

GSA TODAY

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A 195 Ma Terrane in a 165 Ma Sea: Pacific Origin of the Caribbean Plate

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ABSTRACT

Tectonic models purporting to describe the origin of the Caribbean plate can be divided into two broad categories conflicting on the point of in situ origin vs. genesis in the Pacific realm followed by eastward transport relative to the American plate. Important elements of Caribbean geology including Cayman Trough spreading, the presence of the Lesser Antilles and Aves volcanic arcs, incompatible crustal juxtapositions, complicated plate geometry, truncated structural trends,

fossils that originated at higher latitudes, and a lengthy geologic record of eastward progression strongly suggest allochthonous origin. However, none of these is conclusive proof.

The discovery of a Caribbean plate island terrane significantly older than the Caribbean Sea assures that in situ models are incorrect. The Bermeja Complex of southwestern Puerto Rico, located on the northeastern corner of the Caribbean plate, exposes Lower Jurassic chert. Deposited on a deep ocean floor, radiolarian chert from the Bermeja is late Pliensbachian (~195 Ma)

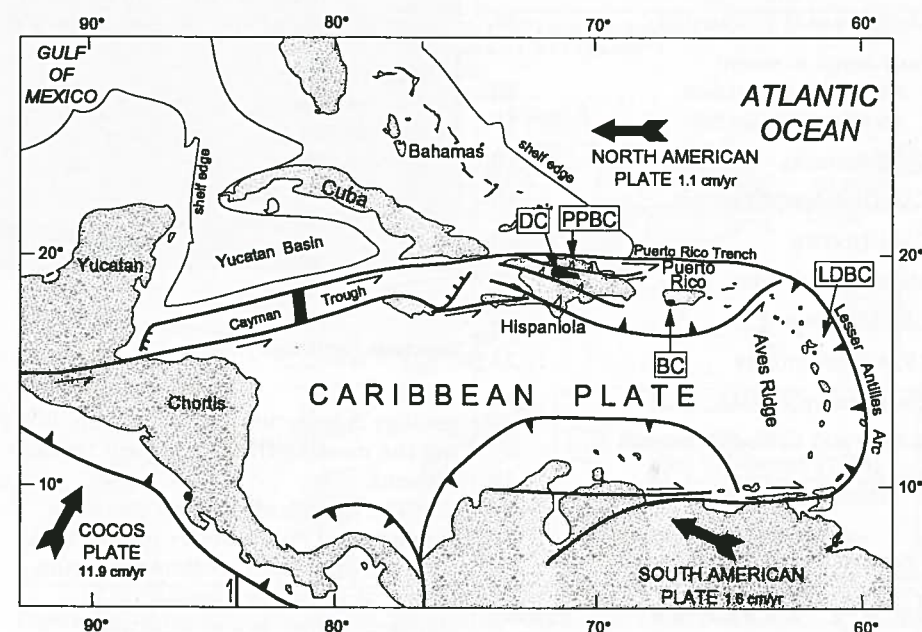


Figure 1. Geography of the Caribbean region. BC—Bermeja Complex, Puerto Rico; DC—Duarte Complex, Hispaniola; PPBC—Puerto Plata basement complex, Hispaniola; LDBC—La Désirade, Guadeloupe. Plate motions and velocities are after Mann et al. (1991).

in age, predating an open marine connection between the North Atlantic and the Pacific by ~30 m.y.

INTRODUCTION

The origin of the Caribbean plate, a small plate intruding into the much larger Atlantic plate (Fig. 1), has remained a subject of intense contro-

versy since the inception of plate tectonics. Did the Caribbean plate form more or less in place or was it entirely engulfed by large-scale westward movement of the Americas? Several plate-tectonic models interpreting the tectonic evolution of the Caribbean, such

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Thanks, Boston, for a Magnificent Meeting—6452 Attend

by Sandra Rush, Communication Consultant

Boston was a perfect host city for the 106th annual meeting of the Geological Society of America. We were treated to a week of perfect weather,

and even the foliage stayed on the trees longer than usual, so that two weeks after the colors peaked, we still enjoyed a dazzling palette. Of course,



This field trip stop at Nahant Island, East Point, Boston Harbor, affords a view of the Lower Cambrian Weymouth Formation, composed of nodular mudstone and limestone, with intrusions of Ordovician Nahant Gabbro and numerous mafic dikes.

the Annual Meeting Committee, headed by General Chairman James W. Skehan, S. J., helped to make this meeting truly enjoyable with one of the most diverse and scientifically compelling technical programs we've seen.

It wasn't surprising that Boston turned out to be a well-attended meeting—6452 registrants—second only to the 1988 Centennial Celebration in Denver (7478 registrants). Of the 2349 abstracts accepted for this meeting, 615 were presented in 40 theme sessions and 254 in 25 symposia—a real logistical challenge to fit into the four-day meeting agenda. The range of topics was diverse, as usual, with an underlying theme of geological awareness related to health, education, environment, and other current public issues.

Field trips before, during (half-day), and after the meeting took advantage of the wealth of New England geology from the Atlantic Ocean to the White Mountains, from Connecticut to Maine, among some of the most picturesque environments in the nation. The spectacular, no-overcoat weather enhanced not only the field trip program, but also the guest tour program. All tours were filled to capacity as guests and their guests went bird watching, museum hopping, and investigating the nearby historic communities of the second-best-known "city by the bay."

Special Sessions Look Into Current Issues

But Boston's scenic setting, enhanced by its harbor, does not immediately reveal the environmental problems the harbor presents. The second Annual Environmental Forum, held Sunday afternoon and cosponsored by the GSA Institute for Environmental Education (IEE) and the GSA Geology and Public Policy Committee, addressed the cleanup of Boston Harbor and the effect of this cleanup on Massachusetts Bay. This topic is a locally controversial one, as the court-mandated plan to clean up the harbor involves discharging sewage effluent through a new ocean outfall into the bay, with as-yet-undetermined effects. Each year at the Annual Meeting, the environmental forum addresses issues involving effects on the environment and public policy of the meeting site.

Monday's keynote symposium focused on the highly dependent connection between human health and the environment, and linked health directly to the geological sciences. The symposium identified solutions to health-related geologic problems and the prudent use of geologic assets to ensure that future generations will have adequate natural resources and a nontoxic environment. The health and

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1993 Boston Annual Meeting Statistics

Technical Program

Abstracts submitted	2502
Abstracts presented	2357
Abstracts rejected or withdrawn	145
Percentage of abstracts accepted	94%
Poster presentations (including theme posters) ..	625
Oral presentations	1732
Oral presentations, discipline sessions	922
Oral presentations, theme sessions	548
Oral presentations, symposia	262
Highest number of concurrent oral sessions	16

Registration

Professional	3525
Student	1872
Exhibitor	729
Guest	326
Total attendance	6452

Short Courses

Number of GSA-sponsored courses	11
Participants	379

Field Trips

Half-day trips	3
Participants	183
One or more days	17
Participants	502

Exhibits

Number of booths	244
Number of exhibitors	164

Employment Service

Applicants	167
Employers	20
Interviews	272
Positions available	32

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geology connection was carried on during the meeting through several theme sessions.

The nineteenth in GSA's series of Geology and Public Policy forums took place on Tuesday. This time the forum looked at geoscience legislation in Congress, which is a more visible entity, thanks to C-Span. Some of the legislation recently enacted or pending in the Congress is of critical importance to the geoscience community, especially if it wants to play an active role in high-level decision making. This excellent forum was followed by a special session in which the current GSA Congressional Science Fellow reported on her experiences on the Hill and detailed how scientists can provide expertise to the Congress.

Although the Mississippi River flood of 1993 occurred after the GSA abstract deadline, a special session was co-convened by three of GSA's divisions on Wednesday evening. This provided a rare and exciting opportunity to hear from current investigators and to view video and remote sensing imagery of the floodplain of the Mississippi-Missouri river drainage. The three-hour session was the largest of the technical sessions with more than 1000 geoscientists attending.

Educational Outreach Proves Challenging

Several major programs were offered for college students and secondary school teachers. An important

adjunct to the exhibit booths, for example, was the Science Classroom of the Future, which provided direct contact between educators and technology developers, manufacturers, and distributors. Hands-on participation in conjunction with the Science Classroom provided an opportunity not only for the teachers and school administrators at all levels to learn what was available, but also for the technologists to hear what was needed in classrooms. Instructional and research software was demonstrated, and users were able to connect to Ethernet and Internet and to upload to their home systems. The Science Classroom of the Future was made possible through an arrangement with the Department of Geology and Geophysics at Boston College, and through the courtesy of IBM and the Annenberg/CPB Project.

The Science Classroom plus many other presentations attracted 151 K-12 educators from as far away as California. Four simultaneous earth science workshops occupied the Saturday before the meeting. Field trips, symposia, and workshops held later in the week included such informative offerings as: (1) an Earth Science Information "Share-A-Thon," at which teacher-developed and classroom-tested earth science materials and activities were shared by their creators with other teachers, (2) the Annenberg/CPB Project-sponsored workshop on using video in earth science classrooms, and (3) excursions to study the geology in the Boston area as well as to learn about marine and glacial field techniques at Cape Cod. The K-12 pro-

grams were sponsored by the GSA SAGE Program, the Annual Meeting K-12 Committee, the National Association of Geology Teachers, and the National Marine Educators Association.

In an effort to make the meeting accessible for local students, a special \$10 undergraduate preregistration fee was offered to all four-year geology programs in GSA's Northeastern Section. A total of 351 undergraduates took advantage of this unique offer. In addition, the third annual Top Senior Program had 34 undergraduate participants from across the country. GSA provided lodging, registration, local transportation, and an abstracts volume for these students. The participating schools, which nominate their top senior, provided transportation to the meeting as well as an optional daily stipend. Boston College hosted a Top Senior field trip of the Boston Basin and a tour of Weston Observatory, a geophysical station in the World-wide Seismic Network. The Top Senior Reception, sponsored by Springer-Verlag, gave the students a chance to meet and talk with leading geologists and authors.

More than 200 student assistants, both graduate and undergraduate, provided much-needed support throughout the meeting. These students each worked 10 hours in various assignments, for which they received wages, free registration, and an abstracts volume.

In addition, the Graduate School Information Forum provided an

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GSA CONTINUING EDUCATION NOTES FOR SALE

Limited supplies of the following short-course manuals/notes remain available from the Cincinnati and Boston Annual Meetings. These may be ordered, while supplies last, through GSA Publication Sales.

1993

SCN020: *GIS and the Geosciences*, by Richard L. Bedell, Jr. \$16.50 net

SCN021: *Asia: A Continent Built and Assembled Over the Past 500 Million Years*, by Kevin Burke and A. M. Celal Şengör \$27.75 net

SCN022: *Contaminant Hydrogeology: Practical Monitoring, Protection, and Cleanup*, by Christopher M. Palmer and Jeffrey L. Peterson ... \$27.75 net

SCN023: *Fracture Mechanics of Rock*, by Terry Engelder, Michael R. Gross, and Mark P. Fischer \$22.75 net

SCN024: *Alternative Pedagogies in Geological Sciences: A Workshop*, by Ann Bykerk-Kauffman, Lauret E. Savoy, and Jill Schneiderman \$13.50 net

SCN025: *Application of Sedimentological Information to Hydrogeological Problems*, by Erik K. Webb \$11.50 net

SCN026: *Computer Mapping at Your Desk that Really Works*, by Russell A. Ambroziak, Grant R. Woodwell, and Renee E. Wicks \$16.50 net

SCN027: *Environmental/Engineering Geology and Land-Use Planning—An Interface Between Science and Regulations*, by Charles W. Welby, Jerome V. DeGraff, and Rhea L. Graham \$16.50 net

Prices include shipping and handling; GSA Member discount does NOT apply. on 1993 editions Prepayment is required (check, major credit card, or money order in U.S. funds on U.S. bank).

1992 (still available)

SCN002: *Paleosols for Sedimentologists*, by Greg H. Mack and Calvin James, 1992 \$18.75

SCN004: *Phase I Preliminary Site Assessments*, by Jeffrey L. Peterson, 1992 \$18.75

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as that of Burke et al. (1984), relied on a Pacific origin for Caribbean terranes. A lightning rod for offbeat theories, the origin and development of the Caribbean plate have attracted numerous enduring alternative hypotheses based on the concepts of geosynclines, expansion, contraction, and mantle surge, all apparently attempting explanation without including plate tectonics. Antithetical ideas are well contrasted in sequential papers by Pindell and Barrett (1990) and Morris et al. (1990).

The Caribbean plate is a mosaic of poorly dated, over-thickened, oceanic, continental, intermediate, and accretionary crust that somehow filled the spreading gap between North and South America. The Caribbean plate collage is separated from adjoining plates by subduction zones on the east and west and by regions of strike-slip faulting along the north and south. Pindell (1990) presented seven arguments for a Pacific origin for the Caribbean plate. Additional stratigraphic and faunal data suggesting Pacific origin were also presented by Schellekens et al. (1990) and Montgomery et al. (1992). Given extensive justifications for the allochthonous nature of the plate, much, but certainly not all, of the work of the last decade has converged on a Pacific origin. In addition, broad plate-tectonic scenarios modeling the U.S. Cordillera and Tethys (Moore, 1970) and mantle flow models (Alvarez, 1982) essentially predicted Pacific origin for reasons mostly independent of Caribbean geology.

Dooming in situ formation is the discovery of Early Jurassic (upper Pliensbachian) radiolarians from the

Bermeja Complex chert in southwestern Puerto Rico. This occurrence predates the Middle Jurassic opening of the North Atlantic Ocean and the Caribbean Sea. Here we review plate-tectonic evidence for Pacific origin of the Caribbean plate and present the first discussion of an Early Jurassic fauna from the region.

BERMEJA COMPLEX, PUERTO RICO

The Bermeja Complex, spread across the southwestern part of Puerto Rico, has long been recognized as geologically unusual to the island because of its greater age (in part), its lithologic character, and its clearly separate tectonic history. Stratigraphic studies in Sierra Bermeja are difficult to conduct and interpret because of the chaotic and discontinuous nature of the component serpentinite, amphibolite, basalt, and chert. Extensive deformation and metamorphism have destroyed most primary textures, bedding, and lithological relations. The lack of continuity of stratigraphic contacts and the inclusion of blocks of diverse size, lithology, and age (ranging through 100 Ma) with many adjacent to or "floating" in serpentinite suggest an ophiolitic melange.

Jurassic chert crops out along the northern and northwestern margin of Sierra Bermeja (Fig. 2) in patches ranging from suitcase-sized blocks to exposures a few tens of square metres in area mostly adjacent to basalt or serpentinite. Upper Jurassic red ribbon chert in the Bermeja Complex is similar in age and physical appearance (Fig. 3) to chert in the La Désirade Basement Complex, Guadeloupe, and in the

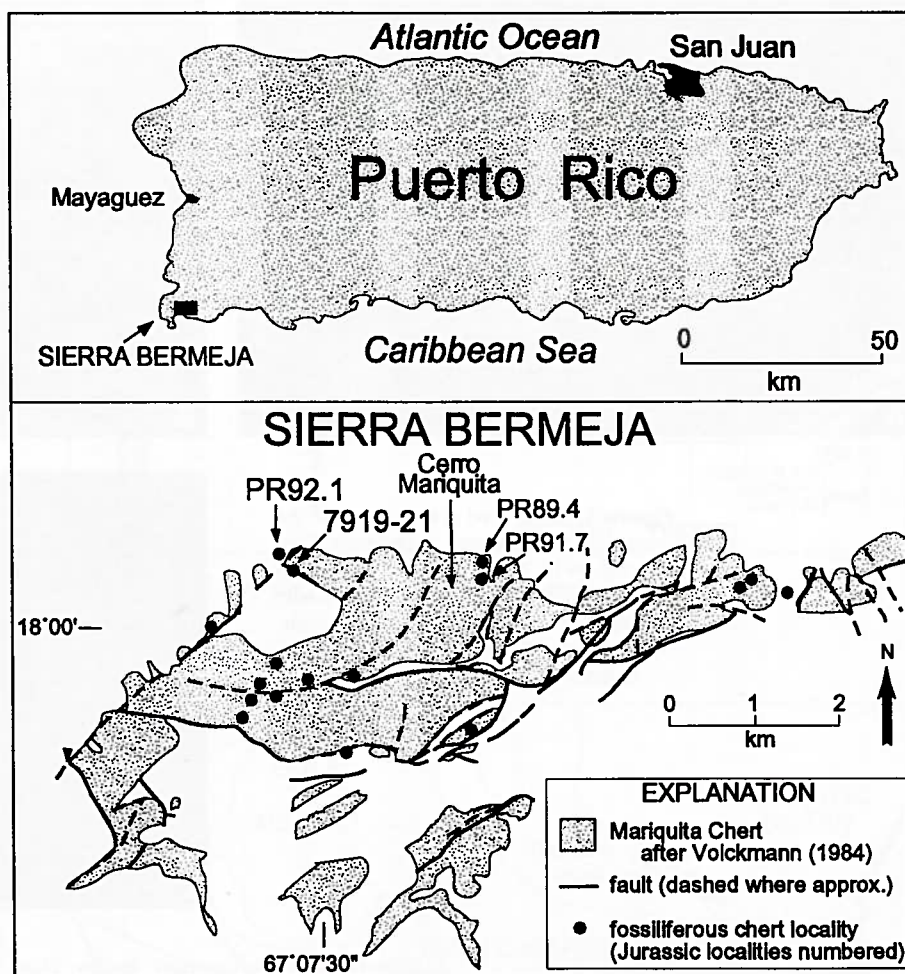


Figure 2. Chert outcrop map of Sierra Bermeja, Bermeja Complex (black rectangle in lower left of top map), southwestern Puerto Rico. Outcrop 7919-21 was sampled by Mattson and Pessagno (1979).

Duarte Complex, Hispaniola (Montgomery et al., 1992).

Outcrop PR92.1 (Fig. 4) is located in an arroyo at the northwestern corner of Sierra Bermeja (Puerto Rico Grid

Coordinates X = 78740 and Y = 19380; Volckmann, 1984). Highly tectonized and badly weathered greenish, grayish,

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Figure 3. Jurassic red ribbon cherts of the northern and eastern Caribbean. A: Outcrop 7919-21, Sierra Bermeja, Bermeja Complex, Puerto Rico. B: Interbedded with pillow lavas on east end of La Désirade, Guadeloupe. C: Quarry near El Aguacate, Duarte Complex, Dominican Republic.

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and brownish chert collected across an exposure of a few square metres yielded two poorly preserved but abundant Jurassic radiolarian faunas of nonoverlapping ages (Fig. 5).

The younger fauna (PR92.1A) is early late Tithonian (Zone 4, middle Subzone 4 α to lowermost Subzone 4 α) in age. The older fauna (PR92.1B, Fig. 6) is clearly of Early Jurassic age and is broadly comparable with Radiolaria of the Maude Formation (Pliensbachian to Toarcian) in the Queen Charlotte Islands, British Columbia (Pessagno and Whalen, 1982) and of the Nicely (upper Pliensbachian) and Hyde (lower Toarcian) formations, in east-central Oregon (Yeh, 1987). Numerous partial specimens of *Parasaturnalis(?)* n. sp. are solid evidence of Lower Jurassic strata, because the genus is restricted to a range from upper Pliensbachian to middle Toarcian (Yeh, 1987).

The specimen *Laxtorum(?) jurasicum* is recorded as late Pliensbachian to Bajocian (?) by Isozaki and Matsuda (1985) from the Mino belt. Circular *Bernoullius* sp. with twisted spines is considered to be a primitive representative of this group. Common *Acanthocircus hexagonus* and rare *Pantanellium* spp. (Late Triassic to Early Cretaceous) are of little biostratigraphic utility. Poorly preserved specimens of *Lupherium* spp. (late Pliensbachian to Bajocian) are abundant. Broken *Ares* spp. are similar to specimens shown by De Wever (1982) from the Liassic (Early Jurassic) of Turkey and to *Ares* and *Parares* spp. shown by Takemura (1986) from the Mino belt.

Fossil age assignments based on Mino belt biostratigraphy are highly suspect, because the Mino belt is a melange with no megafossils associated with the chert. Also problematic is that the Mesozoic (Jurassic) Japanese radiolarian zonation is not calibrated by utilizing ammonite-based chronostratigraphic data. Comparisons of Caribbean radiolarians with closely calibrated Early Jurassic faunas from Oregon and the Queen Charlotte Islands are valid. PR92.1B specimens of *Parasaturnalis(?)* are identical to an unnamed species in our collection restricted to the upper Pliensbachian part of the Queen Charlotte Maude Formation. Similar, but not identical morphotypes were shown by Yao

(1972) from the Mino belt, Japan. The particular *Parasaturnalis(?)* morphotype common in the Bermeja and the upper Pliensbachian part of the Maude Formation indicates that the PR92.1B fauna is of late Pliensbachian age (~195 Ma with reference to the 1983 Decade of North American Geology [DNAG] time scale).

PLATE-TECTONIC EVIDENCE FOR PACIFIC CARIBBEAN PLATE ORIGIN

Geologic evidence presented by Pindell (1990) suggests a Pacific origin for the Caribbean plate. First, the Lesser Antilles and Aves Ridge volcanic arc complexes in the eastern Caribbean plate provide a continuous record of westward-dipping subduction since early Late Cretaceous, indicating relative convergence for that entire time span. In addition, at least 1000 km of offset has clearly occurred on the Cayman Trough since middle or late Eocene time as indicated by the deeper, probably oceanic crustal part of the Cayman Trough and by the paleogeographic reconstruction of Cuba, Hispaniola, Puerto Rico, and the Aves Ridge fragments of the once-continuous Greater Antillean arc (Draper and

Barros, 1988; Pindell and Barrett, 1990).

Middle Cretaceous stratigraphic sequences of the Caribbean and Proto-Caribbean, the original seaway between North and South America, have been juxtaposed at suture zones around the Caribbean. The Caribbean sequence includes intrusive and volcanic rocks, volcanoclastic sandstone, tuff, and limestone on most of the islands, as well as allochthonous thrusts of Colombia and Venezuela and the interior of the Caribbean plate. The Proto-Caribbean suite includes mainly Jurassic rift-related deposits and subsequent passive margin sections without tuffs in autochthonous sequences of Yucatan, Florida-Bahamas, and northern South America, implying spatial separation at least until the Campanian.

Geometrical incompatibility is obvious between a pre-Aptian Caribbean plate and the Aptian size and shape of the Proto-Caribbean seaway. Plate separation by the Aptian was far insufficient to have accommodated

a Caribbean plate of nearly its present size without a huge part being created by spreading or extended by stretching (Pindell et al., 1988).

Structural trends of the southwestern margin of Mexico have been truncated. The eastward movement of the Mexican trench-Middle America trench-Motagua-Polochic transform triple junction truncated the basement of southwest Mexico, resulted in the eastward inception of arc magmatism along the Trans-Mexican volcanic belt coeval with continued magmatism in the Chortis block, and uplifted the northern transform margin (southwest Mexico) as subduction began behind the moving triple junction.

Radiolaria of Puerto Rico (Schellekens et al., 1990) and La Désirade (Montgomery et al., 1992) are of Pacific affinity and originated at higher latitudes than is possible assuming in situ deposition.

After separation between North and South America ceased during the Late Cretaceous, shelf margins around the Proto-Caribbean underwent loading subsidence on the approach of the Caribbean plate (Pindell et al., 1988), thus terminating passive margin subsidence. Progressively eastward development of these basins documents relative movement of the Caribbean plate. Pindell (1990) suggested that a total migration of 1500 km is recorded by basin development since Campanian time. This figure is consistent with an extrapolation of the migration predicted by studies of the development of the Cayman Trough (Rosencrantz et al., 1988).

DISCUSSION

When did an ocean first occupy the spreading gap between North and South America? Part of the answer can be found in the Atlantic Ocean. Cores drilled at Deep Sea Drilling Project Site 534A in the Blake-Bahama Basin in the western Atlantic reached basalt below middle Callovian sedimentary rocks (Sheridan, 1983). The Blake Spur magnetic anomaly marking the birth of the modern North Atlantic Ocean was thus determined as early Callovian in age (Sheridan, 1983). Anderson and

continued on p. 5



Figure 4. PR92.1 outcrop, Bermeja Complex, Puerto Rico. Mixed Upper and Lower Jurassic radiolarian cherts are in no coherent stratigraphic order.

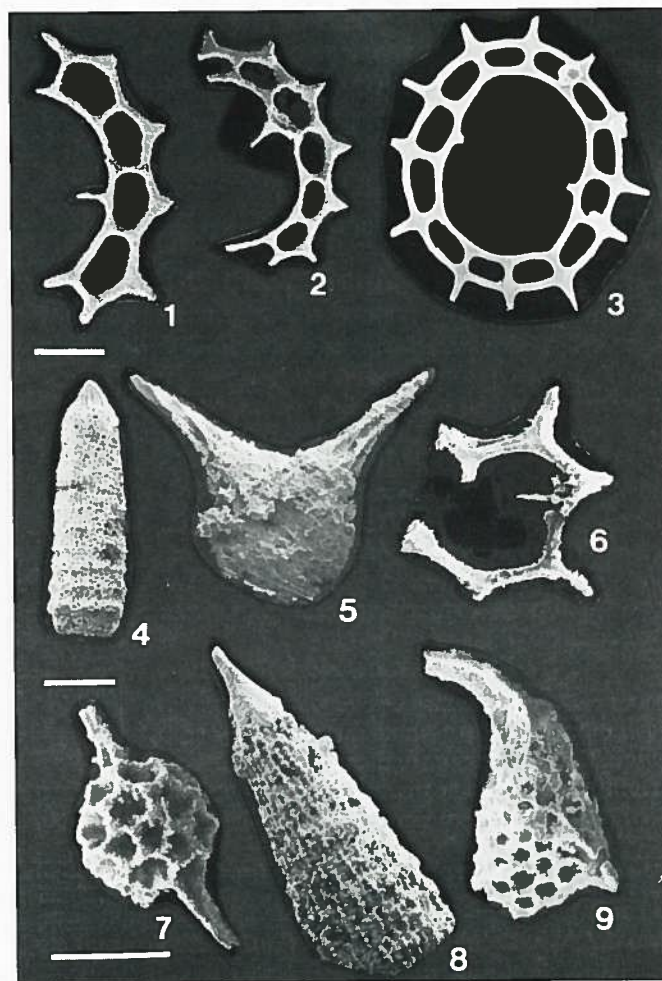


Figure 5. Scanning electron photomicrographs of Radiolaria from Lower Jurassic chert, Sierra Bermeja, southwestern Puerto Rico (PR92.1B) and British Columbia. Scale bars are 100 μ m for each row. 1 and 2—*Parasaturnalis(?)* sp.; 3—*Parasaturnalis(?)* n. sp. from the Maude Formation, Queen Charlotte Islands, British Columbia; 4—*Laxtorum(?) jurasicum*; 5—*Bernoullius* sp.; 6—*Acanthocircus hexagonus*; 7—*Pantanellium* sp.; 8—*Lupherium* sp.; 9—*Ares* sp.

