Vol. 1, No. 7 July 1991

GSA TODAY

A Publication of the Geological Society of America

INSIDE

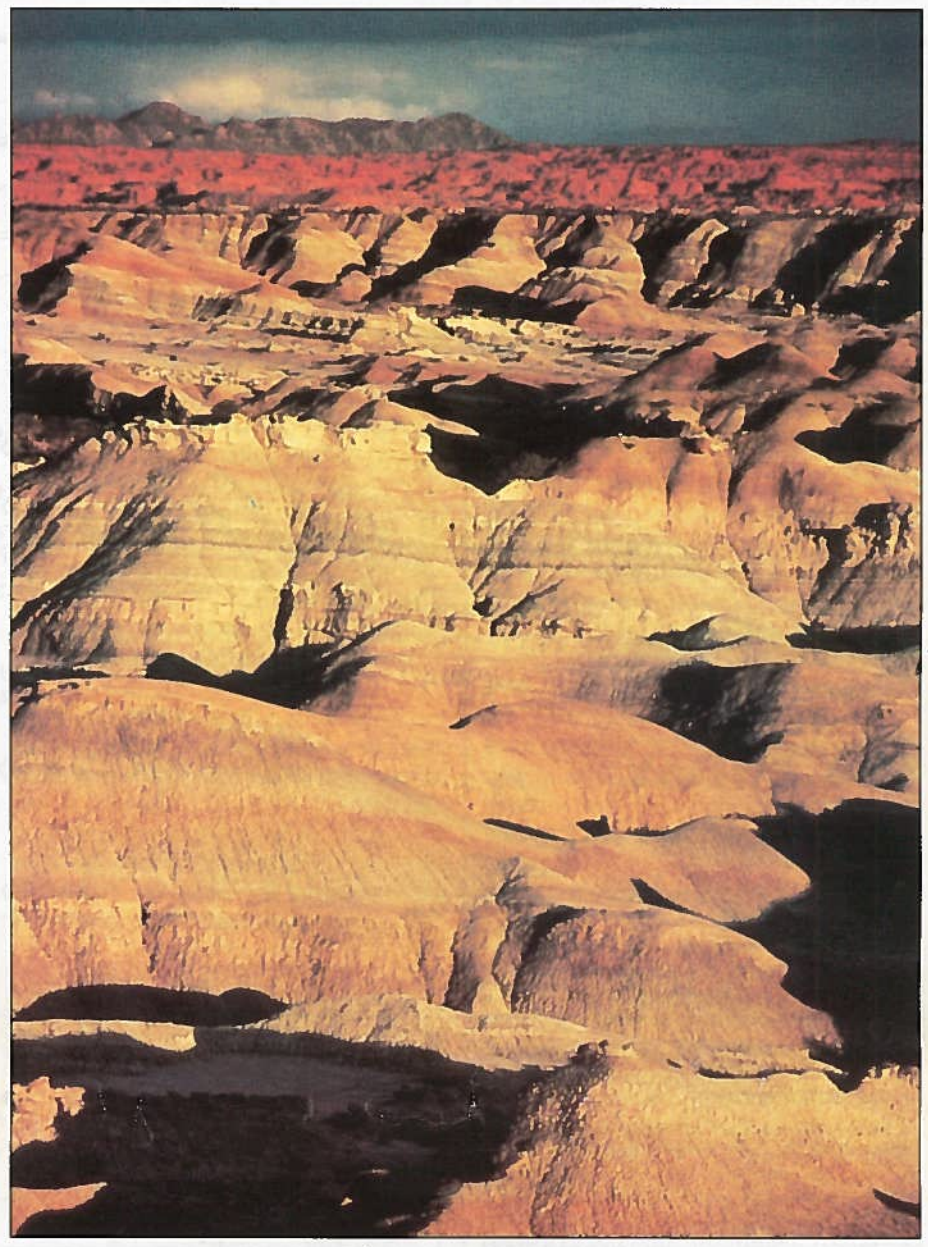
- Geologic Mapping, p. 143
- GSA Employment Service, p. 150
- New Students, Members, Fellows, p. 152

Ruling Reptiles and Wandering Continents: A Global Look at Dinosaur Evolution

Paul C. Sereno
Department of Organismal Biology and Anatomy
University of Chicago, Chicago, IL 60637

ABSTRACT

As Pangaea rifted apart during the latter half of the Mesozoic, dinosaurs dominated all land habitats and evolved into an extraordinary array of land and aerial forms. This mobile episode in Earth history provides a unique opportunity to study the evolution of animal form and diversity during a prolonged period of biogeographic fragmentation. Dinosaurs and their avian descendants belong to a larger clade of reptiles called ornithodirans that were the first vertebrates to evolve bipedal locomotor posture. Although the advent of bipedalism in the Middle Triassic may have promoted the evolution of the first vertebrate powered fliers, the pterosaurs, it cannot be invoked to explain the subsequent dinosaur radiation, which appears to have been an opportunistic, rather than competitive, faunal replacement. The aim of the current research is to provide a unified hypothesis of dinosaur descent for about 200 of the most completely known dinosaur species and temporally calibrate the branch points of this phylogeny. The calibrated phylogeny can then be used to detect missing lineages, to map major speciation events, to track parallel evolution in multiple lineages, and to investigate biogeographic history. Recent discovery of an ancient sparrow-sized fossil bird in China documents the early appearance of anatomical features associated with sustained powered flight and perching that bridge the gap between *Archaeopteryx* and the common ancestor of living birds. Much of the deep branching history that gave rise to the great diversity of living birds must have occurred before the extinction of the dinosaurs, and this ancient heritage can be reconstructed from both anatomical and genetic evidence in living birds.



Fossiliferous overbank deposits of the Ischigualasto Formation in northwestern Argentina.

INTRODUCTION

Perhaps more than the bones of ancient humans, dinosaurs stir popular interest in the fossil record. Today we are inundated with dinosaur encyclopedias and dictionaries, dinosaur lunch boxes and cups, dinosaur models and robots, and dinosaur cookies and spaghetti. Museums trumpet their newest dinosaur displays, now with groaning, lurching latex replicas. The driving force behind dinosaur appeal and the multimillion-dollar industry it has spawned may be simply our fascination—as moderate-sized mammalian endotherms—with extinct beasts of ponderous proportions that appear strangely "reptilian."

Public fanfare about dinosaurs, ironically, has cast a shadow over dinosaurs as legitimate and unique subjects for scientific inquiry. Dinosaurs are kids' stuff, after all. Do they merit serious scientific investigation beyond mere naming and description of new species? Could dinosaur skeletons in the museums of the world really help resolve any fundamental paleontological questions?

When dinosaurs first dominated land habitats in the Late Triassic about 225 Ma, most of Earth's land surfaces were joined as Pangaea. As the supercontinent rifted apart, dinosaurs evolved into an extraordinary array of land and aerial forms. This mobile, creative episode in Earth history provides a unique opportunity to study the evolution of animal form and diversity during a prolonged period of biogeographic fragmentation. Abundant dinosaur remains from every continent record a land-based vertebrate radiation from its origin and rise to dominance to its ultimate demise.

TRACING BIRD AND CROCODILE LINEAGES

Dinosaur origins have remained unnecessarily mysterious and conjectural for more than a century. Dinosaurs and their avian descendants belong to a larger clade of reptiles, the Archosauria, that also includes living crocodilians. Both dinosaur-avian and crocodilian lineages are easily traced back to the Late Triassic, where they are joined by a variety of closely related Triassic forms traditionally grouped together as "thecodonts." The key to understanding dinosaur origins lay in unraveling the "thecodont" plexus by aligning these early archosaurs with either the dinosaur-avian or crocodilian lineages (Gauthier, 1986). By application of quantitative cladistic analysis, the timing and sequence of anatomical associated functional transformations that presaged the dinosaur radiation can be evaluated (Fig. 1; Sereno and Arcucci, 1990; Sereno, 1991).

During the Middle Triassic, archosaurs split into dinosaur-avian and crocodilian clades (Sereno and Arcucci, 1991). The crocodilian clade, Crurotarsi, evolved a peculiar ball-and-socket ankle joint between the proximal tarsals (calcaneum and astragalus) which persists with little alteration in living crocodiles. The dinosaur-avian clade,

Dinosaurs *continued on p. 142*

President Curtis Dies

Doris M. Curtis, 1991 president of the Geological Society of America, died May 26, 1991. Vice-president E-an Zen made the following announcement

With a deep sense of sadness and loss, I announce the death of President Doris Curtis. Doris went into the hospital in Houston, Texas, in March for what was expected to be a routine course of medical treatment for leukemia. The treatment went well, but she developed pneumonia, and the destruction of her immune system defied medical efforts. She died peacefully in her sleep in the early morning of Sunday, May 26. She was 77 years old.

President Curtis was very much involved in the affairs of the GSA right to the end. Her last request to the headquarters was for a GSA poster with the signatures of the entire staff; she had this placed on the wall so that she could see it from her bed. She told her visitors, "They are all here with me." Doris Curtis's commitment to the Society, to the profession, and to the application of geology to the welfare of our nation was deep and active. She worked relentlessly to make geology more accessible to the users of such information, and she nurtured the Committee on Geology and Public Policy. The advocacy program is now a major part of our collaborative effort with the American Geological Institute, and Doris's last official act as President was to sign a letter, prepared by the Council, that addressed the issue of the importance of geologic mapping on a national scale.

As we face the loss of our president, let us remember what she valued in life—professional excellence and dedication to its societal applications. So, let us celebrate her life rather than mourn her death. We have been fortunate to have had Doris Curtis as our president since last October. ■

Contributions in honor of Doris M. Curtis may be made to the GSA Foundation, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301.

IN THIS ISSUE

Ruling Reptiles and Wandering Continents: A Global Look at Dinosaur Evolution page 141

GSA Forum 143

Geologic Mapping—A National Issue 143

Washington Report 147

GSAF Update 148

GSA Council Actions 149

Section Meetings—Call for Papers 149

GSA Employment Service 150

New GSA Members, Student Associates, and Fellows 152

DNAG News 154

In Memoriam 154

Annual Meeting—Travel, Lodging, and Alternative Housing 155

Meetings Calendar 156

Bulletin and *Geology* Contents 158

GSA Meetings 158

Classifieds 159

Photo Contest Winner 160

GSA TODAY *July 1991*
Vol. 1, No. 7

GSA TODAY (ISSN 1052-5173) is published monthly by The Geological Society of America, Inc., with offices at 3300 Penrose Place, Boulder, Colorado. Mailing address: P.O. Box 9140, Boulder, CO 80301-9140, U.S.A. Second-class postage paid at Boulder, Colorado, and at additional mailing offices. **Postmaster**: Send address changes to *GSA Today*, Membership Services, P.O. Box 9140, Boulder, CO 80301-9140.

SUBSCRIPTIONS for 1991 calendar year: **Society Members**: *GSA Today* is provided as part of membership dues. Contact Membership Services at (800) 472-1988 or (303) 447-2020 for membership information. **Nonmembers & Institutions**: $30 for U.S., Canada, and Mexico; $40 elsewhere. Contact Subscription Services (same phones). **Single copies** may be requested from Publication Sales. **Claims**: For nonreceipt or for damaged copies, members contact Membership Services; all others contact Subscription Services. Claims are honored for one year; please allow sufficient delivery time for overseas copies.

STAFF

Prepared from contributions from the GSA staff and membership.

Executive Director: F. Michael Wahl, Ph.D.
Science Editor: Eldridge M. Moores
Department of Geology, University of California, Davis, CA 95616
Forum Editor: Bruce F. Molnia
U.S. Geological Survey, MS 917, National Center, Reston, VA 22092
Managing Editor: Faith Rogers
Associate Editor: Shaun Cisneros
Production & Marketing Manager: James R. Clark
Advertising Coordinator: Ann H. Crawford
Graphics Production: Shaun Cisneros
Production Coordinator: Joan E. Manly

ADVERTISING

Classifieds and display: contact Ann Crawford (303) 447-2020; fax 303-447-1133

Printed in the U.S.A.

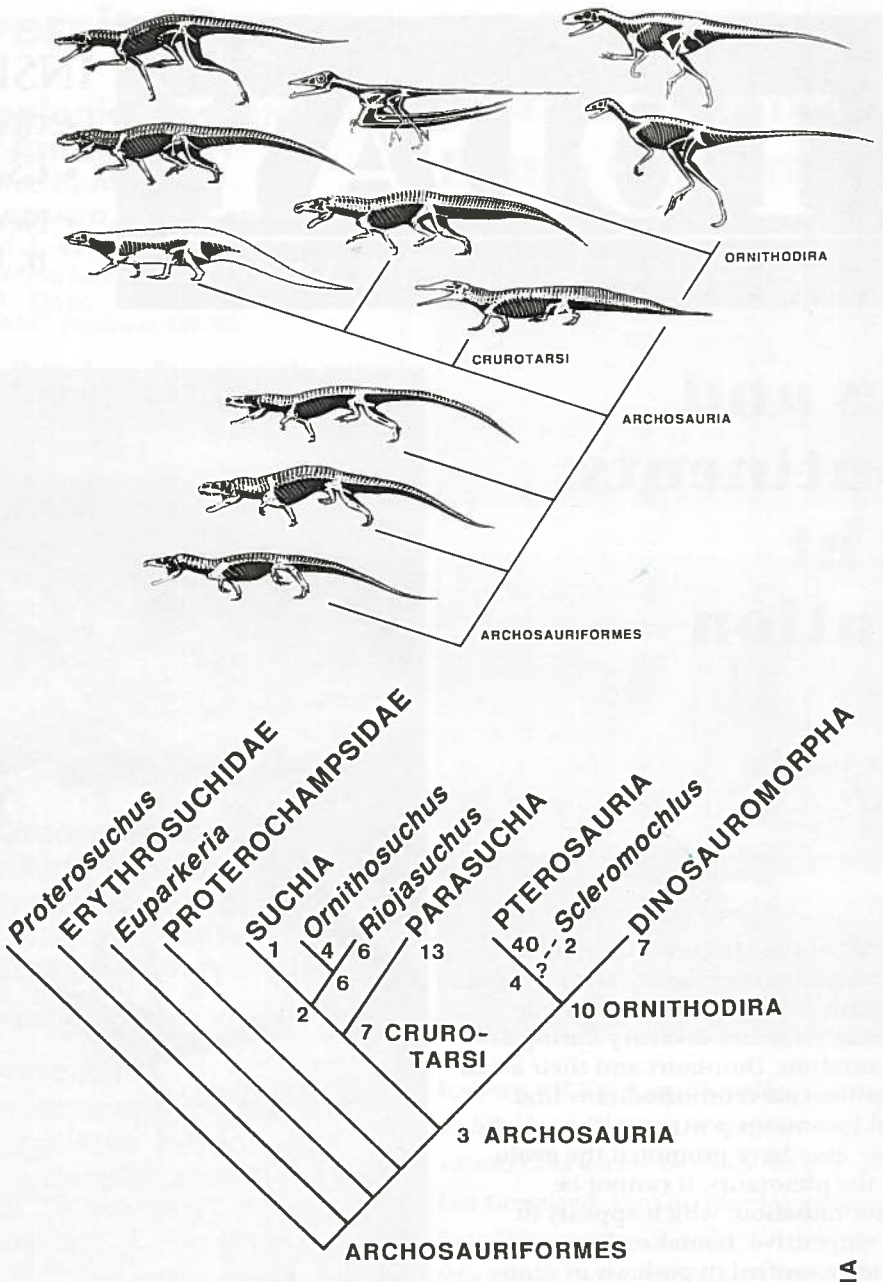


Figure 1. Cladograms (top) and corresponding calibrated tree (bottom) of extinct archosauriforms showing the divergence of the dinosaur-avian lineage (*Herrerasaurus*, top right) from the crocodilian lineage (*Pseudhesperosuchus*, top left) (from Sereno, 1991).

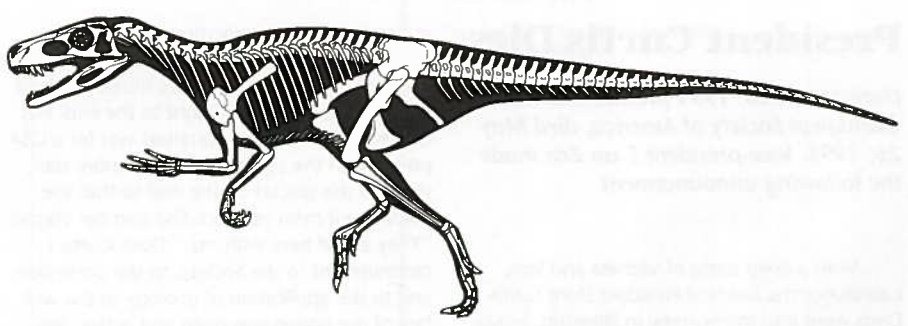


Figure 2. Reconstruction of the skeleton of the earliest dinosaur *Herrerasaurus ischigualastensis*. Overall length is about 3 m.

Dinosaurs *continued from p. 141*

Ornithodira, includes as basal offshoots the pterosaurs and small-bodied dinosaur precursors. Ornithodirans were the first vertebrates to evolve a bipedal locomotor posture, which utilizes only the hind limbs for propulsion. Bipedal locomotion appears to have loosened functional constraints on the forelimbs, which were rapidly modified as wing supports in pterosaurs, the first vertebrate powered fliers.

The earliest dinosaurs were erect bipeds characterized by a suite of modifications in the hand, hip, and ankle, some of which have been invoked as causal factors for the subsequent dinosaur radiation (Bakker, 1971; Charig, 1972; Carrier, 1987). But these small postcranial adjustments do not support a model of superior performance. Living animals with erect locomotor posture, high metabolic rates and the capacity for stamina, such as most birds and mammals, do not perform more efficiently at slow speeds than quadrupedal sprawlers such as lizards (Bennett, 1985). During the Late Triassic, erect dinosaurs coexisted for millions of years alongside more abundant sprawling or semi-erect reptiles, such as rhynchosaurs and early synapsids. The dinosaur radiation at the end of the Triassic postdates the extinction of rhynchosaurs and synapsids and thus appears to be an opportunistic, rather than competitive, replacement (Benton, 1983, 1987).

TRACKING THE FIRST DINOSAUR

Evidence of the earliest dinosaurs was based on two fragmentary postcranial skeletons discovered more than 30 years ago, one in the Ischigualasto Formation of northwestern Argentina (photo, p. 141) and the other in the Santa Maria Formation of southeastern Brazil (Reig, 1963; Colbert, 1970). These dinosaurs, *Herrerasaurus* and *Staurikosaurus*, respectively, did not fit well with either of the two major dinosaur clades, Saurischia and Ornithischia. Rather, they represent a short-lived radiation
at the base of Dinosauria. Recent work in the Ischigualasto Formation has uncovered the first complete remains of *Herrerasaurus*, a 12–15-foot-long bipedal predator (Fig. 2). The lightly constructed skull has a well-developed joint at mid-length along the lower jaw designed for flexing around struggling prey (Fig. 3). The forelimbs are short and the manus (hand) is characterized by a partially opposable pollex and large unguals on the inner three digits for subduing prey.

The new material from Argentina provides the first complete picture of an early dinosaur. The succession of vertebrate horizons in the fossiliferous Ischigualasto Formation and overlying Los Colorados Formation document the transition from Carnian rhynchosaur-synapsid–dominated faunas to Norian faunas with prosauropods, theropods, and the first mammals (Bonaparte, 1982).

RECONSTRUCTING DINOSAUR DESCENT

Although nearly half of currently known dinosaur species have been described in the past 20 years (Weishampel et al., 1990), a more important development has been the recent emergence of cladistic hypothe-

Dinosaurs *continued on p. 144*

GSA FORUM

Bruce F. Molnia

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

ISSUE: Empowering the Earth Science Teacher

American students are not receiving a quality earth science education because their teachers are ill-prepared. How can the earth science community remedy this dilemma and produce an educated and concerned Earth-literate America?

PERSPECTIVE 1: Classroom Technology—Empowering Earth Science Teachers

Carol J. Stadum, Jostens Learning Corporation, San Diego, California

"In the past thirty years new technology has created an extraordinary revolution in our knowledge of Planet Earth. Satellites, robot space probes, manned undersea vehicles, computer enhanced images—all these have inspired new theories about how our planet was created, the dynamics at work today, and our potential to harness the Earth's energies in the future, or tip the balance toward disaster." (Weiner, 1986, *Planet Earth*, Bantam Books, New York).

Precollegiate educators have not been prepared nor provided with the support to bring this extraordinary revolution into their earth science curricula. This revolution is overwhelming to K–12 teachers who have been recruited from other disciplines as well as earth science instructors with years of experience. These teachers are seeking methodology and resources that will empower them to teach the revolutionary earth sciences of geology, meteorology, oceanography and space science to today's video-literate children.

In most precollegiate classrooms earth science teaching is static and fixed—a science that is unchanging from semester to semester and year to year. The teacher's classroom partner has been the textbook—earth science teachers with limited training are dependent upon textbooks. Available precollegiate texts contain a considerable amount of misinformation and outdated content. Precollegiate texts generally present the "what" but not the "why" of earth science as something to memorize and not to question. An example of this is that the actual process of volcanic eruptions is omitted from texts while the shapes of volcanoes and products of eruptions are listed for students to memorize.

Recognizing that texts are not the sole answer to teaching earth science, teachers supplement assignments with films and videos. These media are often presented as rewards for good behavior and, like texts, are forms of static science with no opportunities for student interaction. Classroom control requires little effort from teachers exclusively using textbooks and films. It is no wonder that earth science has been treated by educators as the science for dummies.

Static earth science has been recognized as an inappropriate method of teaching for two decades. Attempts to introduce hands-on science into classrooms have included the development and publication of the Earth Science Curriculum Project and the subsequent Crustal Evolution Education Project. Unfortunately these programs have met resistance due to the insecurity of untrained teachers, the lack of classroom resources, and the high reading level of the lessons.

With the advent of hands-on involvement through these projects and occasional field studies, earth science education evolved from static to dynamic as students experienced science as it was happening. From the fizz of acid on limestone to the cleaving of fluorite, students were observing, analyzing, classifying, and discovering earth science. For the first time the earth science curriculum had reality for students.

During the past decade a new classroom partner of science discovery has begun to empower teachers. This partner is computer technology, a spin-off from the technology that produced the earth science revolution. Computer technology extends hands-on to minds-on learning. It brings science to a personal level that children of diverse abilities can explore. Computers are an excellent method of reaching students for whom English is a second language and students for whom peer interaction is difficult. Using computers, students work alone or in cooperative teams at their own pace to experiment with models and to solve problems.

Well-designed interactive computer lessons do not duplicate hands-on labs, nor are they tutorial. They provide students with opportunities to create and test their own models. Through modeling, middle school students can explore the asthenosphere with zoom animation and discover why volcanoes erupt. They can create a cinder cone or a shield volcano by manipulating variables within the magma reservoir. They discover the why of earth science processes.

Forum *continued on p. 146*

Geologic Mapping—A National Issue

Donald C. Haney, Kentucky Geological Survey

The strength of any nation is based, in a large part, on its mineral wealth and water resources. These valuable assets are dependent upon geologic mapping for their discovery, evaluation, and adequate development. In addition, the prudent use of these resources involves the proper disposal of waste products that may be harmful to man's continued existence on our planet. In its basic, most fundamental form, geologic mapping involves the gathering of information about the distribution of rocks and rock materials at the surface of the earth and plotting this information on maps. All segments of society, including federal agencies, state and local governments, private industry, academia, and the general public, benefit, either directly or indirectly, from the use of geologic maps.

Since President Kennedy's pledge to place a person on the moon, our nation has witnessed a decline in activities related to characterizing in graphic form the nature of the rocks at the surface of the earth in favor of "black-box" research to collect vast amounts of data on things that have limited impact on the immediate problems that directly affect mankind. Although mapping the dark side of the moon may be of great scientific interest, it has little impact on protecting the essentials of life such as water and air. Nor does it provide important information concerning the location and development of mineral resources for the present and near future. Not only did government abandon support for fundamental geological data gathering, but also our universities began emphasizing "high-tech" research methods while phasing out courses in geologic mapping which would provide needed basic information. Now that an overcrowded earth is rapidly destroying its water supply and trying to hide evidence of a throw-away society by burying everything from PCP's to diapers, our need to know about the nature and distribution of rock materials at and near the earth's surface has become much more critical. How do we reverse the trend? Who will teach the students to collect, interpret, and compile geologic data and produce geologic maps? How can government reverse its ever-increasing trend toward "high science"?

Currently the combined capabilities of state, federal, and academic groups to provide mapping are not sufficient to meet the present need of our country, not to mention future needs, which will be greatly increased. A focused nationwide effort with dedicated dollars in the federal budget is required if the nation's needs are to be met as we enter the 21st century.

A 1987 report prepared by a committee of the national Academy of Science clearly recognized the importance of a national geologic mapping program to meet the needs of today's society. The committee stated that those persons and agencies responsible for geologic mapping should take the necessary steps to ensure that adequate geologic information is made available. Further, the committee found that although geologic mapping is carried out in support of other national programs such as wilderness studies, the siting of high-level nuclear waste repositories, federal land management, and earthquake- and volcanic-hazard studies, no separate national geologic mapping program exists in the federal government.

Geologic mapping is both a national issue and a state issue; therefore, it must be addressed at both the federal and state levels. Many states, through their state geological surveys, currently have ongoing geologic mapping programs. However, past progress has been very slow, and these programs will not provide in a timely manner the maps that our nation needs. Therefore, a concentrated effort by the federal government in cooperation with the various states must be made to provide the geologic maps that are needed to satisfy our country's ever-increasing demands for information about our natural resources and environmental concerns.

Geologic maps are the principal sources of geologic information needed for the resolution of nearly all basic and applied earth-science research and decision-making problems. In addition to providing fundamental geologic information, geologic maps indicate mineral-resource potential and serve as a guide to most of the human interactions with the earth. They are used to determined the distribution and availability of energy and mineral resources, the locations and characteristics of natural hazards, the occurrence and availability of water resources, and the availability and limitations of land and water for various uses. Applications include screening and site characterization for toxic and nuclear waste-disposal sites, earthquake-hazard reduction studies, landslide-hazard assessments, volcanic-hazard reduction, siting of critical facilities, evaluation of excessive coastal erosion, and basic earth-science research. While it is commonly recognized that geologic maps are indispensable in the modern search for fuels, mineral deposits (including strategic minerals), and ground-water supplies, it is not well known that geologic maps provide much of the basic data needed for planning many types of engineering construction projects, such as dam and reservoir sites, highways, railroads, pipelines, foundations for buildings, bridges, and industrial plants, location of construction materials, and avoiding construction sites rendered hazardous because of landslides, unstable foundations, and similar earth-rock related problems.

As documented by the 1988 National Academy of Sciences report on geologic mapping, direct users include such diverse groups as private industry, federal, state, and local governments, universities, and the general public. That report clearly attached a high level of importance to geoscience

Mapping *continued on p. 146*

Figure 3. Skull of the early dinosaur *Herrerasaurus ischigualastensis* discovered in the Carnian Ischigualasto Formation in 1988 by a joint American-Argentine team.

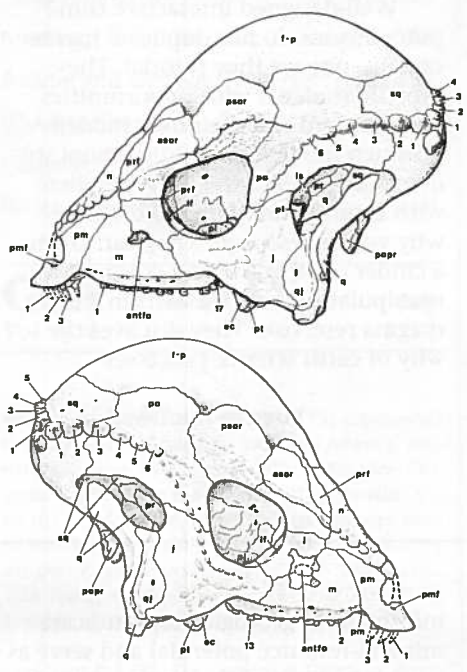


Figure 4. Skull of the Maastrichtian pachycephalosaur *Prenocephale prenes* from the Gobi Desert of Outer Mongolia. *Prenocephale* shows the linear cranial ornamentation that characterizes all pachycephalosaurs and the extreme doming of the skull roof that characterizes a subset of advanced pachycephalosaurs. Character information from specimens like this is analyzed to reconstruct dinosaur descent.

Figure 5. Large tyrannosaurid theropod *Tarbosaurus bataar* at the Paleontological Institute in Moscow. *Tarbosaurus*, a close relative of the North American *Tyrannosaurus*, is exemplary of the large-skulled predators that were restricted to the northern continents during the Late Cretaceous.

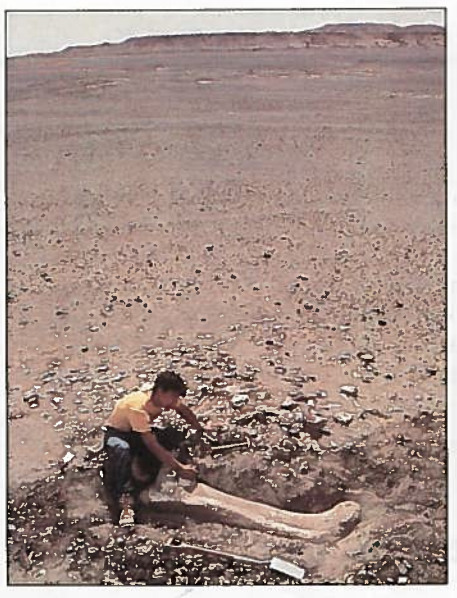


Figure 6. Author Sereno uncovering the femur from a skeleton of a new sauropod dinosaur in Neocomian beds in Niger during a joint British-American expedition in December 1990. Little is known about the sauropods of Africa and the biogeographic history of sauropods on the southern continents.

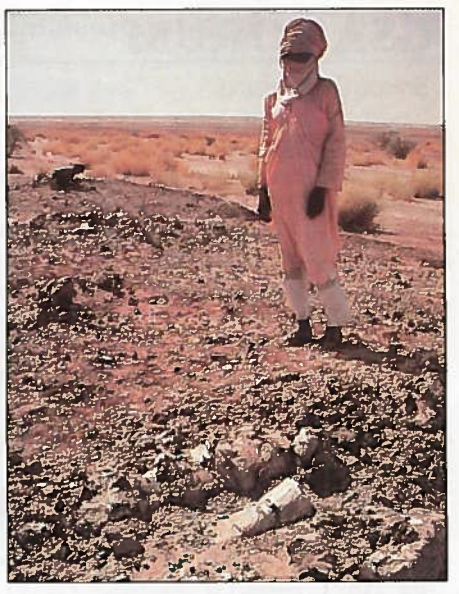


Figure 7. Tuareg tribesman standing over the partially exhumed skeleton of a large sauropod dinosaur in Neocomian beds in Niger during a joint British-American expedition in December 1990.

Dinosaurs *continued from p. 142*

ses that outline dinosaur phylogeny (Gauthier, 1986; Sereno, 1986). One aim of the current research is to provide a unified hypothesis of dinosaur descent for about 200 of the most completely known dinosaur species. The branching pattern and sequence of anatomical transformations is calculated by computer-assisted cladistic analysis of an extensive character/taxon database (Fig. 4). The phylogeny is calibrated temporally by determining the minimum age of divergence for each branch point in the tree. Most evolutionary interpretations depend on a calibrated phylogeny, if only acknowledged implicitly. The phylogeny can be used to detect missing lineages, to calculate the completeness of the fossil record, to date major speciation events, to track parallel evolution in multiple lineages, and to investigate biogeographic history.

The evolution of body size is an interesting example. When body size is mapped onto dinosaur phylogeny, a strong trend toward increasing body size is apparent in many lineages. Although there are several instances when body size must have decreased rapidly, there is only one subgroup (ceratosaurian theropods) that shows a trend (more than a single step) toward smaller body size. In this way the timing of body size increase and its relation to skeletal transformation can be studied in more detail.

Coevolution between feeding mechanisms in dinosaurian herbivores and plants is particularly interesting in light of the mid-Cretaceous transition to angiosperm-dominated floras. Unconstrained by a rigid replacement scheme as occurs in mammalian tooth rows, dinosaur dentitions were free to increase the length of the tooth row and speed of tooth replacement in response to increased tooth wear. Three groups of dinosaurian herbivores (diplodocids, hadrosaurids, ceratopsids) independently evolved rapid tooth replacement, several new crowns being stacked beneath each functioning crown. Hadrosaurids and ceratopsids independently evolved tooth batteries that have a single continuous wear surface on each jaw formed by a patchwork of interlocking crowns. The simultaneous appearance at the beginning of the Late Cretaceous of tooth batteries in large-bodied herbivores and of angiosperm-dominated floras strongly suggests plant-herbivore coevolution (Wing and Tiffney, 1987; Weishampel and Norman, 1989; Lidgard and Crane, 1990).

DINOSAURS AND ISLAND CONTINENTS

Tectonic fragmentation of Pangaea during the latter half of the Mesozoic offers a unique opportunity to compare vicariant and dispersal models of biogeographic differentiation on a continental scale. Are plate dynamics reflected in the phylogenesis of major dinosaur clades in the latter half of the Mesozoic? Where and when did intercontinental land connections permit dinosaur dispersal? And how did continental differentiation or climate influence dinosaur diversity?

The initial split of Pangaea into Laurasia and Gondwana resulted in the evolution of distinct ornithischian and saurischian faunas on each landmass during the Cretaceous, with hadrosaurs, ceratopsids, and tyrannosaurids (Fig. 5) predominating on Laurasia and titanosaurid sauropods and ceratosaurs occupying Gondwana (Figs. 6, 7; Bonaparte and Kielan-Jaworowska, 1987). Continental fragmentation during the Early Cretaceous (Fig. 8) isolated dinosaur faunas on each major land mass. The biogeographic relations among taxa within various dinosaur clades should show either replicate patterns corresponding to continental fragmentation or evidence of dispersal across transitory land bridges or oceanic barriers.

Evidence for dispersal between land masses in the Late Cretaceous abounds when dinosaur phylogenesis is carried to the generic or species level. Asian and North American dinosaur faunas of the Late Cretaceous do not share a single species in common, despite broad similarities in faunal composition at higher taxonomic levels. A cladogram depicting the relations of pachycephalosaurs and ceratopsians (Fig. 9) shows an alternating pattern of biogeographic relations that can only be explained by multiple dispersal events across Beringia with subsequent differentiation on the opposing land mass. The same pattern of dispersal is supported by several other contemporaneous ornithischian and saurischian clades.

EARLY EVOLUTION OF AVIAN FLIGHT AND THE DEEP BRANCHING HISTORY OF LIVING BIRDS

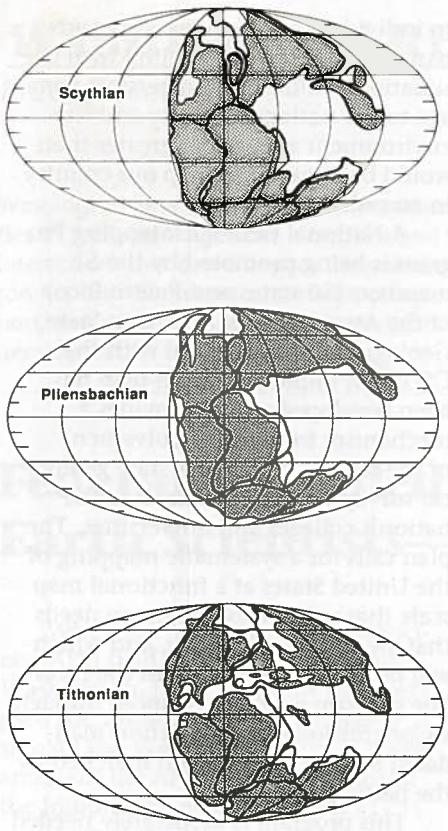
The past 15 years have witnessed two principal conceptual advances in the understanding of the origin and early evolution of birds. First, birds were placed in proper phylogenetic context as dinosaurian descendants with close affinity to advanced theropod dinosaurs (Ostrom, 1976; Cracraft, 1986; Gauthier, 1986), a realignment with a remarkable historical precedent (Huxley, 1868). Second, the best known Mesozoic birds—*Archaeopteryx, Hesperornis,* and *Ichthyornis*—have been reviewed and positioned as successive sister taxa to living birds, or Neornithes (Martin, 1983; Cracraft, 1986). Thus, a framework for the early evolution of Aves has emerged.

The avian fossil record is almost barren during the first third of avian history—a 50 m.y. interval between *Archaeopteryx* (Fig. 10) in the latest Jurassic and *Hesperornis* and *Ichthyornis* in the Late Cretaceous. The recent discovery of an articulated fossil bird about 10 to 15 m.y. younger than *Archaeopteryx*, has opened a new window on early avian evolution (Fig. 11). The sparrow-sized skeleton is preserved in the fine-grained sediment of a freshwater lake, with associated plant, insect, and fish remains.

The fossil bird documents the very early appearance of anatomical features associated with sustained powered flight and perching that are absent in Archaeopteryx (Rao and Sereno, 1990; Ruben, 1991). Modifications for sustained flight include a strut-shaped coracoid that braces the shoulder joint against an ossified sternum during flight, a modified V-shaped wrist bone (ulnare) that allows tight folding of the wing during the flight stroke, and a reduced, coossified tail bone (pygostyle) that holds tail feathers for flight stability and landing (Fig. 11). The Chinese bird was arboreal, with extremely slender recurved unguals and a fully reversed hallux for perching (Fig. 12). Other characters establish the fossil avian as the second most primitive bird next to *Archaeopteryx*, such as the presence of toothed jaws, ossified stomach ribs (gastralia), and a pelvis with a footed pubis reminiscent of the ancestral theropod condition.

The principal groups of living birds, such as ratites, loons, pelicans, penguins, and songbirds, to name a few, must have diverged before the end of the Mesozoic (Olson, 1985) in

Dinosaurs *continued on p. 145*



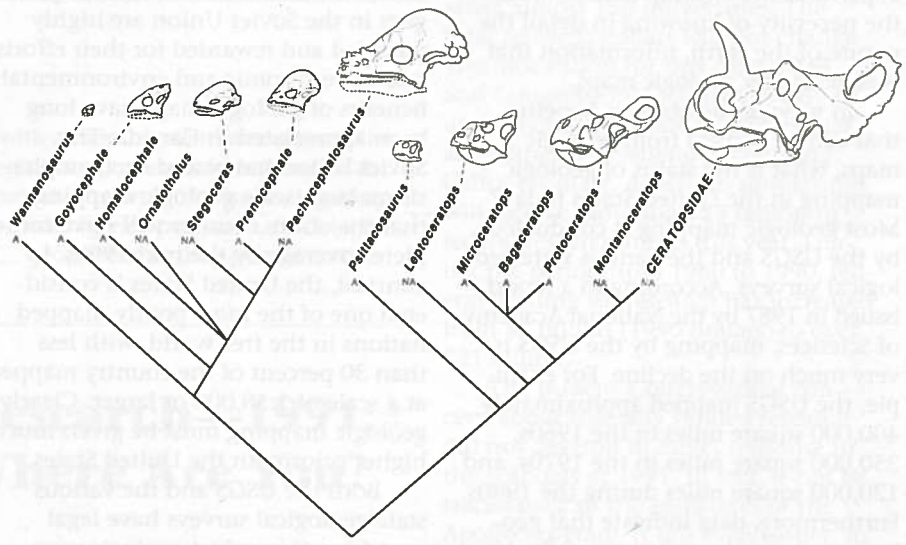


Figure 9. Cladogram showing the relations among pachycephalosaur and ceratopsian dinosaurs; known paleogeographic ranges are indicated below scaled skull profiles (A = central Asia; NA = western North America). A dispersal route across Beringia could account for the alternating biogeographic areas for the species in each group. The scaled skull profiles show the increase in body size that characterizes many dinosaurian subgroups.

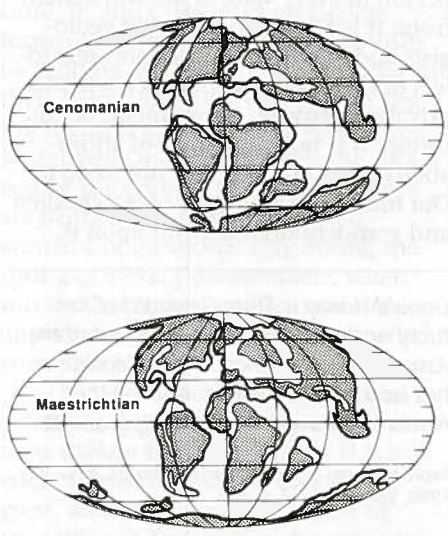


Figure 8. Paleogeographic maps showing exposed land surfaces (stipple) for several Mesozoic stages that span the origin and evolution of dinosaurs (after Zeigler et al., 1983).

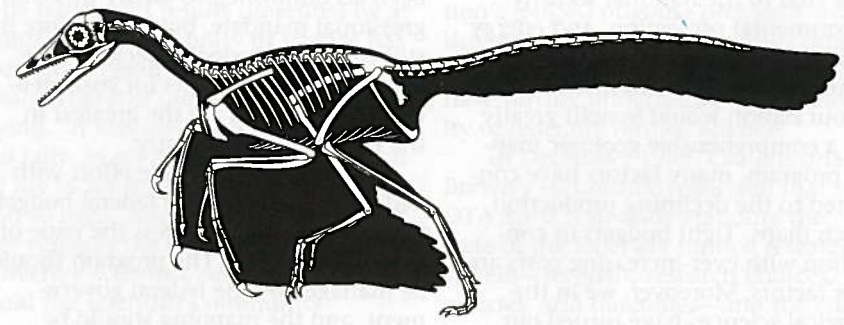


Figure 10. Reconstruction of the ancient dinosaur-bird *Archaeopteryx lithographica*, running. Archaeopteryx was capable of powered flight, as evidenced by aerodynamic flight feathers, but it apparently could not fold its forelimb during flight or resting as modern birds do.

Figure 11. Reconstruction of a newly discovered 125 million-year-old fossil bird, in flight, from Liaoning Province in northeastern China. The presence of an elongate coracoid buttress to an ossified sternum suggests the presence of significant flight musculature. The wrist joint is capable of tight folding as occurs in the flight stroke of modern birds. The shortened tail bone (pygostyle) provides attachment for stabilizing tail feathers and shifts the center of balance from the pelvic girdle to the pectoral girdle for sustained flight.

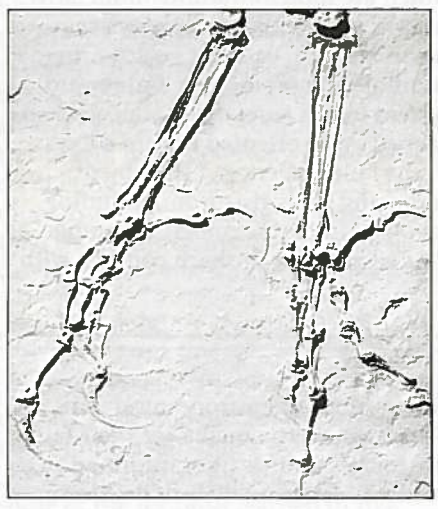


Figure 12. Epoxy cast of perching feet of the new Chinese bird, showing the reversed position of the hallux and the extremely slender, recurved unguals.

Dinosaurs *continued from p. 144*

the last great radiation of the dinosaur-avian clade. Most Cretaceous and Paleogene avian fossils, although usually quite fragmentary, can be aligned with extant subgroups, suggesting that the principal skeletal variation among major groups of living birds arose, perhaps during a relatively short interval, before the end of the Mesozoic. Cladistic surveys of anatomical variation among living birds is very preliminary (Cracraft, 1988). Molecular techniques that measure overall sequence similarity of genomic components between species, such as DNA-DNA hybridization (Sibley and Ahlquist, 1991), have been used to construct composite phylogenies (phenograms), but this technique may not be able to resolve the deep branching history of living birds. My laboratory is currently obtaining DNA sequences from the mitochondrial genome of species from disparate avian subgroups. Sequence information, in combination with new DNA hybridization studies and cladistic evaluation of anatomical characters, will shed light on these early branching events.

ACKNOWLEDGMENTS

I thank the many colleagues in North America and beyond who have made this research possible by their support and critical insight and by allowing generous access to paleontological materials in their care. For execution of the finished illustrations, I thank C. Abraczinckas. This research was supported by The David and Lucile Packard Foundation, the National Science Foundation (BSR 8722586), The National Geographic Society (4262-90), and The Petroleum Research Fund (ACS-PRF 22637-G8).

Editor's Note:
This article is the second of several that we will publish in which Packard Fellows in earth science report on research in their field. See p. 117 of the June 1991 issue of *GSA Today* for more information.

REFERENCES CITED

Bakker, R.T., 1971, Dinosaur physiology and the origin of mammals: Evolution, v. 25, p. 636–658.

Bennett, A.F., 1985, Energetics and locomotion, *in* Hildebrand, M., Bramble, D. M., Liem, K. F., and Wake, D. B., eds., Functional vertebrate morphology: Cambridge, Massachusetts, Harvard University Press, p. 173–184.

Benton, M.J., 1983, Dinosaur success in the Triassic: A noncompetitive ecological model: Quarterly Review of Biology, v. 58, p. 29–55.

Benton, M.J., 1987, Progress and competition in macroevolution: Biological Reviews, v. 62, p. 305–338.

Bonaparte, J.F., 1982, Faunal replacement in the Triassic of South America: Journal of Vertebrate Paleontology, v. 2, p. 362–371.

Bonaparte, J.F., and Kielan-Jaworowska, Z., 1987, Late Cretaceous dinosaur and mammal faunas of Laurasia and Gondwana, *in* Currie, P.M., and Koster, E.H, eds., Fourth symposium on Mesozoic terrestrial ecosystems—Short papers: Drumheller, Alberta, Tyrrell Museum of Palaeontology, p. 24–29.

Carrier, D.R., 1987, The evolution of locomotor stamina in tetrapods: Circumventing a mechanical constraint: Paleobiology, v. 13, p. 326–341.

Charig, A.J., 1972, The evolution of the archosaur pelvis and hindlimb, an explanation in functional terms, *in* Joysey, K.A., and Kemp, T.S., eds., Studies in vertebrate evolution: Edinburgh, Oliver and Boyd, p. 121–151.

Colbert, E.H., 1970, A saurischian dinosaur from the Triassic of Brazil: American Museum Novitates, no. 2405, p. 1–39.

Cracraft, J., 1986, The origin and early diversification of birds: Paleobiology, v. 12, p. 383–399.

Cracraft, J., 1988, The major clades of birds, *in* Benton, M.J., ed., The phylogeny and classification of the tetrapods: Oxford, England, Clarendon Press, p. 339–361.

Gauthier, J.A., 1986, Saurischian monophyly and the origin of birds: California Academy of Sciences Memoirs, v. 8, p. 1–55.

Huxley, T.H., 1868, On the animals which are most nearly intermediate between the birds and reptiles: Annals, Magazine of Natural History, London, v. 2, p. 66–75.

Lidgard, S., and Crane, P.R., 1990, Angiosperm diversification and Cretaceous floristic trends: A comparison of palynofloras and leaf macrofloras: Paleobiology, v. 16, p. 77–93.

Martin, L., 1983, The origin and early radiation of birds [with commentaries by D. Steadman and P. Rich], *in* Brush, A., and Clark, G., eds., Perspectives in ornithology, essays presented for the Centennial of the American Ornithologists' Union: Cambridge, England, Cambridge University Press, p. 291–338.

Olson, S.L., 1985, The fossil record of birds, *in* Farner, D.S., King, J.R., and Parks, K.C., eds., Avian biology: New York, Academic Press, p. 79–256.

Ostrom, J.H., 1976, *Archaeopteryx* and the origin of birds: Biological Journal of the Linnean Society, v. 8, p. 91–182.

Rao, C., and Sereno, P.C., 1990, Early evolution of the avian skeleton: New evidence from the Lower Cretaceous of China: Journal of Vertebrate Paleontology, 10, p. 38–39A.

Reig, O., 1963, La presencia de dinosaurios saurisquios en los "Estratos de Ischigualasto" (Mesotriasico superior) de las provencias de San Juan y La Rioja (Republico Argentina): Ameghiniana, v. 3 , p. 3–20.

Ruben, J., 1991, Reptilian physiology and the flight capacity of *Archaeopteryx*: Evolution (in press).

Sereno, P.C., 1986, Phylogeny of the bird-hipped dinosaurs (Order Ornithischia): National Geographic Research, v. 2, p. 234–256.

Sereno, P.C., 1991, Basal archosaurs: Phylogenetic relationships and functional implications: Journal of Paleontology, v. 65 (in press).

Sereno, P.C., and Arcucci, A.B., 1990, The monophyly of crurotarsal archosaurs and the origin of bird and crocodile ankle joints: Neues Jahrbuch für Geologie und Paläontologie, Abhandlung, v. 180, p. 21–52.

Sibley, C.G., and Ahlquist, J.E., 1991, Phylogeny and classification of birds: New Haven, Connecticut, Yale University Press, p. 1008.

Weishampel, D.B., and Norman, D.B., 1989, Vertebrate herbivory in the Mesozoic: Jaws, plants, and evolutionary metrics, *in* Farlow, J.O., ed., Paleobiology of the dinosaurs: Geological Society of America Special Paper 238, p. 87–100.

Weishampel, D.B., Dodson, P., and Osmólska, H., 1990, The Dinosauria: Berkeley, University of California Press, p. 733.

Wing, S.L., and Tiffney, B.H., 1987, The reciprocal interaction of angiosperm evolution and tetrapod herbivory: Review of Paleobotany and Palynology, v. 50, p. 179–210.

Zeigler, A.M., Scotese, C.R., and Barrett, S.F., 1983, Mesozoic and Cenozoic paleogeographic maps, *in* Brosche, J., and Sündermann, D., eds., Tidal friction and the Earth's rotation: Berlin, Spinger-Verlag, p. 240–252. ■

Mapping *continued from p. 143*

maps in the future. Federal users that benefit from, and are at least in part involved in, preparing geologic maps include the Department of the Interior (U.S. Geological Survey, Bureau of Mines, Bureau of Land Management, Minerals Management Service, Bureau of Reclamation, and Office of Surface Mining), Department of Energy, Environmental Protection Agency, Department of Agriculture, Department of Defense, Department of Commerce, Department of Transportation, Nuclear Regulatory Commission, and the Federal Emergency Management Agency.

Kentucky and Puerto Rico have been completely mapped at a scale of 1:24,000. Kentucky, Connecticut, and Puerto Rico were all mapped as a part of cooperative projects with the U.S. Geological Survey. The Kentucky project required 18 years to complete, and cost approximately $22 million. Estimated benefits from that project have exceeded the costs many times over. The value of petroleum, coal, fluorspar, limestone, and clay deposits discovered during the mapping project exceeded the mapping costs by tens of millions of dollars, and the maps continue to be indispensable tools in the search for much-needed fossil fuels, and other mineral resources. Likewise, much use of the maps is being made in the area of land-use planning, particularly for earthquake preparedness activities in the highly faulted areas of central and western Kentucky (New Madrid area).

Conversely, the lack of adequate geologic information has led to economic and personal disasters due to the improper location and design of such structures as dams, roads, and waste-disposal facilities. The failure of just one large reservoir dam has the potential for great loss of human life and the destruction of millions of dollars in property. Likewise, the cost in tax dollars and human health relative to the improper disposal of toxic wastes resulting in the need for a Superfund site cleanup demonstrates the necessity of knowing in detail the nature of the earth, information that is provided by geologic maps.

In view of the obvious benefits that can be derived from geologic maps, what is the status of geologic mapping in the United States today? Most geologic mapping is conducted by the USGS and the various state geological surveys. According to a report issued in 1987 by the National Academy of Sciences, mapping by the USGS is very much on the decline. For example, the USGS mapped approximately 400,000 square miles in the 1960s, 250,000 square miles in the 1970s, and 120,000 square miles during the 1980s. Furthermore, data indicate that geologic mapping by state surveys is also on the decline. Many older geologic maps, once considered adequate, are now out of date and need revisions in order to meet modern standards. Combined geologic mapping by the USGS, the various state geological surveys, and others is not sufficient to meet the needs vital to the national security, environmental protection, and energy requirements of our country.

Although it is a demonstrated fact that our nation would benefit greatly from a comprehensive geologic mapping program, many factors have contributed to the declining production of such maps. Tight budgets in conjunction with ever-increasing costs are major factors. Moreover, we in the geological sciences have turned our attention to other areas of endeavor that are considered by some of our colleagues to be more sophisticated, or which are more rewarding monetarily, such as geochemistry, geophysics, oceanography, or lunar geology. In addition, the promotion and reward system in our federal and state geological surveys is oriented toward success in the "high sciences," thereby discouraging geologists from becoming involved in basic geologic mapping. This situation is in sharp contrast with that in some other nations such as the Soviet Union and Canada. Field geologists in the Soviet Union are highly regarded and rewarded for their efforts, and the economic and environmental benefits of geologic maps have long been appreciated in Canada. The Soviet Union has placed such emphasis on large-scale geologic mapping that the entire country will have complete coverage by the mid-1990s. In contrast, the United States is considered one of the most poorly mapped nations in the free world, with less than 30 percent of the country mapped at a scale of 1:50,000 or larger. Clearly, geologic mapping must be given much higher priority in the United States.

Both the USGS and the various state geological surveys have legal mandates to conduct geologic mapping. The USGS was established in 1879 by an Act of Congress, and charged with the responsibility for "classification of the public lands, and examination of the geological structure, mineral resources, and projects of the national domain." Much work has been accomplished to satisfy this Congressional mandate, but much more is still critically needed, especially now when our requirements for basic geologic information are the greatest in the history of our country.

A focused nationwide effort with dedicated dollars in the federal budget is required now to address the issue of geologic mapping. The program should be managed by the federal government, and the mapping should be done in cooperation with the states, utilizing qualified state and federal geologists in appropriate partnership. A crisis is upon our nation relative to energy, minerals, water supplies, and waste disposal, and it is a crisis that persons in authority must address without delay. A National Geologic Mapping Program will require a significant amount of funding over an extended period of time; however, the alternative to an organized program such as this is to continue to respond to individual crises on an emergency basis. This method of dealing with the situation could cause irreversible damage to the national security and the environment at costs far greater than would be required to map our country in an orderly fashion.

A National Geologic Mapping Program is being promoted by the 51 members (50 states and Puerto Rico) of the Association of American State Geologists in cooperation with the USGS. An implementation plan has been developed which provides a mechanism for direct involvement of the federal survey and state geological surveys, and would involve the nation's colleges and universities. The plan calls for a systematic mapping of the United States at a functional map scale that will satisfy the many needs that are so pressing today, and which will be even more critical in the future. The program would be financed through a Congressional appropriation mandated for this purpose and matched by the participating states.

This program is desperately needed in our country, and it is one that every person in every walk of life will benefit from. It is also a program that geologists and engineers can support regardless of their personal pursuits, whether private enterprise, government, or education. It is not a question of affordability. We cannot afford not to do it. Our future and the future of our children and grandchildren depend upon it.

Donald Haney is State Geologist of Kentucky and as 1989–1990 President of the Association of American State Geologists has lead AASG's effort to develop the National Geologic Mapping Program. ■

Reprinted from *The Professional Geologist*, AIPG, July 1990, Vol. 27, No. 7, p. 4–6.

Note: A National Geologic Mapping bill has been introduced in the U.S. Senate as S-1179.

Forum *continued from p. 143*

Several national projects are using CD-ROM technology to present earth science interactive lessons and provide resource information. These include the U.S. Geological Survey (USGS) Joint Education Initiative (JEdI) Project, for precollegiate earth science students, and a Canadian International Space Year Project Global Change Encyclopedia and Atlas. Over 200 government produced CD-ROMs are listed in a compendium of available CD-ROMs (U.S. Geological Survey Open File, report 91-40). In fact, all the Magellan Venus images are being placed on 30 CD-ROMs, which will be available to researchers and educators. There is currently an initiative in Washington, D.C., to provide CD-ROM technology to all science teachers.

To supplement these modeling techniques, IBM has developed exterior computer probes that actually measure and graph physical and chemical properties. In concert with CD-ROM and probeware, laser disc technology provides a wealth of still and moving images related to earth science to integrate into lessons.

The next step from these multimedia modeling systems is to actually provide students with real-time earth science by adding a modem. An example is Accu-Weather, an international clearinghouse for current meteorological, seismic, and astronomical data. This is where the media get their satellite images and weather information. Students can actually watch a storm develop with lightning strikes appearing on screen only seconds after the actual strike, or track a tsunami across the Pacific Ocean. With this technology computers become powerful classroom tools that involve students and empower teachers to reinforce their curriculum.

This method of providing students with live data will be a familiar part of future classrooms. By the middle of this decade, California coastal studies will be available daily within a system similar to Accu-Weather. Through computer technology, students will be able to communicate with space scientists and engineers during missions that may include the 1992 Mars Observer Mission. This national space education would be similar to Bob Ballard's highly successful Project Jason.

Visualization is a more rapid means of understanding science than reading a text or listening to a lecture. This concept introduces another facet of classroom computer technology. The University of Arizona, Tucson, has developed a computer enhancement program for students that permits them to translate images into the information they wish to emphasize and gather. Planetary scientist Robert Strom presents this innovative science program, which ranges from medical to planetary surface imaging.

A sophisticated technology available but not yet tapped as a classroom resource is the supercomputer. By providing several parameters of data, the computer is able to take huge quantities of data and provide three-dimensional images. If you have seen the video "L.A. The Movie" or other NASA imaging products, you will understand why students are captivated by this spectacular technology. Ideally a regional school network could send environmental data to an engineer who would process it on a supercomputer and return 3-D images of the region. Agencies with supercomputer programs should be encouraged to consider future technological partnerships with school districts.

Computer technology can organize the expanse of information created by the earth science revolution into a visual minds-on experience on a personal level for precollegiate students of diverse abilities and experiences. Through computer modeling or by actual data collecting, students become a part of science. The expense of this technology is prohibitive in most school districts and a sincere national effort to promote American students in the international arena of science, mathematics, and technological education will require government and industry support. It is time that science teachers were provided with the technology to meet this challenge.

PERSPECTIVE 2: Field Institutes Designed for Teachers—Empowering the Earth Science Teacher

Barbara Frank, U.S. Environmental Protection Agency, Washington, D.C.

As we are all aware, elementary school age children have an innate natural curiosity about Earth. Unfortunately, when they come to school, in great anticipation of sharing their geologic treasures (whether precious fossils, mineral samples, or chunks of local bedrock), with their classmates, they become discouraged rather than encouraged. Their teachers, unprepared in earth science, redirect their attention to other subjects within the teacher's own expertise. Golden opportunities to build on natural interest about Earth are thus missed.

Geologists, used to thinking in terms of cycles, are faced with a distressing and self-perpetuating cycle in terms of lack of earth science pre-

Forum *continued on p. 147*

WASHINGTON REPORT

Bruce F. Molnia

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

Federally Funded Research—1991: Earth Scientists—Where Are You?

When the American Physical Society (APS) held its Spring Meeting in Washington, D.C., 140 of its members used the venue to hold a Congressional Day. Working in teams of three and four, the APS members discussed the importance of science with 117 members of the House of Representatives and 54 Senators. Senator Albert Gore, Jr. and Congressman George Brown, Jr. paved the way for the visits by sending a "Dear Colleague" letter to their fellow members of Congress urging them to meet with the APS representatives. One way to judge the success of the effort is to note that plans are being made to hold a second annual Congressional Day during the spring of 1992. GSA members, when was the last time you discussed the importance of the earth sciences with your own elected representatives?

The timing of the APS visit coincides with a pair of other events that have shaken the credibility of U.S. science, at least in the eyes of the Congress, and the release of a report by the Office of Technology Assessment (OTA) critically evaluating the future of federally funded scientific research. The issues of scientific fraud and questionable overhead and indirect charges served as a backdrop to the APS visit. Starting with disclosures about Stanford University's billing practices before a subcommittee of the House Energy and Commerce Committee, chaired by Rep. John Dingell, and followed by Nobel laureate David Baltimore's acknowledgment that he was wrong in defending what were shown to be fraudulent results presented by a coauthor, the credibility of science has been challenged. The May 4, 1991 *Washington Post* quoted Baltimore as saying, "It was my belief in science and faith in my fellow scientists which led me to set my threshold of suspicion so high" and states that Baltimore now respects the role of government to oversee scientific research and to "hold the scientific community accountable for its use of public funds."

Following revelations about Stanford's billing practices, the investigation of university research accounting practices has spread to more than 50 institutions. Many universities have announced that they will voluntarily pay back money to the Federal Government. On May 15, in order to stop "abuses in cost recovery," the Office of Management and Budget (OMB) announced plans to impose a ceiling on the reimbursement of administrative overhead at a maximum of 26% of total research costs. This decision will affect almost 150 universities. The total research dollars will not change. The motivation for this close OMB and Congressional scrutiny is easy to understand when one considers that, according to a General Accounting Office estimate, American universities will receive more than $9 billion in federal research funds this year. During the period from 1960 to 1990, federal funding for research has increased from $8 billion (1990 dollars) to over $21 billion.

The present Congressional concern about federally funded research did not develop in direct response to the scandals of 1991. In fact, it can be traced back to the early days of the Apollo program, if not even earlier. In the past few years, however, Congress has been more aggressive, especially through the efforts of the House Committee on Science, Space, and Technology, chaired by California's Congressman Brown, to establish control over federally funded science. The National Aeronautics and Space Administration's (NASA) ongoing problems with the space shuttle and last year's problems with the Hubble Space Telescope have further undermined the credibility of federally funded science.

In December 1989, Congressman Brown's committee requested that OTA assist it in understanding the state of the federally funded research system—its goals, research choices, policies, and outcomes—and the challenges that would be faced in the 1990s. The result of this OTA analysis was *Federally Funded Research: Decisions for a Decade*, released in April 1991. In his foreword, John H. Gibbons, Director of OTA, states that: "Given the exceptional history, strength, and character of U.S. research, there will always be more opportunities than can be funded, more deserving researchers competing than can be sustained, and more institutions seeking to expand than the prime sponsor—the federal Government—can fund. The objective for government, then, is to ensure continued funding for a full portfolio of first-rate research and a high-caliber research work force to assure long-term scientific progress."

The report states that "the Federal Government funds research to achieve more than specific national goals. By doing so, it invests in knowledge—and the people who produce it—not only for its intrinsic worth ... but also for the value knowledge acquires as it is applied." The report states, "there is currently no mechanism for evaluating the total research portfolio of the Federal Government in terms of progress toward many national objectives." Elsewhere, it states, "although scientific merit and mission relevance must always be the chief criteria used to judge a research area or agency program's potential worth, they cannot always be the sole criteria."

The report asks the question: "Can Congress look to the scientific community for guidance on setting priorities?" Unfortunately for us in the scientific research community, the answer presented is "no"! The report continues, "Congress and the executive branch have found that the scientific community cannot make crosscutting priority decisions in science. In particular, the traditional mechanism of peer review is clearly not suited to making judgements across scientific fields. Some research communities do set priorities within specific research areas. However, the practice is not universal or widespread. Therefore, while recognizing the preferences of researchers, the Federal Government must set priorities at two levels: among scientifically meritorious research areas and megaprojects, and among agency programs."

The report acknowledges that life as a researcher has "become more stressful and laden with the paperwork of proposal applications and accountability for awarded funds, inhibiting the creativity and joy of the research

Washington Report *continued on p. 154*

Forum *continued from p. 146*

paredness of teachers, students, and the general public. Teachers with little training in earth science do not expose their elementary and middle school students to the wonders of Earth. Later, when young adults choose their careers, it is the rare individual who considers geoscience as a career option. A lack of familiarity with the principles of earth science results in a general public with little or no understanding of the relevance of earth science to any of the issues they will deal with in their adult lives: global change, deforestation, or the siting of their local school on a river floodplain.

Ironically, the same teachers who don't feel competent with earth science subject matter may themselves be curious about Earth and its processes. In fact, many are very frustrated about their lack of knowledge and understanding about their planet.

There is a way out of this dilemma: we must empower the elementary and middle school teacher with knowledge about Earth and an understanding of Earth and environmental processes. Summer or weekend workshops designed with hands-on laboratories and ample field experience are inspirational and provide the teacher with the necessary tools to teach earth science. At present, there are only very limited opportunities of this nature for teachers. There is the additional problem that field experiences, patterned after the traditional-style geologic field trips (i.e., a route chosen through representative outcrops and the burden of extrapolating the big picture left to the participant), do not address the unique needs of the earth science teacher, particularly the teachers of elementary age students. Teachers with limited earth science background find these standard field trips counterproductive. Often, these teachers are left more confused than helped.

Field experiences must be redesigned with the needs of the teacher in mind, not those of the undergraduate geology major or the graduate student. The teacher is more concerned with acquiring the skills to teach earth science than with learning local formation names! In fact, a summer field institute, while providing some earth science content background for the teacher, should emphasize process. Armed with an understanding of process, a teacher will better be able to answer questions raised by students, such as: Was this area glaciated? Did this rock come from the sea floor? Why do volcanoes erupt? An institute, especially one of only a few weeks length, cannot turn a teacher into a geologist. Yet, if designed correctly, an institute will empower the teacher with the inquiry skills necessary to embark with students on the adventure of understanding Earth.

In this regard, I would like to share some of the lessons I learned in five years of offering summer workshops to Department of Defense Dependent Schools (DODDS) educators in Europe. In 1985, while teaching geology for the University of Maryland in Munich, Germany, I was approached by the Science Coordinator of DODDS Europe with a request to create a summer workshop for teachers who were expected to teach earth science during the following year. Initially, creating a workshop for teachers did not appear too difficult a task, as I was used to organizing and leading field trips of one-day to two-week duration throughout Europe for my own students. As Munich is within two hours driving time of world-renowned fossil localities, alpine folded and glaciated mountains, salt mines, and limestone and ice caves, my own courses had a tremendous emphasis on field investigation. This type of instruction proved to be most effective with undergraduate students. Therefore, I hoped DODDS teachers would thrive in the same learning environment. The summer workshop was set up with morning lectures and afternoons of hands-on experiences in the field and the laboratory. Although tired after a full year of teaching, the teachers approached the workshop with a positive attitude and a strong desire to become proficient in earth science.

It soon became evident that the kind of program I taught to young undergraduate students in a 16-week semester with weekly laboratories and weekend field trips simply could not be compacted into an intense three-week workshop. The teachers were overwhelmed, both mentally and physically. I needed to reevaluate my goals. Was it necessary for the teachers to absorb the entire contents of general earth science in three weeks? No, of course not! The teachers were perfectly capable of learning content at a later date on their own. This could happen once they understood the basic principles of earth science and the methodology of the earth scientist.The workshop was presented in the midst of a landscape shaped by varied geologic forces. Undergraduate students usually were in awe of the geology evident in this field location. Teachers, equally impressed, nonetheless had practical concerns about teaching earth science in their own school districts where such wealth of geologic beauty was not typically available. Therefore, rather than concentrating on the more spectacular geologic processes, attention was paid to those processes active in most areas. Of course, we investigated the folds

Forum *continued on p. 148*

GSAF UPDATE

Robert L. Fuchs

Claude C. Albritton, Jr. Memorial Fund is Formed

Under the auspices of the Archaeological Geology Division, family, friends, and close associates of Claude C. Albritton, Jr. have formed a memorial fund in his honor at the GSA Foundation. Initially, the fund has been set up with a gift of several thousand dollars. Members of the GSA Archaeological Geology Division, GSA members, and those who knew Claude Albritton are being asked to consider contributing to this fund. The Albritton Fund will provide scholarships and fellowships for graduate students in the earth sciences and archaeology. Recipients of these awards will be students who have:

- an interest in achieving the M.S. or Ph.D. degree in earth sciences or archaeology,
- an interest in applying earth science methods to archaeological research, and
- an interest in a career in teaching and academic research.

Awards will be given in support of thesis or dissertation research, with emphasis on the field and/or laboratory parts of this research. Those desiring further information about these scholarships should contact Reid Ferring at the University of North Texas in Denton, Texas, (817) 565-2694.

Claude C. Albritton, Jr. was a leader in archaeological and Quaternary geology. His endeavors centered upon a commitment to interdisciplinary investigations, with geology playing a fundamental role in the study of archaeological materials and/or contacts. His work was worldwide, from the Davis Mountains of Texas to the deserts of North Africa.

Claude Albritton received degrees in geology and geography at Southern Methodist University in 1933. Subsequently he earned the Ph.D. in geology from Harvard, following which he returned to SMU. The balance of his career was spent at that institution, with the exception of World War II, when he was a geologist for the U.S. Geological Survey. Albritton had been the Hamilton Professor of Geology at SMU and had held three dean positions there.

In 1966, Albritton collaborated with William B. Heroy, Sr. to form the Institute for the Study of Earth and Man, the purpose of which was to create an organization that would foster interdisciplinary research, especially between geology and archaeology.

GSA was an important part of Albritton's life, beginning with a research grant in 1938. Claude C. Albritton, Jr. and Kirk Bryan were awarded GSA grant number 233-38 in the amount of $500 to study "Late Pleistocene Deposits near Alpine, Texas...." Throughout his career he was active in GSA and especially Archaeological Division affairs. At the time of the GSA Centennial Meeting in Denver in 1988 he was awarded the Archaeological Geology Division Award. Unfortunately, he had become ill prior to the meeting and died while the Centennial was in session.

Those wishing to contribute to the Claude C. Albritton, Jr. Memorial Fund should send gifts to the GSA Foundation, designating the gift for this fund.

Trustees Meet in Dallas

For the third time in less than 12 months, the GSA Trustees met in Dallas, Texas, during the 1991 AAPG Convention in April. Among the important actions taken at the meeting was the approval of a $94,000 disbursement budget for research grants, scholarships, awards, and travel grants. Shortly after this meeting the GSA Research Grants Committee awarded approximately one-third of this amount in the course of its annual review of research grant applications.

The assets of the Foundation are now at $1.5 million, and the Trustees discussed the internal financial controls of the organization. It was felt that further integration with the accounting system of GSA would be desirable in order to provide the necessary fiscal checks and balances on receipts and disbursements.

The Trustees considered the various fund-raising activities of the Foundation, reviewing the recent results, particularly with regard to the specially designated funds that have been created, such as the 28th IGC Fund. President Fuchs mentioned that the GSA Pooled Income Fund had been designated as an acceptable investment for USGS employees. Requests are being received for information about planned giving, such as the Pooled Income Fund and charitable remainder trusts.

The balance of the meeting was occupied with discussions of the two major new program initiatives of GSA: SAGE and the Institute for Environmental Education (IEE). President Fuchs described his work with Education Coordinator Ed Geary with respect to the SAGE Program. Trustee Fred Donath summarized his progress as initial Executive Director of IEE in developing its mission and objectives. The Trustees offered suggestions for further refinement of the institute's mission and objectives and emphasized the need for coordinating the work of IEE with the SAGE Program.

The next meeting of the Foundation Board will be held in conjunction with the GSA Annual Meeting in San Diego, on Monday, October 21. ■

Donors to the Foundation March and April 1991

Century Challenge
Walther M. Barnard
Thomas M. Berg
Michael C. Dix
Charles Fulmer
John J. Gallagher
James O. Jones
Barun K. Sen Gupta

DNAG
Albert W. Bally*
J. Bundschuh*
William C. Gussow*
Kerr-McGee Corporation
Grover and Sally Murray* (in memory of Arthur C. