federal, state, and local open space acquisition. Several bills introduced in the Senate this year aim to capitalize on this opportunity:

- Dianne Feinstein's (Democrat—California) Conservation and Recreation

Improvement Act of 1999 guarantees that money in the LWCF would be available annually without further appropriation.

- Similar to the Feinstein bill, the Conservation and Reinvestment Act of 1999 introduced by Senator Mary Landrieu (Democrat—Louisiana) would exempt LWCF money from the annual appropriations process. In addition, the Landrieu bill would provide $1.24 billion dollars of "impact assistance" to coastal and Great Lakes states through a formula based on coastline length, coastal population, and production of oil and gas on federal outer continental shelf properties.
- A third contending Senate bill is the Permanent Protection For America's Resources 2000 sponsored by Barbara Boxer (Democrat—California). As with the Feinstein and Landrieu initiatives, the Boxer bill stipulates that the LWCF be available every year without further appropriation. Moreover, it earmarks additional funds generated by the outer continental shelf royalties to be used for a broad range of conservation activities, including habitat restoration and farmland protection.

I spent much of my time during the impeachment proceedings evaluating these proposals and drafting an open space conservation bill more sensitive to the priorities of non–petroleum-producing coastal states such as Connecticut. Although Senator Lieberman has not—and may never—introduce this legislation, it was an interesting way to stay focused on a substantive issue during the impeachment circus.

Your Two Cents' Worth

The debate over the bills described above and their companion legislation in the House of Representatives is beginning to heat up. If you are interested in open space conservation and urban sprawl, the bills described above (Feinstein—S.532; Landrieu—S.25; and Boxer—S.446) are accessible on the World Wide Web at http://www.congress.gov. Read the legislation, evaluate it, and contact your Senators to let them know whether you want them to support or oppose the initiatives if the bills reach the floor later this year. ■

Kai Anderson, 1998–1999 GSA Congressional Science Fellow, serves on the staff of Senator Joseph F. Lieberman (Democrat—Connecticut). *This one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 1434-HQ-97-GR-03188. The views and conclusions contained in this article are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government or GSA.* *You can contact Anderson by mail at 1905 37th Street, Washington, DC 20007, by phone at (202) 224-7201, or by e-mail at kai@lieberman.senate.gov.*

Summer Outreach Conundrum

I Want to Lead a Field Trip—Now All I Need is an Audience

Wendy Cunningham, *Senior Project Coordinator, GSA*

Summer is here! For many of us, summer means opportunities for field work, professional development, and (let's face it) fun. Summer is the perfect time to develop and participate in enjoyable outreach activities, especially those that give you an excuse to get outside. Leading field trips is a great way to enjoy the outdoors while supporting your community by enhancing public knowledge of and appreciation for Earth and its resources. For many geoscientists, the hardest part of conducting a field trip is finding an audience and preparing the trip for non-geoscientists. Below, we have provided some ideas to guide you in developing rewarding, successful field trips.

- Come up with a few ideas for field trips that you would feel comfortable leading. If you are not sure what would be of interest to the public, ask a nonscientist friend or relative. Check the newspaper for issues of geologic significance (such as land slides, mining, earthquakes, or water contamination) around which you might be able to structure a field trip.
- Decide on a general age group that you would like to target.
- Consider teaming up with a colleague or a local teacher (contact a local school). Teacher-scientist collaborations are powerful and effective; teachers learn more about local science, scientists learn more about presentation style, and everyone on the trip benefits.
- Research local groups who might be interested in summer field trips. Consider leading trips for scouting groups, youth groups, members of local parks, special interest groups (rockhound clubs, bird watchers), local teachers, policy makers, summer camps, and child care programs. Some good places to start locating these groups are: your town's chamber of commerce; the phone book (community pages); churches, synagogues, temples; community centers (YMCA, YWCA); community newspapers; school district offices; community Internet pages.
- Do not be discouraged if you do not find an audience right away. Ask groups you contact if they know of other groups who might have the ability or interest to go on field trips.
- Once you have made a contact, work together to develop a field trip that will cater to the knowledge and interests of your audience.
- Be sure to explain what geoscientists do and how geoscience impacts everyone's lives. You might also consider wearing your field gear on the trip.

If leading a field trip doesn't appeal to you, there are multitudes of other opportunities for summer outreach. Consider constructing rock and mineral kits for local schools, developing a local walking tour guide, inviting students to help you with a day of field work, creating a virtual field trip, helping with workshops for teachers, and working on museum exhibits. Whatever you choose to do, have fun with it.

If you would like outreach ideas and support year-round, access to a network of 1,800 scientists and teachers participating in outreach, and other resources, consider joining GSA's free Partners for Education Program (PEP). For more information, or to join PEP, please refer to our Web site (http://www.geosociety.org/educate/pep.htm) or contact Wendy Cunningham, Senior Project Coordinator (phone 800-472-1988, extension 182, wcunningham@geosociety.org). ■

GSA Journals On-line—Tell Us What You Think

GSA is moving toward publishing the full text of *GSA Bulletin* and *Geology* on-line beginning in January 2001. We ask members and nonmembers to tell us what on-line features you would find most helpful in your professional endeavors.

The brief survey will be available for your input on GSA's Web site (www.geosociety.org) from June 15 through October 30, 1999. Answers will be automatically tabulated, and GSA staff will use these answers to guide the development of on-line versions of the *GSA Bulletin* and *Geology*.

Help us move GSA publications into the new millennium by sharing your thoughts about journals on-line. ■

DataStreme: A Distance-Learning Project for K–12 Teacher Enhancement

Ira W. Geer, *American Meteorological Society*
Joseph M. Moran, *University of Wisconsin—Green Bay*
Edward J. Hopkins, *University of Wisconsin—Madison*
James A. Brey, *University of Wisconsin—Fox Valley*
Robert S. Weinbeck, *SUNY College at Brockport*
Bernard A. Blair*, American Meteorological Society*

The DataStreme Project is a major teacher enhancement initiative of the American Meteorological Society (AMS). The project is funded by the U.S. National Science Foundation (NSF) with assistance from the National Weather Service and the State University of New York College at Brockport. Over a four-year period, the DataStreme Project expects to train more than 4,000 teachers nationally via a 13-week distance-learning course based on electronically transmitted current weather data (Moran et al., 1996). DataStreme-trained teachers function as weather education resources for fellow teachers, administrators, and parents on electronically delivered environmental data in the classroom.

Organization

The DataStreme Project is directed from the AMS Education Office in Washington, D.C. AMS (1) coordinates the formation and functioning of Local Implementation Teams (LITs) and their teacher participants around the country, (2) arranges for course credit through the State University of New York College at Brockport, (3) ensures the delivery of data and learning activities via the Internet, and (4) provides participant materials to LITs for course use.

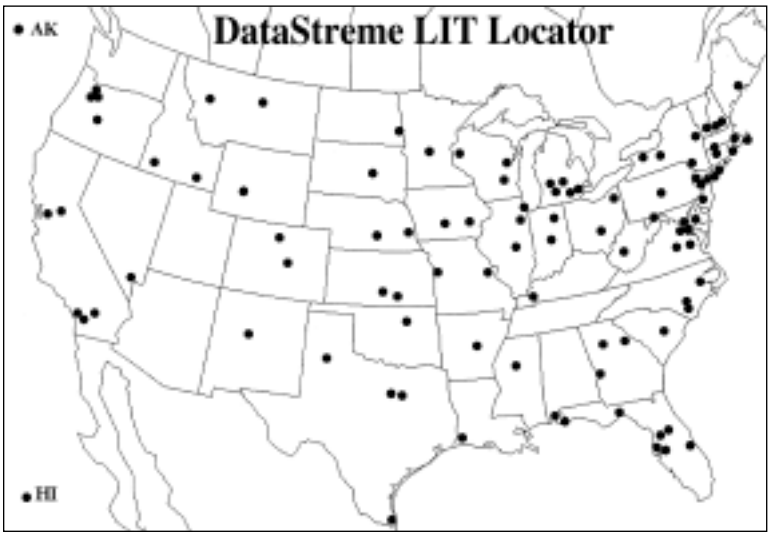
Each LIT coordinates delivery of the course to about eight teacher participants each semester. Each team advertises course availability, recruits and selects participants, arranges and holds local meetings, individually mentors participants on course understandings and activities, evaluates participants, assists participants in developing weather education resource plans (Plans of Action), and interacts with the AMS office as necessary in successful course delivery.

The University Corporation for Atmospheric Research (UCAR) Cooperative program for Operational Meteorology, Education and Training (COMET) and other Internet servers supply data and products for course learning activities.

The teachers are supplied a 12-chapter textbook and study guide. The study guide contains parts of twice-a-week learning activities that are keyed to concepts covered in the week's reading assignment (one chapter per week). The second part of each learning activity is delivered via the DataStreme home page and usually addresses some current (or recent) weather situation. Participants also access the home page for a daily national weather summary and supplementary information on selected atmospheric and related topics (e.g., the growing season, weather watches and warnings). The home page also provides surface and upper-air maps, forecasts, and satellite imagery.

Impacts

The DataStreme Project has just completed its third year. This year (spring 1999), 93 LITs in 43 states offered the DataStreme course, the cornerstone of the project, to 690 in-service teachers (see map). Through the semester, the project has trained more than 3,000 participants to be weather education resources in their schools, districts, communities, and states.



These teachers assist their peers in strengthening their science and mathematics curricula through the use of current environmental data. Students in these classes also are learning to use the Internet for gathering current data, doing research, and assimilating Information Age skills.

At the completion of each semester, participants evaluate the course. For the first five semesters, 96% of participants have given the course as a whole the highest rating; 99% gave science content the highest; 91% gave study materials the highest rating; and 87% gave offering the course through LITs the highest rating. These evaluations also showed that, on average, each participant had an impact on about four teachers and 150 students, even while taking the course (Weinbeck et al., 1999).

A follow-up survey in spring 1998 to determine the long-term impact of the project elicited responses from about 30% of the 1,300 participants. The survey found that, on average, each teacher had introduced the DataStreme Internet home page with its weather products to 15 other teachers, 112 students, and three school administrators. Long-term value to the participant's teaching was rated "great" or "moderate" by 99.8% of the respondents; impact on the participant's teaching, 98.8%; value of the course in becoming a resource teacher, 96.3%; and meeting science education standards, 96.4%.

The DataStreme Project has also involved teachers beyond the United States. DataStreme participating educators have been enrolled from U.S. Department of Defense schools in Germany and Japan, and from Canada, South Africa, and Australia.

Evaluation

Since fall 1997, participants have been given a Beginning-of-Course Survey and an End-of-Course Survey. Four pedagogical items in each survey ask for their perception of their ability to use weather information in their classrooms and with their colleagues. The items have five options: minimal, rudimentary, average, superior, and exemplary. An additional 11 content items assess general understandings of meteorology concepts from chapters of the textbook. Generally, participants showed improvement of 10%–50% in content understanding, depending on

SAGE Remarks *continued on p. 13*

GSA Names 1999 Medal and Award Recipients

Society awards for 1999 will be presented to the following people at the GSA Annual Meeting in Denver in October.

Penrose Medal

M. Gordon Wolman
Johns Hopkins University

Day Medal

Donald J. DePaolo
Berkeley Center for Isotope Geochemistry

Donath Medal (Young Scientist Award)

Peter C. Burns
University of Notre Dame

New Honorary Fellows

Shunso Ishihara
Geological Survey of Japan

Albrecht W. Hofmann
Max-Planck-Institut für Chemie

GSA Distinguished Service Award

Sue S. Beggs
Boulder, Colorado

Randolph W. Bromery
Amherst, Massachusetts

Lynn M. Walter
University of Michigan

Public Service Award

Stephen Jay Gould
Harvard University

Rip Rapp Archaeological Geology Award

Julie K. Stein
University of Washington

Gilbert H. Cady Award (Coal Geology Division)

Alan Davis
Pennsylvania State University

E. B. Burwell, Jr., Award (Engineering Geology Division)

Paul F. Karrow
University of Waterloo
Owen L. White
Toronto, Ontario

George P. Woollard Award (Geophysics Division)

Frank M. Richter
University of Chicago

History of Geology Award

David R. Oldroyd
University of New South Wales

O. E. Meinzer Award (Hydrogeology Division)

Edward A. Sudicky
University of Waterloo

G. K. Gilbert Award (Planetary Geology Division)

Sean C. Solomon
Carnegie Institution of Washington

Kirk Bryan Award (Quaternary Geology and Geomorphology Division)

William L. Graf
Arizona State University

Laurence L. Sloss Award for Sedimentary Geology (Sedimentary Geology Division)

William R. Dickinson
University of Arizona

Structural Geology and Tectonics Division Career Contribution Award

Hans Laubscher
Geologisch Institut der Universität, Switzerland

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SAGE Remarks *continued from p. 12*

the item. With the exception of one poorly worded item on the fall 1996 survey, these increases were statistically significant at the 99.9% level. Judging their current confidence on the same pedagogy items, participants perceived that their abilities to be effective teachers and resource persons in their schools had increased by one to one and one-half levels during the course. These pedagogical self-assuredness increases were also significant at better than the 99.9% level.

Project Achievement

Through June 1999, more than 3,000 teachers were introduced to the fundamentals of meteorology via the innovative, on-line, distance-learning DataStreme Project. The project is on schedule in training more than 4,100 teachers directly, and training participants as weather education resources to provide peer training to more than 40,000 additional teachers indirectly, during the five-year funding period. DataStreme is well on its way to invigorating the teaching of science and mathematics in the nation's schools by using the excitement and immediacy of current telecommunicated data.

The DataStreme home page is at http://www.ametsoc.org/dstreme/.

Note: Funding for the DataStreme Project is provided by NSF grant ESI-9453205. We thank the AMS, Executive Director Ronald McPherson, and Executive Director Emeritus Richard Hallgren for their continuing support of precollege activities.

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PENROSE CONFERENCE REPORT

Subduction to Strike-slip Transitions on Plate Boundaries

Conveners:
Paul Mann, *Institute for Geophysics, University of Texas at Austin, paulm@utig.ig.utexas.edu*
Nancy R. Grindlay, *Department of Earth Sciences, University of North Carolina at Wilmington, grindlayn@uncwil.edu*
James F. Dolan, *Department of Earth Sciences, University of Southern California, dolan@earth.usc.edu*

Most previous research has looked at plate boundaries as either strike-slip zones or subduction zones and has not emphasized plate-boundary segments with a hybrid character combining both tectonic styles. The manifestation of both tectonic styles is seen in: outboard subduction systems coupled to inboard strike-slip faults; deep filled or underfilled trenches marked by the world's largest gravity minima and characterized by a combination of strike-slip and thrust faults; complex subducted slab geometries that include continuous but steep slabs, partially detached slabs, and completely detached slabs; a complex pattern of historical and instrumentally recorded seismicity that includes great (M > 8) thrust and strike-slip earthquakes emanating from the transition zone.

Such modern zones leave complex geologic records characterized by superimposed tectonic styles with a common progression, marked by a subduction boundary, a collisional event, and a strike-slip phase. The structures and igneous products of each stage are generally distinctive, although the younger, typically strike-slip phase can obscure relationships formed during the earlier convergent phase.

We organized this Penrose Conference to discuss and compare all aspects of subduction to strike-slip transition areas within a modern plate-tectonic framework. Our goal was to foster feedback between experts in all lithospheric levels of ancient and active transitions; we felt that these interactions might lead to new insights on practical aspects of transition zones, including the seismogenic mechanisms for the large and commonly destructive earthquakes affecting these areas.

The conference was held January 18–24, 1999, in Puerto Plata, Dominican Republic, an area of seismogenic transition from subduction-dominated tectonics to the east, produced by subduction of Atlantic (North American plate) lithosphere beneath the Puerto Rico area, and strike-slip tectonics to the west. The 72 participants came from the United States, the Dominican Republic, Germany, New Zealand, the United Kingdom, France, Spain, Venezuela, Hungary, and Italy. Included were 17 graduate students from the United States and Germany and one undergraduate.

For more information on the conference, including the titles of all presentations, visit the Web site http://www.uncwil.edu/people/grindlayn/Penrose.html.

GLOBAL OVERVIEW, CLASSIFICATION, AND COMPARISONS OF STRIKE-SLIP TO SUBDUCTION TRANSITIONS ON PLATE BOUNDARIES

Paul Mann opened the meeting with a global overview and classification of subduction to strike-slip transition areas on active plate boundaries. Because most transition areas form prominent cusps in the trend of the plate boundary, he classified transition areas into three types (see illustrations in abstract by Mann and Frohlich at http://www.uncwil.edu/people/grindlayn/Penrose.html).

"Open corner" transition zones are characterized by plate cusps that describe convex or "open" angles when viewed from the downgoing plate. Examples include the northeastern and southeastern Caribbean, northeastern and southeastern Scotia, central Aleutians, northern and southern Marianas, Philippines, Taiwan, San Cristobal trench of Solomon Islands, southern Vanuatu, northern Tonga, North and South Islands of New Zealand, southern Carpathian Mountains, Aegean, and Sumatra-Andaman. *"Closed corner" transition zones* are characterized by cusps in plate boundaries that describe concave or "closed" angles when viewed from the downgoing plate. Examples of closed corners and their associated bathymetric highs include Kamchatka (Hawaii-Emperor seamounts), western Himalaya (promontory of Indian subcontinent), and southeastern Alaska (Yakutat block).

The process responsible for closed and open corners may relate to both the subduction and collision of bathymetric highs at subduction zones. Collision of the high forms a prominent closed corner adjacent to the collided area, but continued interaction of the subduction zone with the high can result in regional changes in the shape of the subduction zone that produce open corners adjacent to the closed corner.

A third type of transition from subduction to strike-slip is the fault-fault-trench (FFT) or fault-trench-trench (FTT) *triple junction type.* These junctions can produce abrupt transitions between strike-slip and subduction tectonics as observed in Guatemala, Panama, Chile, Mendocino, Woodlark, New Ireland, and New Guinea.

Cliff Frohlich summarized the seismic characteristics of the three transition types, on the basis of an analysis from three global earthquake catalogues—Harvard, Abe, and Engdahl et al. Prominent features of open and closed transition zones include the absence or rarity of strike-slip events even in areas of known strike-slip faults and a corresponding moment deficit in strike-slip events in comparison to more numerous thrust events. It is unclear if this deficit in strike-slip events is related to a fundamental mechanical process or whether it simply reflects the occurrence of large but infrequent strike-slip events not well represented in the catalogues used for the study. This question recurred throughout the conference because of obvious seismic-risk implications for densely populated transition areas like the Caribbean and the Philippines.

TRANSITIONS IN OBLIQUE SUBDUCTION SETTINGS

Eric Calais summarized the main geologic and geophysical constraints on the directions and rates of the North American– Caribbean plate boundary and differing tectonic models that have been derived from these observations. Recent, still preliminary GPS results favor a model with a Caribbean–North American motion slightly oblique to the plate-boundary trace and partitioned into strike-slip faulting in interior areas and thrust faulting in more outboard areas of Hispaniola and Puerto Rico. Nancy Grindlay discussed evidence from marine surveys for oblique collision between the Bahama Platform and the Greater Antilles arc in Hispaniola and Puerto Rico that appears to have formed a major bend at this transition area. Phil Barnes summarized geologic and geophysical data from two transition areas in New Zealand: a northern one from the west-dipping Hikurangi subduction zone

to a diffuse Marlborough strike-slip system, and a southern one from the east-dipping Puysegur-Fiordland subduction zone to a much more localized Alpine strike-slip system. David Scholl used the central and western Aleutian transition area to illustrate how recently active arc systems deform under the influence of a superimposed strike-slip regime. Posters accompanying this session focused on specific aspects of transition areas in the Caribbean, Alboran, Scotia, southeastern Alaska, Solomon Islands, and western Aleutians.

TRANSITION AT FTT TRIPLE JUNCTIONS

Alan Levander presented results from deep crustal profiling in the Mendocino triple junction of northern California. These data show the rapid transition from subduction to strike slip associated with the passage of the triple junction and the presence of magma bodies near the base of the crust. Patricia McCrory reviewed the sedimentary and structural response of the Humboldt basin in reaction to the migrating Mendocino triple junction. Posters focused on specific aspects of the Mendocino triple junction.

STRAIN PARTITIONING IN SUBDUCTION–STRIKE-SLIP AREAS

Martin Reyners summarized earthquake studies of partitioned strike-slip and thrust deformation on the plate interface at the Hikurangi-Marlborough transition zone of the South Island of New Zealand. He showed that the intensity of strike-slip deformation is directly related to the degree of plate coupling, the tightly coupled southern transition area taking up 100% of the margin-parallel motion. Rob McCaffrey reviewed the direct mechanical relationships that exist between strike-slip faults in the overriding plate and the shear stresses along the subduction thrust. These relations determine the existence and position of the strike-slip fault in the overriding plate and the regional pattern of slip vectors along the margin. Finite element models and natural examples suggest that strike-slip faults need not form in all zones of oblique subduction. Serge Lallemand reviewed three-dimensional analog experiments devised to study the various parameters controlling strain partitioning. He concluded that shear can be accommodated either on strike-slip faults in the overriding plate or along the slab interface if a weak zone of the lithosphere is present. Posters addressed problems of partitioning in southern Alaska, the Aegean, the Chile triple junction, New Zealand, Ecuador, the Caribbean, the Ryukus, and the western Carpathians.

2000 Officer and Councilor Nominees

Council announces the following officer and councilor candidates. Biographical information on all candidates will be mailed with the ballot to all voting members in August.

PRESIDENT (2000)
Mary Lou Zoback, Menlo Park, California

VICE-PRESIDENT (2000)
Sharon Mosher, Austin, Texas

TREASURER (2000)
David E. Dunn, Richardson, Texas

COUNCILOR (2000–2002), POSITION 1
John P. Grotzinger, Cambridge, Massachusetts
Barbara Tewksbury, Clinton, New York

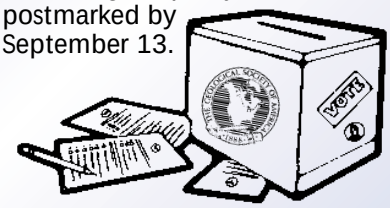
COUNCILOR (2000–2002), POSITION 2
_____, _____
Rena M. Bonem, Waco, Texas

COUNCILOR (2000–2002), POSITION 3
Mary Anderson, Madison, Wisconsin
Leslie McFadden, Albuquerque, New Mexico

COUNCILOR (2000–2002), POSITION 4
Harry Y. McSween, Jr., Knoxville, Tennessee
Charles R. Marshall, Los Angeles, California

VOTE!

Attention, voting members: your vote is an important part of the management process! The 1999 GSA ballot to elect officers for 2000 and councilors for the term 2000–2002 will be mailed with the annual report in August. Ballot and *signed* proxy must be postmarked by September 13.



CONTROLS ON SLAB BEHAVIOR IN TRANSITION AREAS

Jim Dolan provided an overview of evidence for the collision of the opposed North American and Caribbean slabs at depth in the Hispaniola–Puerto Rico transition zone. The collision of the shallowly dipping Caribbean slab may force down the steeper-dipping North American slab and result in a regional-scale subsidence of the forearc in the Puerto Rico area. Blanka Sperner outlined a model for collision and slab behavior at depth in the Alpine-Carpathian system. Mantle flow around the subducting slab reduced the hydrodynamic suction between the overriding and subducting plates and caused the slab to steepen and roll back, as revealed by tomographic studies of the eastern Carpathians. Posters included detailed earthquake and geologic studies of the remnant eastern Carpathian slab and the slab of the northeastern Caribbean beneath Puerto Rico and eastern Hispaniola and beneath the South Island of New Zealand and the volcanic expression of ancient transition areas in the Caribbean, Mexico, and Alaska.

EARTHQUAKE AND TSUNAMI HAZARDS IN TRANSITION AREAS

Eli Silver presented an overview of a FFT triple junction north of the island of New Guinea. Rupture of a thrust fault near this triple junction was responsible for the destructive earthquake and tsunami on July 17, 1998. The complexity of plate boundaries and triple junctions is under investigation by means of a GPS network. Jim McCalpin provided an overview of damage resulting from historic earthquakes in transition zones worldwide. Posters addressed hazard problems in the Dominican Republic, New Zealand, and Kamchatka. To convey hazards-related information to the general population in the Dominican Republic, a special open house was offered at the end of the meeting, and it attracted people from the civil defense, military, and political sectors, as well as local geologists.

FIELD TRIP

The northern Dominican Republic provides an abundance of scenic landscapes, rapidly changing microclimates and diverse geology largely controlled by the active North American–Caribbean plate strike-slip boundary that traverses the area from east to west.

At stops guided by Jim Pindell and Grenville Draper, participants examined outcrops of arc-related rocks, serpentinite and melange formed during Eocene and older subduction of Atlantic (North American) lithosphere beneath the Caribbean island arc, and their uplift and exhumation history. The guides stressed the importance of late Neogene strike-slip–related deformation, including shale and serpentinite diapirism, in the uplift and reactivation of Paleogene arc and collision-related structures. At a stop led by Paul Mann, deformed Eocene-Oligocene rocks crop out along the 1000-m-high crest of the Cordillera Septentrional. These

Subduction *continued on p. 16*

Subduction *continued from p. 15*

rocks unconformably overlie subduction-related rocks and record a transition to strike-slip tectonics within a submarine, California borderlands-type setting. Luis Peña led a stop to view a quarry exposure of recent faulting of a late Quaternary alluvial fan on the northern edge of the Cibao basin. Strike-slip and normal fault splays across the width of the quarry align with a major fault strand of the North American–Caribbean plate boundary. Johan Erikson summarized evidence for a transpressional origin for the Cibao basin on the basis of gravity and geologic data. At a stop led by Tish Tuttle, Luis Peña, and Carol Prentice, participants examined earthquake-induced liquefaction features along riverbank exposures of the Rio Yaqué del Norte in the western Cibao Valley. An ongoing study is relating the ages of these features to historical and prehistorical earthquakes that have affected the area.

Other field trip stops were related to the paleoseismicity and slip rate of the central segment of the Septentrional fault zone, the main strand of the North American–Caribbean strike-slip plate boundary. Carol Prentice, Paul Mann, Luis Peña, and George Burr showed participants offset terraces and summarized the results of previous fault trenching at Rio Licey. An offset terrace at the Rio Juan Lopez has produced dates that constrain a slip rate that is also within the error of slip rates from the Rio Licey site and those modeled using GPS data. At Matancita, a small coastal community that was inundated by tsunamis triggered by a M8.2 offshore thrust event in 1946, Nancy Grindlay and Jim Dolan presented the results of offshore mapping of active structures, including large cusps in the submarine slopes that may mark the scars of past tsunamogenic slumps. At an uplifted staircase of Pleistocene coral reefs that Jim Dolan attributed to the localized oblique subduction of an adjacent submarine ridge, Eric Calais and Alberto Lopez Venegas summarized recent GPS results from Hispaniola. At the final stop, Grenville Draper showed the group an outcrop of Cretaceous glaucophane schist within a serpentinite matrix. These rocks were metamorphosed in a Late Cretaceous subduction zone and uplifted by late Neogene strike-slip movements.

More information on the field trip is available at http://www.ig.utexas.edu/research/projects/caribbean/carib.links.htm.

WRAP-UP

Participants summarized the main conclusions of the conference as follows.

- Open and closed transitions have properties that are quite distinct from the triple junction–type transitions, and thus should be considered as a separate phenomenon.
- As a first-order observation, the close association of bathymetric highs and closed corners suggests that closed corners begin to form when highs indent subduction margins. The association of open corners flanking closed corners or bathymetric highs suggests that open corners may form by radial expansion of the arc system adjacent to the area of localized arc indentation.
- Within this overall genetic framework, salient characteristics of closed corner transitions include: (1) the presence of an adjacent bathymetric high; (2) transpressional partitioning of deformation into thrust and strike-slip deformation and earthquakes; (3) a high degree of coupling between the overriding and underriding plates consistent with the presence of a subducted, thicker-than-average bathymetric high; and (4) associated deep bathymetric troughs flanking the closed corner.
- A salient characteristic of some open corner transitions is detached or vertical subducted slabs. Detached and vertical slabs appear to reflect the termination of the normal subduction process by the entry of a bathymetric high into the subduction zone.
- Although these comparisons are crude, they do suggest an evolutionary process that begins with the indentation of a subduction margin by a bathymetric high and the expansion of adjacent open corners flanking the original closed corner. Evolutionary trends are clearest for intra-oceanic subduction systems where bathymetric highs are small in area.
- There is a paucity of strike slip and very large earthquakes in the parts of open and closed transitions where plate models predict transform motion. This has important implications for hazard assessment. Is plate motion aseismic in these regions, or do the largest earthquakes simply have very long recurrence times?
- A priority area for future conferences and research is the tomography of crust and mantle structure in the open and closed regions and on the rheology and mechanics of the plate interactions within and adjacent to those areas. One area of particular interest for the study of the northeastern Caribbean and the Solomon Islands is whether the interaction of opposed slabs at depth control deformation in the overlying arc. This information would help clarify the earthquake hazards associated with these dual subduction systems.

ACKNOWLEDGMENTS

We thank the management and staff of the Puerto Plata Village Caribbean Resort for providing an ideal venue on an active and subaerial transition area; Lois Elms of Western Experience for her organizational expertise; and Christine Herridge de Guerrero and Grenville Draper for help with logistics. We also thank the field trip leaders, who did an excellent job of organizing informative and multidisciplinary stops and assembling a comprehensive field trip guide. We especially thank Michael Rymer for satellite imagery used in the field guide. The conference was supported in part by a National Science Foundation grant, an American Chemical Society Petroleum Research Fund grant, NASA, the U.S. Geological Survey, and the Penrose Conference fund of the Geological Society of America. UTIG contribution no. 1432.

Note: For a full version of this report, see http://www.geosociety.org/profdev/penrose/99pcrpt1.htm.

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Ramon Vegas
Alberto M. Lopez Venegas
Christa G. von Hillebrandt
John Weber
Chesley Williams ■

GSA DIVISIONS—DO YOU BELONG?

GSA's twelve divisions provide a home for like-minded scientists within the Society as a whole, as well as a focus for cross-disciplinary discussion and interaction. In particular, the divisions help develop the scientific program for the annual meetings, provide opportunities for students to participate in the meetings, and help fund student research.

This is the second article on GSA's Divisions (see May *GSA Today*—v. 9, no. 5, p. 18—for the first). If you would like to become a part of a GSA division, call Membership Services, 1-800-472-1988.

Archaeological Geology Division

C. Reid Ferring, *Division Chair, ferring@ unt.edu*

The Archaeological Geology Division's 450 members espouse using geomorphology, sedimentology, geochronology, geophysics, and other approaches to working on problems that include paleoenvironments, site formation, artifact provenance, and prospecting for sites. Activities and a newsletter inform members about current research, provide them with contacts for collaboration or information about academic programs, and work directly to improve archaeological research. Activities include:

- Symposia and general sessions at the GSA annual and section meetings;
- Field trips for the annual and section meetings, where professionals and students can meet, share ideas, and see firsthand applications of research;
- Claude Albritton, Jr., Scholarships to support graduate students' research; student paper awards for presentations at the annual meeting;
- the Rip Rapp Archaeological Geology Award to recognize career achievements.

Rolfe Mandel (Kansas) has led efforts to strengthen Archaeological Geology Division ties with the Society for American Archaeology (SAA), including founding the SAA's Geoarchaeology Discussion Group, which has more than 500 members. This partnership will enhance communications and shared activities among archaeologists and earth scientists. For up-to-date information on the division and its activities, see the www.geosociety.org Web site.

Engineering Geology Division

Scott Burns, *Division Chair, burnss@ pdx.edu*

Oldest of the GSA divisions, the Engineering Geology Division celebrated its 50th anniversary two years ago. Many of the 780 division members work in the consulting and agency areas. Its purpose is to improve and promote the science of geology as applied to engineering works, natural hazards, and environmental problems. Originally focusing on engineering problems, the division's scope has broadened to include environmental geology.

At the GSA Annual Meeting, the division hosts a luncheon and gives the Burwell Award to the author(s) of the top published book or paper in the field, the Distinguished Service Award to a member of the division who has excelled in the area of applied geology, and an Outstanding Student Research Award. The division sponsors at least three to four theme sessions and at least one field trip and a short course at the GSA Annual Meeting.

The Engineering Geology Division's long history of publications in environmental and engineering geology includes the GSA series Case Histories in Engineering Geology and Reviews in Engineering Geology and the journal, *Environmental and Engineering Geosciences* (co-published with Association of Engineering Geologists—AEG). Also in cooperation with AEG, the division supports the Richard Jahns Lectureship, for which an outstanding scientist visits more than 20 geology departments each year, discussing the importance of environmental and engineering geology with future geologists. The semi-annual Engineering Geology Division newsletter updates members on the happenings of the division and engineering geology in general.

Division funds offer support for student members to attend division-sponsored short courses and field trips at the GSA Annual Meeting.

The Engineering Geology Division, always an important part of GSA, offers students and professionals the means to interact and learn more about the applied end of geology.

History of Geology Division

Kenneth L. Taylor, *Division Chair, ktaylor@ou.edu*

Why bother with the history of geology? Why spend time trying to find out who discovered what when—and how and why they did it?

History of Geology Division members have several answers to these questions. Among them: To understand how we got where we are; to be inspired by our predecessors; to turn up leads on new directions for research, or find valuable approaches in teaching; and, not least, to enjoy the intrinsic human and intellectual interest of geology's rich heritage.

The History of Geology Division represents one of GSA's most highly interdisciplinary groupings, drawing together historical-minded scientists from all specializations within the earth sciences, along with historians of science. It provides a lively forum for exchange of information and ideas about the entire landscape of geology.

Division programs at GSA Annual Meetings have examined the evolution of geologic mapping, the effects of the Western surveys, and the contributions of great geologists of the past such as Hutton, Lyell, and Dana.

As part of its responsibility to inform and inspire members of GSA, the division produces profiles of famous geologists, "Rock Stars," for *GSA Today*. (Find the Rock Stars articles on the Web at http://geoclio.st.usm.edu/gsahistory.html.)

Division members receive a newsletter, generally twice a year, focusing on news, meetings, and publications related to the history of geology. Since 1982 the division has presented the History of Geology Award annually to an individual who has made contributions of fundamental importance to our understanding of the history of the geological sciences.

International Division

Marybeth Davies-Hatteberg, *International Division Secretary/Treasurer and 2nd Vice-President, gary2220@worldnet.att.net*

Through the efforts of the GSA International Division, geologists from all over the world are connecting and collaborating. The division raises funds to assist international scientists in attending GSA Annual Meetings, where they participate in the International Survey Program (ISP), field trips, and the general sessions and symposia. Visiting international geologists connect with local geologists who volunteer as goodwill ambassadors during the meetings. In addition to helping with the ISP, the division reaches out to international students through the Geopals Program.

The International Division sponsors symposia that have internationally timely themes, such as the 1998 session "Environmental Quality vs. Economic Development: The Role of Coal in Developing Nations."

The division stays connected through its own Web site www.nannos.com/gsa/index.htm. Here you can find out how to become a Geopal or an ISP Ambassador, or discover other opportunities for international volunteerism. For a quick response to your inquiries, call Marybeth Davies-Hatteberg at (651) 274-6180 or e-mail gary2220@worldnet.att.net. ■

Institute for Earth Science and the Environment

Geophilosophy: Philosophers and Geoscientists Thinking Together on the Future of the Earth Sciences

Robert Frodeman, *University of Tennessee*
Carl Mitcham, *Colorado School of Mines*

There is a feeling today that geology is caught in a kind of cultural tectonics, as the relations between the geosciences and the rest of society are being fundamentally altered. Geoscientists are being asked to take on new roles and responsibilities that often extend beyond their specific disciplinary expertise.

This situation is the result of changes largely external to the disciplines that study the integrated earth system. It is certainly true that changes in technology—e.g., faster computers and the rise of integrated observation systems—have altered the possibilities for research within the earth sciences. But the fundamental fact ushering in the new era is this: for the first time in the history of the planet, humans are a major geologic force. We now affect climate and biodiversity in unprecedented ways at the local, regional, national, and global levels. Furthermore, these changes result from our use of energy and mineral resources at levels that are unlikely to be sustainable over the long term. Accordingly, it is likely that the geosciences will face greater challenges and will have a larger role to play than ever before in the future of human well-being and the health of the planet.

The challenges faced today by the geosciences are analogous to those faced in other sciences, such as nuclear physics, computer science, and genetics. In the words of Albert Einstein, "The bomb . . . and other discoveries present us with . . . a problem not of physics but of ethics." Indeed, the challenges facing these sciences are more than ethical. Scientific advances in, for example, artificial intelligence and the Human Genome Project not only raise basic moral and political issues in regard to the right of privacy and the appropriate limits for human action, but also challenge traditional notions of the self and human nature.

In response to these new conditions, there are signs that a consensus is emerging within the geoscience community. This consensus recognizes that the challenge of global change calls not only for advances in scientific research and methodology, but also for an enlarged sense of stewardship, ethics, and cross-disciplinary integration among the disciplines. The geoscience community has found that it must now rethink fundamental questions concerning its role within and responsibilities to society.

The National Science Foundation (NSF) recently funded a workshop of environmental philosophers to help identify future research priorities in the earth sciences. On previous occasions, individual philosophers have been invited to meet with various scientific groups to reflect on future research directions and applications. But on no previous occasion of which we are aware has a group of philosophers been invited to make their own recommendations to a research planning exercise.

The workshop was held in Boulder, Colorado, at the National Center for Atmospheric Research (NCAR) and the Natural Resources Law Center of the University of Colorado in March 1999. The 15 philosophers present included specialists in environmental philosophy, philosophy and technology, and science-technology-society studies. The workshop began with participants being tutored by several prominent members of the earth sciences community on the current state of the geosciences, with particular focus on federal funding. It ended with the drafting of a white paper, which was presented in April to the National Academy of Sciences Committee on Basic Research Opportunities in the Earth Sciences (CBROES).

The work of CBROES will feed into "GEO Beyond 2000," a strategic planning process involving the entire Geosciences Directorate of the National Science Foundation. The three divisions of the GEO Directorate—Earth Sciences, Atmospheric Sciences, and Ocean Sciences—have each been asked to identify research priorities for the time frame 2001–2010. Part of the process involves soliciting the views of a range of earth scientists, from meteorologists and hydrologists to geochemists, geomorphologists, and paleontologists. What is remarkable about this workshop is that a group of environmental philosophers was also asked to contribute its perspective.

The workshop took place against two backdrops—one external, another internal to the earth sciences. At the external or governmental level, U.S. science policy is undergoing a fundamental reevaluation. In September 1998, U.S. Representative Verne Ehlers (Republican—Michigan) issued his study, "Unlocking Our Future: Toward A New National Science Policy." The Ehlers report argues for the need to develop a post–Cold War U.S. science policy. Science policy since the end of World War II has been guided by Vannevar Bush's 1945 study, "Science: The Endless Frontier." For Bush, the public funding of science is justified on the grounds of national defense, public health, and economic strength. The assumption of Bush and of the scientific community since then has been that such applications are the natural result of science pursued for its own sake—a view that has come to be called the "linear hypothesis." To the three grounds proposed by Bush, Ehlers would add a fourth: to help society make good decisions, especially in dealing with difficult issues related to the environment. One of the challenges identified by workshop participants was the need for a more nuanced understanding of the relation between scientific research and social benefit.

Within the earth sciences community, there has also been a discussion about the changing role of the earth sciences in society. This debate has been prompted by the recognition that human civilization today alters Earth's physical and biological environments on all scales, from local and regional to global. Furthermore, as noted by the "GEO Beyond 2000" draft document, the earth sciences are being affected by revolutionary transformations in computer information and sensor technologies. Such developments place the earth sciences in a pivotal position to provide "knowledge and tools that decision makers will need to enable humankind to develop and maintain a healthier, safer world."

Such discussion raises a host of philosophical issues, which it was the aim of the Boulder workshop to address. The white paper resulting from the workshop offered an account of the research priorities facing the earth science community in terms of three overall areas: education, public participation, and new areas for research.

Education

Because of economic, technological, and ecological transformations, the relation between science and society has fundamentally changed. Therefore, the education of both earth scientists and the public must change as well.

To be an effective scientist today requires more than being trained in science. It also requires an understanding of both the historical and cultural contexts of science. Conversely, informed

citizenship requires a basic knowledge of earth history and processes. As the environmental philosopher Holmes Rolston has written, "Philosophers since Socrates have insisted that the unexamined life is not worth living; . . . environmental philosophers [have] insisted that life in an unexamined world is not worth living either."

The workshop white paper therefore called for the following initiatives: (1) promote geoscience K–12 education, to insure that the next generation of scientists and the general public have a more thorough understanding of the nature and limits of geoscience research. (2) Encourage the creation of interdisciplinary workshops and conferences where geoscientists, social scientists, and humanists can meet and learn from one another. (3) Further cross-disciplinary institutional funding opportunities of the NSF with the Environmental Protection Agency, the National Endowment for the Humanities and National Endowment for the Arts, the Department of Education, and professional organizations in the social sciences and humanities.

Public Participation

The geosciences are both dependent on and of critical importance to the public. Therefore, science will benefit from becoming more responsive to democratic concerns and open to nonprofessional contributions. Without compromising its scientific rigor, the scientific research agenda should be exposed to perspectives beyond those of specific disciplinary expertise.

As policy analyst and geologist Daniel Sarewitz has argued, when science is pursued as a surrogate for social action, both science and social action suffer. Public science has an essentially political character: it is funded because it contributes to the common good. This fact must be addressed with candor. It is thus essential that, in addition to the criteria of technical competency, the research process accommodates criteria originating within an informed democratic citizenry.

The workshop white paper called for the following initiatives in this area: (1) Complement the peer-review process by providing avenues for public input from members of such community groups as business and labor, regional interests, environmentalists, economic developers, and the like. (2) Provide increased opportunities for interdisciplinary, problem-focused research and citizen science (e.g., stream monitoring, animal and plant inventories, etc.) in addition to more traditional basic research.

New Areas for Research

The geosciences offer a paradigm for synthetic science. Therefore, building on their interdisciplinary tradition and achievements, the geosciences are in a unique position to reach even further and face more explicitly than any other scientific field the broadly philosophical dimensions of their work.

The workshop white paper concluded with the following suggestions: (1) Increase the diversity of the peer review process within the earth sciences by including scholars from the other natural sciences, the social sciences, and the humanities. (2) Develop forums for critically examining the nature and limits of integrated observation systems, computer modeling, and the like. (3) Further pursue emerging discussions of the ethical, political, and philosophical dimensions of the geosciences. (4) Promote critical reflections concerning the fundamental philosophical and even religious significance of humans becoming a geologic force and attempting to become managers of planetary scope.

Finally, the report called for a continuing dialogue between the geosciences and philosophy by finding ways to institutionalize the discussion begun at the workshop.

Tentative plans call for this workshop to be expanded into a research conference to build upon the progress made. An account of this report, plus other initiatives within the geoscience community, will be featured at the 1999 GSA Annual Meeting in Denver, in a session titled "Crossing the Next Divide: The Earth Sciences, the Humanities, and the Needs of Society. ■

About People

GSA Fellow James E. Brooks, emeritus, Southern Methodist University, has received the American Association of Petroleum Geologists Public Service Award for 1999.

Member Kevin Coflin, Calgary, Alberta, has been elected journal editor for the Canadian Society of Exploration Geophysicists.

Fellow Kenneth Taylor, University of Oklahoma, current chair of the GSA History of Geology division, has been awarded the Sue Friedman Medal by the Geological Society of London for his research into the 18th century history of the earth sciences.

LETTER

Finite Resources

Bruce Molnia's article "Sustaining America" (*GSA Today*, January 1999, p. 21) was upbeat—but as every geoscientist surely is aware, there is no such thing as "sustainable development," and I think that GSA spokesmen should not misrepresent the situation with happytalk. Far too many essential resources, for which no substitutions or technofixes are possible, are finite. Consider just the production of food. The world can barely feed its present population, yet arable land is fast being decreased by development, erosion, and soil degradation, even as population increases. Without fertilizer, food production would plummet; of the three major ingredients, phosphorus will be gone in a few decades (and even if unexpected major new supplies are found, they will add merely decades). Potassium will last longer. Nitrogen is effectively limitless but requires much energy (and carbon and hydrocarbon fuels, including the natural gas with which nitrogen is most easily fixed, will be effectively gone in a century). The oceans are catastrophically overfished, and fishfarming too much resembles slash-and-burn agriculture. The matters Molnia discussed are delaying and cosmetic actions to make life more pleasant, but only for the fortunate and for less than a century.

Warren Hamilton
Golden, Colorado

Looking for a New Job?

Are you seeking a new position in the field of geology? The GSA Employment Service offers an economical way to look for one. Potential employers use the service throughout the year to find the qualified individuals they need, and applicants may register at any time. Your name and résumé will be provided to all participating employers who seek individuals with your qualifications.

To register, complete the application form on page 21, prepare a one- to two-page résumé, and mail both with your payment to GSA headquarters. A one-year listing for GSA Members and Associates in good standing is $35; for nonmembers the cost is $65. Let GSA help you find a new position!

Looking for a New Employee?

When was the last time you hired a new employee? Did you waste time and resources in your search for a qualified geoscientist? Let the GSA computerized database make your search easier year round. Complete the Employer's Request for Earth Science Applicants form on page 22. Specify educational and professional experience requirements as well as the area or areas of expertise your applicant should have. The GSA database will take it from there.

You will receive a printout that includes the matching applicants' names, addresses, phone numbers, areas of specialty, type of employment desired, degrees held, years of professional experience, and current employment status. Applicants' résumés are sent with each printout at no additional charge. For 1999, the cost of a printout of one or two specialty codes is $175. Each additional specialty is $50. A printout of the entire applicant database is available for $350. (Please note: Specialty codes printed in boldface type are considered major headings. If you request a listing of one of the subspecialties, applicants coded under the major category will be included but those coded under the other related subspecialties will not.) It is solely the employer's decision to contact applicants who interest them; we do not notify applicants of computer matches that are made. Employers using the matching service are invited, at no additional cost, to post their position announcement for three months on the GSA Web site.

Employment Interview Service at the Annual Meeting

If possible, take advantage of GSA's Employment Interview Service, which is conducted each fall in conjunction with the Society's annual meeting. The service brings potential employers and employees together for face-to-face interviews. Mark your calendar for the 1999 GSA Annual Meeting, October 25–28 in Denver.

Applicants: If we receive your materials by September 15, your file will be included in the information employers receive *before* the meeting. Submit the form earlier to receive maximum exposure, and indicate on your application form that you would like to interview in October.

Employers: You may rent interview space in half-day increments from GSA. Our staff will schedule all interviews for you, and provisions will be made for access to the entire applicant listing and résumés, a message center, ongoing posting of job openings, on-site applicant registration and résumé updating, and photocopying services.

For additional information or forms, please visit the GSA Web site at www.geosociety.org or contact Nancy Williams, Professional Development Coordinator—Career Services, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140, (303) 447-2020, or profdev@geosociety.org. ■

The Geological Society of America

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303/447-2020 • FAX 303/447-1133 • E-mail member@geosociety.org

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Current? __________ $35 $65

Ck # ____________________

Acct. # 1-000-4086-000

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APPLICATION FOR EMPLOYMENT MATCHING SERVICE

(Please type or print legibly)

TITLE: ☐ Dr. ☐ Mr. ☐ Ms. ☐ Mrs. ☐ Miss

NAME ________________________________ **DATE** __________

Family/Last Name First

MAILING ADDRESS ____________________________________

CITY ____________________ **STATE** __________ **ZIP CODE** __________

DATE AVAILABLE __________ **CONTACT TELEPHONE (** **)** __________ **or (** **)** __________

list one only area code Business Home

E-MAIL ____________________ **VISA** (If not U.S. citizen, list visa) __________

I ☐ HAVE ☐ HAVE NOT PREVIOUSLY BEEN REGISTERED WITH THE EMPLOYMENT MATCHING SERVICE

EXPERIENCE Must use specialty codes listed below.
Choose **THREE** that best describe your expertise in order of importance.
1. __________ **2.** __________ **3.** __________

PRESENT SPECIALTY
Choose **ONE** from codes listed below __________
YEARS EXPERIENCE IN THIS SPECIALTY __________

PRESENT EMPLOYER ____________________________________

TYPE OF POSITION DESIRED (Check as many boxes as apply.)

Interested in: ☐ Academic ☐ Government ☐ Industry ☐ Other
Specific interest: ☐ Administration ☐ Exploration/Production ☐ Field ☐ Research ☐ Teaching
Will accept employment in: ☐ U.S. only ☐ U.S. with foreign assignments ☐ Either

GIVE NUMBER OF YEARS EXPERIENCE FOR ANY OF THE FOLLOWING THAT ARE APPLICABLE

Administrative_____ Exploration/Production_____ Field_____ Research_____ Teaching_____ Total geological experience______

KNOWLEDGE OF FOREIGN LANGUAGES: ☐ French ☐ German ☐ Russian ☐ Spanish ☐ Other __________

ACADEMIC TRAINING

College or University	Degree (rec'd or expected)	Year	Major	Minor

Postdoctoral research: Field __________ **Institution** __________ **Number of years** ______

SPECIALTY CODES Select those that best describe your ability. Use codes in bold face only when other breakdowns are inadequate.

100 Economic Geology
101 coal geology
102 geothermal, etc.
103 metallic deposits
104 nonmetallic deposits
105 mining geology
120 Engineering Geology
150 Environmental Geology
160 Public Education & Communication
200 General Geology
220 Geochemistry
221 organic
222 high temperature
223 low temperature
224 stable isotopes
225 geochronology
250 Geomorphology
300 Geophysics
301 seismic
302 gravity/magnetics
303 seismicity
304 paleomagnetism
320 Hydrogeology
321 hydrochemistry
322 ground water
323 surface water
330 Library
350 Mathematical Geology
351 computer science
352 statistical geology
400 Mineralogy
401 crystallography
402 clay mineralogy
410 Museum (curator)
420 Oceanography
421 marine geology
422 coastal geology
450 Paleontology
451 invertebrate
452 vertebrate
453 micropaleontology
454 paleobotany
455 paleoecology
500 Petroleum Geology
501 exploration
502 subsurface strat.
520 Petrology
521 igneous
522 metamorphic
523 sedimentary (clastic)
524 sedimentary (carb.)
525 experimental
550 Planetology
575 Quaternary Geology
600 Regional Geology
620 Remote Sensing
621 photogeology
622 photogrammetry
630 Science Editing
650 Sedimentology
651 sed. processes
652 sed. environments
720 Stratigraphy
750 Structural Geology
751 tectonics
752 tectonophysics
753 rock mechanics
800 Volcanology

Résumé must be attached, ***limited to two pages,*** typewritten on one side only, to be acceptable for reproduction to employers. Include your name, address, and phone number; concise details of work experience; and majors/minors on degrees.

Fee: $35 if you are a Member or Student Associate of GSA in good standing (Member #__________), $65 if you are not a member of GSA. Payment in U.S. funds (check, money order, or charge information ***must accompany form).***

Make check payable to the Geological Society of America. This application will be active for 1 year.

☐ Check / Money Order ☐ MasterCard ☐ VISA ☐ Diners Club ☐ American Express or Optima

Card Expires (Mo/Yr) Card Number

Signature ____________________

Required for credit card payment Date

I agree to release GSA or their representatives from responsibility for errors that may occur in processing or distributing this data. I understand that GSA makes ***no guarantee*** of contact by an employer in this service. I agree to notify GSA Employment Service immediately of change of address or acceptance of a position.

Signature ***(required)*** ____________________

I will/will not attend the 1999 GSA Annual Meeting in Denver.

The Geological Society of America
3300 Penrose Place • P.O. Box 9140 • Boulder, Colorado 80301-9140 • (303) 447-2020 • Fax 303-447-1133 • E-mail: member@geosociety.org

EMPLOYER'S REQUEST FOR EARTH SCIENCE APPLICANTS

(Please type or print legibly)

NAME _____ **DATE** _____

ORGANIZATION _____

MAILING ADDRESS _____

CITY _____ **STATE** _____ **ZIP CODE** _____ **TELEPHONE (** **)** _____
area code Number

E-MAIL _____ **FAX (** **)** _____

SPECIALTY CODES (see list below) 1–2 Codes, $175; additional codes, $50 each; entire list, $350
List the specialty code numbers that you wish to order, or ☐ check here if you want the entire file of applicants in *ALL* specialties.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

POSITION DATA: What position(s) do you expect to fill? _____

In what area(s)? _____

Degree requirements _____ Number of positions available _____

SPECIALTY CODES

100 Economic Geology
101 coal geology
102 geothermal, etc.
103 metallic deposits
104 nonmetallic deposits
105 mining geology
120 Engineering Geology
150 Environmental Geology
160 Public Education & Communication
200 General Geology
220 Geochemistry
221 organic
222 high temperature
223 low temperature
224 stable isotopes
225 geochronology
250 Geomorphology
300 Geophysics
301 seismic
302 gravity/magnetics
303 seismicity
304 paleomagnetism
320 Hydrogeology
321 hydrochemistry
322 ground water
323 surface water
330 Library
350 Mathematical Geology
351 computer science
352 statistical geology
400 Mineralogy
401 crystallography
402 clay mineralogy
410 Museum (curator)
420 Oceanography
421 marine geology
422 coastal geology
450 Paleontology
451 invertebrate
452 vertebrate
453 micropaleontology
454 paleobotany
455 paleoecology
500 Petroleum Geology
501 exploration
502 subsurface strat.
520 Petrology
521 igneous
522 metamorphic
523 sedimentary (clastic)
524 sedimentary (carb.)
525 experimental
550 Planetology
575 Quaternary Geology
600 Regional Geology
620 Remote Sensing
621 photogeology
622 photogrammetry
630 Science Editing
650 Sedimentology
651 sed. processes
652 sed. environments
720 Stratigraphy
750 Structural Geology
751 tectonics
752 tectonophysics
753 rock mechanics
800 Volcanology

Applicants seeking employment in:
☐ Academic ☐ Government ☐ Industry ☐ Other _____

***Minimum* degree required:**
☐ None ☐ B.A. or B.S. ☐ M.A. or M.S. ☐ Ph.D.

***Minimum* professional experience:**
☐ None ☐ 1–5 years ☐ 6-plus years

Experience desired (years):

	None	1–5	6-plus
Administrative	☐	☐	☐
Exploration/Production	☐	☐	☐
Field	☐	☐	☐
Research	☐	☐	☐
Teaching	☐	☐	☐

Employment in: ☐ U.S. only ☐ U.S. with foreign assignments ☐ Either

Foreign Languages: ☐ French ☐ German ☐ Russian ☐ Spanish ☐ Other _____ ☐ Not required

I am interested in interviewing applicants through the GSA Employment Service at the 1999 Annual Meeting in Denver.

Signature (required) _____

Date _____

1. I agree to use this service for valid recruiting purposes.
2. I agree that no placement charges will be assessed to any applicant participating in the GSA Employment Matching Service.

Total fee enclosed ..... **$** _____

Or invoice requested ..... **$** _____

Come to Denver this fall for the 1999 GSA Annual Meeting for an exceptionally dynamic and stimulating event!

Sharon Mosher
Annual Program Committee Chair

As GSA enters the next millennium, new programming initiatives have been instituted to offer effective, dynamic, and flexible programming. Celebrate the cross-disciplinary nature of the geological sciences in a scientific program that crosses divides between the various chemical, biological, and physical disciplines of our science.

The program features eight *special events* of broad interest to the geoscience community, the Pardee Keynote Symposia. Topics are on the leading edge in a scientific discipline or area of public policy, address broad fundamental problems, are interdisciplinary, and/or focus on global problems. A multitude of stimulating Topical Sessions, with a mixture of invited and volunteered papers and different session formats, focus on specific topics. The popular general discipline sessions are scheduled as usual. Four Hot Topics at Lunch are offered to stimulate lively debates on controversial issues. Come participate in crossing the scientific divide into the future with GSA!

1999

October 25–28
Colorado Convention Center
Hyatt Regency Hotel
Marriott City Center Hotel
www.geosociety.org/meetings/99

Abstracts due: July 12

Preregistration and Housing due: September 17

Technical Program Schedule: September *GSA Today* and the Web

Registration and Housing Forms: June *GSA Today* and the Web

REGISTER TODAY!

General Co-Chairs: *Mary J. Kraus and David Budd, University of Colorado*

Technical Program Co-Chairs: *Craig Jones and G. Lang Farmer, University of Colorado*

Field Trip Co-Chairs: *Alan Lester and Bruce Trudgill, University of Colorado*

THURSDAY... Saving some of the best for last!

Planning on leaving the GSA Annual Meeting early? Think again...

See what we have planned for you!

Thursday Morning

PARDEE KEYNOTE SYMPOSIUM: *New Insights on Organic Metamorphism in the Earth*

Everett L. Shock, Washington University, St. Louis, Missouri; Harold C. Helgeson, University of California, Berkeley. *Group Exploring Organic Processes In Geochemistry.*

Organic compounds persist at much higher temperatures and pressures than generally thought. Analytical, theoretical, and experimental studies are revealing the reversibility of organic reactions and the pathways through which metastable equilibrium states are reached. This symposium presents evidence that requires rethinking organic geochemical processes throughout the crust and upper mantle.

Thursday Noon

HOT TOPIC: *Earth Systems Science: Gaia as Goddess of Insight or Siren of Doom*

Some say that systemic approaches to understanding the Earth will yield useful new insights. Others claim that this trend is nothing more than "New Age Environmentalism" in disguise.

Thursday Afternoon

PARDEE KEYNOTE SYMPOSIUM: *Human Transformation of the Physical Landscape*

Lisa E. Wells, Vanderbilt University, Nashville, Tennessee; Patrick Julig, Laurentian University, Sudbury, Ontario. *GSA Archaeological Geology Division.*

Agriculture, grazing, mining, deforestation, and urbanism cause profound changes to Earth's topography, geochemistry, soil, and sediment budget. Humans move more sediment per year than all other processes. Soil erosion impacts both biologic productivity and global climate by changing the carbon cycle, the hydrologic cycle, and eolian dust flux. This symposium will integrate millennial-scale lessons of landscape degradation and conservation into the discussion of modern landscape transformation.

PLUS more than 36 discipline and topical sessions—25% of the entire program!

The GSA Headquarters Services booths will also be open Thursday from 9:00 a.m. to 2:00 p.m.!

Let's set a record for the Thursday afternoon end-of-the-meeting celebration!

Don't forget to visit the GSA Web site at www.geosociety.org for current information and to review our new and improved Technical Program format!

GSA Offers Variety of Short Courses at 1999 Annual Meeting

Registration information and course descriptions were published in the June issue of *GSA Today*. For additional information, contact Edna Collis, GSA headquarters, (303) 447-2020, ext. 134, ecollis@geosociety.org, or see GSA's Web site, www.geosociety.org.

Preregistration deadline: September 17

1. ■ Practical Methods in Applied Contaminant Geochemistry: From Characterization to Remediation

Saturday, October 23, 8:00 a.m. to 5:00 p.m. Colorado Convention Center. Cosponsored by *GSA Hydrogeology Division*. Students: The GSA Hydrogeology Division will subsidize the first student registrant who is a valid division member. The student *must pay the full course fee* when registering, but will be reimbursed $50 after the GSA meeting by the Hydrogeology Division. Faculty: Donald I. Siegel, Dept. of Earth Sciences, Syracuse University; Ph.D., University of Minnesota.
Limit: 40. Fee: $175, students $155; includes course manual and lunch. CEUs: 0.8.

2. ■ Applied Inverse Ground Water Modeling: Why Use Anything Less?

Saturday–Sunday, October 23–24, 8:00 a.m. to 5:00 p.m. both days. Colorado Convention Center. Cosponsored by *GSA Hydrogeology Division*. Students: The GSA Hydrogeology Division will subsidize the first student registrant who is a valid division member. The student *must pay the full course fee* when registering, but will be reimbursed $50 after the GSA meeting by the Hydrogeology Division. Faculty: Evan R. Anderman, ERA Ground-Water Modeling, LLC, Denver; Ph.D., Colorado School of Mines; James O. Rumbaugh, Environmental Simulations, Denver.
Limit: 25. Fee: $385, students $365; includes course manual and lunches. CEUs: 1.6.

3. ■ Digital Mapping Methods: Accurate Digital Data Capture and Analysis for the Field Geoscientist

Saturday–Sunday, October 23–24, 8:00 a.m. to 5:00 p.m. both days. Colorado Convention Center. Faculty: Kent Nielsen, Dept. of Geosciences, University of Texas at Dallas; Ph.D., University of British Columbia; Carlos Aiken, Dept. of Geosciences, University of Texas at Dallas; Ph.D., University of Arizona; Xueming Xu, Dept. of Geosciences, University of Texas at Dallas; M.S., Chinese Academy of Science.
Limit: 40. Fee: $385, students $365; includes course manual, lunches, and field trip transportation. CEUs: 1.6.

4. ■ Introduction to Remote Sensing for Geologic Applications

Saturday–Sunday, October 23–24, 8:00 a.m. to 5:00 p.m. both days. Colorado Convention Center. Cosponsored by *GSA Planetary Geology Division*. Students: The GSA Planetary Geology Division will subsidize the first two student registrants who are valid division members. The students must pay the full course fee when registering, but will be reimbursed $100 after the GSA meeting by the Planetary Geology Division. Faculty: Andrea Gallagher, Research Systems, Boulder, Colorado; B.S., Colorado School of Mines; Rebecca Dodge, University of Texas at El Paso; Ph.D., Colorado School of Mines; K. Eric Livo, U.S. Geological Survey, Denver; M.S., Colorado School of Mines.
Limit: 30. Fee: $325, students $305; includes course manual and lunches. CEUs: 1.6.

5. ■ Modern Salt Tectonics

Saturday–Sunday, October 23–24, 8:00 a.m. to 5:00 p.m. both days. Colorado Convention Center. Cosponsored by *GSA Structural Geology and Tectonics Division*. Students: The GSA Structural Geology and Tectonics Division offers five $100 scholarships to division-affiliated student members for division-sponsored short courses. Apply in writing, giving name, institution, class, specialty, poster or talk title, short-course title, and a one-paragraph rationale, to Stephen Marshak by e-mail (smarshak@uiuc.edu) or fax (217-333-3542) from September 6 through September 10, 1999. See the Structural Geology and Tectonics newsletter for more information. Faculty: Mark G. Rowan, Rowan Structural Consulting, Boulder, Colorado; Ph.D., University of Colorado, Boulder.
Limit: 50. Fee: $265, students $245; includes course manual and lunches. CEUs: 1.6.

6. ■ Three-Dimensional Seismic Interpretation: A Primer for Geologists

Saturday–Sunday, October 23–24, 8:00 a.m. to 5:00 p.m. both days. Colorado Convention Center. Cosponsored by *GSA Sedimentary Geology Division*. Students: The GSA Sedimentary Geology Division will subsidize all students who are valid division members. Students *must pay the full course fee* when registering, but will be reimbursed $100 after the GSA meeting by the Sedimentary Geology Division. To be reimbursed, students *must apply in writing to* David McCormick, Schlumberger-Doll Research, Old Quarry Road, Ridgefield, CT 06877, (203) 431-5524, mccormic@ridgefield.sdr.slb.com. Faculty: Bruce S. Hart, New Mexico Bureau of Mines and Mineral Resources; Ph.D., University of Western Ontario.
Limit: 40. Fee: $280, students $260; includes course manual and lunches. CEUs: 1.6.

7. ■ Applications of Environmental Isotopes to Watershed Hydrology and Biogeochemistry

Sunday, October 24, 8:00 a.m. to 5:00 p.m. Colorado Convention Center. Cosponsored by *GSA Hydrogeology Division*. Students: The GSA Hydrogeology Division will subsidize the first student registrant who is a valid division member. The student *must pay the full course fee* when registering, but will be reimbursed $50 after the GSA meeting by the Hydrogeology Division. Faculty: Carol Kendall, Water Resources Division, U.S. Geological Survey, Menlo Park, California; Ph.D., University of Maryland; Thomas D. Bullen, Water Resources Division, U.S. Geological Survey, Menlo Park, California; Ph.D., University of California, Santa Cruz.
Limit: 40. Fee: $275, students $255; includes course manual and lunch. CEUs: 0.8.

8. ■ Teaching Earth System History: A Computer-Assisted Approach

Sunday, October 24, 8:00 a.m. to 5:00 p.m. Colorado Convention Center. Faculty: Christopher R. Scotese, Dept. of Geology, University of Texas at Arlington; Ph.D., University of Chicago.
Limit: 30. Fee: $175, students $155; includes course manual, CD-ROM, software, and lunch. CEUs: 0.8. ■

CORRECTION:

GSA Hydrogeology Division is the cosponsor for 1999 Annual Meeting Field Trip #3, Hydrogeology and Wetlands of the Mountains and Foothills near Denver, Colorado.

CALL FOR GSA Short Course Proposals for Future Meeting

Due December 1, 1999

The GSA Committee on Continuing Education invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines. Short courses may be conducted in conjunction with all GSA annual or section meetings. We are interested in receiving proposals for the 2000 Annual Meeting (Reno) or the 2001 Annual Meeting (Boston), particularly, but not exclusively, in the following disciplines of geology.

Structural Geology: Analysis of veins in low-temperature environments; computer modeling in structural geology; deformation mechanisms; fractals; fault gouge studies–pseudotachylites; metamorphic processes and deformation strain analysis; tectonic regimes

Economic Geology: Applications of structural geology to mineral deposits

Petroleum Geology: Exploration technology; petroleum exploration and exploitation

Environmental Geology: Environmental assessment; environmental law—geologist's role; environmental or engineering problems associated with karst landscapes, including subsurface investigation procedures, sampling and testing—site characterization; evaluating groundwater resources for long-term municipal water supplies; groundwater modeling; Phase II and Phase III environmental site assessment; wellhead protection area (capture zone) delineation

Geochemistry: Geochemical modeling; geophysics-geochemistry or structural geology–geochemistry; isotope applications in ecological-geological systems

New Mapping Techniques and Technologies: ARC INFO; GPS technologies in geological research; mapping and GPS mapping

Pedagogy and Teaching Methods: Multimedia for use in the classroom; Pedagogy

Proposals must be received by December 1, 1999. Selection of courses for 2000 will be made by February 1, 2000. For those planning ahead, we will also consider courses for 2001 at that time.

For proposal guidelines or information, contact Edna Collis, GSA headquarters, (303) 447-2020, ext. 134, ecollis@geosociety.org

CALENDAR

Only new or changed information is published in *GSA Today*. A complete listing can be found in the Calendar section on the Internet: **http://www.geosociety.org.**

1999 Meetings

September

September 6–9, Western States Seismic Policy Council 21st Annual Conference, Santa Fe, New Mexico. Information: Western States Seismic Policy Council, 121 Second Street, 4th Floor, San Francisco, CA 94105, phone (415) 974-6435, fax 415-974-1747, wsspc@wsspc.org.

September 15–16, 1999 Conference on the Hydrology of the Black Hills, Rapid City, South Dakota. Information: Michael Strobel, U.S. Geological Survey, 1608 Mt. View Rd., Rapid City, SD 57702, phone (605) 355-4560 x247, fax 605-355-4523, mstrobel@usgs.gov.

September 24–26, Deepwater Channel Complexes of the Brushy Canyon Formation, Delaware Mountains, Texas, Annual Field Trip, Texas. Information: PBS-SEPM, P.O. Box 1595, Midland, TX 79702, phone (915) 683-1573, wtgs@basinlink.com.

October

October 3–6, VII International Congress on Pacific Neogene Stratigraphy, Mexico City, Mexico. Information: A. Molina Cruz, Organizing Committee VII RCPNS, Inst. Ciencias del Mar, UNAM, Ap. Post. 70-305, Ciudad Universitaria, Mexico, D.F., 04510, Mexico, amolina@mar.icmyl.unam.mx, fax 525-616-0748.

October 4–9, Tidal Action, Tidal Processes, and Tidal Effects on Coastal Evolution, Porto Seguro, Brazil. Information: Guí Lessa, Laboratório de Estudos Costeiros, Campus Ondina, Salvador (BA) 40210-340 Brazil, phone 55-71-332-6760, fax 55-71-247-3004, www.pppg.ufba.br/~glessa/personal.

October 24–30, Indian Association of Sedimentologists XVI Convention, India. Information: G. M. Bhatt, PG Department of Geology, University of Jammu, Jammu 180 006, India, phone 191-452987, fax 191-450014/432715/453079, elkayem@hotmail.com.

2000 Meetings

February

February 20–24, Annual Meeting of the Environmental and Engineering Geophysical Society, Arlington, Virginia. Information: Jeff Wynn, U.S. Geological Survey, 954 National Center, Reston, VA 20192, fax 703-648-6383, jwynn@usgs.gov.

February 21–24, Fifth International Conference on the Geology of the Arab World, Giza, Egypt. Information: phone (202) 5540593, gaw@orex.org.

February 23–24, Petroleum Systems of Sedimentary Basins in the Southern Midcontinent, Norman, Oklahoma. Information: Kenneth Johnson, Oklahoma Geological Survey, 100 East Boyd, Room N-131, Norman, OK 73019, phone (405) 325-3031, fax 405-325-7069.

May

May 15–18, Geology and Ore Deposits 2000: The Great Basin and Beyond, Reno/Sparks, Nevada. Information: GSN Symposium Editor, P.O. Box 12021, Reno, NV 89510-2021, phone (775) 323-3500, fax 775-323-3599, gsnsymp@nbmg.unr.edu, www.seismo.unr.edu/GSN. *(Abstracts deadline October, 1999.)*

May 30–June 2, International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2000), Calgary, Canada. Information: Raj Singhal, P.O. Box 68002, Crowfoot Postal Outlet, 28 Crowfoot Terrace N.W., Calgary, AB, T3G 1Y0, Canada, phone (403) 241-9460, fax 403-241-9460, singhal@agt.net.

August

August 30–September 1, Geoanalysis 2000: 4th International Conference on the Analysis of Geological and Environmental Materials, Abbaye des Prémontrés, Pont à Mousson, Lorraine, France. Information: Jean Carignan, CRPG-CNRS, 15 rue Notre Dame de Pauvres, B.P. 20, 54501 Vandeouvre-lès-Nancy cedex, France, phone 33-3-83-59-42-17, fax 33-3-83-51-17-98, geoanalysis-2000@crpg.cnrs-nancy.fr.

Send notices of meetings of general interest, in format above, to Editor, *GSA Today,* P.O. Box 9140, Boulder, CO 80301, E-mail: editing@geosociety.org.

The Laurence L. Sloss Award for Sedimentary Geology

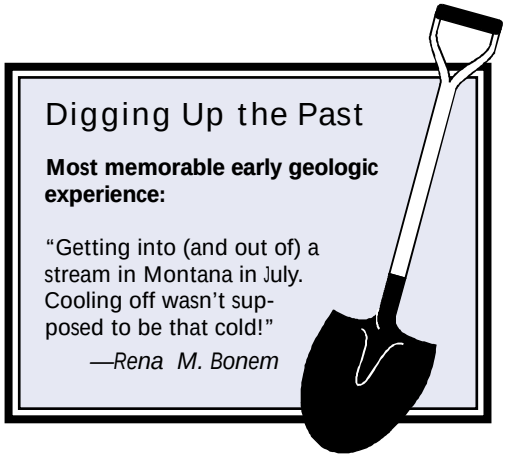
Mark Johnsson, *Chair of the Sedimentary Geology Division*

The Sedimentary Geology Division has established the Laurence L. Sloss Award for Sedimentary Geology, to recognize service to the field and to GSA.

Over the course of his life, Larry contributed greatly to a diverse set of disciplines, including stratigraphy, paleontology, petroleum geology, basin analysis, and evaporite and carbonate petrology. Larry also is perhaps the most deserving candidate for the title "parent of sequence stratigraphy," on the basis of his classic work in defining the megasequences of interior North America. Larry's contributions to GSA also are extensive; in addition to serving on numerous committees, he served as president of GSA in 1980, and was awarded the Penrose medal in 1986. Finally, all those who knew him remember Larry as a warm, personable individual. For all of these reasons, we are pleased to name GSA's premier award for sedimentary geology in honor of Larry Sloss.

The award will be given annually to a sedimentary geologist whose lifetime career achievements best exemplify Larry's lifework. After soliciting nominations from the membership of the Sedimentary Geology Division, the nominations committee has put forward two names to the management board of the division, which has responsibility for choosing the recipient. The first recipient of the Sloss Award will be honored at the GSA Annual Meeting in Denver in October.

The financial component of this award will be supported by an endowment held by the GSA Foundation, which will match initial contributions to this fund to a combined total of $50,000. If you are in a position to help remember Larry through contributing to this fund, please fill out the accompanying coupon, and send your contributions to the GSA Foundation, P.O. Box 9140, Boulder, Colorado 80301. If you have any questions, please call Donna Russell at (303) 447-2020, ext. 154, or you may contact me at (610) 526-5110 or johnsson@brynmawr.edu.



Fund Established in Memory of Desmond Pretorious

Donna L. Russell, *Director of Annual Giving, GSA Foundation*

The GSA Foundation has established the Desmond & Judy Pretorius Fund in memory of Desmond Pretorius, who died in September 1998. The Pretorius Fund will support the new GSA Field Forums program scheduled to begin in 2000.

Desmond Aubrey Pretorius was born in 1925 in Johannesburg, South Africa. He attended the University of Witwatersrand in Johannesburg, earning a B.S. (Engineering) degree, *cum laude,* in mining geology, an M.S.(Engineering) degree, also in mining geology, and a Ph.D. for a study involving the application of quantitative hydrogeology.

Pretorius worked for government geological surveys, mining companies, exploration organizations, private consultants, and international aid schemes throughout eastern and southern Africa, as well as Greece, Egypt, and Iraq. In 1959, he returned to South Africa to head the newly established Economic Geology Research Unit, sponsored by the Chamber of Mines of South Africa and the University of Witwatersrand. Pretorius pioneered the application of quantitative sedimentology in exploration, and his approaches have been applied in paleoplacer gold-uranium districts around the world.

A second major research contribution included his work on the tectonic evolution and framework of southern Africa, improving insight into the metallogeny of this region and the origin of its immense gold, diamond, chrome, platinum group elements, and manganese reserves.

Pretorius held many visiting professorships in the United States and Australia. He received the Corstorphine Medal and the Draper Memorial Medal from the Geological Society of South Africa. In 1981, he was made an Honorary Fellow of the Geological Society of America.

Contributions to the Pretorius Fund can be made to the GSA Foundation. For further information please contact the foundation office, (303) 447-2020, ext. 154. ■

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July *BULLETIN* and *GEOLOGY* Contents

GEOLOGICAL SOCIETY OF AMERICA
BULLETIN
VOLUME 111, NUMBER 7, JULY 1999

GEOLOGY
VOLUME 27
NO. 7
P. 577–672
JULY 1999

CLASSIFIED ADVERTISING

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

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Positions Open

ILLINOIS STATE GEOLOGICAL SURVEY
QUATERNARY GEOLOGIST

Full-time state-supported position to conduct and/or support original research in glacial geology, glacial/ fluvial sedimentology, and geologic mapping; work with a team of geoscientists in mapping 1:24,000-scale quadrangles; conduct topical research in Quaternary geology and surface/subsurface mapping of Quaternary sediments in Illinois. Requires valid driver's license and substantial travel in Illinois for field mapping. Some lifting may be required. Master's degree in geology with 2 years related work experience in Quaternary geology and geologic mapping. Prefer master's degree with 4 years experience, or recent Ph.D. and field experience in 3-dimensional mapping of Quaternary deposits. Salary Range: $29,000–$34,000. Closing date: 8/1/99. For application form, please contact walston@isgs.uiuc.edu or (217) 244-2401, Human Resources, Illinois State Geological Survey, 615 East Peabody Drive, Champaign, IL 61820. AA/EEO/ADA Employer.

DEPARTMENT OF GEOLOGICAL SCIENCES
UNIVERSITY OF TEXAS AT EL PASO
FACULTY POSITION

The Department of Geological Sciences at the University of Texas at El Paso invites applicaitons for an appointment at the rank of associate or full professor in geology to begin as early as January, 2000. A Ph.D. and a demonstrated commitment to teaching and research at both the undergraduate and graduate levels are required.

We seek applicants whose research interests complement existing research programs in petrology, sedimentology, environmental geology, paleontology, remote sensing, geochemistry, mineral deposits, and geophysics. The specialization is open; however, we are particularly interested in those with track records in the application of remote sensing and GPS techniques to geological problems. The successful applicant would be expected to teach introductory courses in geology as well as upper division undergraduate and graduate courses in his/her specialty.

El Paso, located on the Mexican border within the Rio Grande rift, provides one of the most diverse and striking geological settings in the world. The department is housed in an attractive 90,000 sq. ft. building that contains faculty and student offices, laboratory and classroom space with analytical facilities that include: electron microprobe, DCP, ICPMS, INAA, counter, XRD, geophysical field equipment and extensive computing facilities. More information about the activities and facilities in the department can be found at our web site: http://www.geo.utep.edu.

Applicants should send a CV, a short description of teaching and research interests and the names of three people willing to provide professional references to: Kate C. Miller, Chair, Deparment of Geological Sciences, University of Texas at El Paso, El Paso,TX 79968-0555, phone: (915) 747-5424, fax 915-747-5073, e-mail: miller@geo.utep.edu.

We will begin reviewing applications on September 15, 1999, and will accept applications until the position is filled.

The University does not discriminate on the basis of race, color, national origin, sex, religion, age, or disability in employment or the provision of services.

AUBURN UNIVERSITY

The Department of Geology at Auburn University, Alabama, has a temporary instructorship available for the three quarter period beginning September 16, 1999, and ending June 15, 2000. The successful candidate will be required to teach two introductory-level geology courses per quarter and to coordinate the teaching of introductory labs with graduate teaching assistants. A master's degree is required; Ph.D. preferred. A letter of application, current vitae and the names and addresses of three references should be sent to: Robert B. Cook, Department of Geology, 210 Petrie Hall, Auburn University, AL 36849. Review of applications will begin on June 15, 1999, and continue until a candidate is chosen for appointment. For additional information call (334) 844-4891 or e-mail cookrob@mail.auburn.edu. Auburn University is an affirmative action/equal opportunity employer. Women and minorities are encouraged to apply.

PRINCIPAL GEOLOGIST
ENVIRONMENTAL GEOLOGY PROGRAM
MARYLAND GEOLOGICAL SURVEY

The Maryland Geological Survey, an agency of the Maryland Department of Natural Resources, is seeking a Principal Geologist to serve as Program Chief in its Environmental Geology Program. The program comprises three elements: small watersheds, applied geology (geologic mapping and geologic factors affecting land modification) and the Earth Science Information Center. The responsibilities of this position include managing the scientific, fiscal, personnel and administrative matters of a statewide program; planning & supervising activities of the Program's elements, preparing proposals for intergovernmental projects (e.g., USGS-STATEMAP, FEMA, MD SHA); conducting environmental geology studies (stratigraphy/sedimentary geology preferred specialty area); coordinating projects & planning with other DNR, State, County and Federal agencies and collaborating with them as opportunities emerge. Computer skills including GIS and mapping concepts are essential. The successful candidate will possess a Master's Degree in geology or a related field of earth science with six (6) years experience as a practicing geologist of which two (2) years will have been of a scientific administrative and/or scientific supervisory nature.

The salary range for this position is $40,633–$61,468 plus an attractive benefit package which includes paid annual, personal & sick leave, health care and retirement.

The closing date for receipt of resume and/or applications is September 15, 1999. Qualified applicants may obtain a State of Maryland employment application by contacting Jeanne Gary, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, Maryland 21218. Voice (410) 554-5511, Fax 410-554-5502, e-mail jgary@mgs.state.md.us.

POSTDOCTORAL OPPORTUNITIES, USGS

The U.S. Geological Survey, Geologic Divison, is conducting a national competition to find outstanding scientists, who have recently completed doctorate-level research, to fill contractural positions as Guest Research Associates in the following areas of research: Sediment Transport Modeling; Coastal and Near-Shore Erosion; Marine Environmental Geochemistry; Integrated Information Management; Interdisciplinary-Statistical Analysis; Economics; Carbon Sequestration; Basin History; Economic Geography; Hydrocarbon Generation Modeling; Clastic Sequence Stratigraphy; Geology Impacts on Human Health; Organic Geochemistry/Biogeochemistry; Multi-Spectral Remote Sensing of Earth Surface Materials; Seismic Source Parameters; and Instrumentation and Data Analysis of Building for Seismic Engineering. Possible locations: Denver, CO; Pasadena, CA; Woods Hole, MA; Reston, VA; Newark, DE; and St. Petersburg, FL.

Applicants should be outstanding scientists who have recently completed doctoral-level research and have a record of demonstrated ability or outstanding potential for basic and applied research. Compensation will be in fixed weekly stipends for the geographic area in which they work. Approximate stipend amounts are as follows: Reston, VA $1,013.00; Denver, CO, $1,026.00; Woods Hole, MA; Pasadena, CA, Newark, DE, and St. Petersburg, FL $995.00. Awardees are offered a services contract initially for 12 months and may be extended for 1 year upon availability of funds and management recommendation. Application Deadline, July 16, 1999.

For more information about the program and the application materials required, complete details are provided in the Guest Research Associateship Program Announcement which is available on the web at http://geology.usgs.gov/postdoc/ or you may call (703) 648-6630 to request a copy.

The U.S. Geological Survey is an equal opportunity employer. Qualified applicants will receive consideration without regard to race, creed, color, age, sex, national origin, political preference, labor-organization affiliation or non-affiliation, marital status, or non-disqualifying handicap.

Classifieds *continued on p. 30*

July *BULLETIN* and *GEOLOGY* Contents *(continued)*

PROFESSOR OF GEOLOGY
SEMESTER AT SEA, UNIVERSITY OF PITTSBURGH

Visiting lecturer for one semester only (100 days). Teach three undergraduate courses on shipboard campus comprising approximately 650 students, 25 faculty, 15,000 volume core library. Applications requested from faculty with Ph.D. and in tenure-track position who can demonstrate excellence in undergraduate teaching. Preference given to candidates with resident field experience in at least one of the countries on the intinerary. Now hiring for Winter/Spring 2000 (Venezuela, Brazil, South Africa, Kenya, India, Vietnam, Malaysia, China, Japan) and Fall 2000 (Japan, China, Malaysia, Vietnam, India, Egypt, Israel, Turkey, Morocco). Salary $7,000 plus $700 travel allowance. Up to three family dependents can accompany for a maintenance fee of $1850 each. For application please write to Chief Academic Officer, Semester at Sea, William Pitt Union 811, University of Pittsburgh, Pittsburgh, PA 15260.

HEAD, DEPARTMENT OF GEOLOGY
UTAH STATE UNIVERSITY

Applications are invited for the position of Head of the Department of Geology at Utah State University. The successful candidate is expected to have an outstanding record of research. Applicants must have a doctorate in the geosciences, must qualify for a full professorship, should have excellent teaching credentials, and an established record of University and professional service. This is a 12-month, full professor position. Applications from qualified women and minorities are encouraged. Utah State University is a Carnegie I Land-Grant Institution. The Department of Geology offers the M.S. degree in Geology and four degree programs at the bachelor level. Excellent physical facilities for teaching and research, a vigorous faculty, and proximity to world-class geology are key attractions of this position. Candidates will be expected to teach upper division/graduate level courses in their area of expertise. Preference will be given to candidates with experience teaching undergraduate courses in mineralogy, optical mineralogy, and/or igneous and metamorphic petrology. Applicants should submit a letter of application, curriculum vitae, statements of teaching and research interests, and administrative philosophy, and the names of five references to: Dr. Susanne U. Janecke, Chair of Screening Committee, Department of Geology, Utah State University, Logan, UT 84322-4505. For a full description of this position refer to http://www.usu.edu/~geoldept. Application Deadline: Screening of applications will begin on September 15, 1999, but applications will be accepted until a pool of qualified candidates is identified. Utah State Univeristy if an affirmative action equal opportunity employer.

SENIOR MANAGER / HEAD
INFORMATION DELIVERY GROUP

The Illinois State Geological Survey is seeking an outstanding leader to administer its Information Delvery Group of 40 scientists and support staff, having expertise in GIS, publications, graphic arts, photography, computing, library and public information, and geoscience education and outreach. Must be a proactive, creative individual who can facilitate effective communicaiton with the public, education community, industry, agencies, and the scientific community. Broad knowledge of scientific information delivery; experience producing and distributing scientific information through a variety of media; ability to develop and use marketing plans; understanding of modern information/data management systems; creativity in interpreting science for lay audiences. Preferred: Ph.D. with 20 years experience in geology or related scientific field, or in communications, information management, or marketing, including supervisory experience; successful communication and marketing of scientific products. Individuals with less experience, but otherwise exceptional qualifications, will be considered. Includes excellent health benefits and University of Illinois staff privileges. closing date: 8/16/99 or until a suitable candidate is found. For an application form, contact walston@isgs.uiuc.edu or (217) 244-2401, Human Resources, Illinois State Geological Survey, 615 East Peabody Drive, Champaign, IL 61820. AA/EEO/ADA Employer.

SENIOR MANAGER / HEAD
ECONOMIC GEOLOGY GROUP

The Illinois State Geological Survey is seeking an outstanding scientist/manager of national stature to oversee research and service programs in sedimentary and crustal processes, coal, oil and gas, industrial minerals, geochemistry, energy and environmental engineering, and resource economics. Will lead multi-disciplinary programs, attract soft money, effectively communicate scientific results to the public, industry, and government, and have strong personnel skills. The Economic Geology Group, one of three scientific groups, includes 50 scientists and support staff and is a key element of the ISGS program. Required: Ph.D. and 14 yrs or master's degree and 17 yrs experience in geological science with emphasis in geologic resources and both research and managerial experience. Preferred: Ph.D. and 20 years experience in geological science with emphasis in geologic resources research with extensive managerial experience/training. Includes excellent benefits and University of Illinois staff privileges. Closing date: 8/16/99 or until a suitable candidate is found. For an application form, contact walston@isgs.uiuc.edu or (217) 244-2401, Human Resources, Illinois State Geological Survey, 615 East Peabody Drive, Champaign, IL 61820. AA/EEO/ADA Employer.

FACULTY POSITIONS IN ATMOSPHERE, OCEAN, CLIMATE DYNAMICS AT YALE UNIVERSITY

The Department of Geology and Geophysics at Yale University announces a search for several ladder faculty positions in the general area of atmosphere, ocean, and climate dynamics. We seek both junior and senior applicants with records of creative research in subject areas that improve understanding of modern atmospheric and oceanic processes and/or the evolution of the earth's climate on geologic time scales. Areas of special interest include atmosphere/ocean modeling; climate-system modeling; coupled air-sea interaction; dynamical meteorology and oceanography; glaciology; hydrology; remote sensing; and the physics, dynamics, and chemistry of clouds. New appointments at Yale in these areas will contribute to a broad emphasis in the Department on paleoclimatology, paleo-environments, and global change. Additional appointments in the Department will be made in areas of active tectonics and geomorphology, geochemistry, paleontology, and solid-earth geophysics. Closing date for applications is September 30, 1999.

We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of professional goals, and the names and addresses of three or more referees to:

AOCD Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

FACULTY POSITIONS IN GEOCHEMISTRY
AT YALE UNIVERISTY

The Department of Geology and Geophysics at Yale University is starting a new multidisciplinary hiring initiative in earth science, which will include several ladder faculty appointments in the general area of geochemistry, starting as early as January, 2000. We invite applications from both junior and senior-level candidates who will develop internationally recognized research programs in collaboration with present and future Yale geoscientists. The positions will include teaching at both the undergraduate and graduate levels. All subfields will be considered, including, but not limited to: biogeochemistry, earth surface chemical processes, experimental geochemistry, mantle geochemistry, organic geochemistry, radiogenic and stable isotopes, and theoretical geochemistry. Closing date for applications is September 30, 1999.

We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of professional goals, and the names and addresses of three or more referees to:

Geochemistry Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

FACULTY POSITIONS IN SOLID-EARTH GEOPHYSICS
AT YALE UNIVERSITY

The Department of Geology and Geophysics at Yale University is starting a new multidisciplinary hiring initiative in earth science, which includes a major expansion in solid-earth geophysics. To this end, we intend to fill several ladder faculty positions in solid-earth geophysics, either at the junior or senior level, starting as early as January 2000. We invite applicants who will develop internationally recognized research programs in collaboration with present and future Yale geoscientists. The positions will include teaching at both the graduate and undergraduate levels. All subfields of solid-earth geophysics will be considered, including, but not limited to: geodesy, geodynamics, geomagnetism, mineral physics, rock and earthquake mechanics, and seismology. Closing date for applications is September 30, 1999.

We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of professional goals, and the names and addresses of three or more referees to:

Solid-Earth Geophysics Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

FACULTY POSITION IN ACTIVE TECTONICS AND GEOMORPHOLOGY AT YALE UNIVERSITY

The Department of Geology and Geophysics at Yale University announces a ladder faculty position, at either the junior or senior level, in the general area of active tectonics and geomorphology, starting as early as January 2000. This position is part of a broad multidisciplinary hiring initiative in earth sciences at Yale, including the areas of the dynamics of the oceans, atmospheres, and climate; geochemistry; solid-earth geophysics; and paleontology. For the active tectonics and geomorphology search, we are particularly interested in finding candidates who relate the evolution of landforms to the forcing caused by tectonic and climate processes. We also welcome applications from related fields, including but not limited to: geodynamics of landscape evolution, paleoseismology, structural geology, and tectonics. The successful candidate is expected to develop an internationally visible research program, and teach at both the graduate and undergraduate levels.

The closing date is September 30, 1999. We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of professional goals, and the names and addresses of three or more referees to:

Geomorphology Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

FACULTY POSITION IN PALEONTOLOGY
AT YALE UNIVERSITY

The Department of Geology and Geophysics at Yale University is starting a new multidisciplinary hiring initiative in earth science, which includes strengthening of its program in paleontology. To this end, we intend to fill a ladder faculty position in paleontology, at either the junior or senior level, starting as early as January 2000. We invite applicants who will develop an internationally recognized research program in collaboration with present and future Yale geoscientists and bioscientists. The position will include teaching at both the graduate and undergraduate levels. All subfields of paleontology will be considered, including but not limited to: biogeochemistry, biostratigraphy, event stratigraphy, evolutionary processes, functional morphology, macroevolution, origin of major groups/body plans, marine paleoecology, mass extinctions, paleobiogeography, paleoenvironmental analysis, systematics, or taphonomy. Closing date for applications is January 15, 2000.

We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of professional goals, and the names and addresses of three or more referees to:

Paleontology Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

VISITING FACULTY POSITIONS IN EARTH SCIENCES
AT YALE UNIVERISTY

The Department of Geology and Geophysics at Yale University announces the opening of several visiting faculty positions, starting as early as September 1, 1999. Applicants from all areas of earth science and all career levels are welcome to apply. The visiting positions are part of a major hiring initiative in earth sciences at Yale focused on rebuilding the size and strength of the department. We are

looking for individuals who would enjoy contributing and interacting in a broad multidisciplinary department that includes active programs in atmospheres, oceans and climate; geochemistry; petrology; solid-earth geophysics; paleontology and evolutionary theory; and tectonics. The successful applicant would be expected to conduct an active research program, to interact with students and faculty, and to teach one course or seminar per semester with the topic to be negotiated. The duration and scope of the visit are negotiable as well. Applications will be considered as they arrive.

We encourage applicants from historically disadvantaged ethnic, racial, and gender categories. Yale University is an equal-opportunity employer. Applicants should send a curriculum vitae, a statement of objectives for the visit, and the names and addresses of three or more referees to:

Visiting Faculty Search Committee, c/o Professor Danny Rye, Chair, Department of Geology and Geophysics, Yale University, P.O. Box 208109, New Haven, CT 06520-8109.

GEOLOGY/ENVIRONMENTAL STUDIES
RICHARD STOCKTON COLLEGE, NEW JERSEY

One-year appointment as half-time Visiting Instructor (M.S.) or Assistant Professor (Ph.D.), September 1999. Teach Mineralogy and its lab, and one Physical Geology lab in the fall, and Petrology and one Physical Geology lab in the spring. Interest in low-temperature geochemistry and/or remote sensing a plus. Field orientation of the program requires significant field experience. Richard Stockton College is a 5000-student undergraduate institution in the New Jersey Pine Barrens; Salary: $14,745-$20,612, may be higher depending on qualifications, experience, and increases in the appropriately established compensation plan. Screening begins immediately. Send letter of application, resume, and three letters of recommendation and evidence of completion or expected date of completion of Ph.D. to Lynn Stiles, Dean of Natural Sciences and Mathematics, Richard Stockton College of New Jersey, P.O. Box 195, AA66, Pomona, New Jersey 08240. Stockton is an AA/EOE. Women and minorities are encouraged to apply. R905254.

FLUVIAL GEOMORPHOLOGIST
GOMEZ AND SULLIVAN ENGINEERS

Gomez and Sullivan Engineers, P.C., an engineering and environmental science firm with offices in Utica, NY and Dunbarton, NH, has an immediate opening for a fluvial geomorphologist in our new Portland, OR area office. The successful candidate will have 5–12 years experience in geomorphology as it relates to aquatic ecology including channel forming processes, sediment transport, gravel bar deposition, stream bank erosion and mitigation, watershed analysis and instream flow regimes. FERC licensing experience, an ability to use GIS as an analytical tool, and a desire to develop new markets in natural resources GIS are also a plus.

Applicants should provide a resume, 3 references, salary history, and a writing sample (5 pages or less) to: Thomas J. Sullivan, P.E., Gomez and Sullivan Engineers, P.C., 150 Concord Stage Road, Dunbarton, NH 03045, Phone: (603) 774-3323, Fax: 603-774-3324, e-mail: tsulli6683@aol.com. Gomez and Sullivan Engineers, P.C. is an Equal Opportunity Employer.

FACULTY POSITION / DEPARTMENT OF GEOLOGY
UNIVERSITY OF MARYLAND, COLLEGE PARK

The Department of Geology at UM is searching for a tenure-track faculty member who has made funadmental contributions in the application of geochemistry to understanding Earth processes. We seek an outstanding scientist whose research interests could be in trace element and/or isotope geochemistry.

Research strengths in the Department of Geology are in the broad areas of mineralogy, petrology and geochemistry, in particular of granites and associated mineralization; hydrological processes and integration of geomorphology, hydrology and ecology to understand surface environments; and, isotope geochemistry in support of these areas and in mantle geochemistry, meteoritics, tectonics, carbonate diagenesis, sediment cycling, geochronology, stratigraphy and paleoclimate studies. The Department of Geology encourages interdisciplinary approaches to the study of the Earth and participates in the Earth System Science Interdisciplinary Center. This new Center has been formed through collaboration between the University of Maryland and NASA's Goddard Space Flight Center to advance fundamental knowledge about the earth system through preeminent research and teaching programs.

The Department expects to fill this position by the beginning of the Spring Semester 2000 or as soon as possible thereafter, most likely at the rank of Assistant Professor. Salary will be commensurate with experience. The appointee is expected to develop and maintain an active, externally-funded research program, to direct graduate students, and to participate fully in teaching at the graduate and undergraduate levels, including courses in the introductory non-major program.

The University of Maryland is an affirmative action/equal employment opportunity employer. Applications should be submitted by September 20, 1999 for best consideration and should be submitted to: Chair, Search Committee, Department of Geology, University of Maryland, College Park, MD 20742, USA. Applicants should provide a statement describing research and teaching interests, indicating how s/he envisons contributing to the Department's research and teaching activities, and a signed current curriculum vitae. Applicants should arrange to have a minimum of four letters of recommendation sent directly to the Chair of the Search Committee before September 20, 1999. The Search Committee encourages applicants to submit copies of up to two recent publications in support of their candidacy.

PROFESSOR AND DIRECTOR OF THE
INSTITUTE FOR CRUSTAL STUDIES

The Department of Geological Sciences at the University of California at Santa Barbara invites applications for a tenured position at the full professor level, with 50% in Geological Sciences and 50% as full-time Director of the Institute for Crustal Studies (ICS). Appointment will commence July 1, 2000 or sooner, for an initial period of 5 years. After being Director of ICS the appointment will become 100% in Geological Sciences.

We seek an internationally recognized scholar who conducts quantitative research in solid earth structure and processes in areas such as (but not limited to): tectonic geomorphology, geomechanics, geodesy, and crustal seismology. The appointee to this position is expected to develop a strong, well-funded research program, supervise graduate students, and teach undergraduate and graduate courses on various aspects of active tectonics.

The ICS Director leads an organization with about eight staff members and about 40 Principal Investigators whose research activities focus on seismology, neotectonics, petrology, tectonic evolution of the Earth, and vadose zone monitoring of contaminants. We seek an applicant who will complement existing programs in Geological Sciences and foster multidisciplinary research with related programs at UCSB, e.g., in geography, materials science, and physics. The ICS portfolio includes approximately 55 research projects totaling about $6M. Administrative or project leadership experience is desirable.

The preferred deadline for applications is July 15, 1999; however, applications will be considered until the position is filled. Please submit curriculum vita, statement of research, teaching, and administrative experience, along with the names of three references to: Professor Ralph Archuleta, Search Committee Chairman, Acting Director, Institute for Crustal Studies, Department of Geological Sciences, University of California, Santa Barbara, CA 93106-9630.

UCSB is an equal opportunity/affirmative action employer.

Park Service Interns Serve for Summer

The GSA Institute for Earth Sciences and the Environment has placed ten interns in U.S. national parks for the 1999 summer season. They are:

Sarah Spradlin	Capitol Reef National Park, Utah
Ann Tillery	Craters of the Moon National Monument, Idaho
Nichole Alhadeff	Denali National Park and Preserve, Alaska
Kelly Newman Moore	Florissant Fossil Beds National Monument, Colorado
Susan Joy	Fossil Butte National Monument, Wyoming
Kevin Casey	Great Sand Dunes National Monument, Colorado
Lindy London	Lake Roosevelt National Recreation Area, Washington
Matt Swanson	Mount Rainier National Park, Washington
Mary Barnes	Oregon Caves National Monument, Oregon
Karrie Karpinski	Sleeping Bear Dunes National Lakeshore, Michigan

The interns are spending the summer working in the parks on various duties such as interpreting and visitor education services, geology assistance, and paleontology assistance. All the interns except two are funded by Shell Oil Company. The two at Denali and Sleeping Bear Dunes are funded through the GSA Foundation's John F. Mann fund.

See the IEE section of the GSA Web site for details (http:///www.geosociety.org/science/nps.htm). If you would like more information on internship opportunities, contact Stacey Ginsburg at 303-447-2020, ext. 194 or email sginsburg@geosociety.org. ■

Consultants

Global Geological Services is experienced with geological consulting to domestic and foreign, Engineering, Geotechnical, and Environmental projects. For information on services, contact by email: globgeosrv@aol.com or fax: 909-735-9908.

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SCEPTER QUARTZ CRYSTALS -- LIMITED EDITION PRINT. Traditional scientific illustration, geological art. Lorena Babcock Moore, (307) 772-0559. e-mail: ironwing@earthlink.net. Website: home.earthlink.net/~ironwing/artwork.html.

Opportunities for Students

Graduate Student Opportunities in Earth Sciences, Lehigh University. The Department of Earth and Environmental Sciences of Lehigh University has Graduate Student Fellowships for highly qualified individuals. The department has active research programs in tectonic studies (geochronology, stable isotope geochemistry, low temperature geochemistry, reflection seismology, structural geology, paleomagnetism) and surficial processes (low temperature geochemistry, geomorphology, glacial geology, hydrology, and limnology). Please contact Prof. D. Morris, Dept. of Earth and Environmental Sciences (dpm2@lehigh.edu) or see our Web page for more details (http://www.lehigh.edu/~inees/inees.html).

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October 25–28, 1999

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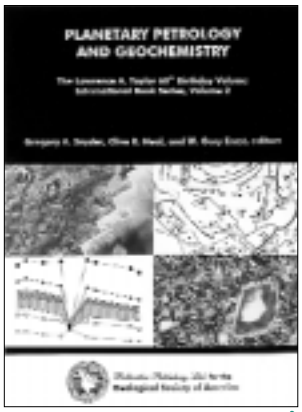
Planetary Petrology AND Geochemistry

The Lawrence A. Taylor 60th Birthday Volume



edited by G. A. Snyder, C. R. Neal, W. G. Ernst, 1999

Papers ranging from Earth to the Moon — and stops between — make this a broad-spectrum volume. The breadth of topics covered in the 17 papers is a reflection of Taylor's interests over the years, from lunar petrology and geochemistry, to mantle xenoliths and diamonds, to Martian meteorites and the evolution of the solar system.

Notable in the first section, The Earth, is a paper by Nick Sobolev on the largely overlooked significance of eclogitic diamonds. A second paper, by Joe Boyd, is an overview of major-element considerations on the evolution of peridotites. Other papers in this section discuss topics relating to mantle xenoliths, kimberlites, continental basalts, layered mafic intrusions, and mineral-melt, trace-element, partition coefficients. The Moon section includes contributions by Alex Ruzicka and co-workers on the ultimate origin (giant impact vs. fission) of the Moon as determined by a critical review of refractory element analyses, by Wayne Premo and co-workers on the Pb isotopic evolution of the lunar crust, and by Brad Jolliff on the significance of liquid immiscibility as a major mode of differentiation on the Moon. Other papers in this section discuss isotopic and mineralogic evolution of breccias and the petrologic evolution of the lunar crust. The third section, Meteorites and Planets, consists of three notable papers: Carle Pieters on the spectral effects of space weathering, Hap McSween (with Ralph Harvey) on a low-temperature evaporation model for carbonate formation in the famous Martian meteorite ALH84001, and Tezer Esat and Ross Taylor on isotopic fractionation in the solar system. If you study terrestrial or extra-terrestrial rocks of igneous origin, this book should be on your shelf.

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