Caribbean continued

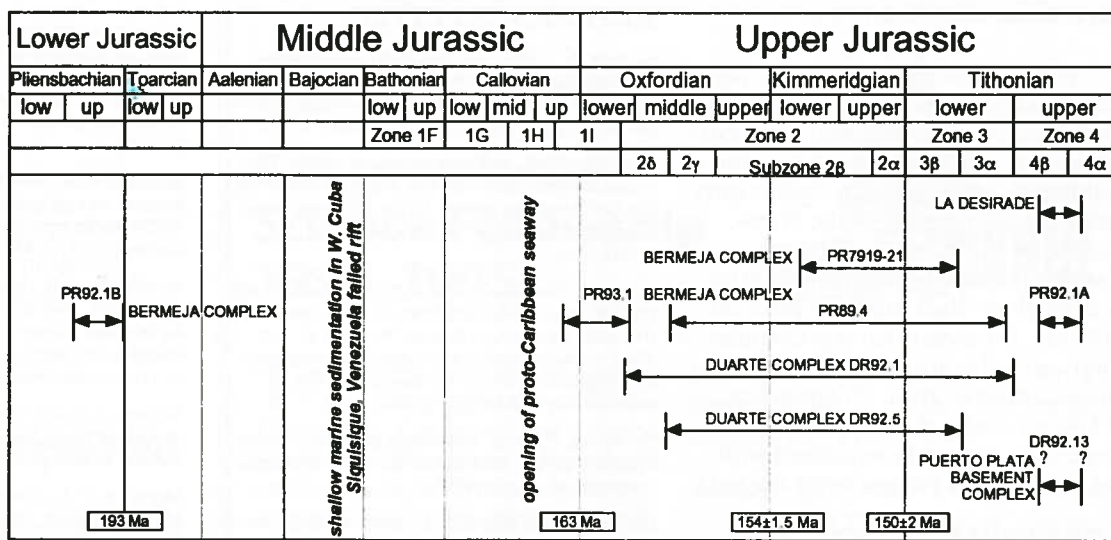
Schmidt (1983) presented evidence of a Callovian age for the origin of the Caribbean. Therefore, we assume that a fully open Proto-Caribbean-Atlantic seaway was a Callovian event with an age of ~165 Ma (1983 DNAG time scale).

How old is the Caribbean plate? The answer to this question depends on where you look. Deep sea drilling of oceanic crust south of Hispaniola yielded Turonian basalt (Edgar et al., 1973), but drilling did not reach true oceanic basement. At least part of the Caribbean plate (La Désirade, Bermeja, and Duarte) is Jurassic. Lower Jurassic radiolarian chert establishes Bermeja as the oldest known island terrane on the Caribbean plate.

What is the significance of red ribbon chert? Red ribbon chert interbedded with basalt in ophiolitic complexes was presumed to have originated at mid-ocean ridges (Hopson et al., 1981). The characteristic MnFeO-rich umbers of the chert are probably due to hydrothermal activity at an active ridge-crest such as has been observed at the Galapagos and East Pacific rise spreading ridges (Hopson et al., 1981). The Caribbean Jurassic red cherts are dark and MnFeO-rich, and most are interbedded, or at least associated, with basalt.

Discussion of one other possible Jurassic terrane is of importance. The Puerto Plata basement complex exposed along the north coast of the Dominican Republic contains pillow lavas with jasper rinds and other volcanic rocks with chert and limestone nodules and limestone masses. The limestones contain Late Cretaceous (early Campanian) radiolarians in HCl-acid residues. A few samples of greenish chert produced rare and poorly preserved Radiolaria including possible

Figure 6. Age ranges of radiolarian chert from Jurassic Caribbean terranes. The lines are maximum possible age ranges and are longer where biostratigraphic control is weaker. Kimmeridgian-Tithonian picks are after Pessagno and Blome (1990). Pliensbachian-Toarcian pick is after 1983 DNAG time scale. Some of the Puerto Rico (PR) sample locations are shown in Figure 2. Dominican Republic sample DR92.1 was taken near Janico, DR92.5 near El Aguacate, and DR92.13 from the Puerto Plata basement complex east of Maimon Bay. La Désirade samples are from cherts on the east and west ends of the island.



Vallupus hopsoni, a Late Jurassic (Tithonian) form. The Puerto Plata basement complex is located on the northern side of the Greater Antillean arc and thus is thought to be a remnant of Proto-Caribbean crust. This exposure is unlike the La Désirade, Bermeja, and Duarte terranes because it lacks red ribbon chert.

Development of the Greater Antillean arc during Cretaceous time remains a subject of debate: did subduction proceed from the south or the north? Island-arc magmatism occurred in Hispaniola, Puerto Rico, the Virgin Islands, Jamaica, and Cuba during the Early Cretaceous. The arc probably began subducting the Farallon plate from the south with polarity flipping during the Aptian (Pindell, 1993), and moving in a relative northeastward direction into the gap between North and South America (Fig. 7) subducting the Proto-Caribbean plate.

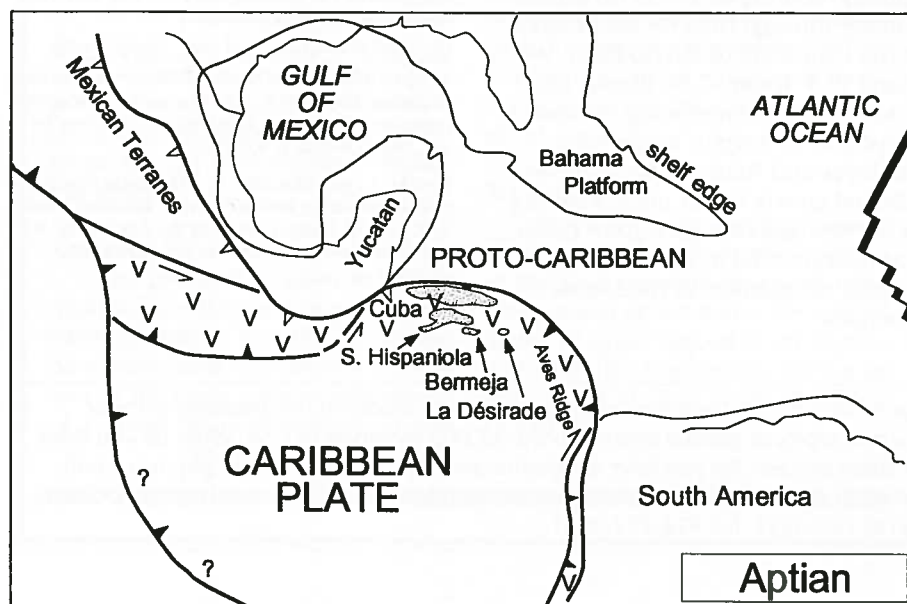


Figure 7. Reconstruction of the Caribbean region during the Early Cretaceous (Aptian) immediately after subduction zone polarity flipped from west-facing to east-facing, marking the entrance of the Caribbean plate into the spreading gap between North and South America.

Caribbean continued on p. 6

GSA publications on the
CARIBBEAN

The Caribbean-South American Plate Boundary and Regional Tectonics

edited by W. E. Bonini, R. B. Hargraves, and R. Shagam, 1984

The continuing debate on the evolution of the Caribbean plate and its borderlands is a reflection of the complexity of the regional geology. Since the disruption of Pangaea, the plates have been opened and closed, rotated and translated; that, combined with obduction and accretion of displaced terranes, has resulted in the highly integrated geology we see today. These 28 papers reflect the complexity of the tectonics of this area and the need for diverse approaches and sources of new data essential for understanding its history. Analytical tools of the 1970s and 1980s and regional plate kinematic syntheses, along with detailed case histories, provide evidence for the radical, large-scale rotations and translations in the heretofore sacrosanct cratonic "autochthon." This evidence indicates that these processes, once thought to have occurred prior to the earliest Cretaceous, are continuing today! Well illustrated, including oversize full-color map showing major geologic provinces of the Caribbean region. No specialist in the Caribbean or in island-arc terranes can afford to be without this book.

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The Caribbean Region

edited by G. Deno and J. E. Case, 1990

The result of a major international effort involving authors and organizations from 13 countries, this volume summarizes the complex geology and tectonic evolution of the Caribbean plate and its relation to the adjacent North American, South American, Nazca, and Cocos plates. Focuses on regional geology and geophysics, magmatic processes, neotectonic features, geologic hazards, and energy and metallic resources. Contrasting views for the Mesozoic and Cenozoic geological evolution are presented in chapters on plate tectonics and mantle surge

tectonics. Chapters on marine geology and geophysics are new syntheses for the entire Caribbean region. Highlights of the volume include extensive bibliographies and new syntheses of stratigraphic-lithologic columnar sections, seismicity, gravity and magnetic anomalies, neotectonic features, resource data, and crustal properties.

GNA-H, 538 p., indexed, 1 microfiche card in pocket, and 14 plates in matching slipcase, ISBN 0-8137-5212-4, \$80.00

Geologic and Tectonic Development of the North America-Caribbean Plate Boundary in Hispaniola

edited by P. Mann, G. Draper, and J. F. Lewis, 1992

The North America-Caribbean plate boundary has a complex geologic and tectonic history. The island of Hispaniola is one of the largest landmasses straddling the plate boundary and is a critical area for testing ideas for the development of the plate boundary as well as for the Caribbean region as a whole. The authors in this volume seek to establish a systematic geologic data base and coherent stratigraphic nomenclature for Hispaniola, test recent models for the tectonic evolution of the island, provide a better integration of earth science disciplines to solve regional geologic problems, and establish Hispaniola as an important area for studying a variety of plate boundary zone processes at all scales. Included is a set of geologic maps of the Dominican Republic, incorporating most of the results reported in this volume.

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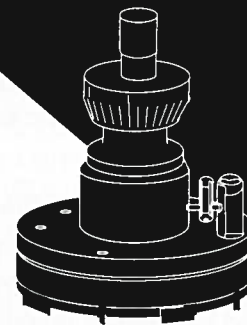
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The plate-tectonic arguments presented cannot be explained within the confines of in situ Caribbean plate evolution. The discovery of Early Jurassic radiolarians in Puerto Rico significantly predating the opening of the Proto-Caribbean and North Atlantic seaway is strong justification for an allochthonous origin of the Caribbean plate. At ~195 Ma, the oldest Bermeja Complex chert certainly cannot be obducted Proto-Caribbean crust. The presence of Lower Jurassic chert in a Middle Jurassic sea cannot be explained without arguing that Pangea never existed.

ACKNOWLEDGMENTS

Support was provided by National Science Foundation grants EAR-9117397 (to Pessagno and Montgomery) and RII-85-13533 (to Montgomery through the EPSCoR program at the University of Puerto Rico). We thank W. P. Irwin, C. D. Blome, and E. M. Moores for reviewing the manuscript and for helpful suggestions. Jim Joyce and Hans Schellekens contributed greatly to our understanding of the Bermeja Complex. John Lewis was instrumental in the discovery of Jurassic radiolarians in the Duarte Complex.

Each month, *GSA Today* features a short science article on fast-breaking items or current topics of general interest to the 17,000 members of GSA. What do you think of these articles? Do you have an idea for an article that you would like to see published in *GSA Today*? If so, please contact Eldridge Moores, Science Editor, *GSA Today*, (916) 752-0352, fax 916-752-0951.

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1994-1995 JOI/USSAC Distinguished Lecturer Series

The JOI/U.S. Science Support Program associated with the international Ocean Drilling Program is very pleased to announce the fourth annual JOI/USSAC Distinguished Lecturer Series. The speakers for the 1994-1995 season are:

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Institutions interested in hosting a presentation by one of the lecturers should contact JOI/USSSP for more information and an application form. The application deadline is Friday, April 1, 1993.

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GSA BULLETIN EDITORS NEEDED

GSA solicits applications and nominations of two persons to serve as Editors of the *Bulletin*. The terms of the current Editors will end December 31, 1994, and the new Editors will begin three-year terms at that time. A phased transition should begin in the fall of 1994.

These are not salaried positions, but GSA pays expenses for secretarial assistance, mail, and telephone at the editor's locations and for travel to GSA headquarters. GSA headquarters staff conducts copy-editing and production activities.

Interested persons should submit a résumé and a brief letter describing relevant qualifications, experience, and objectives. Nominations should include a letter and the nominee's written permission and résumé. Applications and nominations should be sent **BEFORE FEBRUARY 18, 1994** to F. Michael Wahl, Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301

EDITOR DUTIES

1. Ensure that the *Bulletin* remains one of the premier journals in the geological sciences.
2. Select and maintain an appropriate Board of Associate Editors.
3. Maintain expeditious manuscript flow.
4. Make decisions regarding acceptability of submitted manuscripts in concert with recommendations of reviewers and Associate Editors.
5. Advise authors about necessary revisions.
6. Organize the content and select cover design for each issue of the *Bulletin*.
7. Keep the Committee on Publications and the GSA headquarters staff informed about the flow of manuscripts and other *Bulletin* business.
8. Respond promptly to inquiries from authors and prospective authors.

EDITOR QUALITIES

1. Broad background and active research in the geological sciences with particular emphasis on regional geology (including geomorphology, geophysics, geochemistry).
2. Good organizational skills.
3. Willingness to invest approximately one day per week.
4. Enthusiasm, tenacity, and imagination for future innovations and improvements in the *Bulletin*.
5. Broad knowledge of the geological research activities of scientists both nationally and internationally.
6. Good English language skills.
7. Objectivity.
8. Scientific maturity.
9. Patience, courtesy, tact, and firmness in dealing with authors.

Bruce F. Molnia

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

Our Changing Planet: Global Change Revisited

Three years ago, the first of the *GSA Today* Washington Reports (January 1991) examined the FY 1991 U.S. Global Change Research Program (USGCRP) and its program document, "Our Changing Planet." The 1991 column concludes with the statement "A future column will address how successful the USGCRP has been in answering the policy-relevant questions posed by the CEES, describe where the money has gone and is going, and discuss the political aspects of global change." This month's Washington Report describes the health of the FY 1994 version of the USGCRP and attempts to address aspects of queries raised in 1991.

A quick comparison of the program for FY 1994 with that for FY 1991 reveals that the USGCRP continues to succeed, has become bigger, is more polished, and out of necessity has become more relevant. Budget has more than doubled since FY 1990: the FY 1994 request is \$1,475,100,000. Unfortunately for the geological community, geological projects still occupy a very distant backseat, receiving substantially less than \$50,000,000. The big winner is space-based instrumentation, specifically the National Aeronautics and Space Administration's (NASA) Earth Observing System (EOS) and its EOS Data Information Systems (EOSDIS).

"Our Changing Planet: The FY 1994 U.S. Global Change Research Program" document states that the underlying premise of the USGCRP "involves a view of the Earth as a single, integrated system whose behavior can be anticipated in order to support national and international policy formulation and decisions relating to natural and human-induced changes in the global environment and their regional impacts."

Relevance. John Gibbons, head of the Office of Science and Technology Policy, in his letter transmitting "Our Changing Planet" to Members of Congress, emphasizes that the USGCRP is an "important element" of the Clinton-Gore strategy for "moving America's investment in science and technology in a ... new direction to build economic strength and spur economic growth." He further states that "The President and Vice President have identified the importance of investments in research to better understand global warming, ozone depletion and other phenomena important to local, regional and global environments...." Gibbons quotes the President and Vice President as saying that "This research is essential if we are to fully assess the damage mankind is doing to our planet and take effective action to address it."

Specifically, the FY 1994 Program has links to U.S. commitments made in support of the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro; the Framework Convention for Climate Change; the results of the international Intergovernmental Panel on

Climate Change (IPCC); and the World Climate Research Programme and the International Geosphere-Biosphere Programme.

Program Management. Administratively, the USGCRP is still under the Executive Office of the President's Office of Science and Technology Policy (OSTP). The USGCRP is directly administered by the Subcommittee on Global Change Research (SGCR), formerly the Working Group on Global Change Research of the Committee on Earth and Environmental Sciences (CEES). Although renamed, SGCR is still chaired by Robert W. Corell of the National Science Foundation (NSF). CEES is but one of a number of components of OSTP's Federal Coordinating Council for Science, Engineering and Technology (FCCSET). In addition to the NSF, SGCR member agencies include the following departments: Agriculture (DOA); Commerce; National Atmospheric and Oceanic Administration (NOAA); Defense (DOD); Energy (DOE); Health and Human Services; National Institute of Environmental Health Sciences (NIEHS); Interior (DOI); Environmental Protection Agency (EPA); the intelligence community; NASA; Office of Management and Budget; OSTP; Smithsonian Institution (SI); State (DOS); and the Tennessee Valley Authority (TVA).

Goal. In FY 1991, the goal of the USGCRP was to "establish the scientific basis for national and international

In 1994 the goal of the U.S. Global Change Research Program is to "produce a predictive understanding of the Earth system to support national and international policy-making activities across a broad spectrum of global, national, and regional environmental issues."

policy making relating to natural and human-induced changes in the global Earth system." In FY 1994 the goal is to "produce a predictive understanding of the Earth system to support national and international policy-making activities across a broad spectrum of global, national, and regional environmental issues."

Science Elements. As was the case in FY 1991, the seven science elements—(1) climate and hydrologic systems, (2) biogeochemical dynamics, (3) ecological systems and dynamics, (4) Earth-system history, (5) human interactions, (6) solid Earth processes, and (7) solar influences—still serve as the foundation of the USGCRP. However, "as the need to develop cross-disciplinary programs has evolved," four parallel, interconnected activity streams "are being used to integrate across" the science elements. The interconnected activities are observations and data management, process research, integrative modeling and prediction, and assessments.



The Geological Society of America

Congressional Science Fellowship 1994-1995



The Geological Society of America is accepting applications for the 1994-1995 Congressional Science Fellowship. The Fellow selected will spend a year (September 1994-August 1995) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is open to highly qualified postdoctoral to mid-career earth scientists. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside

the Fellow's particular area, and a strong interest in working on a range of public policy problems.

Award

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

To Apply

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

DEADLINE FOR RECEIPT OF ALL APPLICATION MATERIALS IS FEBRUARY 15, 1994

Policy-Relevant Questions.

In FY 1991 the seven primary interdisciplinary science priorities (science elements) were accompanied by some 30 policy-relevant questions. These ranged from "What is the role of the polar regions in global climate change?" to "Is there more than one stable mode of atmosphere-ocean circulation?" In FY 1994, these science element-specific questions appear to have been super-

and climate cycles from analyses of the Greenland Ice Shelf II (GISP II) ice core; observation and mapping of the global SO₂ plume produced by the eruption of Mt. Pinatubo; improved observation, analysis, modeling, prediction, and understanding of the El Niño Southern Oscillation (ENSO) cycle, including a successful prediction of an ENSO event one year in advance of its occurrence; refined (lower) estimates of the rate of tropical deforestation; and improvements in the predictive understanding of the sinks and sources of excess CO₂ and CH₄ in the global carbon budget.

Budget. The FY 1994 budget request (all numbers are listed in billions of dollars) for the USGCRP was \$1.4751, up from the FY 1993 appropriation of \$1.326. By comparison, the FY 1991 budget reported in the January 1991 Washington Report was \$0.9505. The FY 1990 appropriation had been \$0.6593. The FY 1994 breakdown by individual agency (listed in decreasing order and by percent of total) is: NASA—\$1.0131 (68.68%); NSF—\$0.169 (11.46%); DOE—\$0.0983 (6.66%); NOAA—\$0.0699 (4.74%); DOA—\$0.0476 (3.23%); DOI—\$0.034 (2.31%); EPA—\$0.0275 (1.86%); SI—\$0.0073 (0.50%); DOD—\$0.0068 (0.46%); NIEHS—\$0.0015 (0.01%); and the TVA—\$0.0001 (0.01%). Of NASA's funds, \$0.3227 (21.88% of total program) supports development of the Earth Observing System (EOS); an additional \$0.1827 (12.39% of total program) supports the development of EOS Data Information Systems.

Between Washington Report examinations, the USGCRP has continued to expand and prosper. The December 1996 issue of *GSA Today*, will feature another update of the FY 1996 and FY 1997 USGCRP and an examination of the question: How are the geological sciences doing in the USGCRP? ■

sed by a desire to integrate the activities of the CEES agencies "in the context of a set of crosscutting, policy relevant priorities." The priorities are described as evolving "over time, as new scientific insights are developed, existing problems are resolved, new opportunities are identified, and decisionmaking requirements change." Seven "critical Earth-System priorities" are identified: climate change and greenhouse warming; seasonal to interannual climate prediction; stratospheric ozone and UV-B radiation; ecological change and biodiversity; human dimensions, including economics; international cooperation; and education and public awareness.

Accomplishments. Research and investigations funded by the USGCRP are providing a better understanding of processes that regulate the total Earth system. Last year, USGCRP results included monitoring and detection of both northern and southern hemisphere ozone depletion; climate prediction; refinement of past climate

1994 John C. Frye Environmental Geology Award

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

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

CRITERIA FOR NOMINATION

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

BASIS FOR SELECTION

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

1993 AWARD RECIPIENT NAMED

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

Penrose Conference Report

Late Precambrian Tectonics and the Dawn of the Phanerozoic

Conveners

Ian Dalziel, Institute for Geophysics, University of Texas at Austin
Andrew Knoll, Department of Earth and Planetary Sciences, Harvard University
Eldridge Moores, Department of Geology, University of California at Davis

The conference was held to explore the tectonics and paleogeography of the Neoproterozoic and earliest Phanerozoic eras (approximately 1000–500 Ma), and their possible influence on the profound paleoenvironmental and biological events of this interval. It was perhaps the first conference to focus on the events of that time period both on a global scale and from an interdisciplinary perspective. Geologists and geophysicists working in all continents, including Antarctica, sat down with geochemists and paleobiologists interested in the biogeochemical and evolutionary events that culminated in the Cambrian explosion of macroscopic animals. Held October 18–23, 1992, at Furnace Creek Ranch in Death Valley, California, the conference was attended by 68 scientists from 12 countries on 5 continents.

In an introductory session, Andrew Knoll, Ian Dalziel, and Eldridge Moores outlined the background to the conference. Although Neoproterozoic geology and the Precambrian-Cambrian boundary had been widely debated over the years and are topics of current International Geological Correlation Programme projects, there was a specific reason to convene the interdisciplinary meeting, and to hold it in Death Valley—the publication of the so-called Southwest United States–Antarctica (SWEAT) hypothesis (1991—Moores, Dalziel) that suggests specific connections between Laurentia and the East Antarctic craton in the Neoproterozoic, prior to the opening of the Pacific Ocean basin. Together with the ensuing idea that Laurentia had “broken out” from between East Antarctica and South America prior to the amalgamation of Gondwanaland (1991—Dalziel, Hoffman), the SWEAT hypothesis provides a testable paleogeographic scenario for one of the most biologically critical time intervals in Earth history. Death Valley is located near the edge of the Laurentian craton, and it has an impressive Neoproterozoic to lower Paleozoic stratigraphic sequence that could be studied in a mid-conference field trip.

Andy Knoll went on to summarize the biologic events leading to the dawn of the Phanerozoic. In recent years the fossil record of early animal evolution has improved considerably, as has the broader and deeper record of Neoproterozoic eukaryotic organisms in general. The hypothesis that the Ediacaran radiation of macroscopic animals was triggered by environmental change, specifically a rise in atmospheric oxygen concentrations, has been around for decades, but only recently have geochemical data relevant to the hypothesis been produced. The details of stratigraphic trends in the isotopic records of C, Sr, and S have rapidly become available. They show that the end of the Proterozoic was an interval of strong biogeochemical change that provides a possible link between signal tectonic and biological events. Information flows in two directions. Knoll outlined emerging paleontological and geochemical data that offer the promise of improved Neoproterozoic and

basal Cambrian stratigraphic correlations, thereby providing new constraints on tectonic and paleogeographic hypotheses.

The introductory session continued with Paul Hoffman (University of Victoria, British Columbia) reviewing the evidence for late Precambrian paleogeographic development that follows directly from the SWEAT hypothesis. Fusion of a Rodinian supercontinent during global Grenvillian events was followed by the breakout of Laurentia, Baltica, and Siberia, and finally by the assembly of Gondwanaland. Hoffman's model has this happening in fanlike fashion about a pole near the present Weddell Sea for two late Precambrian rifting events along the western North American margin, thus raising a major question regarding the timing of the postulated Laurentia–East Antarctica separation that was a recurring question during the meeting: did this take place in the mid-Neoproterozoic, or near the Precambrian–Cambrian boundary? Developing the theme of Gondwana amalgamation, Brian Windley reported on new developments in understanding the geology of Madagascar. Louis Derry (CNRS, France) summarized the evidence for geochemical changes just before the Cambrian. He emphasized the sharp increase in radiogenic Sr in ocean water around 0.6 Ga, and suggested that large Indus-like rivers draining a Himalaya–Tibet–scale region of uplift could produce the isotopic changes observed.

John Crowell (University of California, Santa Barbara) summarized the evidence for Proterozoic glaciations. Convincing evidence exists for continental glaciation ca. 2300 Ma and ca. 800–600 Ma. But no compelling evidence exists for ice ages during the intervening 1.5 Ga. In contrast, alpine glaciation may have existed throughout geologic time. Weathering, formation of iron formations, and paleogeographic reconstructions present enduring problems in attempts to explain Neoproterozoic climatic changes. As pointed out many years ago by Brian Harland (Cambridge, UK), Neoproterozoic ice maxima at ca. 850, 720, and 600 Ma seem to be world wide. Further, they are widely interpreted as reaching low paleolatitudes, which presents a formidable problem for climate modelers (Tom Crowley, Applied Research Corporation, Texas). Paleomagnetic and other paleogeographic evidence for low-latitude continental glaciation (even worse, at sea level!) was debated vigorously by the participants. The most convincing data come from South Australia, but while Wolfgang Preiss (Geological Survey of South Australia) acknowledged that the glaciogenic deposits there could have been derived from local highlands, he emphasized that this was not the case in Western Australia. The stratigraphically equivalent Kimberley deposits in that region rest on a striated pavement, and there seems little room for doubt that they reflect the presence of ice at sea level. Regardless, participants agreed on the need for more carefully documented paleomagnetic data on

tillite-bearing successions from different Neoproterozoic ice ages and different parts of the world.

The first day continued with discussions of processes of rifting and rift-drift transitions in the Neoproterozoic by Nick Christie-Blick (Columbia University), John Grotzinger (MIT), and others. It concluded with the airing of Neoproterozoic paleomagnetic problems in a debate led by Joe Meert (University of Michigan), John Park (Geological Survey of Canada), Rob Hargraves (Princeton), and Chris Powell (University of Western Australia). The paleomagnetic data appear to be consistent with Laurentia and East Gondwana (East Antarctica–Australia–India) being juxtaposed between ca. 1.0 and 0.75 Ga. By ca. 0.6 Ga, however, Laurentia was at a high latitude, while East Antarctica–Australia stayed close to the equator. Together with the geometrical constraints posed by a globe of constant radius, as demonstrated by Ian Dalziel, this seems to require that the postulated separation of the Transantarctic–eastern Australian margin occurred during the 0.8–0.6 Ga (Windermere) rifting and subsidence event along the Cordilleran margin of Laurentia discussed earlier by Gerard Bond (Columbia University). As separation of the proto-Appalachian margin of Laurentia does not seem to have occurred until the interval 0.65–0.54 Ga, this points to the existence of two supercontinental configurations in the Neoproterozoic, before and after the opening of the Pacific Ocean basin: Rodinia from the Grenvillian event until ca. 0.7 Ga and a supercontinent consisting of Laurentia plus the newly amalgamated Gondwana at the end of the Precambrian. The latter may have been comparatively ephemeral in geologic terms.

Discussions of Neoproterozoic paleogeography occupied the second day of the conference. This was a geologic high point, because it brought together workers in Antarctica, Australia, and other fragments of Gondwanaland with those from North America and Eurasia. There was considerable support for the hypothesis that the Pacific margins of Laurentia and East Antarctica–Australia may have been juxtaposed. Gerry Ross (Geological Survey of Canada) presented evidence (based on the age of detrital zircons) that the clastic rocks of the Belt Supergroup were not derived from Laurentia, but could be of Australian origin; this thesis gained support from Wolfgang Preiss (Geological Survey of South Australia). Chris Powell summarized the evidence for correlation of Laurentia with Tasmania at about 0.84–0.7 Ga. Ed Stump (Arizona State University) outlined the geology of the Beardmore Group of the Transantarctic Mountains: deep-water turbidites with diamictite and pillow basalt with an Nd/Sm model age of 750 Ma are similar to Windermere rocks in northwestern Canada. Scott Borg (Office of Polar Programs, National Science Foundation) demonstrated that isotopic signatures

continued on p. 9

in the basement of the Transantarctic Mountains bear some resemblance to those of the Pacific margin of Laurentia. "Panafrican" events along the Antarctic margin include the ductile Ross deformation at 520–550 Ma. Werner Buggisch (University of Göttingen, Germany) described the geology of the little-known Shackleton Mountains—an area that is critical to the SWEAT hypothesis. He described south-vergent folds and thrusts of Grenville-age rocks. The Watts Needle Formation that contains Vendian acritarchs may have formed in a back-arc environment. This stromatolite-bearing sequence appears to be the only undisturbed example of Neoproterozoic strata on the Antarctic continent, and would have been comparatively close to the well-known section at Caborca in northwestern Mexico if the SWEAT reconstruction is correct.

There was considerable debate regarding the thesis put forward by Gerry Ross that the detrital zircon data from the Belt rocks required geometric modification of the original SWEAT fit for East Antarctica–Australia against Laurentia. Given the evidence of widespread redistribution of detrital grains by major river systems during the Neoproterozoic (Grant Young, University of Western Ontario, provided an excellent example of this), several participants felt strongly that while an Australian source for the zircons seems plausible, readjustment of the SWEAT fit by 1500–2000 km was not justified on the basis of this type of data. Quite apart from violating the original basis of the proposed fit, such readjustment leaves 3000–4000 km of the late Precambrian rifted Pacific margins of Laurentia and Australia without a counterpart.

Turning to the proto-Appalachian margin of Laurentia, Dalziel and Luis Dalla Salda (Universidad de La Plata, Argentina) presented some new ideas regarding an original fit between Laurentia and Amazonia and possible interaction between Laurentia and the proto-Andean margin of Gondwana during the Paleozoic. Dalziel suggested that the Labrador-Scotland-Greenland promontory of Laurentia might have been rifted from the Arica embayment in the Gondwana craton margin at the end of the Precambrian. Together they defended the hypothesis that the Oclroyic orogen in Argentina (the older part of the Famatinian belt) might represent a former continuation of the Taconian Appalachians, the combined Taconic-Oclroyic mountain belt having resulted from Laurentia-Gondwana collision during the Ordovician following their separation at the end of the Precambrian. Despite the long-recognized presence in the Precordillera of northwestern Argentina of part of the Laurentian Cambrian-Ordovician carbonate platform, these ideas proved rather too radical for most of the participants to take on board in the short time available for debate!

Problems of Gondwana assembly were the subject of spirited discussion, particularly with regard to timing. Although most participants seemed to agree that East Gondwana was basically assembled by the end of the global Grenvillian event, it is clear that the cratonic nuclei of West Gondwana (Kalahari, Congo, São Francisco, Rio de la Plata, Amazonia, West Africa) did not amalgamate until the end of the Proterozoic. Thus, as Paul Hoffman pointed out and Ian Dalziel acknowledged, the model of a simple Mozambique Ocean between East and West Gondwana during the Neoproterozoic is an oversimplification. Moreover, as

demonstrated by Robert Stern (University of Texas at Dallas), this ocean between central East Africa and India was virtually closed by 0.78–0.64 Ga. Roland Trompette and Georg Sadowski (University of São Paulo, Brazil), Heinrich Bahlburg (University of Heidelberg, Germany), Chris Hartnady (University of Cape Town, South Africa), Raphael Unrug (Wright State University, Ohio), Alfred Kröner (University of Mainz, Germany), and others working in Africa and South America outlined the evidence for tectonic activity along the various Panafrican and Brazilide belts that appear to reflect ocean closure (or at least basin inversion) within Neoproterozoic West Gondwana. Closure of the Mozambique Ocean clearly preceded amalgamation of West Gondwana. Some of the Brazilide oceans may not have closed until near the Precambrian-Cambrian boundary. One of the last regions to have been deformed was the Damara belt of Namibia, described for the participants by Karl Hoffmann of the Geological Survey of Namibia. There remains the possibility that some basins within Gondwana did not close until the Cambrian. Indeed, Alfred Kröner and Anne Grunow (Ohio State University) cautioned that even East Gondwana may not have been completely assembled until the Early Ordovician.

Turning from issues of paleogeography to paleoenvironment, Tom Crowley pointed out that while global circulation models could account for ice extending to subtropical latitudes in certain situations involving specific arrangement of land masses and of mountains, it was still very difficult to explain low-latitude ice at sea level as in the Western Australian case. A discussion then ensued regarding the possible relation between glaciations and the conditions necessary to generate Proterozoic iron formations. Cornelius Klein (University of New Mexico) postulated that intervals of glaciation make marine waters stagnant, with a build up of Fe²⁺, and that oxygenation upon ice retreat leads to the deposition of Fe³⁺ as hematite. Given the likelihood of rapidly changing paleogeography, and the possibility of rapid polar wander (discussed by Joe Kirschvink, Caltech), the problems associated with low-latitude glaciation and iron deposition in the latest Precambrian are bound to receive a lot of attention in the future and seem destined to be with us for some time to come.

The final sessions of the conference involved wide-ranging discussions on possible relations between biologic changes, environmental changes, and tectonics. Andy Knoll, Malcolm Walter (Macquarie University, Australia), Jay Kaufman (Harvard University), Martin Brasier (Oxford University, UK), and Yemane Asmerom (University of Minnesota) outlined for the geologists and geophysicists the state of the art in understanding evolutionary changes in relation to isotopic variations. In this discussion, every effort was made to distinguish between fact and interpretation. Paleontological facts include



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the initial diversification of higher eukaryotes (including, by inference from molecular phylogeny, the ancestors of animals) ca. 1000 Ma, the first simple body fossils of possible cnidarian affinities in rocks just beneath Varanger-age tillites, the widespread appearance of diverse, macroscopic animals in rocks that overlie Varanger glaciogenic rocks, and a spectacular radiation of eucoelomate animal phyla near the Proterozoic-Cambrian boundary. As discussed by Guy Narbonne (Queen's University, Ontario), Richard Jenkins (Adelaide University, Australia), Bruce Runnegar (UCLA), Stephen Grant (Uppsala University, Sweden), and others, much current debate centers on the biological interpretation of Ediacaran fossils, variously seen as early representatives of diverse modern phyla, simple cnidarian-grade animals and ancestral bilaterians (by not necessarily belonging to extant phyla), and experiments in multicellular life unrelated to living animals. The debate—which was certainly not resolved in Death Valley—is important because the position one takes on Ediacaran fossil affinities determines in large part whether the Ediacaran and Cambrian events are interpreted as early and late phases of a single event or as two distinct radiations driven by different proximal causes.

Facts from isotopic geochemistry include the observation that Neoproterozoic C isotopic variations match or exceed the largest variations recorded in Phanerozoic rocks, or, for that matter, Proterozoic rocks deposited during the preceding billion years; large excursions in the C-isotopic record correlate stratigraphically with Neoproterozoic ice ages (Jay Kaufman). Stein Jacobsen (Harvard University) and Yemane Asmerom showed that unusually low Sr isotopic ratios characterize most carbonates within the time umbrella defined by unusual C-isotopic values. The stratigraphic discrepancy between the two records occurs in rocks associated with the oldest diverse Ediacaran faunas. Drawing on this fact, Louis Derry outlined a model which indicated that this interval was a time of

rapid increase in atmospheric oxygen levels. There was much discussion of possible relation among the assembly and fragmentation of supercontinents, glaciations, and these isotopic records. Inevitably, perhaps, no firm conclusions were reached, except that one week was not nearly enough to cover the entire topic. Improved calibration of geochemical and paleontological events by radiometric dating will do much to constrain future speculation.

What role did tectonic and environmental change play in Cambrian animal evolution? Martin Brasier continued the isotopic curves into the Cambrian and suggested possible relation with evolution. Phil Signor (UC Davis), Stuart McKerrow (Oxford), and Pete Palmer (Cambrian Research Institute, Colorado) debated the consequences of continental diaspora for evolution, and the constraints that paleobiogeography places on tectonic interpretations—providing two more topics on which there is no current consensus.

Perhaps only one general agreement emerged from the conference: that the exercise in interdisciplinary "global system science" applied to a long and crucial interval in Earth history had been thoroughly worthwhile. It is only by taking such an interdisciplinary approach that the answers to critical problems in Earth history are likely to be found.

The conference was cosponsored by the Institute for Geophysics, University of Texas, as part of the activities of its 20th anniversary year. Support was also received from the National Science Foundation (grant EAR-9205611), from International Geological Correlation Programme Projects 303 (Late Precambrian–Early Cambrian Event Stratigraphy), 320 (Neoproterozoic Events and Resources), and 288 (Gondwana Sutures and Fold Belts), from the Working Group on the Terminal Proterozoic Period of the International Commission on Stratigraphy, and from the Group of Specialists on the Structure and Evolution of the Antarctic Lithosphere of the Scientific Committee on Antarctic Research. ■

Penrose Conference Participants

James Aitken
Arild Andresen
Yemane Asmerom
Heinrich Bahlburg
Andrew Bekker
Gerard C. Bond
Scott Borg
Martin Brasier
W. Buggisch
James Calzia
Nicholas Christie-Blick
Frank Corsetti
John C. Crowell
Thomas Crowley

Luis Dalla Salda
Louis A. Derry
John W. Goodge
Stephen W. F. Grant
John P. Grotzinger
Anne Grunow
Robert B. Hargraves
Brian Harland
Chris J. H. Hartnady
Robert D. Hatcher, Jr.
Paul F. Hoffman
Karl-Heinz Hoffmann
Frederick E. Hutson
Stein B. Jacobsen

Richard J. F. Jenkins
Alan Jay Kaufman
Duncan Kerp
Joseph L. Kirschvink
Cornelis Klein
Alfred Kröner
Marjorie Levy
Paul K. Link
W. Stuart McKerrow
James M. McLelland
Joseph Meert
J. Brendan Murphy
Paul Myrow
R. Damian Nance

Guy M. Narbonne
A. R. (Pete) Palmer
John R. Park
Marcio M. Pimentel
J. D. A. Piper
Hubertus Porada
Chris McA. Powell
Anthony Prave
Wolfgang V. Preiss
Margaret Rees
Gerald M. Ross
Bruce N. Runnegar
George R. Sadowski
Phil Signor

A. Krishna Sinha
Kristian Soegaard
Ian G. Stanistreet
Robert J. Stern
Edmund Stump
Catherine L. Summa
Roland Trompette
Raphael Unrug
Malcolm Walter
Brian Windley
Lauren Wright
Grant M. Young

1993 GSA Annual Meeting

POSTER SESSION AWARD WINNERS



Monday Morning

- 1st Place: Brian E. Bodenbender, "Cystallographic Patterns in Blastoid Skeletal Elements"
2nd Place: W. Naylor Stone, Raymond Siever, Stanley T. Paxton, "Compaction and Quartz Cementation in Quartzarenites and Subarkoses from the Greater Green River, Anadarko, and East Texas Basins"
3rd Place: Robert G. Corbett, Barbara M. Manner, Thomas J. Quick, "Reconstruction of Precursors to Liesegang-banded Concretions in the Morrison Formation"

Monday Afternoon

- 1st Place: G. Michael Grammer, Gregor P. Eberli, "Unfilled Accommodation Space and the Implications to Cyclostratigraphy—An Example from a Pennsylvanian Mixed Carbonate/Siliciclastic System, Paradox Basin, Utah"
2nd Place: Anurag Sharma, "Some Observations on Pargasitic Amphibole Synthesis with Comments on Its Miscibility with Tremolite (TR) and MG-Cumingtonite (MC) End-Members"
3rd Place: T. J. Weiland, I. B. Suayah, R. C. Finch, "Mesozoic Volcanic Rocks of the Rio Wampu, Eastern Honduras: Chronology, Geochemistry, and Petrology"

Tuesday Morning

- 1st Place: M. K. Johns, S. Mosher, "Physical Models of Fold Interference: The Role of Rheology"
2nd Place: S. F. Diehl, C. W. Clendenin, "Fluid Flow Along a Fault—Petrofabric Evidence from a Fault Bend, English Hill Fault System, Southeast Missouri"
3rd Place: Theodore S. Melis, Robert H. Webb, T.W. Wise, "Effect of Historic Debris Flows on the Colorado River in Grand Canyon"

Tuesday Afternoon

- 1st Place: Steven L. Goodbred, Jr., Albert C. Hine, Wendolyn C. Quigley, Richard Stumpf, "Storm of the Century Makes Contribution to Sediment-starved Coastal Marshes"
2nd Place: James Z. Taylor, Mark Person, "Effect of Upconing on Well Head Delineation for Island Aquifer Systems"
3rd Place: Joen G. V. Widmark, "Biogeographic and Paleocologic Patterns Among Benthic Foraminifera in the Late Cretaceous Deep-Sea—Paleoceanographic Implications"

Wednesday Morning

- 1st Place: C. T. Foster, Jr., "A Program to Model Metamorphic Textures"
2nd Place: M. L. Gerdes, L. P. Baumgartner, M. A. Person, D. Rumble III, "Comparison Between 1-D and 2-D Models of Outcrop-Scale Stable Isotope Exchange During Fluid Infiltration"
3rd Place: M. Sturm, D. R. Smith, R. Beane, R. A. Wobus, B. Gustavson, G. Kay, B. Saltoun, J. Stewart, "Geochemistry of Late Stage Alkaline Intrusions of the Pikes Peak Batholith, Colorado"

Wednesday Afternoon

- 1st Place: Hilary Le Q. Stuart-Williams, Henry P. Schwarcz, "Oxygen Isotopic Environmental Information Showing Possible Seasonal Variation in Large Rodent Incisors"
2nd Place: David C. Gosselin, P. Nabelek, Z. Peterman, "Major Ion, 18-O, and SR Variations in K-Rich Lakes of the Alkali Lakes Region, Western Sandhills, Nebraska"
3rd Place: Sandra L. Kamo, Thomas E. Krogh, Bruce H. Bohor, "U-Pb Dating of Single Shocked Zircons: A Method for Locating the Target Site and Determining the Time of Impact"

Thursday Morning

- 1st Place: Dwight F. Coleman, William P. Dillon, "Geometry of Plates in the Northeastern Caribbean Plate Boundary Region Revealed by 3-D Visualization of Earthquake Hypocenters"
2nd Place: Sverre Planke, Olav Eldholm, "Seismic Properties of Seaward Dipping Wedges of Flood Basalts: Examples from the Vøring Volcanic Margin"
3rd Place: Robert J. Malcuit, Ronald R. Winters, "Origin and Evolution of the Earth-Moon System: Can the Archean Sedimentary Rock Record be Used to Distinguish Between Giant-Impact and Tidal-Capture Scenarios?"

Thursday Afternoon

- 1st Place: Mohammad S. Khan, William J. Wayne, "Landslide Hazards Along Karakoram Highway in Northern Pakistan"
2nd Place: J. Douglas Yule, "New Geologic Map of the Rogue, Illinois, and Chetco River Areas, Western Jurassic Belt, Oregon Klamath Mountains: A Cross Section Through a Paired Jurassic Oceanic Arc and Inter-Arc Basin"
3rd Place: M. T. Swanson, "The Casco Bay Restraining Bend on the Norumbega Fault Zone: A Model for Regional Deformation in Coastal Maine"

Boston continued from p. 2

opportunity for students to explore the graduate programs of 45 top schools across the country. More than 140 students registered and spoke with the schools of their choice. This year's forum took place Monday through Wednesday in the poster area of the exhibit hall.

And finally, GSA President Robert Hatcher held the first President's Student Forum late Tuesday afternoon. This forum drew more than 100 students, who were given an opportunity to ask questions and to voice concerns.

UNUSUAL EXHIBITS ATTRACT INTEREST

One 40' x 40' corner of the 244-booth exhibit hall was the setting for a relief model of Mount Everest, thanks to the Boston Museum of Science. This imposing ultra-large scale (1:2500) model was recently displayed in London at the 200th anniversary of the birth of Sir George Everest. It also has been exhibited in Paris and Hong Kong. The project of preparing the model was directed by exploratory cartographer Bradford Washburn, who also provided a spectacular black and white large-photo display for this meeting.

GSA MAKES THE NEWS

What caught the public's eye about the meeting? According to the GSA News Room, Lizzie Borden and dinosaurs topped the list. The link between Lizzie Borden (who took an ax ...) and geology is not obvious at first. Two forensic scientists from George Washington University have used ground-penetrating radar to locate the "missing heads" of Lizzie's parents, and now want to exhume them to compare bone perforations with the hatchet believed used in the infamous murders a hundred years ago. The scientists thereby put to rest speculation about Lizzie's innocence (she was acquitted of the crime). This story received widespread attention on the Boston television news programs and in the local papers.

World-wide interest, however, was in the results from analyzing gas bubbles trapped in amber. According to presenters at the meeting on Wednesday, oxygen levels in the atmosphere, which were as high as 35%

owing to volcanic activity pumping out carbon dioxide that was then converted by plants into oxygen, declined rapidly after the "superplumes" shut down about 65 million years ago. This evidence points to the end of the dinosaur era being marked by a rapid decline in atmospheric oxygen. The story, when it got to the public through the news media, was "Did the Dinosaurs Suffocate?" (from page one of *USA Today*) or "Lack of Oxygen Blamed for Dinosaurs' Extinction" (from the *Washington Post*). The story was also picked up by most newspapers and radio and television programs in the country as well as by the BBC in London and other European media.

The press also was interested in the geological implications of the Gulf War in Kuwait, the subject of a theme session, as well as in what was said about the cleanup of Boston Harbor. The special session on the Great Flood of '93 attracted the popular press, while the theme session on fractal geometry and chaos theory attracted the more scholarly press. Individual presentations in many of the sessions throughout the meeting were targeted by the more than 40 media representatives who attended the meeting, coming from as far away as London (*Nature*).

UNIQUE CHORALE PERFORMANCE RECEIVES RAVE REVIEWS

Months of behind-the-scenes organization resulted in an extraordinary performance of Mozart's Requiem, K. 626. Prior to the meeting, 100 singers from among GSA meeting attendees were chosen for participation, arrangements were made for a 30-piece professional chamber orchestra, and Jordan Hall at the New England Conservatory of Music was scheduled for Tuesday night. When the hundred voices came together for the first rehearsal, it was evident that everyone had done their "homework." Under the able direction of the conductor, the performance was both musically and personally moving. The evening's program also featured Vivaldi's Concerto in G minor for Two Cellos and Purcell's Trumpet Tune and Sonata in D Major. This evening was an extraordinary event most fitting for an extraordinary annual meeting.

Boston was indeed an ideal meeting place. What can top that? We'll see next year in Seattle! ■

Think Seattle



October 24-27, 1994

Washington State Convention and Trade Center
Seattle Sheraton Hotel

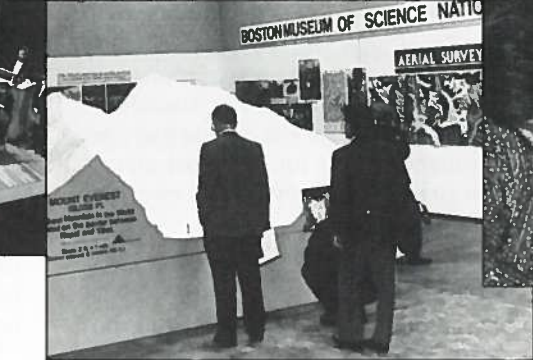
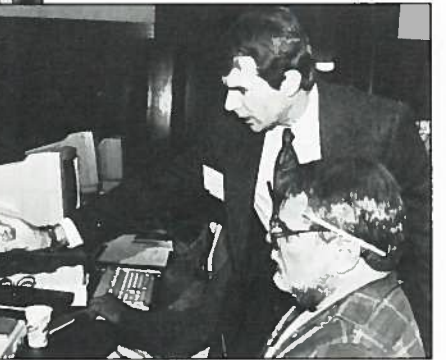
General Chairman: Darrel S. Cowan

Technical Program Chairmen: Mark S. Ghiorso, Thomas Dunne
Symposia and theme proposals due: January 4, 1994.

Field Trip Chairman: Donald A. Swanson
Field trip proposal deadline was May 15, 1993.

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

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



Coal Division Offers Medlin Award

The Coal Geology Division of the Geological Society of America announces the availability of the Antoinette Lierman Medlin Scholarship in Coal Geology for the 1994-1995 academic year. The scholarships provide full-time students who are involved in research in coal geology (origin, occurrence, geologic characteristics or economic implications of coal and associated rocks) with financial support for their project for one year.

Scholarship funding can be used for field or laboratory expenses, sample analyses, instrumentation, supplies, or other expenses essential to the successful completion of the research project. Approximately \$1500 will be available for the 1994-1995 scholarship award. In addition, the recipient of the scholarship may be provided with a stipend to present results of the research at the 1995 GSA Annual Meeting. For the academic year 1994-1995, the Coal Geology Division is also offering a field study award of \$500.

Proposals for the scholarship and the field study award will be evaluated by a panel of coal geoscientists. The awards will go to the students whose proposals are ranked highest by this panel. Applicants may apply for the scholarship award, the field study award, or both; however, only one award will be made to a successful applicant.

Interested students should submit 5 copies of the following:

1. A covering letter indicating which award(s) is (are) sought.
2. A concise statement of objectives and methods, and a statement of how the scholarship funds will be used to enhance the project. The proposal would be no more than five (5) double-spaced pages in length, including references.
3. A letter of recommendation from the student's immediate advisor which includes a statement of financial need and the amount and nature of other available funding for the research project.

Send the material to:

Paul C. Lyons
Chairman, A. Lierman Medlin Scholarship Committee
U.S. Geological Survey
MS 956 National Center
Reston, VA 22092
Phone: (703)648-6449

The proposal and letter of recommendation must arrive no later than February 15, 1994. Applicants will be notified of the Scholarship Committee's decision by April 1, 1994.

The scholarship was established as a memorial to Antoinette "Toni" Medlin who, for many years, quietly and efficiently dedicated herself to the advancement of coal geoscience and to the encouragement of students in coal geology. Monies for the scholarships are derived from the annual interest income from the scholarship fund. ■

Bravo Boston GSA Chorale

AUDIO CASSETTE TAPES AVAILABLE

The Bravo Boston GSA Chorale performed the melodic and moving Mozart Requiem, popularized in the film *Amadeus*, on Tuesday evening, October 26 as part of the 1993 GSA Annual Meeting. The chorale was assembled from your geological colleagues and was accompanied by a professional orchestra. In addition, the performance featured two concerto works by Vivaldi and Purcell, featuring geologists as soloists. The chorale was conducted by John Finney at Jordan Recital Hall on the campus of the New England Conservatory of Music.



Purcell: *Sonata in D for Trumpet and Strings and Trumpet Tune in D*

Vivaldi: *Concerto in G minor for Two Violoncellos*

Mozart: *Requiem, K. 626*

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NORTHEASTERN SECTION, GSA 29th Annual Meeting

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



The State University of New York (SUNY) at Binghamton, the Paleontological Research Institution, Ithaca, New York, and the New York State Geological Survey, Albany, will host the Northeastern Section of the Geological Society of America Annual Meeting at the Holiday Inn Arena in Binghamton, New York. The Eastern Section of SEPM, the Northeastern Section of the Paleontological Society (NE-PS), the Eastern and New England Sections of the National Association of Geology Teachers (NAGT), and the Association for Women Geoscientists will be meeting with GSA's Northeastern Section. The meeting will be conducted from 8:00 a.m. Monday, March 28, to noon Wednesday, March 30. Field trips and a short course will be held on Saturday, March 26, Sunday, March 27, and Wednesday, March 30.

REGISTRATION

Anyone wishing to attend oral sessions, poster sessions, or exhibits must register for the meeting.

Preregistration. All participants are strongly encouraged to preregister as early as possible. Your preregistration form and payment must be received no later than *March 4, 1994*. Complete the attached preregistration form and return it with a check or money order in U.S. currency (made payable to Northeastern Section GSA) to Jim Sorauf, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000. Refunds on canceled preregistration will be made until March 4, 1994. No refunds will be made after that date except for canceled events.

On-Site Registration. On-site registration and pick-up of meeting materials for those who have preregistered will be from 5:00 to 10:00 p.m. on Sunday, March 27; from 7:00 a.m.

to 5:00 p.m. on Monday, March 28, and Tuesday, March 29; and from 8:00 a.m. to noon on Wednesday, March 30. On-site registration and packet pick-up will be held in the entrance lobby of the Holiday Inn Arena.

The Northeastern Section of GSA is unable to accept credit cards for preregistration. Visa and MasterCard will be accepted for on-site registration.

A limited quantity of *Abstracts with Programs* for the meeting will be available during on-site registration. To guarantee a copy, order one when you preregister.

LOCATION

Binghamton is just north of the New York-Pennsylvania border at the confluence of the Susquehanna and Chenango rivers. The area is situated physiographically at the northern edge of the Appalachian Plateau, the eastern edge of the Catskill Mountains, and the

southern edge of the Finger Lakes district. The metropolitan area of approximately 200,000 is served by Interstate 81 and 88 and by State Highway 17, providing excellent highway access from the entire Northeastern Section area and from southeastern Canada. A modern airport with convenient shuttle service to downtown Binghamton is located north of town. Temperatures during March range from the 30s to the 60s (°F); rain, snow, or sunshine can be expected.

HOUSING

A large block of rooms has been reserved for meeting participants and their guests at the Holiday Inn Arena convention facility. The Holiday Inn Arena is conveniently located in downtown Binghamton, with easy access from Interstate 81 or State Highway 17. All of the meeting exhibits will be located within the hotel building, and stores, travel agencies, and restaurants are within easy walking distance. Free parking is available on site for registered guests. For conference planning and to take advantage of attractive conference room rates, it is important to reserve your room before **March 1, 1994**. Guaranteed rates are \$65 single, \$70 double, \$80 triple, or \$90 quad. Mail the housing form directly to the hotel.

TRANSPORTATION

See the accompanying map for directions to the Holiday Inn Arena in downtown Binghamton, New York. Convenient limo service to the downtown area is available from E.A. Link field of the Binghamton Regional Airport, 7 miles north of Binghamton.

TECHNICAL PROGRAM

General technical sessions (oral and poster), symposia, and theme sessions will begin at 8:00 a.m. on Mon-

day, March 28 and will end at noon

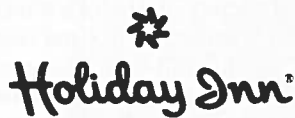
on Wednesday, March 30. Questions should be addressed to Herman Robertson, Abstracts Coordinator, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2835, fax 607-777-2288. The following symposia and theme sessions have been proposed for the Binghamton meeting.

SYMPOSIA

Scheduled symposia are listed below with the conveners.

- 1. Northeast Hydrologic Problems: An Industrial Perspective.** Robert Demicco, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2604; Peter Demicco; Brent Waters.
- 2. What Can Clays Tell Us?: The Application of Clay Mineralogy to Geological Investigations (in the Northeast).** Michele Hluchy, Dept. of Geology, Alfred University, Alfred, NY 14802, (607) 871-2203; Jeff Walker.
- 3. Intraspecific Variation.** Sponsored by the Northeastern Section of the Paleontological Society. Robert Titus, Dept. of Geology, Hartwick College, Oneonta, NY 13820, (607) 432-4200.
- 4. Geochemistry and Movement of Modern and Ancient Crustal Brines.** Tim Lowenstein, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2604; Robert Darling.
- 5. State Geological Surveys and Public Policy.** Sponsored by the GSA Northeastern Section Committee on Geology and Public Policy. Robert Fakundiny, New York State Geological Survey, Room 3140, Cultural Education Center, Albany, NY 12230, (518) 474-5816.
- 6. Sedimentary Geology and Public Policy.** Sponsored by the Eastern Section of SEPM. Susan Halsey, New Jersey Dept. of Environmental Protec-

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Holiday Inn Arena
2-8 Hawley Street
Binghamton, NY 13902
(607) 722-1212

Reservations will be held until 6:00 p.m. unless guaranteed by credit card or advance deposit. Checkout time is 12 Noon.

Northeastern Section • Geological Society of America Sunday, March 27-Wednesday, March 30, 1994

Arrival Date _____ Departure Date _____
 Arrival Time _____ By Car _____ By Plane _____
 Name _____
 Institution or Firm _____
 Address or P.O. Box Number _____
 City, State, Zip Code _____
 Telephone () _____
 Names of Additional Persons Sharing Room _____

Rates: Please check type of room requested at rate requested.

- | | | |
|--|---|-------------------------------------|
| <input type="checkbox"/> \$65.00—Single Occupancy | <input type="checkbox"/> \$10.00—Extra Person | <input type="checkbox"/> Smoking |
| <input type="checkbox"/> \$70.00—Double Occupancy | <input type="checkbox"/> \$10.00—Extra Cot | <input type="checkbox"/> Nonsmoking |
| <input type="checkbox"/> \$80.00—Triple Occupancy | <input type="checkbox"/> One Bed | |
| <input type="checkbox"/> \$90.00—Quadruple Occupancy | <input type="checkbox"/> Two Beds | |

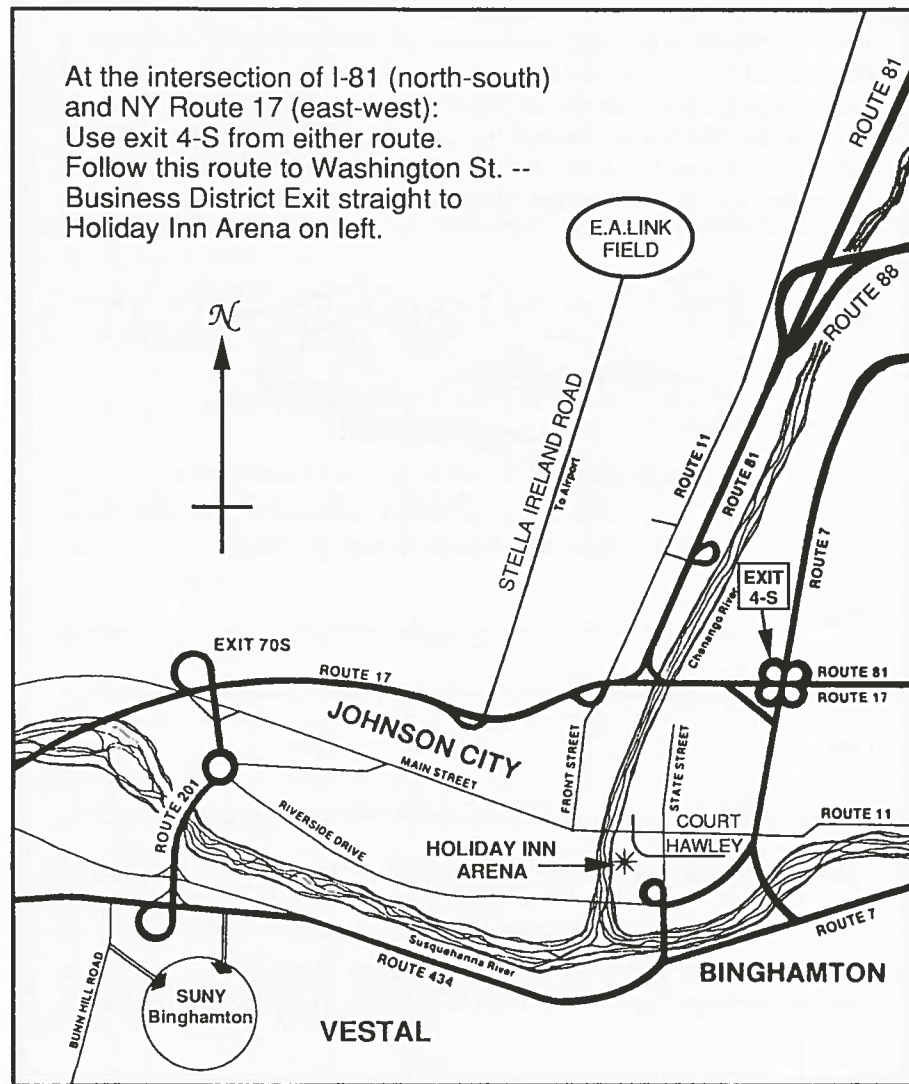
Rates are subject to a 10% tax. Written Confirmation? _____

*All reservations must be accompanied by a credit card guarantee or a deposit of one night's fee in advance. Rooms may not be available prior to 3:00 p.m. on the day of arrival. Check-out time is 12 noon. Reservations received after March 1, 1994, are subject to availability.

- The enclosed check for one night's stay
 Credit Card Guarantee _____
Credit Card Name and Number Required

Exp. Date _____ Signature _____
 Return form and remittance to the Holiday Inn Arena at the above address.

BINGHAMTON AREA



tion and Energy, CN 409, Trenton, NJ 08625-0409, (609) 292-0950; Kelvin Ramsey.

THEME SESSIONS

Scheduled theme sessions are listed below with the conveners.

1. **Use of Computer Graphics for Geologic Instruction.** William J. Brennan, Dept. of Geological Sciences, SUNY at Geneseo, Geneseo, NY 14454, (716) 245-5291.
2. **Mesozoic Magmatism.** H. Richard Naslund, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-4313.
3. **Undergraduate Research.** Poster session. *Sponsored by the Geology Division of the Council on Undergraduate Research.* Barbara Tewksbury, Dept. of Geology, Hamilton College, Clinton, NY 13323, (315) 859-4713.
4. **Advances in Earth Science Education K-12.** Poster session. *Sponsored by the Northeastern and New England sections of NAGT and the GSA Northeastern Section Committee on Education.* Daniel Murray, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 792-2197.
5. **Geological Investigations in the Adirondack Mountains.** Robert Badger, Dept. of Geology, SUNY at Potsdam, Potsdam, NY 13676, (315) 267-2286.
6. **Silurian-Devonian Stratigraphy, Volcanic Characteristics, and Tectonic Settings in the Acadian Orogen of the Northern Appalachians.** Peter Robinson, Dept. of Geology and Geography, University of Massachusetts, Amherst, MA 01003, (413) 545-2593; Alain Tremblay.
7. **Recent Developments in Avalonian Tectonics.** Margaret Thompson, Dept. of Geology, Wellesley College, Wellesley, MA 02181, (617) 283-3029; Damian Nance.
8. **Geochemistry and Geochronology of Igneous and Sedimentary Rocks in the Northern Appalachians.** Scott Samson, Dept. of Geology, Syracuse University, Syracuse, NY 13244-1070, (315) 443-2672; Kurt Hollacher.
9. **Geology Applied to Infrastructure Design, Construction, and Remediation.** Sponsored by the GSA Engineering Geology Division. Robert Fakundiny, New York State Geological Survey, Room 3140, Cultural Education Center, Albany, NY 12230, (518) 474-5816; Robert Fickies.

POSTER SESSIONS

Poster booths (8' x 8') will be framed by pipe and drape and have three 4' x 8' panels. All materials must be attached using double-stick or Velcro tape; no thumb tacks will be allowed. All poster sessions will be located at the Holiday Inn Arena. For general information and suggestions, contact Robert Demicco, Facilities Coordinator, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2604, fax 607-777-2288.

PROJECTION EQUIPMENT

All slides must fit a standard 35 mm carousel tray. Two projectors and two screens will be provided in each of the technical sessions. Overhead projectors will not be available. Speakers are expected to bring their own loaded tray or trays to the session. Please label trays with your name, session, left or right screen, and time of paper; give trays to the projectionist at least 20 minutes before the beginning of the

Preregistration Form

GSA Northeastern Section
Binghamton, New York • March 28-30, 1994

Preregistration deadline is March 4, 1994. (No refunds after March 4, 1994.)

Please print clearly. This area is for your badge.

Name as it should appear on your badge _____

Employer/University Affiliation _____

City _____ State _____

Mailing Address _____

City _____ State _____ Zip Code _____

Country (if other than USA) _____

() () ()
Business Phone fax Home Phone

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

Circle member affiliation (to qualify for registration discount): (A) GSA Member # _____, (B) SEPM Member # _____, (C) PS Member # _____, (D) NAGT Member # _____, (E) AWG Member # _____

Guest Information. Please print clearly. This area is for your badge.

Name as it should appear on your badge _____

City/State or Country _____

	BY MARCH 4		ON SITE		Qty	Amount
	Full Meeting	One Day	Full Meeting	One Day		
Professional Member*	\$50 <input type="checkbox"/>	\$30 <input type="checkbox"/>	\$65 <input type="checkbox"/>	\$40 <input type="checkbox"/>	1	\$ _____
Professional Nonmember	\$65 <input type="checkbox"/>	\$40 <input type="checkbox"/>	\$80 <input type="checkbox"/>	\$50 <input type="checkbox"/>	1	\$ _____
Student Member*	\$20 <input type="checkbox"/>	\$20 <input type="checkbox"/>	\$25 <input type="checkbox"/>	\$25 <input type="checkbox"/>	1	\$ _____
Student Nonmember	\$25 <input type="checkbox"/>	\$25 <input type="checkbox"/>	\$30 <input type="checkbox"/>	\$30 <input type="checkbox"/>	1	\$ _____
K-12 Teacher	\$30 <input type="checkbox"/>	\$20 <input type="checkbox"/>	\$40 <input type="checkbox"/>	\$30 <input type="checkbox"/>	1	\$ _____
Guest/Spouse	\$20 <input type="checkbox"/>	\$20 <input type="checkbox"/>	\$20 <input type="checkbox"/>	\$20 <input type="checkbox"/>	1	\$ _____
*Member fee applies to any existing professional OR Student Member of GSA or Associated Societies listed above.						
SPECIAL EVENTS						
Welcoming Reception			FREE		1	\$ _____
NAGT Business Meeting and Luncheon			\$12		1	\$ _____
SEPM Business Meeting and Reception			FREE		1	\$ _____
Association for Women Geoscientists Breakfast			\$10		1	\$ _____
Paleontological Society Luncheon			\$12		1	\$ _____
Northeast Section Reception and Banquet						
Prime Rib			\$20		1	\$ _____
Pasta Primavera			\$20		1	\$ _____
FIELD TRIPS						
Devonian Marine and Nonmarine Deposits						
Saturday and Sunday			\$45		1	\$ _____
Sunday only			\$25		1	\$ _____
Geomorphology and Environmental Geology			\$15		1	\$ _____
Local Geology of the Binghamton Area			\$10		1	\$ _____
SHORT COURSE						
Emerging Software Technologies			\$20		1	\$ _____
GUEST EXCURSIONS						
Corning Glass Museum			\$10		1	\$ _____
Montezuma Wildlife Refuge			\$10		1	\$ _____
TOTAL FEES						\$ _____

Remit in U.S. funds payable to: 1994 GSA Northeastern Section Meeting
(All preregistrations must be prepaid. Purchase Orders or credit cards not accepted.)

MAIL TO: JAMES E. SORAUF
Department of Geological Sciences and Environmental Studies
State University of New York
Binghamton, NY 13902-6000

FOR OFFICE USE

Check # _____

Amount paid \$ _____

Refund Check # _____

session. A speaker ready room for pre-viewing slides will be provided. Extra trays will be available.

SHORT COURSE

A single short course will be run at the Binghamton meeting on Sunday, March 27 from 1:00 to 5:00 p.m. at the Holiday Inn Arena. Preregistration is required.

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

This course introduces five major new programming paradigms that are being transferred from a research status to a status of serious industrial use. These are Expert (or Knowledge-based) Systems, Neural Networks, Multimedia, Genetic Algorithms, and Virtual Reality. The course will cover each of these areas, starting from an introductory level. Thus, participants need have no prior knowledge of any of these fields, but should have solid familiarity with

computing in general. Each subject will include an introduction to the programming paradigm, some history and background including theoretical or scientific origins, and detailed discussion of how to recognize applications for each or how to assess a project for use of these techniques, and will provide examples from the fields of geology and other sciences in which these techniques have been applied. Cornelia Yoder has a Ph.D. in computer sciences and has strong interests in geological applications of computer techniques. Cost: \$20.

FIELD TRIPS

Proposed field trips for the Binghamton meeting are listed below. The actual trips run will depend on weather and enrollment. All trips will depart from and return to the Holiday Inn Arena, Binghamton, New York.

Devonian Marine to Non-marine Deposits in South-Central New York State. Saturday, March 26 at 9:00 a.m. to Sunday, March 27 at

5:00 p.m. John S. Bridge, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2831, fax 607-777-2288.

Marine transgressions and regressions during the Middle to Late Devonian are recorded in shallow-marine, coastal, and alluvial deposits in south-central New York. Emphasis will be upon examining the changing position, geometry, and processes of the nearshore zones during these changes of relative sea level, and upon establishing causes for such changes.

On Saturday, March 26, we will visit the Schoharie valley and vicinity, including Hardenburgh Falls and Stevens Mountain Quarry, to examine a regressive coastal sequence with a variety of tide-influenced channel and mouth bars overlying storm-dominated shallow-marine deposits. At Manorkill Falls, we will see a transgressive coastal sequence with an example of the famous Gilboa fossil forest buried by

Northeastern continued on p. 14

marine sand. Grand Gorge, route 30, illustrates a regressive coastal sequence overlain by alluvial flood basin deposits. Davenport Quarry contains alluvial overbank deposits with unusual (but not unique) nonmarine carbonate beds.

On Sunday, March 27, we will visit the Appalachian-Waverly area, including Ashcraft quarry, a marine transgressive sequence with a very unusual lime-sandstone body, and stops where we will see storm-dominated shallow-marine strata with the best hummocky cross strata in the area, and meter-scale coarsening-upward sequences.

Lunches will be provided; overnight accommodations, breakfasts, and dinners are the responsibility of participants. Cost: \$45. Those wishing to attend only the second day of the trip may do so on a space-available basis for a cost of \$25.

Geomorphology and Environmental Geology of the Binghamton Area. Sunday, March 27 from 8:00 a.m. to 5:00 p.m. Marie Morisawa, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2837, fax 607-777-2288.

On this trip we will examine the geomorphic factors influencing the development and urbanization of the Binghamton area. The glacial geology and postglacial erosion have established the environmental setting. The area provides an excellent opportunity to observe some of the dangers and problems that arise with urbanization and to see some of the solutions offered (for better or worse). The emphasis will be on the geomorphic response to human alteration of the geologic environment of streams and slopes. Cost: \$15.

Local Geology in the Binghamton Area. Wednesday, March 30, 1:00 to 5:00 p.m. Nick Donnelly, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000. (607) 777-2323, fax 607-777-2288.

This trip is designed especially for teachers of earth sciences to provide ideas for local field trips for high school students in the Binghamton area. The trip will examine glacial till, outcrops of Devonian silts and sandstones, and an exposure of glacial outwash gravels along the Susquehanna River. Other minor glacial features will be seen. At the beginning of the trip there will be a brief lecture on the geologic history of the Binghamton area. Cost: \$10.

EXHIBITS

Exhibit space will be available at the Holiday Inn Arena; snacks and refreshments will be available for exhibit visitors. Exhibit booths (8' x 8'), framed with drapes and containing a table and chairs, will be available for

exhibitors during the entire meeting from 8:00 a.m. Monday, March 28, to noon Wednesday, March 30. The cost of standard booths will be \$400 for commercial exhibitors and \$200 for educational or nonprofit groups or institutions.

Three special half-day Theme Exhibit Sessions are planned for (1) Graduate Programs in the Geological Sciences, (2) State Geological Surveys, and (3) Environmental Consulting Companies. These special sessions are designed to encourage participation by groups that might not wish to have an exhibit during the entire meeting, and to provide a time and place for exhibit visitors to examine a variety of groups or programs with similar interests. During these special exhibit sessions, tables and chairs will be available in a central area without booths at a reduced exhibit price of \$50. Exhibitors renting a booth for the entire meeting will be provided with a table and chairs at the appropriate special theme exhibit sessions at no additional cost.

Arrangements will be made for alumni reunions, organizational get-togethers, or business meetings on Monday, March 28 from 7:00 to 10:00 p.m. at the Holiday Inn Arena. Receptions in a joint meeting room will be \$20 per organization; private meeting rooms will be \$50. There will be a cash bar set up in the joint meeting room; receptions or meetings in private meeting rooms will be able to make individual arrangements for refreshments.

For further information and space reservations, contact: Bill MacDonald, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-2863, fax 607-777-2288, E-mail: bg0098@bingvmb.cc.binghamton.edu.

PHOTO EXHIBIT

A photographic competition and exhibit will be held during the meeting. Entries will be judged on the basis of impact, content, composition, and overall presentation. Subjects should highlight some aspect of geology and/or some aspect of the GSA Northeastern Section area. Photographs will be exhibited during the entire meeting. First, second, third, and honorable mention prizes will be awarded for color and black and white prints.

Guidelines: Photographs must be either color or black and white. Prints must be at least 8" x 10" and at most 16" x 20". Photos should be firmly matted, with your name, address, and telephone number on the back of each matte board. No more than three entries per photographer. Entries should be picked up between 8:00 a.m. and noon on Wednesday, March 30. GSA will not be responsible for any damage or loss of photographs.

To enter, fill out the entry form in this announcement and send it with your photos to David Tuttle, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-6774, fax 607-777-2288.

SPECIAL EVENTS

Hockey Game—Binghamton Rangers vs. Rochester Americans. Saturday, March 26, 7:00 p.m. at the Broome County Arena (a 3-minute walk from the Holiday Inn Arena conference center). Advance reservations are suggested. The ticket office may be contacted at (607) 723-8937.

GSA Northeastern Section Management Board Meeting. Sunday, March 27, from 4:30 to 6:00 p.m. at the Holiday Inn Arena.

Welcoming Reception. A welcoming reception will be held at the Holiday Inn Arena from 6:00 to 10:00 p.m. Liquid refreshments and hors d'oeuvres will be served. A cash bar will also be available.

Combined Eastern Section and New England Section of NAGT Business Meeting and Luncheon. Monday, March 28, from noon to 1:15 p.m. Cost: \$12. Preregistration is required.

Eastern Section of SEPM Business Meeting. Immediately following the last talk of the SEPM Symposium there will be a business meeting with refreshments. Noel P. James, President-elect of SEPM, will speak on "Cold-water Carbonates in the Southern Ocean." The meeting is open to all SEPM members. **Institutional Receptions.** Arrangements will be made for alumni reunions, organizational get-togethers, or business meetings on Monday, March 28, from 7:00 to 10:00 p.m. at the Holiday Inn Arena.

Association for Women Geoscientists Breakfast. Tuesday, March 29, from 6:45 to 8:30 a.m. at the Holiday Inn Arena. A program will be presented. Cost: \$10. Preregistration is required.

Northeastern Section of the Paleontological Society Luncheon. Tuesday, March 29, from noon to 1:15 p.m. Cost: \$12. Preregistration is required.

Annual Northeastern Section GSA Reception and Banquet. Tuesday, March 29, from 7:00 to 9:00 p.m. at the Holiday Inn Arena. Isaac Winograd of the U.S. Geological Survey will give an after-dinner talk, "The Paleoclimate Record in Cave Deposits." Banquet cost: \$20. Advance registration is required. The doors will be opened following the banquet so that everyone may hear Winograd's talk.

EARTH SCIENCE EDUCATION

Special activities are planned for K-12 earth science educators. A poster session, "New Advances in Earth Science Education K-12," is scheduled, as well as a field trip to the Kopernik Observatory and Science Center in Vestal, New York, and a local geology field trip for K-12 earth science educators on Wednesday, March 30. The K-12 program is cosponsored by the Northeastern and New England Sections of NAGT and the GSA Northeastern Section Committee on Education. Participants wishing to present a poster session, lead a demonstration, or run a workshop directed toward earth science education on levels K-12 and/or those wishing to register for the full K-12 program for one college credit in continuing education should contact Daniel Murray, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 792-2197.

GUEST ACTIVITIES

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

Corning Glass Museum, Monday, March 28, 10:00 a.m. to 4:30 p.m. Cost: \$10. Preregistration is required.

Montezuma Wildlife Refuge, Tuesday, March 29, to see the spring waterfowl migration, with a stop at one of the Finger Lakes Wineries. Cost: \$10. Preregistration is required.

For further information, contact Ailsa Donnelly, Guest Activities Coordinator, c/o Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000. (607) 722-4939.

SCIENCE THEATER

A wide variety of films of interest to students and educators at all levels will be available for viewing. For details, contact Ina Brownridge, Director of Multimedia Resources, Computer Center, SUNY, Binghamton, NY 13902-6000.

FURTHER INFORMATION

Requests for additional information should be addressed to General Chairman H. Richard Naslund, (607) 777-4313, to Registration Coordinator James E. Sorauf, (607) 777-2561, or to Abstracts Coordinator Herman E. Roberson, (607) 777-2835, all at Dept. of Geological Sciences and Environmental Studies, State University of New York, Binghamton, New York 13902-6000, fax 607-777-2288, E-mail: geomail@bingvaxa. ■

Northeastern Section Photo Contest Entry Form

Name _____
 Institution _____
 Address _____
 City _____ State _____ ZIP _____ Country _____
 Daytime phone () _____
 Description of photo: _____

Mail to: David Tuttle
 Department of Geology - SUNY
 Binghamton, NY 13902-6000

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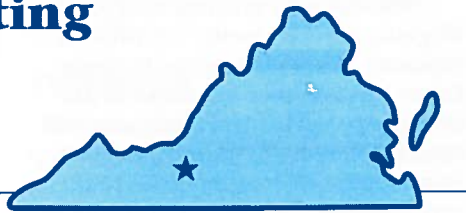
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SOUTHEASTERN SECTION, GSA 43rd Annual Meeting

Blacksburg, Virginia
April 7-8, 1994



The Southeastern Section of the Geological Society of America will meet in the Donaldson Brown Center for Continuing Education, the adjacent Squires Student Center, and nearby Owens Hall on the campus of Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg. The meeting will be hosted by the Department of Geological Sciences, Virginia Tech, in cooperation with the Department of Geology at Radford University.

SETTING

Blacksburg, the home of Virginia's largest university, is located in the Valley and Ridge at the junction of the central and southern Appalachians. The town is on a rolling upland at an elevation of 2100 feet and is a short drive from the state's highest natural lake, Mountain Lake and resort, at 3900 feet. In early April spring bulbs are in full bloom and dogwoods are just opening. In addition to major regional malls in the Blacksburg-New River Valley area, the Roanoke metropolitan area (population about 200,000) provides shopping, museums, airport access, and entry to the Blue Ridge Parkway in just 40 minutes by four-lane Interstate I-81 and US 460 from Blacksburg.

TRAVEL TO BLACKSBURG

Blacksburg is located on US Route 460 nine miles west of Interstate 81 in southwestern Virginia. It is serviced by

Roanoke Regional Airport located just off Interstate 81 about 40 miles to the east of Blacksburg. Access is by USAir, United, American, Delta, and Northwest airlines. Attendees should arrange their own ground transport from Roanoke to Blacksburg by calling Blacksburg Limousine Service, (703) 951-3973. Most of the major national car rental firms are located at the airport.

HOUSING

Rooms have been reserved for participants in Blacksburg motels up to 1.5 miles from the meeting site. Shuttle bus transportation will be available for attendees. *Do not plan to park at the conference site unless you are staying in the hotel at the Donaldson Brown Center.*

PARKING

Parking is not available on campus during the day except for attendees staying at the Donaldson Brown Center

meeting headquarters. Shuttles will be provided for transporting other attendees between hotels and the meeting at the Donaldson Brown Center.

WELCOMING PARTY

A Welcoming Party will be held in the Donaldson Brown Center for Continuing Education, in the Dining and Old Guard Rooms, Wednesday, April 6, from 6 to 8 p.m. The party is for all who will be attending the meeting plus friends and guests. It will not be necessary to have registered for the meeting in order to attend, but registration is recommended because a complimentary beverage will be part of the registration package. Plan to attend, visit with old friends, and make new ones. Light refreshments will be served.

OPEN HOUSE

An Open House in the Department of Geological Sciences will be held in the Museum of Geological Sciences on the second floor of Derring Hall on Friday, April 8, from 5 to 7 p.m. Light refreshments will be served, and you are welcome to wander around the department, visit the laboratories and meet with faculty and students.

FIELD TRIPS

Registration. *Field trip registrants must register for the meeting.* Field trip cost includes transportation, guidebook, and other items as listed in the description. Registration procedures, forms, and deadlines are provided in this announcement. Registration at the meeting for postmeeting trips may be possible if trip logistics and space permit. If trips are under-enrolled and canceled, participants will be notified no later than ten days before the meeting, and all field trip fees will be refunded after the meeting. There will be no

refunds if participants fail to show up on time for a field trip for reasons other than serious illness or other emergency. Sponsoring agencies assume no liability whatsoever for failure of participants to show for a trip, for missed connections, or for injury, loss, or damage during or resulting from transportation in the field trips. *The number of participants in most trips is limited, so get your registration in as early as possible to avoid disappointment.* Further information, if required, will be sent to trip participants by the trip leaders. Field trip coordinators are Bill Henika, Virginia Division of Mineral Resources, Blacksburg, (703) 231-4298, and Art Schultz, U.S. Geological Survey, Reston, (703) 648-6501.

Premeeting

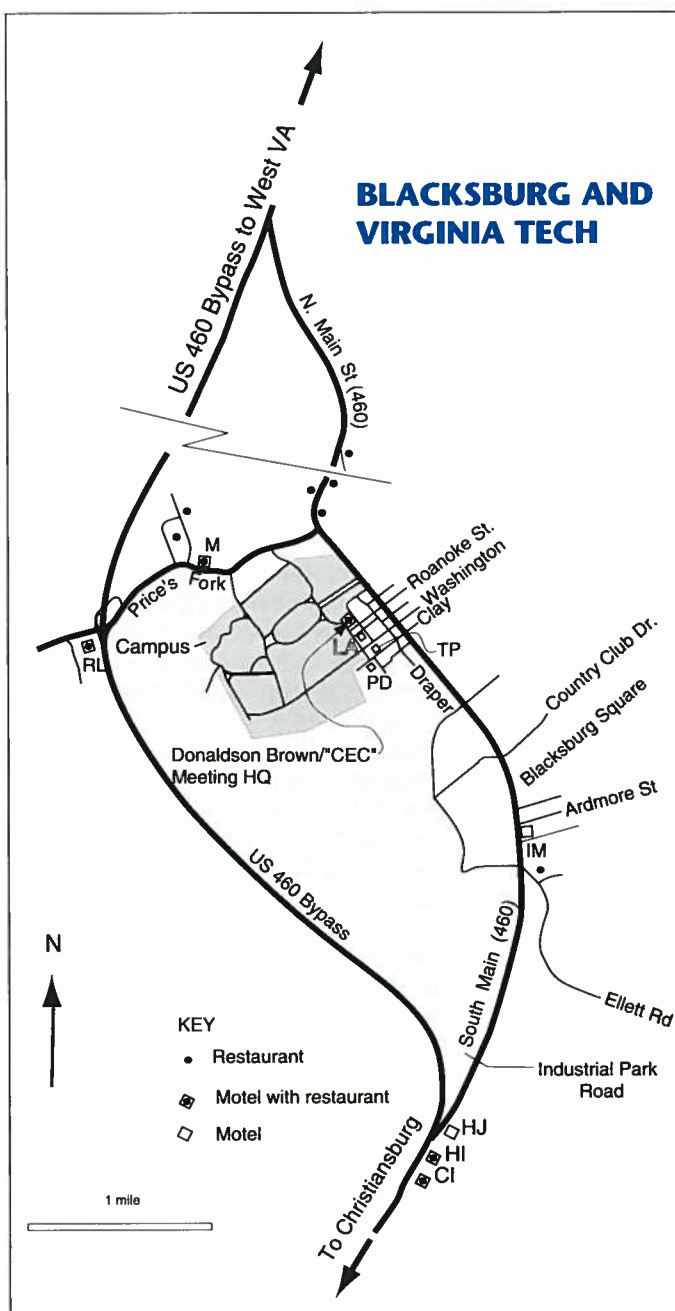
1. Late Precambrian Rift and Drift Sequences and Structure across the Blue Ridge-James River Gorge to Lynchburg, Virginia. April 5-6. Lynn Glover, III, Dept. of Geological Sciences, VPI&SU, Blacksburg, VA 24060, (703) 231-6213 and Edgar Spencer, Dept. of Geology, Washington and Lee University, Lexington, VA 24450, (703) 463-8800.

The trip is a geological traverse through the Blue Ridge along the James River Gorge from Glasgow to Lynchburg, Virginia. On the first day, we will examine outcrops of the Chilhowee Group and Catoctin Formation on the western flank of the Blue Ridge. Emphasis will be on the stratigraphy of the rift facies, superimposed compressional and extensional structures, and the relation of the Blue Ridge thrust to zones of ductile deformation in the crystalline basement. Post-Grenville correlations across the Blue Ridge, including the rift to drift transition in development of the Late Proterozoic Iapetus passive margin will be discussed. On the second day we will examine the Late Proterozoic rift facies of the newly recognized volcanic Moneta Formation, and the overlying Lynchburg Group on the east flank of the Blue Ridge. The focus will be on structure, tectonic environment of accumulation, and ophiolite vs. non-ophiolite origin of the mafic-ultramafic suite. The trip departs from Roanoke at 8:00 a.m. Tuesday, April 5, and returns to Blacksburg (early evening April 6) through Roanoke. Cost: \$85, includes transportation, one lunch, one night's lodging (double occupancy), and guidebook. Limit: 20.

2. Stratigraphic Relations and Structural Chaos on the Southeastern Limb of the Blue Ridge Anticlinorium and Points East, Central Virginia Piedmont.

April 5-6. Nick H. Evans, Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903, (804) 293-5121; Robert C. Milici, USGS, Box 25046, Federal Center, Denver, CO 80225, (303) 236-1644.

Recent geologic mapping in low-grade metamorphic rocks of Albemarle and Fluvanna Counties has refined the stratigraphic framework in early Paleozoic(?) passive-margin cover rocks on the southeastern limb of the Blue Ridge anticlinorium, and poses new constraints on the regional tectonic boundary between these rocks and early Paleozoic(?) metagraywackes of back-arc-basin or accretionary complex affinity to the southeast. This boundary, equivalent to the Mountain Run fault zone of Pavlides (1989), is a zone of complex structure derivative of multiple episodes and styles of deformation. Metagraywackes were first



REGISTRATION FEES

	Preregistration	On-site
Professional Member	\$55	\$60
Professional Nonmember	\$60	\$65
Student Member	\$20	\$25
Student Nonmember	\$25	\$30
Guest	\$10	\$10
K-12	\$12	\$12

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Donaldson Brown Hotel and Conference Center (DB) (703) 231-5156	115	\$46	\$54	\$62
Blacksburg Marriott (M) (703) 552-7001	100	\$69	\$76	\$86
Best Western Red Lion Inn (RI) (703) 552-7770	80	\$45	\$55	\$61
Imperial Motor Hotel (IM) (703) 552-4011	35	\$35	\$40	—
Holiday Inn (HI) (703) 951-1330	70	\$48	\$54	—
Comfort Inn (CI) (703) 951-1500	60	\$45	\$50	\$55
Howard Johnson Inn (HJ) (703) 951-4242	25	\$32	\$38	—

*Rooms to be used by meeting participants and their guests have been blocked in the hotels and motels listed. To reserve rooms, call the motel, hotel, or bed and breakfast directly, before March 15, state your Geological Society of America connection, and request a reservation number. Guaranteeing your reservation is highly recommended. Nearby bed and breakfasts: L-Arche [LA] (703) 951-1808 (\$75/night for 2); Per Diem [PD] (800) 272-4704 (\$75/night for 2); Twin Porches [TP] (703) 552-0930 (\$55/night for 2, Sunday through Thursday, \$75/night Friday and Saturday).

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juxtaposed against Blue Ridge cover rocks during synmetamorphic (D1—Taconic?) contractional deformation that transposed primary layering in hanging-wall metagraywackes, and produced "pinstriped" mylonitic schists. Subsequent postmetamorphic contractional deformation (D2—Alleghanian?) imbricated a "pseudostratigraphy" consisting of Blue Ridge cover rocks in the footwall, D1 fault rocks, and hanging-wall metagraywackes along northwest-directed thrusts, which are associated with northwest-verging asymmetric map-scale folds. Extensional faulting (D3—Mesozoic?) was localized along several D2 faults, further contributing to map-scale structural complexity. The field trip will first demonstrate the stratigraphic sequence on the southeastern limb of the Blue Ridge Anticlinorium, beginning with an exposure of the contact between Catoclin meta-basalt and overlying metasedimentary rocks. Subsequent stops will present field evidence of each deformation phase, culminating in window exposures southeast of the main fault zone where Blue Ridge-sequence rocks occupy the core of a D2 ramp anticline that folds a D1 fault (Rivanna River anticline). The trip will begin at 8:00 a.m. Tuesday, April 5, at the Holiday Inn, Monticello, 5th Street and I-64, Charlottesville, VA, (804) 977-5100, and will end at the same location in the afternoon on Wednesday, April 6, allowing time for the 2½-hour drive to Blacksburg. Several field trip stops will involve some walking over rough terrain. Cost: \$85, includes one night's lodging (April 5; double occupancy), two lunches, transportation, guidebook, and pertinent published geologic maps. Those desiring lodging on the night of April 4 should make their own arrangements. Limit: 26.

3. K-Bentonites, Conglomerates, and Unconformities in the Ordovician of Southwestern Virginia.

April 4 (afternoon)—April 6 (evening). John T. Haynes, Dept. of Mineral Sciences, Smithsonian Institution, Washington, DC 20560, (202) 357-2060. Co-sponsored by the Southeastern Section of SEPM.

The Deicke and Millbrig K-bentonite Beds and the associated Walker Mountain Sandstone Member have been traced throughout southwestern Virginia, where they occur in the Moccasin, Eggleston, and Bays Formations. On this trip, we will visit several localities, classic and new, in Virginia and Tennessee, and discuss the petrogenetic and diagenetic history and the regional stratigraphy of the Deicke and Millbrig, including their relation to the base of the Trenton Formation, a widely recognized horizon considered by some to be a sequence boundary. The Walker Mountain, a thin but widespread and commonly conglomeratic sandstone, is itself an excellent marker bed, and it overlies a widely traceable unconformity that, where present, is the only significant unconformity above the post-Knox unconformity and below the pre-Silurian unconformity. We will examine the petrology, sedimentology, and stratigraphy of the Walker Mountain, focusing on its relation to the K-bentonite. Stops will include Hagan, Virginia, localities along the Clinch, Bays, Big Walker, Cove, and Draper Mountain belts, and localities in the Salem and Fincastle synclinoria. The trip will begin and end in Blacksburg. Cost: \$120, includes transportation, two lunches, two nights' lodging (double occupancy), and guidebook. Limit: 30.

4. Devonian Strata of Catawba Syncline near Salem, Virginia.

April 6, Thomas J. Rossbach, Dept. of Earth Sciences, University of North

Carolina, Wilmington, NC 28403, (919) 395-3491; John M. Dennison, Dept. of Geology, University of North Carolina, Chapel Hill, NC 27599-3315, (919) 966-4516.

The Catawba syncline near Salem, Virginia, provides nearly continuous exposure of Middle Silurian through Lower Mississippian age rocks of the central Appalachians. Participants will examine varying lithologies, ranging from dysaerobic marine shales to fluvial conglomerates. Much of the trip will concentrate on the lithology and paleontology of the rocks that make up the Devonian Catskill delta, and which can be found along and on Ft. Lewis Mountain. The stratigraphic positions of conglomerates, conglomeratic sandstones, red beds, and siltstone bundles are used to correlate this section to several others within the Appalachian basin. Fossil beds are common and display excellent molds and casts of brachiopods, bivalves, and other fauna. Near the top of Ft. Lewis Mountain is a thin shale unit that marks the Devonian-Mississippian boundary. The trip will leave Blacksburg, Virginia, at 8:00 a.m. and will return to Blacksburg at 5:00 p.m. Cost: \$30, includes transportation, field guide, and lunch at the Sunnybrook Inn. Limit: 22.

Postmeeting

5. **Geology of the Mt. Rogers Area, Southwestern Virginia Blue Ridge and Unaka Belt.** April 8 (evening)—April 10. Douglas W. Rankin, USGS, 926 National Center, Reston, VA 22092, (703) 648-6903; Julia M.G. Miller, Dept. of Geology, Vanderbilt University, Nashville, TN 37235, (615) 322-2144; Edward L. Simpson, Dept. of Physical Sciences, Kutztown University, Kutztown, PA 19530, (215) 683-4447.

On this trip we will examine evidence for volcanic and glacial events surrounding the Late Proterozoic breakup of Laurentia and clastic sedimentation during the Early Cambrian opening of the Iapetus Ocean in the Mt. Rogers area. We will see a sequence of anorogenic, dominantly rhyolitic, volcanic rocks and volcanogenic sedimentary rocks of the Mount Rogers Formation, and the nonconformable contact between these and the underlying billion-year-old Grenvillian continental crust. Participants will walk through a section of a chemically and mineralogically zoned welded ash-flow sheet representing the climactic eruption of the 760 Ma volcanic episode of a failed rift. We will study exposures of glaciogenic sedimentary rocks of the Konnarock Formation that conformably overlie the Mount Rogers Formation and discuss the type of glacial environments represented. Outcrops include examples of massive and bedded diamictite, laminite (some with dropstones), and massive and graded sandstones, all probably deposited in a glacial lake. Participants will also examine exposures of the basal Cambrian clastic sequence, the Chilhowee Group, of which the basal Unicoi Formation probably includes the Proterozoic-Cambrian boundary and the marine transgression representing the successful opening of the Iapetus. Exposures visited will include thin metabasalts, possibly correlative with the ca. 560–570 Ma Catoclin Formation of northern Virginia, and stratigraphically higher exposures from which Early Cambrian fossils have been recovered. We will discuss the structural setting of these rocks within an imbricate stack of Alleghanian thrust sheets. The trip will begin and end in Blacksburg. Cost: \$120, includes transportation, two nights' lodging (double occu-

pancy), three meals on Saturday, two meals on Sunday, and guidebook. Limit: 40.

6. **Geologic and Structural Transect of the New River Valley: Valley and Ridge and Blue Ridge Provinces, Southwestern Virginia.** April 9–10. Mervin J. Bartholomew, Earth Sciences and Resources Institute, University of South Carolina, Columbia, SC 29802, (803) 777-0178, E-mail: jbarth@esri.esri.sc.edu; Sharon E. Lewis, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC 29808; and William S. Henika, Virginia Division of Mineral Resources Office @ Dept. of Geological Sciences, Virginia Tech., Blacksburg, VA 24061, (703) 231-4298.

Characteristic lithologies, sequences, and structural features are highlighted along an Appalachian transect. The trip extends across the fold and thrust belt from the structural front along the New River at Glen Lyn, Virginia, across the Grenvillian massifs of the Blue Ridge southwest of Roanoke, and across the Piedmont to the Smith River allochthon near Martinsville, VA. Stops and discussions are centered around several themes: the Grenvillian orogenic cycle, Iapetus-related rocks of the Piedmont and Blue Ridge, and a tectonothermal sequence for the fold and thrust belt. The first day will begin in the Grenvillian granulite-facies gneisses and Bottom Creek (charnockite) suite of the Pedlar massif. Other Blue Ridge stops include representative rocks of the Lovington massif, the Fries fault zone, mylonitic rocks along the northwest border zone of the Late Proterozoic Moneta rift basin, and the Iapetus Dillons Mill pluton. Stops in the prograde (Paleozoic) amphibolite-facies rocks of the Piedmont between Boones Mill and Fairystone State Park illustrate the stratigraphic succession among rift facies siliciclastics (Ashe Formations) and detrital carbonate facies thought to be derived from the Laurentian continental margin and fine-grained, sulfidic schists intercalated with mafic to ultramafic volcanic and igneous rocks (Alligator Back and Candler Formations) that are interpreted to be deep-water basinal facies. One stop will be at the spectacular exposure of a "quartz lump" conglomerate that is characteristic of the volcanic-arc-derived "diamictite" facies of the Bassett Formation southeast of the Brevard-Bowens Creek transpressional fault zone. The second day will begin with detailed structures at Glen Lyn in the footwall syncline of the St. Clair thrust, followed by examination of the thrust itself. Major stops will include the Bane Dome where Max Meadows breccia occurs near the windows through the Narrows thrust; the footwall synclines, breakthrough thrust, syncline-detachment fault, and associated structures of the Saltville fault system; footwall synclines of the Salem, Catawba, and Tract Mountain thrusts; spectacular classic exposures of the highly deformed basal part of the Pulaski thrust sheet; and "orphans" of the Pulaski thrust system. Some stops illustrate tectonothermal relations such as contrasting thermal histories in coal beds, nonuniform and/or multiple(?) cleavage development, sequence of structures, and reactivation of paleosol(?) features during thrusting. Departure on both Saturday and Sunday mornings will be from the front of the Donaldson Brown Center at Virginia Tech at 7:30 a.m. The Sunday trip will conclude at the Donaldson Brown Center at 5:00 p.m. Cost: \$40, includes guidebook, two lunches, and

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transportation (does not include lodging or other meals). Limit: 27.

7. Slope Stability Problems along Highway Cuts in the Virginia Valley and Ridge. April 9. Chester F. Watts and Robert C. Whisonant, Dept. of Geology, Radford University, Radford, VA 24142, (703) 831-5224. Cosponsored by the GSA Engineering Geology Division.

The Valley and Ridge of southwestern Virginia presents significant problems for engineering geologists who are concerned with slope stability along highway and railroad cuts. The combination of steep slopes and complex stratigraphy and structure produces a variety of failures including rock slides, rockfalls, and slump movements. On this trip, participants will see examples of each of these failure types along major transportation routes. In particular, we will examine unstable slope conditions associated with three major Appalachian thrust fault zones; the Pulaski, Narrows, and St. Clair. Emphasis will be on the specific geologic causes of these failures and subsequent remediation efforts. The trip will begin and end in Blacksburg (8:00 a.m. to 6:00 p.m.). Cost: \$30, includes transportation and guidebook (lunch not included but fast food available). Limit: 25.

8. Carboniferous and Ordovician Clastic and Carbonate Cyclic Facies in Kentucky. April 8 (evening)–April 10 (early evening). J. Fred Read, Aus Al Tawil, M. Pope, Bret Bennington, and R. K. Bambach, Dept. of Geological Sciences, VPI&SU, Blacksburg, VA 24061, (703) 231-6521.

The field trip will examine superb exposures in the Paleozoic rocks of Kentucky within the context of moderate- to high-amplitude, Milankovitch-driven eustasy and associated tectonics, and its effect on the carbonate and siliciclastic sedimentary record. The Pennsylvanian clastic cycles in eastern Kentucky reveal evidence of sea-level changes even in a setting of high rate of clastic influx. Several stops will be made in the Magoffin marine interval where the full spectrum of transgressive and regressive conditions can be recognized and examined in settings of different rates of accumulation. Several other marine-nonmarine cycles will also be observed. These clastic cycles probably are related to sea-level fluctuations during the late Carboniferous glaciation. Participants will examine an extremely thinned Mississippian carbonate section in the classic I-64 highway cuts and a much thickened down-ramp section of the time-equivalent rocks in the Renfro Valley area. These cyclic warm-water carbonates with their abundant subaerial exposure surfaces and scarcity of regional tidal flats reflect development within a foreland setting and moderate-amplitude high-frequency eustasy during the buildup of the late Paleozoic Gondwana glaciation. Regional paleoaquifers and associated calcite cement zones within the Mississippian carbonates, which can be tied to major Late Mississippian and Mississippian-Pennsylvanian unconformities as the climate became wetter, will be discussed. We will also visit an excellent section of later Middle Ordovician cool-water carbonates of the Lexington Limestone, to observe some of the interesting small-scale cycles. These are characterized by rapid shallowing from relatively deeper water facies up into high-energy shallow bank facies, which preserve evidence of high-frequency, moderate-amplitude eustasy. This might reflect the early stages of Late Ordovician Gondwana

glaciation. The trip begins and ends in Blacksburg; return route is via Lexington airport Sunday afternoon. Cost: \$100, includes transportation, two nights' lodging (double occupancy), two lunches, and guidebook. Limit: 30.

SYMPOSIA

Six symposia are scheduled for both oral and poster sessions, and will include invited papers only. Please contact conveners for additional information. Additional sessions are scheduled for volunteered papers.

1. Silicic Magmatism in the Southern Appalachians: Implications for Tectonic and Thermal Evolution. James S. Beard, Virginia Museum of Natural History, 1001 Douglas Avenue, Martinsville, VA 24112, (703) 666-8611; Mark Drummond, Dept. of Geology, University of Alabama at Birmingham, Birmingham, AL 35294, (205) 934-2439.

2. Evolution of the Southeast Piedmont—Island Arc to Continental Collision. A Symposium in Honor of J. Robert Butler. Steven Goldberg, Dept. of Geology, University of North Carolina, Chapel Hill, NC 27599-3315, (803) 966-4516; W. Ranson, Dept. of Geology, Furman University, Greenville, SC 29613, (803) 294-2052.

3. Provenance Characterization of Appalachian Clastic Wedges: Implications for Terrain Assembly. Ken Eriksson, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061, (703) 231-4680. Cosponsored by SEPM Southeastern Section.

4. Timing, Location, and Nature of Cambrian (Penobscotian?) and Middle Ordovician (Taconic) Collisions in the Central and Southern Appalachians. Lynn Glover, III, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061, (703) 231-6213; Alexander Gates, Dept. of Geology, Rutgers University, Newark, NJ 07102, (201) 648-5034.

5. Special Poster Symposium: Geologic and Geophysical Maps: Recent Advances. J. Wright Horton, Jr., MS 928, U.S. Geological Survey, Reston, VA 22092, (703) 648-6933. The purpose of this symposium is to provide a forum for communicating recent advances, innovations, and applications of geologic and geophysical maps. Maps that are exemplary and/or innovative in terms of scientific content are of special interest. Posters illustrating the value and potential of digital map information or uses of geologic and geophysical maps in applied geology are also encouraged. These should be new maps that have not been presented at previous meetings. All presentations for this symposium will be in poster (rather than oral) format. Those who plan to include an on-screen computer demonstration must provide their own equipment and take full responsibility for it.

6. Special Symposium on Earth Science Education. This symposium will explore the current national models of education in promoting earth science literacy through more effective teaching and learning of earth science process skills. It is designed to appeal to earth science educators in K-12 schools as well as freshman and sophomore college instructors. Topics to be addressed include: *National Science Education Standards: Fundamental Understandings for Earth and Space Sciences* (National Research Council), of AAAS's *Project 2061* and AGI's *Earth Science Education for the 21st Century: A Planning Guide*.

The morning symposium will be followed by a buffet luncheon combined with a "marketplace" of teaching activities in earth science. Teachers and professors may submit posters and/or table-top activities to share with colleagues. *This session is open to anyone interested in earth science teaching. Educators interested in submitting a poster or teaching activity for this session should contact Susan C. Eriksson, Virginia Tech Museum of Natural History, 428 North Main Street, Blacksburg, VA 24061-0542, (703) 231-5360.*

THEME SESSIONS

Theme sessions provide a focus for volunteered presentations on specific topics. The following theme sessions have been organized.

1. Milankovitch Cycles in the Stratigraphic Record: Fact or Fantasy? J. Fred Read, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061, (703) 231-5124.

2. Scales of Stratigraphic Cyclicity. R. Diecchio, Dept. of Geography and Earth Systems Science, George Mason University, 4400 University Dr., Fairfax, VA 22030, (703) 993-1208; W. B. Harris, Dept. of Earth Sciences, University of North Carolina, Wilmington, NC 28403, (919) 395-3490.

3. Expanding Opportunities: Geoscience Education and Information Technology. Gail Russell, Dept. of Geology, University of Southern Mississippi, Box 5044, Hattiesburg, MS 39406, (601) 266-4526. Sponsored by NAGT. Posters only.

4. Environmental Geology and Public Policy. C. W. Welby, Dept. of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695, (919) 515-7158. Sponsored by Engineering Geology Division of the Geological Society of America.

WORKSHOP IN EARTH SCIENCE EDUCATION

This session for earth science educators—K-12 as well as freshman and sophomore college levels—will be organized into 50-minute workshops on investigative earth science activities which follow national guidelines for teaching excellence in science. Mini-field trips, hands-on classroom and laboratory activities, building partnerships, and applications of computers and technology in the classroom will make up these workshops. Presenters have been selected from teachers and educators recognized for teaching excellence, experts in the most recent technology in teaching earth science, and participants in NSF-funded education projects. Participants may choose up to three activities during the afternoon. For more information, contact Susan C. Eriksson, Virginia Tech Museum of Natural History, 428 North Main Street, Blacksburg, VA 24061-0542, (703) 231-5360.

POSTER SESSIONS

Poster sessions will be located in Owens Hall (across the street from the Continuing Education Center). Poster booths are limited to two 4' x 8' display boards.

SHORT COURSES

Registration. Short course registrants must register for the meeting. The following short courses will be offered.

1. Getting Maximum Information from Highly Deformed Rocks. Wednesday, April 6. Carol Simpson, Dept. of Earth and Planetary Sciences, Johns Hopkins University, Baltimore,

MD 21218; Declan G. De Paor, Dept. of Geology, George Washington University, Washington, DC 20052, (202) 994-6190.

This hands-on course for professionals and graduate students explains modern theories for strain, microstructure, and kinematic analysis. Microscope, graphical, and microcomputer exercises are used to illustrate the practical techniques. The course will be taught in Derring Hall on the Virginia Tech campus from 12:00 to 5:30 p.m. Cost: \$35. Limit: 25.

2. Don't Crush That Sample—Hand Me the Pliers! The Care of Rock and Mineral Collections.

April 6. Llyn Sharp, Collections Manager, Virginia Tech Museum of Natural History, 428 N. Main St., Blacksburg, VA 24061, (703) 231-4080.

A workshop for faculty, graduate students, rockhounds, technical support staff, and professional geologists dealing with all kinds of geologic collections including department teaching collections, private mineral collections, display collections, fossil collections, research project collections, voucher collections, etc. This should be helpful information about caring properly for these collections and avoiding some of the predictable problems and damage that may occur over time. Hands-on activities and a panel presentation will explore the major hazards to geologic materials and provide examples of suitable methods for handling, storage, documentation, and repairs. Participants will also have an opportunity to share their own experiences and discuss these issues with the panelists.

Panel: Curation of mineralogical specimens—**Susan Eriksson**, Director, Virginia Tech Museum of Natural History and Museum of Geological Sciences; Field and research samples—**Barbara Munn**, Ph.D. candidate (metamorphic petrology), Virginia Tech Dept. of Geological Sciences; Professional and amateur collections—**D. Allen Penick, Jr.**, Senior Geologist, Virginia Division of Mineral Resources; Commercial concerns and private estates—**Robert Smith**, Jeweler, Registered Gemologist, Gemological Institute of America.

The workshop will be held at the Museum of Geological Sciences, 2062 Derring on the Virginia Tech campus from 1:00 to 5:00 p.m. Cost: \$20 (\$10 for students). Limit: 20.

3. Environmental Hydrogeology. April 9–10. Eric Eslinger, Alpha Earth Inc., 10 Sussex Road, Glenmont, NY 12077, (518) 439-8447.

This is a two-day SEPM (Society for Sedimentary Geology)-sponsored short course. The first day is devoted to a discussion of remediation (cleanup) of soil and water. Principles of hydrology will be introduced and expanded on with an emphasis on floating, dissolved, sinking, and volatilized contaminant movement and how each of these types is monitored and remediated. Equations utilized for modeling contaminant movement will be introduced. Both petroleum and non-petroleum wastes will be addressed. In addition, an introduction to landfill closure design and monitoring and an introduction to the geological and hydrological aspects of siting low-level and high-level radioactive wastes will be discussed. The second day is devoted to computer modeling of various hydrogeological problems. The course will be taught in Conference Room C of the Continuing Education Center on the Virginia Tech Campus from 8:00 a.m. to 5:00 p.m. Cost: Preregistration fee of \$360 for SEPM members and

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Preregistration Form

Preregistration deadline is March 4, 1994.

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K-12 Earth Science Teacher	(42) \$12	<input type="checkbox"/> 1	\$ _____
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*Member fee applies to any existing professional OR Student Member of GSA or Associated Societies listed above. Discount does not apply to guest registrants.

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Greenbrier Hotel (lunch cost at Greenbrier \$8-\$10)	April 8	(21) N/C	\$ _____

LUNCHES

Earth Science Education Luncheon	April 8	(60) \$10	\$ _____
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FIELD TRIPS

1. Late Precambrian Rift and Drift Sequences	April 5-6	(100) \$ 85	1	\$ _____
2. Stratigraphic Relations and Structural Chaos	April 5-6	(101) \$ 85	1	\$ _____
3. K-Bentonites, Conglomerates, and Unconformities	April 4-6	(102) \$120	1	\$ _____
4. Devonian Strata of Catawba Syncline	April 6	(103) \$ 30	1	\$ _____
5. Geology of Mt. Rogers Area, SW Virginia	April 8-10	(104) \$120	1	\$ _____
6. Geologic and Structural Transect, New River Valley	April 9-10	(105) \$ 40	1	\$ _____
7. Slope Stability Problems along Highway Cuts	April 9	(106) \$ 30	1	\$ _____
8. Carboniferous and Ordovician Clastic and Carbonate Cycle	April 8-10	(107) \$100	1	\$ _____

SHORT COURSES

1. Maximum Information from Highly Deformed Rocks	April 6	(150) \$ 35	1	\$ _____
2.a. Care of Rock and Mineral Collections—Professionals	April 6	(151) \$ 20	1	\$ _____
b. Care of Rock and Mineral Collections—Students	April 6	(152) \$ 10	1	\$ _____
3.a. Environmental Hydrogeology—SEPM Member	April 9-10	(153) \$360	1	\$ _____
b. Environmental Hydrogeology—Nonmember	April 9-10	(154) \$410	1	\$ _____

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

\$410 for nonmembers and on-site registration. Contact Blacksburg Marriott, (703) 552-7001, for lodging, and J. Tso at (703) 831-5638 for additional details. Limit: approximately 35 participants.

REGISTRATION

PREREGISTER TODAY!
DEADLINE: March 4, 1994

- Note that there is a savings in fees if you preregister! Preregistration also assists the local committee in making final plans for the meeting. The preregistration form is provided in this announcement.
- Badges must be worn for access to ALL activities except the Welcoming Party and the Open House at the Department of Geological Sciences.
- Registration discounts are given to GSA or associated society members. Associated societies that qualify for this discount are indicated on the preregistration form. Please indicate your affiliation(s) and member number to register at member rates.

- Full payment must accompany the preregistration form. Unpaid purchase orders are not accepted as valid registration. Charge cards are accepted, as indicated on the form. Please recheck the charge card number given; errors will delay your registration. Your confirmation letter from GSA will be your only receipt.
- Please register only one professional or student per form; keep a copy for your records.
- Current student ID is required to obtain student rates at both the preregistration and on-site counters. Students must present their current student ID when picking up registration materials in order to receive the student rate.
- A reduced registration fee will be offered to precollege earth science teachers and students. Field trip and short course attendees (except precollege earth science teachers) must register for the meeting.
- Guest registrations must be accompanied by a regular professional or

student registration. A guest is defined as a nongeologist spouse or friend of a professional or student registrant.

ON-SITE REGISTRATION

Donaldson Brown Continuing Education Center Lobby

Wed. 4:00 p.m.-8:00 p.m.
Thur. 7:30 a.m.-4:30 p.m.
Fri. 7:30 a.m.-11:30 a.m.

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

CANCELLATIONS, CHANGES, AND REFUNDS

All requests for registration additions, changes, and cancellations must be made in writing and received by March 11, 1994, at GSA headquarters. GSA will refund advance registration fees for cancellations received in writing by that date. Faxes will be accepted. **NO REFUNDS WILL BE MADE ON CANCELLATION NOTICES RECEIVED**

Southeastern continued from p. 17

AFTER THAT DATE. Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card will be credited to the card number on the preregistration form. NO refunds will be given for on-site registration.

PUBLICATIONS

Abstracts are published in a volume of the GSA *Abstracts with Programs* for 1994. Advance purchase orders must be received by February 3, 1994; prepayment is required. An order form is provided in this announcement. These advance copies will be mailed out about three weeks prior to the meeting. Refunds for duplicate orders will not be given; members should check their records carefully to make sure that they have not previously purchased a copy of this publication on either their dues statement or through GSA Publications Sales. Meeting attendees may purchase copies of *Abstracts with Programs* on site, while the supply lasts, in the meeting registration area of the Donaldson Brown Center for Continuing Education.

Field trip participants will receive field trip guidebooks as part of their registration, but a limited number of guidebooks will also be available for sale for \$10 at the meeting in the registration area. After the meeting, guidebooks will be available for sale through the Department of Geological Sciences, Virginia Tech, Blacksburg, VA 24061-0420.

PROJECTION EQUIPMENT

All slides must be 2" x 2" and fit a standard 35 mm carousel tray. Please bring your own loaded carousel trays. Two 35 mm slide projectors and screens will be available for each oral technical session. Overhead projectors will be available upon special advance request.

EXHIBITS

Exhibit booths for business, educational, and governmental institutions will be available in the Owens Banquet Hall, sharing this location with poster sessions and coffee breaks. The exhibit area will be open all day Thursday and Friday. For further information and space reservation, contact Susan C. Eriksson, Virginia Tech Museum of Natural History, 428 North Main Street, Blacksburg, VA 24061-0542, (703) 231-5360.

STUDENT ARRANGEMENTS

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

Graduate Student Recruitment Fair. Space will be available on Thursday afternoon in the Conference Center for any graduate programs in the geosciences that wish to have representatives available to talk with prospective graduate students. Details will be posted at the meeting, and there will be no charge for participating. Representatives may wish to bring identification signs as well as literature to distribute to interested students. For information, contact Karen Hunt, (703) 231-8824.

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Communicating Science to the Public: Whose Responsibility Is It?

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

"Xenoblastic," "Precambrian," "Supracrustal," "Aseismic," "Duplexes." To a majority of citizens scientists communicate in a foreign language. The most common forms of scientific communication—the technical paper, the abstract, the oral presentation, and the poster—are designed to convey as much information as possible in the briefest space possible. The cryptic vocabulary associated with this form of communication is useful when talking with our colleagues, but it effectively excludes most policy makers, business leaders, educators, students, and voters from understanding the importance, benefits, and limitations of science.

As earth scientists we have an ethical responsibility to ensure that the public is well-informed on issues such as natural and human-made hazards, resource and land use, and funding of basic versus applied research. We are the technical experts. If we cannot make our science understandable, who can? Furthermore, if we abrogate our responsibility in this area, we risk alienating the taxpayers who pay for much of our research. Just ask the physicists who were hoping to work on the Superconducting Super Collider how real this risk can be.

Can science be made understandable and interesting to the public? The success of programs like "Cosmos,"

"Nova," and the National Geographic specials, as well as the popularity of books such as *Basin and Range* by John McPhee, *Jurassic Park* by Michael Crichton, *The Flamingo's Smile* by Stephen Jay Gould, and *Silent Spring* by Rachael Carson, suggest that it can. However, effective public communication takes work and it takes time. Not all of us have the skills to write a best seller or host a television show, but all of us do have the ability to write clear, effective science articles for popular magazines and newspapers, make interesting presentations in our children's schools, lead field trips in our communities, or be scientific resource agents for our local school boards and legislators.

If you are interested in becoming a more effective science communicator please let us know how we (GSA/SAGE) can help you. If you are already an effective science communicator, please let us know what you are doing and what makes your public communication effective. If you have no interest in learning how to better communicate your science to the public, please keep in mind the fate of the Superconducting Super Collider and return to the first sentence in this paragraph. ■

GSA Division Officers and Newsletter Editors—1994

GSA's twelve specialty divisions provide a focus for members interested in a particular discipline. The divisions hold annual business meetings in conjunction with the Society's Annual Meeting, and most divisions publish newsletters periodically. Division membership totals are as of December 7, 1993.

Archaeological Geology 420 Members

Officers: Henry P. Schwarcz, chair; Margaret J. Guccione, first vice-chair; Edwin R. Hajic, second vice-chair; C. Reid Ferring, secretary-treasurer; Bonnie A. Blackwell, past chair. Newsletter editor: Vance T. Holliday

Coal Geology 280 Members

Officers: Alan Davis, chair; James C. Hower, first vice-chair; John H. Calder, second vice-chair; Cortland F. Eble, secretary; Robert A. Gastaldo, past chair. Newsletter editor: Cortland F. Eble

Engineering Geology 941 Members

Officers: Rhea L. Graham, chair; Michael W. Hart, chair-elect; John R. Giardino, secretary; Jerome V. DeGraff, past chair. Newsletter editor: John R. Giardino

Geophysics 420 Members

Officers: Lawrence L. Malinconico, Jr., chair; John W. Geissman, first vice-chair; Alan R. Levander, second vice-chair; G. Randy Keller, secretary-treasurer; Richard G. Gordon, past chair. Newsletter editor: Laura F. Serpa

Geoscience Education 447 Members

Officers: Dorothy L. Stout, chair; Robert W. Ridky, first vice-chair; Barbara M. Manner, second vice-chair; Stephen H. Stow, secretary-treasurer. Newsletter editor: Glenn R. Roquemore

History of Geology 265 Members

Officers: Joanne Bourgeois, chair; Robert N. Ginsburg, first vice-chair; William R. Brice, second vice-chair; William M. Jordan, secretary-treasurer; Samuel T. Pees, past chair. Newsletter editor: William M. Jordan

Hydrogeology 1887 Members

Officers: Leonard F. Konikow, chair; Donald I. Siegel, first vice-chair; John W. Hess, Jr., second vice-chair; John F. Harsh, secretary-treasurer; Franklin W. Schwartz, past chair. Newsletter editor: Alan R. Dutton

International 227 Members

Officers: Bruce F. Molnia, president; Pinar Oya Yilmaz, first vice-president; James W. Skehan, second vice-president; Frederick O. Simon, secretary-treasurer; Kevin Burke, past president. (Division does not publish a newsletter.)

Planetary Geology 372 Members

Officers: George E. McGill, chair; Odette B. James, first vice-chair; Larry S. Crumpler, second vice-chair; Cassandra R. Coombs, secretary-treasurer; Harry Y. McSween, Jr., past chair. Newsletter editor: Larry S. Crumpler

Quaternary Geology and Geomorphology 1305 Members

Officers: Parker E. Calkin, chair; Steven M. Colman, first vice-chair; William L. Graf, second vice-chair; Deborah R. Harden, secretary-treasurer; Stephen G. Wells, past chair. Newsletter editor: Richard B. Waitt

Sedimentary Geology 881 Members

Officers: Norman D. Smith, chair; John P. Grotzinger, first vice-chair; Jay M. Gregg, second vice-chair; Gordon S. Fraser, secretary-treasurer; Cathy J. Busby, past chair. Newsletter editor: Robert K. Suchecki

Structural Geology and Tectonics 1705 Members

Officers: Richard H. Groshong, Jr., chair; Edward C. Beutner, first vice-chair; John M. Bartley, second vice-chair; Arthur G. Goldstein, secretary-treasurer; Jan A. Tullis, past chair. Newsletter editors: Gregory A. Davis, Scott R. Paterson. ■

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SPECIAL EVENTS AND ACTIVITIES

Scheduled Meetings

All meetings of committees of the Southeastern Section of GSA and affiliated societies will be held in the Donaldson Brown Center for Continuing Education. A final schedule of times and locations will be announced in the meeting program.

Earth Science Education Luncheon and "Marketplace"

This luncheon and associated activities are included in registration for K-12 teachers and may be attended by others at additional cost (see registration form).

GUEST ACTIVITIES

Thursday, April 7: Visit the 18th century *Smithfield Plantation* (fee of \$4

payable by guests at door), regional art galleries, and antique shops.

Friday, April 8: Tour and luncheon at the world-famous *Greenbrier Hotel at White Sulphur Springs*, West Virginia. Tour leaves at 7:45 p.m. Guests purchase their own lunches during the tour at the Greenbrier Hotel, \$8-\$10 plus tax and gratuity. Limit: 7. Indicate your participation for both guest events by registering on the preregistration form.

THINGS TO DO IN THE NEW RIVER VALLEY

Spring is one of the prettiest times of the year in the mountain valleys of southwestern Virginia. Blacksburg is a convenient starting point for numerous scenic drives: to the west into the Alleghenies and Appalachian Plateau; to the east and south through the Blue Ridge; and to the northeast into the southern part of the Shenandoah Valley. One of the more scenic stretches of the Blue Ridge Parkway passes just to

the east of Blacksburg. Several historic towns and resorts, including Mountain Lake and White Sulphur Springs, lie within one to two hours' drive of Blacksburg, and good antiquing can be found throughout the region. The local musical scene is very active, with numerous clubs, cafes, and watering spots offering live music in a variety of styles, particularly mountain or bluegrass music. The Appalachian Trail passes close by Virginia Tech, with excellent opportunities for day hikes on it and other local trails. The New River itself provides outstanding recreational activities, including fishing, canoeing, and kayaking; canoe rentals are available. The region abounds in museums, with art galleries, the Museum of Geological Sciences, and a branch of the Virginia Museum of Natural History located on the Virginia Tech campus. The nearby city of Roanoke has numerous museums, including art and science museums, the Transportation Museum, a major rail-

way museum, and the Mill Mountain Zoo.

OTHER INFORMATION

More detailed information concerning fees and registration, motel accommodations, field trips, and other activities will appear as part of the GSA Southeastern Section *Abstracts with Programs* for 1994. For detailed information regarding technical programs, contact Krishna Sinha (Dept. of Geological Sciences, VPI&SU, Blacksburg, VA 24061, (703) 231-5580, E-mail: searches@vtvm1.cc.vt.edu). For all other information, contact Lynn Glover (Dept. of Geological Sciences, VPI&SU, Blacksburg, VA 24061, (703) 231-6213), or Bob Tracy (Dept. of Geological Sciences, VPI&SU, Blacksburg, VA 24061, (703) 231-5980), co-chairmen of the local organizing committee. ■

Robert L. Fuchs

The Will to Will

It's not easy to think about preparing a will, probably because that process brings to mind all sorts of related, uncomfortable thoughts surrounding the realization of one's own mortality. Nevertheless, a will is an important document that should be considered of equal stature to a birth certificate, driver's license, marriage certificate, professional license, and college diploma.

A will is far from a static document, and should be reviewed periodically. There are a number of reasons for this: children become self-supporting, relatives die, grandchildren are born, philanthropic priorities shift, and divorce and remarriage occur. Your will should reflect changes in the tax law, and we are all certainly well aware of the frequency with which these occur.

There are strong reasons to go to the time and expense of preparing, and periodically revising, a will. This important document establishes how your property will be used and distributed after your death. Without a will the state in which you reside will distribute your property according to certain strict and impersonal laws. Such a distribution would be beyond your heirs' control and could, more likely than not, violate your every wish as to what would happen to your property. A will plays a critical role in minimizing estate taxes and expenses. Also, without a will, valuable assets can be frozen in court proceedings for long periods of time.

Estates valued at more than \$600,000 are subject to federal and state estate taxes. While husbands and wives can transfer assets between them during their lifetimes or under wills, when both have died, everything in the estate in excess of \$600,000 will be taxed. However, through careful planning there can be mitigation of this tax burden. Some of the procedures involve trust arrangements, periodic gifts to children and relatives, and charitable gifts.

Bequests to charitable organizations such as the GSA Foundation are deductible for federal estate tax purposes. Thus, a \$1 million estate making a \$100,000 gift to the GSA Foundation will save \$39,000 in estate taxes. Viewed another way, the \$100,000 received by GSA will have cost the estate only \$61,000.

A bequest to the GSA Foundation can be made without affecting one's current financial security, because both the principal and income on one's estate are available during the donor's lifetime. Bequests can take several forms, of which the most common is the general bequest such as cash, which may be satisfied from the general assets of the estate. A specific bequest is the designation of a particular class or kind of property such as securities or real estate. The residuary bequest comprises all of the remaining estate after expenses, general bequests, and specific bequests. A testamentary trust can provide lifetime income to a beneficiary. Following the death of that individual, the assets would go to the GSA Foundation. Other types of bequests include contingent and deferred, and there are all sorts of related devices such as annuity trusts, unitrusts, and even life insurance. We have a primer, *Planning Your Bequests*, that will introduce you to this field of wills, bequests, and estate planning. Mail in the accompanying

coupon or call the Foundation office at 303-447-2020, and we will be happy to send you a free copy.

The financial health of GSA and its ability to support publications, research, education, and other programs for the benefit of members, the geoscience community, and the public are soundly based upon a bequest, the \$3.9 million gift in 1931 by member R.A.F. Penrose, Jr. For the succeeding 63 years, geologists have benefitted from this major bequest. Each year, GSA receives money from the estates of members who have had the "will to will" and developed estate plans that included the Society. Further, numerous members have advised us that the Foundation is included in their wills. The preparation of a will has primary importance to the family, but bequests to the GSA Foundation will ensure future funds for education, research, publications, and general advancement of the science of geology.

By-law Change Affects Unrestricted Gifts

At the Foundation Board of Trustees meeting during the GSA Annual Meeting in Boston, the Foundation's bylaws were amended to remove several ambiguities and thereby clarify

the structural and operating relationship between the Society and the Foundation. One change affects the destination of unrestricted gifts to endowment. Under the amendment, such gifts shall be directed to GSA unless the donor specifies that the gift reside in the Foundation's endowment.

Beginning in 1994 and thereafter, donors wishing their gifts to remain in the Foundation's endowment should note this on checks, coupons, or trans-

mittal letters. Gifts not so designated will be placed in GSA's endowment.

As in the past, all gifts for restricted funds remain in the Foundation, with the income to be used for GSA programs in accordance with the terms of the restriction. All programmatic (nonendowment) funds continue to pass directly to GSA for specific program use. ■

Donors to the Foundation—October 1993

Birdsall Award

Margaret S. Woyski

DNAG

David G. Hardy

Engineering Geology

Division Award

Eldon M. Gath

History of Geology Award

Kennard B. Bork

J. Thomas Dutro

Samuel T. Pees

Hydrogeology Division

Award

George H. Davis

Steven P. Esling

J. Hoover Mackin Award

Peter W. Birkeland

H. Richard Blank

Robert Grant

June Mirecki

GEOSTAR Funds

Claude C. Albritton, Jr.,

Memorial

Kennard B. Bork

Biggs Excellence in Earth

Science Education

Erlece P. Allen

Heather Macdonald

Gretchen Louise

Blechschildt Scholarship

Larisa Streeter

Minze Stuiver

Allan V. Cox Student

Scholarship Award

Philip H. Close III

Judson Mead*

Clyde Wahrhaftig

Doris M. Curtis Memorial

Janet M. Aitken

J. Kasper Arbenz

R. Laurence Davis

Charles Gilbert

Merrill Haas

Louis Heyman

John T. Dillon Alaska

Scholarship

David D. Adams

William Brosge

William and Maria Luisa

Crawford*

John C. Crowell

John Thomas Dutro, Jr.

B. Murchey-Setnickner

Sarah M. Roeske

Dwornik Planetary

Geoscience Award

Joseph M. Boyce

Jay F. Piper

John C. Frye

Environmental Award

Edward Dapples

Peter T. Flawn

John P. Kempton

Shinjiro Mizutani

Athel Unklesbay

GEOSTAR

Catherine C. Campbell

Mark Cloos

John C. Crowell

Norbert E. Cygan

Steven N. Daviess

Duane Eversoll

Harry D. Goode

John J. Hickey

John E. Kilkenny

Jesus R. S. Moriel

William Newman

Alan O'Neill

Jennifer Roberts

James K. Roche

David L. Warburton

Joseph L. Weitz

Hiromitsu Yamagishi

Institute for

Environmental Education

Donald F. Goodell

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Carol G. and John T.

McGill Fund

William K. Barry

Robert W. Fleming

Wallace R. Hansen

Harold H. Sullwold

Antoinette Lierman

Medlin Scholarship

Frank T. Dulong

Richard Meyer

Terry W. Offield

Minority

Andy Horn

John Rodgers

Clyde Wahrhaftig

Howard G. Wilshire

Publications

Sherwood and Esther Tuttle*

Research

William E. Benson

M. E. Bickford

William J. Bowen III

H. Robert Burger

J. Donnelly-Nolan

Russell Everts



GEO STAR
Supporting The Advancement of Research

GSA Foundation
3300 Penrose Place
P.O. Box 9140
Boulder, CO 80301
(303) 447-2020

Enclosed is my gift of _____ to the GSA Foundation

If gift is for unrestricted endowment, please check one:

GSA endowment

Foundation endowment

Please add my name to the Century Plus Roster (gifts of \$150 or more)

Please send me your booklet about wills and bequests

PLEASE PRINT

Name _____

Address _____

City/State/ZIP _____

Phone _____

GSA Penrose Conferences

March 1994

From the Inside and the Outside: Interdisciplinary Perspectives on the History of Earth Sciences, March 19-21, 1994, San Diego, California. Information: Léo F. Laporte, Dept. of Earth Sciences, University of California, Santa Cruz, CA 95064, (408) 459-2248, fax 408-459-3074; Naomi Oreskes, Dept. of Earth Sciences, Dartmouth College, Hanover, NH 03755, (603) 646-1420, fax 603-646-3922; Kenneth L. Taylor, Dept. of History of Science, University of Oklahoma, Norman, OK 73019-0315, (405) 325-2213, fax 405-325-2363.

April 1994

Triple Junction Interactions at Plate Margins, April 21-26, 1994, Eureka, California. Information: Virginia B. Sisson, Dept. of Geology and Geophysics, Rice University, P.O. Box 1892, Houston, TX 77251-1892, (713) 285-5234; Terry L. Pavlis, Dept. of Geology and Geophysics, University of New Orleans, New Orleans, LA 70148, (504) 286-6797; David J. Prior, Dept. of Earth Sciences, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK.

June 1994

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

1994 Meetings

January

Remote Sensing and GIS International Symposium, January 27-28, 1994, location to be determined. Information: Vern Singhroy, Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, Ontario K1A 0Y7, Canada, (613) 947-1215, fax 613-947-1385; or Ivan Johnson, 7474 Upham Court, Arvada, CO 80003, (303) 425-5610; and

Doug Nebert, Water Resources Division, USGS National Centre, MS 445, Reston, VA 22092, (703) 648-5691, fax 703-959-5691.

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

February

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

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

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

American Association for the Advancement of Science Annual Meeting, February 18-23, 1994, San Francisco, California. Information: AAAS Meeting Office, 1333 H St. NW, Washington, DC 20005, (202) 326-6450, fax 202-289-4021.

■ **13th Annual Symposium on Caribbean Geology**, "Impact" of Geology on Global Climate, February 23-27, 1994, Puerto Rico. Information: Lewis Abrams, Dept. of Geology, University of Puerto Rico, P.O. Box 5000, Mayagüez, PR 00681-5000, (809) 832-4040, ext. 3845, fax 809-265-3845.

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

March

International Convention on Global Exploration and Development, March 6-9, 1994, Toronto, Ontario, Canada. Information: Rita Plaskett, Convention Manager, Suite 1002, 74 Victoria Street, Toronto, Ontario M5C 2A5, Canada, (416) 362-1969, fax 416-362-0101.

Lunar and Planetary Science 25th Annual Conference, March 14-18, 1994, Houston, Texas. Information: 25th LPSC, Publications and Program Services Dept., Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058-1113, (713) 486-2166, fax 713-486-2160. (Abstract deadline: January 7, 1994.)

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

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

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

Seventh Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), March 27-31, 1994, Boston, Massachusetts. Information: EEGS, Mark Cramer, P.O. Box 4475, Englewood, CO 80112, (303) 771-6101.

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

■ **Contaminated Soils and Ground Water**, Fifth Annual Association for the Environmental Health of Soils West Coast Conference, March 28-April 1, 1994, Long Beach, California. Information: Mary K. Terry, Association for the Environmental Health of Soils, 150 Fearing St., Suite 20, Amherst, MA 01002, (413) 549-5170, fax 413-549-0579.

Simpson and Viola Groups in the Southern Midcontinent, March 29-30, 1994, Norman, Oklahoma. Information: Kenneth S. Johnson, Oklahoma Geological Survey, 100 E. Boyd, Rm. N-131, Norman, OK 73019, (405) 325-3013.

April

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

Meetings continued on p. 22

Short-Course Series

Principles and Applications of MODFLOW

March 22 - 25, 1994

Instructors:
Peter F. Andersen and Robert M. Greenwald (Geo Trans, Inc.)

This course focuses on the use of the U.S.G.S. Three-Dimensional Finite-Difference Ground-water Flow Model MODFLOW and its accompanying programs. Lectures on the principles of ground-water flow modeling and the use of MODFLOW will be complemented by hands-on computer sessions during which participants will work through a series of real-world problems.

For more information contact the IGWMC.



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

United States Geological Survey 9th V.E. McKelvey Forum

Co-sponsored by University of Arizona, Arizona Geological Survey, and Arizona Geological Society

February 22-25, 1994
Tucson Convention Center
Tucson, Arizona

Featuring:

- ▼ Environmental studies related to mineral resources
- ▼ Geology and mineral-deposit studies of the southwestern United States and Latin America
- ▼ Land-use planning and mineral-resource assessments of federal lands
- ▼ Field Trips

For information contact:
U.S. Geological Survey, Attn: McKelvey Forum, Federal Center, Mail Stop 905, P.O. Box 25046, Denver, CO 80225-0046 (303) 236-5568; Fax: (303) 236-5603

WANTED

Hydrologists, Hydrogeologists, Engineers, and other Environmentally Interested Professionals

REWARD OFFERED

The opportunity for the exchange of information and contact between persons from private industry, government, and academia.

DETAILS
April 10-13, 1993

Join your peers at the **Toxic Substances and the Hydrologic Sciences** conference at the Omni Austin Hotel, Austin, Texas. Contact the American Institute of Hydrology (AIH), 3416 University Ave. SE, Minneapolis, MN 55414-3328, Phone (612) 379-1030, Fax (612) 379-0169.

The Conference will feature the USGS Toxic Substance and Hydrology program, as well as sessions on Estuarine Hydrodynamics, Contaminant Hydrogeology, Aquifer Remediation in the Presence of NAPLs, the 1993 Mississippi River Flood, Watershed Hydrology, Low-Level Radioactive Waste Management, and the Edwards Aquifer.

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

Transport and Reactive Processes in Aquifers IAHR Symposium, April 11-15, 1994, ETH-Zürich, Switzerland. Information: Th. Dracos or F. Stauffer, Institute of Hydromechanics and Water Resources Management (IHW), ETH-Hönggerberg, CH-8093 Zürich, Switzerland, phone 41-1-377 30 66 or 41-1-377 30 79, fax 41-1-371 22 83.

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

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

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

European Association of Science Editors 5th General Assembly and Conference, April 24-28, 1994, Budapest, Hungary. Information: EASE Secretariat, 49 Rossendale Way, London,

NW1 0XB, UK, phone 44-71-388 9668, fax 44-71-383 3092.

Petroleum Source Rocks: Formation, Diagenesis, and Expulsion, April 25-29, 1994, Calgary, Alberta, Canada. Information: Han Wielens, Unocal Canada Exploration Ltd., Box 2120, Calgary, Alberta, Canada T2P 2M4, (403) 268-0370, fax 403-268-0101; Marc Bustin, Dept. of Geological Sciences, University of British Columbia, Vancouver, B.C., Canada V6T 1Z4, (604) 822-6179, fax 604-822-6088; or Steve Calvert, Dept. of Oceanography, University of British Columbia, Vancouver, B.C., Canada V6T 1Z4, (604) 822-5210, fax 604-822-6091.

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

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

May
GSA Rocky Mountain Section Meeting, May 4-6, 1994, Durango, Colorado. Information: Douglas Brew, Geology Dept., Ft. Lewis College, Durango, CO 81301, (303) 247-7254, fax 303-247-7310. (*Abstract deadline: January 13, 1994.*)

Geologic Remote Sensing Tenth Thematic Conference, May 9-12, 1994, San Antonio, Texas. Informa-

tion: ERIM/Thematic Conferences, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123, Internet: wallman@vaxb.erim.org.

Midwest Friends of the Pleistocene Annual Meeting, May 13-15, 1994, Cincinnati, Ohio. Information: Tom Lowell, Dept. of Geology, University of Cincinnati, Cincinnati, OH 45226, (513) 556-4165, E-mail: Lowelltv@ucbeh.san-uc.edu; or Scott Brockman, Division of Geological Survey, Ohio Department of Natural Resources, Columbus, OH 43224, (614) 265-6604.

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

National Association of Geology Teachers, Eastern Section Annual Meeting, May 20-22, 1994, Nyack, New York. Information: Michael J. Passow, 296 Central Ave., Englewood, NJ 07631, (201) 871-0846.

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

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

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

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

Fifth International Conference on Ground Penetrating Radar, June 12-16, 1994, Kitchener, Ontario, Canada. Information: GPR '94, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada, (519) 885-1211, ext. 2892, fax 519-725-8720.

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

July
FORAMS '94: International Symposium on Foraminifera, July 5-9, 1994, Berkeley, California. Information: FORAMS '94, Museum of Paleontology, University of California, Berkeley,

CA 94720, (510) 642-1821, fax 510-642-1822.

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

Geological Indicators of Rapid Change, International Workshop, July 11-18, 1994, Corner Brook, Newfoundland. Information: A. R. Berger, Chairman, Geo-Indicators Working Group, 528 Paradise St., Victoria, BC V9A 5E2, Canada, (604) 480-0480, fax 604-480-0480.

Basement Tectonics 11th International Conference, July 25-29, 1994, Potsdam, Germany. Information: Onno Oncken, Conference Chairman, Geo-Forschungs Zentrum, Telegrafenberg, D-01561 Potsdam, Germany, phone 49-331-310601, fax 49-331-310306. (*Abstract deadline: March 1, 1994.*)

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

August
West Australian Basins Symposium, August 14-17, 1994, Perth, Australia. Information: Petroleum Exploration Society Australia, Attn: J. B. O'Reilly/N. K. Guppy, P.O. Box 1102, West Perth, W.A. 6872, Australia, phone 61-9-481-6666, fax 61-9-481-1952.

Clay Minerals Society 31st Annual Meeting, August 14-19, 1994, Saskatoon, Saskatchewan, Canada. Information: Ahmet R. Mermut, Dept. of Soil Science, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon S7N 0W0, Canada, (306) 966-6839, fax 306-966-6881, E-mail: mermut@sask.usask.ca.

The South Atlantic: Present and Past Circulation, August 15-18, 1994, Bremen, Germany. Information: South Atlantic Symposium, Barbara Donner, Fachbereich Geowissenschaften der Universität, Postfach 33 04 40, D-28334 Bremen, Germany.

14th International Sedimentological Congress, Equatorial Gateway in Atlantic Symposium, August 21-26, 1994, Recife, Brazil. Information: Luba Jansa, Bedford Institute of Oceanography, Dartmouth, N.S. Canada B2Y 4A2, (902) 426-2734, fax 902-426-4465, E-mail: jansa@agcr.bio.ns.ca. (*Abstract deadline: February 15, 1994.*)

International Geographical Union Regional Conference, Environment and Quality of Life in Central Europe: Problems of Transition, August 22-26, 1994, Prague, Czech Republic. Information: Conference Secretariat, IGU RC 1994, Albertov 6, 128 43 Praha 2, Czech Republic, phone 42-2-24912060, or 42-2-296025, fax 42-2-24915817 or 42-2-296025, E-mail: kucera@prfdec.natur.cuni.cz

Proterozoic Crustal and Metallogenic Evolution, August 29-September 1, 1994, Windhoek, Namibia. Information: G.I.C. Schneider, Geological Society of Namibia, P.O. Box 699, Wind-

CALL FOR NOMINATIONS

To reward and encourage teaching excellence in beginning professors of earth science at the college level, the Geological Society of America announces:

THE THIRD ANNUAL

Biggs Award

For Excellence
In Earth Science Teaching
For Beginning Professors

ELIGIBILITY: All earth science instructors and faculty at 2- and 4-year colleges who have been teaching full-time for 10 years or less. (Part-time teaching is not counted in the 10 years.)

AWARD AMOUNT: An award of \$500 is made possible as a result of support from the Donald and Carolyn Biggs Fund.

NOMINATION PROCEDURE: Write to Dr. Edward E. Geary, Coordinator for Educational Programs, Geological Society of America, PO Box 9140, Boulder, CO 80301.

DEADLINE: Nominations for the 1994 Biggs Earth Science Teaching Award must be received by June 30, 1994.

hoek, Namibia, phone 264-61-37240, fax 264-61-228324.

V.M. Goldschmidt Conference, August 29–September 2, 1994, Edinburgh, Scotland. Information: B. Harte or P. Symms, V.M. Goldschmidt Conference 1994, Dept. of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Road, Edinburgh EH9 3JW, Scotland, UK.

September

Cyclivity in Global Geology, Australian Geological Convention Symposium, September 1994, Perth, Australia. Information: Bryan Krapez, C. McA. Powell, Dept. of Geology, University of Western Australia, Nedlands, 6009, Australia.

Prospecting in Areas of Glaciated Terrain—Tenth Conference, September 5–7, 1994, St. Petersburg, Russia. Information: The Conference Office, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England, phone 44-71-580-3802, fax 44-71-436-5388.

■ **Biotic Recoveries from Mass Extinctions**, IGCP Project 335, September 5–8, 1994, Plymouth, United Kingdom. Information: Malcom B. Hart, Dept. of Geological Sciences, University of Plymouth, Drake Circus, Plymouth, Devon PL1A 8AA, UK, fax 44-745-233-117; or Douglas H. Erwin, Dept. of Paleobiology, NHB-121, Smithsonian Institution, Washington, DC 20560, (202) 357-2053.

International Conference on Arctic Margins, (ICAM '94), September 5–9, 1994, Magadan, Russia. Information: Kirill V. Simakov, North East Science Center, Russian Academy of Sciences, 16 Portovaya St., Magadan, Russia 685000, (907) 474-7219 (USA) or 7-41-3-223-0953 (Russia); or Dennis K. Thurston, Minerals Management Service, 949 E. 36th Ave., Anchorage, AK 99508-4302, (907) 271-6545, fax 907-271-6565.

First International Airborne Remote Sensing Conference and Exhibition: Applications, Technology, and Science, September 11–15, 1994, Strasbourg, France. Information: Robert Rogers, ERIM, Box 13001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234; fax 313-994-5123.

■ **Salt Tectonics**, September 14–15, 1994, London, England. Information: Ian Alsop, Derek Blundell, and Ian Davison, Dept. of Geology, Royal Holloway, University of London, Egham, Surrey, UK, phone 44-784-443615, fax 44-784-471780. (Abstract deadline: April 1, 1994.)

Fifth International Mine Water Congress, September 18–23, 1994, Nottingham, UK. Information: Conference Secretary, IMWA Conference, c/o Department of Mineral Resources Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK.

12th Australian Geological Convention, September 26–30, 1994, Perth, Australia. Information: Secretary, 12AGC, P.O. Box 119, Cannington, WA 6107, Australia, 61-9-351-7968, fax 61-9-351-3153. (Abstract deadline: January 14, 1994.)

Eco Rio '94, International Symposium on Resource and Environmental Monitoring, September 26–30, 1994, Rio de Janeiro. Information: National Institute of Space Research—

INPE c/o Mônica Oliveira, CRI, P.O. Box 515, Av. dos Astronautas, 1758-CEP 12227-010, San José dos Campos, SP-Brazil, phone 55-123-22-9816 or 41-8977 x250, fax 55-123-21-8543 or 22-9325.

October

■ **Association of Engineering Geologists Annual Meeting**, October 2–7, 1994, Williamsburg, Virginia. Information: AEG, 323 Boston Post Rd., Suite 2D, Sudbury, MA 01776, (508) 443-4369 or (508) 443-3639.

German Geological Society (DGG) Annual Meeting, October 4–7, 1994, Heidelberg, Germany. Information: Th. Bechstädt and R. O. Greiling, Geologische-Paläontologisches Institut, Ruprecht-Karls-Universität, Im Neuenheimer Feld 234, D-6900 Heidelberg, Germany.

Symposium on Porphyry Copper Deposits from Alaska to Chile, October 5–7, 1994, Tucson, Arizona. Information: Jim Laukes, University of Arizona Extended University, 1955 East Sixth Street, Tucson, AZ 85719-5224, 1-800-955-UofA, fax 602-621-3269, E-mail (Internet): jlaukes.ccit.arizona.edu.

■ **LIRA Workshop on the Ross Orogen: Crustal Structure and Tectonic Significance**, October 20–22, 1994, Dallas, Texas. Information: John W. Goodge, Dept. of Geological Sciences, Southern Methodist University, Dallas, TX 75275, (214) 768-4140, E-mail: jgoodge@sun.cis.smu.edu.

November

Geology and Resources of the Eastern Frontal Belt, Ouachita Mountains, Oklahoma, November 15–17, 1994, Poteau, Oklahoma. Information: Neil H. Suneson, Oklahoma Geological Survey, Sarkeys Energy Center Room N-131, 100 East Boyd St., Norman, OK 73019-0628, (405) 325-3031.

December

Tectonic Evolution of Southeast Asia, December 7–8, 1994, London, UK. Information: Robert Hall, Geological Sciences, University College, Gower St., London WC1E 6BT, UK, phone 44-784-443592, fax 44-71-387-1612, E-mail (Internet): robert.hall@ucl.ac.uk.

■ **Symposium on Inverse Problems: Geophysical Applications**, December 12–14, 1994, Yosemite Fish Camp, California. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org. (Abstract deadline: April 25, 1994.)

1995 Meetings

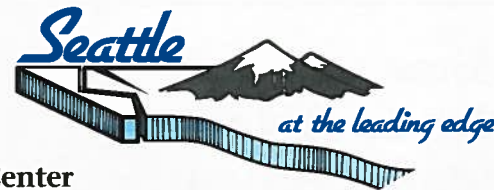
April

Geological Society of Nevada Symposium III: Geology and Ore Deposits of the American Cordillera, April 10–13, 1995, Reno, Nevada. Information: Bob Hatch, Chairperson, Geological Society of Nevada, P.O. Box 12021, Reno, NV 89510, (702) 323-4569, fax 702-323-3599.

Geological Society of South Africa Centennial Geocongress, April 3–7, 1995, Johannesburg, South Africa. Information: Congress Secretariat, Centennial Geocongress, P.O. Box 36815, Menlo Park, 0102, South Africa, phone and fax 27-12-47-3398.

Meetings continued on p. 27

GSA ANNUAL MEETINGS



■ **1994**

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

General Chairman: Darrel S. Cowan

Technical Program Chairmen: Mark S. Ghiorsio, Thomas Dunne
Symposia and theme proposals due: January 4, 1994.

Field Trip Chairman: Donald A. Swanson
Field trip proposal deadline was May 15, 1993.

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

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

■ **1995**

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

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

Technical Program Chairman: Laura Serpa, University of New Orleans
Call for Field Trip Proposals: Please contact the Field Trip Chairmen listed below.

Whitney Autin Louisiana Geological Survey P.O. Box G, University Station Baton Rouge, LA 70893-4107 (504) 388-5320	Duncan Goldthwaite 4608 James Drive Metairie, LA 70003 (504) 887-4377
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For general information call the GSA Meetings Department, 1-800-472-1988 or (303) 447-2020.

■ **FUTURE**

Seattle	October 24–27	1994
New Orleans	November 6–9	1995
Denver	October 28–31	1996
Salt Lake City	October 20–23	1997

For general information on technical program participation (1994 or beyond) contact Sue Beggs, Meetings Manager, GSA headquarters.

GSA SECTION MEETINGS

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

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

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

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

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

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

Student Travel Grants

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

Cordilleran	Bruce A. Blackerby, (209) 278-2955
Rocky Mountain	Kenneth E. Kolm, (303) 273-3932
North-Central	George R. Hallberg, (319) 335-1575
South-Central	Rena M. Bonem, (817) 755-2361
Northeastern	Kenneth N. Weaver, (410) 554-5534
Southeastern	Michael J. Neilson, (205) 934-5102

GEOTRIP

Rim to River: Moab, Canyonlands, and Cataract Canyon

7 days, 8 nights: May 28–June 4, 1994

Scientific Leaders:

Kenneth Kolm, Department of Geology and Geological Engineering,
Colorado School of Mines

John Emerick, Division of Science and Engineering,
Colorado School of Mines

This trip is an exceptional educational opportunity for the physically active person. The itinerary includes geologic features found nowhere else. Cataract Canyon is a major whitewater experience. The complete daily itinerary and requirements for each day's activities (length of hikes, elevation gain, rafting) are available from GSA.

Leaders are familiar with the Canyonlands area in terms of the geologic, hydrogeologic, or biologic framework. Leaders will be with the group throughout the trip.

Itinerary

May 28, Saturday—Travel day to Moab. Orientation at 7:30 p.m.
May 29, Sunday—Arches National Park. Lodging in Moab.
May 30–June 1, Monday–Wednesday—Hiking in Canyonlands (Island in the Sky, Maze, and Needles District) and rafting along the Colorado River. Tent camping.
June 2, Thursday—Rafting Cataract Canyons. Side hikes.
June 3–4, Friday, Saturday—Behind-the-Rocks and La Sal Mountains by van from Moab. Optional overflight of Canyonlands.
June 4, Saturday—Final farewell party in Moab.
June 5, Sunday—Travel day.

Transportation, Lodging, Meals

Travel will be by four-wheel drive vans, motorized rafts, or on foot. During the days in the Arches area, Behind-the-Rocks, and the La Sal Mountains, transportation will be in vans. Travel on the Colorado River will be in motorized rafts (J-rigs). Lodging in Moab will be in a comfortable modern motel. Camping near the river for three nights will be in tents and sleeping bags provided by the rafting outfitter. Meals are provided except for the arrival night and the departure morning.

Physical Requirements

This trip includes several substantial hikes for which each person will carry a day pack with camera, water, and snacks. The longest hike is 12 miles—downhill. Although taken at a reasonable pace with many points to rest or to explore the geology, these hikes should be undertaken only by persons in good health who are physically active. No rafting experience is necessary.

Fee and Deposit

Estimated Cost: GSA Member: \$1150. Nonmember: \$1300.
(Based on 24 people. May be more if there are fewer registrants.) (If you have previously traveled on a GSA GeoTrip, the additional nonmember charge will be waived.) \$200 deposit, due with your reservation, is refundable through April 1, less \$50 processing fee. Total balance due: April 1.
Minimum age: 21. Limit: 24 persons.

Fee includes all meals except dinner on the arrival day and breakfast on the departure day; comfortable four-wheel-drive van transportation; double-occupancy lodging in Moab; tents, sleeping bags, and pads when camping; geological reading material and guidebook; and of course, the companionship of expert scientific leaders.



GEOVENTURES REGISTRATION FORM

Registration Open

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

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

If you would like to send a deposit to hold your reservation, please pay by check or credit card, which will be used only for this deposit. (Future charges will be authorized by you first.) You will receive further information and a confirmation of your registration within one week after your reservation.

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

Name _____

Institution/Employer _____

Mailing Address _____

City _____ State _____ Country _____ ZIP _____

Phone: () _____ () _____
Business Home

Guest Name _____

GSA Member #	Deposit Per Person	No. of Persons	Total Paid Deposit
GT941—Canadian Transect	\$200	_____	_____
GT942—Canyonlands/Cataract Canyon	\$200	_____	_____
GH943—Gunnison/Central Colorado	\$100	_____	_____
TOTAL DEPOSIT			_____

I've enclosed no deposit, but I'm interested. Please send more information.

VISA MasterCard American Express

Credit Card # _____ Exp. Date _____

Signature _____

Make checks payable to: **GSA 1994 GeoVentures**

Mail registration form and check or credit card information to:
1994 GSA GeoVentures, GSA Meetings Department,
P.O. Box 9140, Boulder, CO 80301

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

GEOHOSTEL

Scenic Geology and Natural History of the Central Colorado Rocky Mountains

Western State College, Gunnison, Colorado

5 days, 6 nights: June 25–30, 1994

Scientific Leaders:

Kenneth E. Kolm and **Gregory S. Holden**,
Department of Geology and Geological Engineering,
Colorado School of Mines

Gunnison is in the high core of the Colorado Rockies at the center of a wide, well-watered valley, surrounded by 14,000-ft peaks of the Elk, West Elk, Sawatch, and San Juan Mountains, which we will explore during the GeoHostel. At 7700 ft, our center is a small college and recreational town, famous for top-quality fishing in local trout streams. The geology, geomorphology, and geohydrological systems are diverse. We will see the full range of Colorado geological history and environmental systems, from Precambrian basement gneiss through Laramide structural features; Tertiary intrusions, calderas and ash flows; Pleistocene age glaciated mountains; and Quaternary events such as the famous Slumgullion Slide. The GeoHostel will include van tours to the Black Canyon of the Gunnison River, the Rio Grande Rift at Salida, Great Sand Dunes National Monument, the Cochetopa country, Lake City, and tram rides to the tops of Mount Crested Butte and Monarch Peak. The tours are both full and half day and will allow leisure time for late-day hikes, fishing, or further sightseeing. Come join us.

Program Schedule

June 25, Saturday—Welcoming get-together
June 26–30, Sunday through Thursday—Classes and field trips
June 30, Thursday—Farewell party

RIM TO RIVER: MOAB



Cataract Canyon
Ken Kolm



Ken Kolm

The Dollhouse, Maze District, Canyonlands

Not included is airfare to and from Grand Junction, Colorado, or transfer to Moab, Utah. We will arrange for an optional group pick-up and return. The cost is about \$20 each way (100 miles). The overflight of the Canyonlands is also optional and costs about \$60.

Air Transportation

Air transportation can be arranged by Cain Travel Agency in Boulder, 1-800-346-4747, Monday through Friday, 8:30 a.m. to 5:30 p.m. MST. Please ask for Robyn Langerak, who has been serving GSA travelers well for several years. She can also advise you on other travel in the Four Corners area, including Zion, Bryce, and Grand Canyon National Parks.

Please make your decision as soon as possible. There is active interest in this unusual trip, and it will fill soon.

Fee and Deposit

Cost: \$480 for GSA Members. Nonmembers \$530.
\$100 deposit, due with your reservation, is refundable through April 30, less \$20 processing fee.

Total balance due: May 1
Minimum age: 21
Limit: 32 persons

Fee includes classroom programs and materials, field trip transportation, lodging for 6 nights (single-occupancy, or double for couples, dormitory rooms), breakfast and sack lunch daily through Thursday, tram rides, and welcome and farewell events. **Not included** are transportation to and from Gunnison, Colorado, transportation during hours outside class and field trips, meals, and other expenses not specifically included.



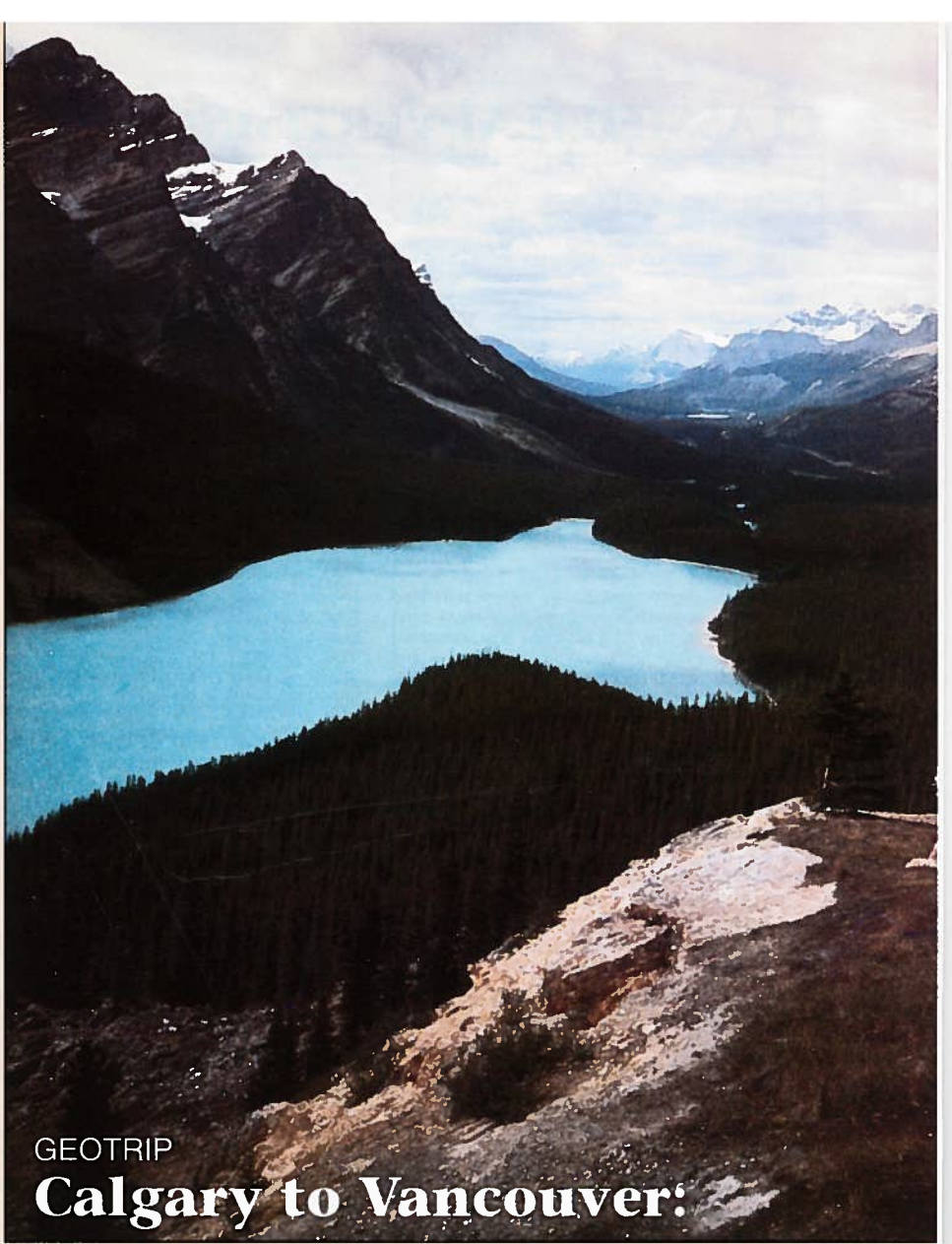
Mt. Owen Ridge, Keebler Pass: Elk Range, Colorado. Ken Kolm

Central Colorado Rocky Mountains



Ken Kolm

Chair mountain, McClure's Pass: Elk Range, Colorado



Peyto Lake, Banff National Park, Canada. Mark Duvall

GEOTRIP Calgary to Vancouver:

Transect across the Southern Canadian Cordillera: A Cross Section through a Convergent Margin.

14 days, 15 nights: Mid-August 1994

This trip is still in the planning stages but promises to be one of the best trips put together through this significant section of Canadian geology. Although details are still in development, the trip will definitely be in mid- to late-August.

Scientific Leaders:

An array of excellent scientific leaders from Canadian universities and the Geological Survey of Canada will participate. Although the final list was unavailable at press time, the complete list will be announced in the February issue of *GSA Today* or may be available from GSA at this time.

Itinerary

This trip is a geologic excursion across the southern Canadian Cordillera, from Calgary, Alberta, to Vancouver, British Columbia. Participants will journey through the Canadian Rocky Mountain fold and thrust belt, the Omineca metamorphic complex and Mesozoic arc assemblages, sedimentary basins, and plutonic complexes of the accreted terranes. The trip will focus on the tectonic evolution of the region, and will emphasize the current level of understanding and areas of current research. As with all GeoTrips, the daily itinerary is planned with both the geologist and nongeologist in mind.

Physical Requirements, Transportation, Lodging, Meals

The leaders have planned several extensive day hikes. Persons in good physical health with the ability to hike several miles uphill are encouraged to consider this trip; however, bus will be the primary transportation mode. Also included will be a trip by horseback, another with jeeps, and very possibly one by jet boat. Lodging (double occupancy) will be in comfortable hotels or inns. Camping may be planned for two or three nights. Meals, including a final farewell dinner, will be included with the exception of the arrival night, "the on-your-own day," and the departure morning.

Fee and Deposit

Estimate: \$2300 for GSA Members (based on 25 participants). \$2450 for nonmembers. A \$200 deposit will hold your place. Cancellation penalties will apply within 60 days of departure, otherwise the deposit will be fully refundable less the \$50 processing fee.

Registration

If you are interested in receiving more information, send in the clip-out form at left or call GSA. Complete details should be available by January 15, and we will begin registration at that time.

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Positions Open

DEPARTMENT OF GEOLOGICAL SCIENCES UNIVERSITY OF TEXAS AT AUSTIN

The Department of Geological Sciences invites applications for a tenure-track faculty position, starting fall 1994. We are seeking candidates in the area of structure/tectonics who specialize in brittle deformation at any scale and/or on the relationships between sedimentation and tectonics. The successful candidate will be expected to teach undergraduate and graduate courses, supervise M.A. and Ph.D. students, and develop a strong research program which will complement our existing structure/tectonics program.

Applicants should provide a resume, list of research publications, and names of three refer-

ences prior to the closing date of January 31, 1994. Mail to: Structure Search Committee Chairman, Department of Geological Sciences, University of Texas at Austin, Austin, Texas 78712.

The University of Texas at Austin is an equal opportunity/affirmative action employer.

GEOPHYSICIST AND CLIMATOLOGIST

Two possible positions at the assistant or associate professor level in the Dept. of Earth and Atmospheric Science at the City College of New York. Candidates must have a Ph.D. in Geophysics or Atmospheric Sciences, have a strong record in research, as well as some teaching experience in field of expertise. The candidates will be part of a new Earth Systems, Program with emphasis on International Urban Natural Risks, including seismic, meteorologic, hydrologic, etc.

Salary range \$29,931-\$60,711. Send C.V. and names of three references by February 15, 1994, to Prof. M. Winslow, Chair, EAS Dept., J-106, City College of New York, Convent Ave. and 138th St., New York, NY 10031. City College is part of the City University of New York, and is an equal opportunity, affirmative action employer.

DEPARTMENT OF LAND, AIR, AND WATER RESOURCES UNIVERSITY OF CALIFORNIA, DAVIS

Applicants are invited for an Assistant/Associate Cooperative Extension Specialist in Hydrology/Hydrogeology to be located at the Kearney Agricultural Center at Parlier (near Fresno) — the largest off campus agricultural research facility operated by the University of California. The position offers a unique opportunity to conduct independent, detailed investigations of pressing groundwater contamination problems ranging from non-point nitrate pollution issues to urban water well contamination, and to address these problems through innovative research and educational efforts. An applied research program should emphasize hydrologic/hydrogeologic processes, contaminant transport and transformations in both the vadose and saturated zones, sampling and monitoring, and mitigation of contamination problems. The extension program should provide educational and technical support to state and federal regulatory agencies, county farm advisors, and policy makers in both the agricultural and urban sectors. The program will comply with all applicable federal and state laws and regulations and University, Campus, and Division policies and procedures related to civil rights, affirmative action, and equal employment opportunity. The candidate should promote, in all

ways consistent with the other responsibilities of this position, accomplishment of Campus and Division affirmative action and equal opportunity goals. Applicants should possess a Ph.D. in geology, engineering, hydrology, hydrogeology, or a closely related field. A broad-based hydrology background and interest in water quality, contaminant transport, and field applications are desirable. Applications and inquiries should be directed by January 31, 1994 to David A. Goldhamer, Search Committee Chair, Cooperative Extension Specialist position in Hydrology/Hydrogeology, Department of Land, Air, and Water Resources, University of California, Davis, California 95616, Telephone (916) 752-1130. Applications should include a resume, official undergraduate and graduate academic transcripts; statements of research and teaching interests and experience; copies of publications and reports; a summary or abstracts of the Ph.D. dissertation; and names, addresses, and telephone numbers of at least three references. The University of California is an affirmative action, equal opportunity employer.

SCIENCE EDUCATION / ASSISTANT PROFESSOR WRIGHT STATE UNIVERSITY

The College of Science and Mathematics invites applications for a tenure-track position for an assistant professor specializing in science education, to begin September 1994. This will be a joint appointment between the appropriate science department and the College of Education. Teaching duties will include science courses for elementary education majors, courses in the science of specialization, and methods courses in education. Candidates must have at least an M.S. in Geology, Chemistry, or Physics, and a Ph.D. or Ed.D. by September 1994. Experience in teaching pre-college science highly desirable. Expertise in course content, methods of presentation, and learning theory preferred. An active program of scholarship in science education, including publications and proposal writing will be expected. A curriculum vitae, statements of intended research and scholarship plans, copies of transcripts, and three letters of recommendation should be sent to: Dr. John Fortman, Chair, Science Education Search Committee, College of Science and Mathematics, Wright State University, Dayton, OH 45435-0001.

Consideration of applicants will begin February 15, 1994. Wright State University is an Affirmative Action /Equal Opportunity Employer.

ASSISTANT PROFESSOR GEOLOGY DEPARTMENT

Applications are invited for a tenure-track position at the rank of Assistant Professor. Teaching responsibilities will include physical geology, environmental geology, and an upper division course in the specialty of the successful candidate. Desired specializations include quantitative geomorphology, low-temperature/contaminant geochemistry, or paleoclimatology. We are seeking an individual who is committed to high-quality undergraduate teaching and who will develop a research program that involves our geology majors. A Ph.D. in the geological sciences is required. The appointment will begin September 1, 1994. Furman University is a private, liberal arts university with 2500 students, located in the South Carolina Piedmont at the foot of the Blue Ridge Front. The Department of Geology consists of four full-time and one adjunct faculty and offers the B.S. and B.A. degrees in geology. Major equipment items include XRD, XRF, EM, AND AA.

Applicants should send a resume, a statement of research and teaching interests, transcripts, and the names of three references to Kenneth A. Sargent, Chairperson, Department of Geology, Furman University, Greenville, SC 29613. Screening of applications will begin January 31, 1994 and will continue until the position is filled. Women and minorities are encouraged to reply. Furman University is an equal opportunity/affirmative action employer.

ENVIRONMENTAL GEOLOGY

Colby College seeks a one-year sabbatical leave replacement in environmental geology for the 1994-95 academic year. The successful candidate will be expected to teach introductory environmental geology (first-year level) and structural geology with laboratory in the fall semester. In spring semester, she/he will teach groundwater hydrology (with or without laboratory), lecture in introductory physical geology, and be part of a three-person team teaching introductory environmental studies. The January short term will be left open. Applicants should have Ph.D. in hand at the time of appointment (Sept. 1st) although ABD candidates will also be considered. Applicants should submit letters of formal application, resume, complete college transcripts, and names of three potential teaching references by 1 February, 1994 to: Chair, Geology Search Committee; Department of Geology; Colby College, Waterville, ME 04901-4799. Colby College is an EEO/AA employer and applications from women and minority candidates are particularly encouraged.

January BULLETIN and GEOLOGY Contents

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LOW TEMPERATURE GEOCHEMISTRY FLORIDA INTERNATIONAL UNIVERSITY

Florida International University invites applications for a tenure-track position in low temperature geochemistry at the assistant/associate professor level, available August 1994. The position is a joint appointment, half-time in the Dept. of Geology in the College of Arts and Sciences and half-time in the Drinking Water Research Center (DWRC), an interdisciplinary center in the College of Engineering and Design. The position carries a 12-month salary and a reduced teaching load (two courses per year). Excellent opportunities exist for collaboration within the Dept. of Geology, and with environmental engineers, chemists, hydrologists, and biologists in the DWRC, elsewhere on campus, and affiliated federal and local government agencies. The desired speciality is open, although there is particular interest in pure or applied aspects of inorganic, carbonate, and/or stable isotope geochemistry, and linkages between geochemical and hydrologic processes. Ph.D. or equivalent is required for the position. To apply, send curriculum vitae, statement of research and teaching interests, graduate and undergraduate transcripts, and three letters of recommendation to: Prof. David Genereux, Dept. of Geology, and Drinking Water Research Center, Florida International University, Miami, FL 33199 USA, (telephone: 305-348-3119; fax: 305-348-3877; Internet: genereux@servax.fiu.edu). Closing date for applications is February 10, 1994. Florida International University is part of the State University System of Florida, and is an affirmative action/equal opportunity/equal access employer.

APPLIED GEOLOGY / NEOTECTONICS CALIFORNIA STATE POLYTECHNIC UNIVERSITY POMONA

The Geological Sciences Department invites applications for a tenure-track faculty position at the Assist. Prof. level, to begin Sept. 94. At time of appointment an earned Ph.D. in Geology, Geol. Eng. or Geohydrology is required. Applicants must have expertise in Neotectonics/Applied Geology. Responsibilities include teaching and developing upper division courses, e.g.: Geotectonics, Geohydrology, Eng. Geology and Env. Geol., lower division Gen. Ed. courses and directing undergraduates in field-oriented research concentrating on geologic problems in S. Calif. Participation in student advising, committee assignments, development of interdisciplinary studies, an active research, publication, and grant funding record, and forging liaison with local industry and the community are also expected. For information send resume to: Dr. John A. Klasik, Chair, Geological Sci. Dept., Cal Poly Pomona, 3801 W. Temple Ave., Pomona, CA, 91768. (E-mail: JAKLASIK@CSUPomona.EDU). Application deadline Mar. 18, 1994. Official transcripts required of all finalists. Cal Poly Pomona is an EO/AA employer.

IDAHO STATE UNIVERSITY

We seek a field-based geologist to fill a tenure-track position in the subject area of Surficial Processes/Environmental Geophysics. A Ph.D. or A.B.D. is necessary. Teaching duties include five undergraduate/graduate classes per year such as: Physical and Historical Geology, Hydrogeology, Geomorphology, and courses in specialty area. Active participation in our Geology Field Camp is expected. Supervision of M.S. students and pursuit of a funded research program is required, while expertise in the geology of Idaho is desirable. The successful candidate will have broad geologic interests and be comfortable in a small department where cooperation and shared teaching and research are standard. Send resume, transcripts, statement of academic philosophy and interests, and names of 3 referees to Search Committee, Department of Geology, Idaho State University, Pocatello, ID 83209-8072. Applications will be reviewed beginning February 15. ISU is an Equal Opportunity/Affirmative Action Employer.

ENVIRONMENTAL GEOCHEMIST

The Department of Geological Sciences, University at Albany, SUNY, invites applications for a tenure-track faculty position at the Assistant Professor level, starting Fall 1994. We are looking for an individual of exceptional talent who will take a leading role in developing a new focus in the Department. We seek to develop a focus, centered on geochemistry, that will contribute significantly to fundamental understanding of geological aspects of the surface and near-surface environment, including Global Change.

For this appointment, the field of specialization must contain geochemistry (defined in a broad sense, and including isotopic fields), and a current and projected research focus having a connection with environmental effects or processes. Approaches that have a component of field-based investigation would contribute to a continuing strength of the Department and would be welcome. The successful candidate will be expected to develop a vigorous, funded research program in her/his specialty, teach undergraduate courses in geology, and graduate courses in her/his area of specialization. Applications, which must include a CV, the names, addresses, e-mail addresses, and phone numbers of three referees, and a statement of research and teaching interests, should be sent to: William S.F. Kidd, Chairman, Department of Geological Sciences, University at Albany—SUNY, Albany, NY 12222. Closing date for applications: January 31, 1994. Ph.D. required. The University at Albany is an equal opportunity/affirmative action employer. Applications from women, minority persons, handicapped persons, and special disabled or Vietnam era veterans are especially welcome.

ENVIRONMENTAL GEOLOGY BOWLING GREEN STATE UNIVERSITY

The Department of Geology invites applications for a new position in environmental geology with a specialization in geochemistry (low-temperature aqueous, environmental and/or groundwater geochemistry) or hydrology (groundwater hydrology, surface water hydrology, contaminant transport, or engineering hydrology). Experience with GIS is also desirable. The opening is a tenure-track position to be filled at the Assistant Professor level beginning in August 1994. A Ph.D. is required. Responsibilities include supervision of M.S. theses, graduate and undergraduate teaching, and research.

Applications should include teaching and research interests, vita, and three letters of reference. Screening will begin March 1, 1994, but applications will be accepted until March 15. Applications should be sent to: Chair, Search Committee, Department of Geology, Bowling Green State University, Bowling Green, OH 43403. Women and minority candidates are encouraged to apply. BGSU is an affirmative action/equal opportunity employer.

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Opportunities for Students

University of Texas at Austin, Institute for Geophysics, Ewing/Worzel Fellowship in Geology/Geophysics, Seismic Processing, Seismology, or Tectonics. Candidates are expected to have a bachelors or masters degree in geology, geophysics, physics, computing, or other related field, and must be accepted in a graduate program of one of the University of Texas at Austin academic departments.

The Institute for Geophysics is an organized research unit of the University of Texas. Fellows are expected to ally themselves with a member of the Institute research staff and either generate an original research project or join an existing project during their first year. The Fellowship amount is \$12,000 per 9-month academic year, which is intended to cover tuition, fees, and stipend. Additional support may be awarded after the first year, depending on the research performance of the individual.

Questions about the fellowship program should be directed to Dr. Thomas A. Davies, Chairman, UTIG

Fellowship Committee, 8701 N. MoPac Expy. Austin, Texas, 78759-8397 (tel. 512-471-6156, fax 512-471-8844 or e-mail to:tomd@utlig.utexas.edu). Application materials for admission as a graduate student may be obtained from the Graduate Studies Office of the appropriate academic department of The University of Texas at Austin. The Fall 1994 deadline for graduate admission and fellowship applications is February 1, 1994. The Spring 1995 deadline is October 1, 1994.

California Institute of Technology. Postdoctoral Fellowships in Earth and Planetary Sciences. The California Institute of Technology announces two fellowships in Earth and Planetary Sciences: The O.K. Earl Postdoctoral Fellowship, and the Texaco Postdoctoral Fellowship.

These awards are from funds endowed by Orrin K. Earl, Jr., and by the Texaco Philanthropic Foundation. Each fellowship carries an annual stipend of \$34,000 and offers a research expense fund of \$1,000 per year and one-way travel to Pasadena. The duration of each appointment will normally be for two years, contingent upon good progress in the first year, and beginning with the 1994-95 academic year. Fellows are eligible to participate in Caltech's health and dental program.

These fellowships have been established to support the research of scientists, typically within two years of receipt of the Ph.D. The intent of the program is to identify and support innovative and creative work in the earth and planetary sciences, with particular emphasis on interdisciplinary work. Applicants with training in physics, chemistry, biology, or computer sciences are urged to apply. The Caltech faculty is currently active in Geobiology, Geochemistry, Geology, Geophysics, Petrology, Seismology, and Atmospheric and Planetary Sciences. It is expected that each fellowship holder will be hosted by a Division professor (designated by the Division Chair) who will contribute to the fellowship support both financially and by providing intellectual guidance.

Application forms may be obtained by writing to Prof. D. J. Stevenson, Chairman, Division of Geological and Planetary Sciences, Mail Code 170-25, California Institute of Technology, Pasadena, California 91125.

Completed applications with references should arrive at Caltech by Monday, February 28, 1994.

Fellowship candidates will automatically be considered for other available postdoctoral positions at Caltech in their fields of interest.

Caltech is an Affirmative Action/Equal Opportunity Employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

Graduate Assistantships, Texas Christian University. The Geology Department has assistantships available for students working toward an M.S. degree. Areas of department expertise include carbonate and clastic sedimentology, paleovolcanology, structure and tectonics, paleontology, hydrogeology, computer applications in geology, remote sensing, and environmental geology. Field-oriented thesis topics include Paleozoic and Mesozoic volcanic arc rocks in the Sierra Nevada, California, Cambrian rhyolites and Paleozoic carbonates in southern Oklahoma, Devonian carbonates in Scotland, and Mesozoic and Cenozoic geology of Big Bend National Park, West Texas. Financial aid includes a yearly stipend of \$7,000, full tuition waiver, and up to \$1,500 for research expenses. Contact the Graduate Advisor, Department of Geology, Texas Christian University, Fort Worth, TX 76129 (817-921-7270).

NASA Planetary Biology Internships. The Marine Biological Laboratory, Woods Hole, Massachusetts, invites applications from graduate students and seniors accepted to graduate programs for awards of \$2200 plus travel to participate in research at NASA centers and collaborating institutions for approximately 8 weeks. Typical intern programs include: global ecology, remote sensing, microbial ecology, biomineralization, and origin and early evolution of life. Application deadline: 1 March 1994. For information/applications, contact: Lorraine Olendzenski, Planetary Biology Internship, Department of Biology, University of Massachusetts, Amherst, MA 01003-5810. e-mail: PBI@botany.umass.edu. An Equal Opportunity/Affirmative Action Employer.

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May

Water Resources at Risk, May 14-18, 1995, Denver, Colorado. Information: Helen Klose, American Institute of Hydrology, 3416 University Ave., S.E., Minneapolis, MN 55414, (612) 379-1030.

17th International Geochemical Exploration Symposium

Exploring the Tropics, May 15-19, 1995, Townsville, Queensland, Australia. Information: Russell Myers, 171GES, National Key Centre in Economic Geology, James Cook University, Townsville, Q4814, Australia, phone 61-77-814486, fax 61-77-815522.

Geological Association of Canada— Mineralogical Association of Canada Joint Annual Meeting

May 17-19, 1995, Victoria, British Columbia, Canada. Information: Chris Barnes, General Chair, SEOS, University of Victoria, P.O. Box 1700, Victoria, B.C. V8W 2Y2, Canada, fax 604-721-6200.

1995 World Geothermal Congress

May 18-31, Florence, Italy. Information: George Frye, Executive Director, International Geothermal Association, LBL 50C, Rms. 106-108, One Cyclotron Road, Berkeley, CA 94720, (510) 486-4584, fax 510-486-4889.

August

■ Tectonics and Metallogeny of Early/Mid Precambrian Orogenic Belts

August 28-September 1, 1995, Montreal, Canada. Information: J. A. Percival, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, (613) 995-4723, fax 613-995-9273, E-mail: jpercival@601C.gsc.emr.ca.

Third Hutton Symposium: The Origin of Granites

August 28-September 2, 1995, College Park, Maryland. Information: Michael Brown, Dept. of Geology, University of Maryland, College Park, MD 20742, (301) 405-4082, fax 301-314-9661.

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Reminders

CALL FOR NOMINATIONS

Materials and supporting information for any of the following nominations may be sent to GSA Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. For more detailed information about the nomination procedures, refer to the October 1993 issue of *GSA Today*, or call headquarters at (303) 447-2020, extension 136.

Officers and Councilors

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

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

Penrose and Day Medals, and Honorary Fellowship

Nominations for GSA's Penrose and Day Medals and for Honorary Fellowship in the Society are due at headquarters by **FEBRUARY 1, 1994**.

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 or younger during the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal called the Donath Medal and a cash prize of \$15,000, was endowed by Dr. and Mrs. Fred A. Donath.

For the year 1994, only those candidates born on or after January 1, 1959, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1994 award must include

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

Nominations for the 1994 Young Scientist Award must be received at GSA headquarters by **FEBRUARY 1, 1994**.

Distinguished Service Award

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Student Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the Annual Meeting of the Society. Deadline for nominations for 1994 is **MARCH 1, 1994**.

Geological Society of America
Memoir 178

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Edited by Robert E. Powell, R. J. Weldon, II, and Jonathan C. Matti



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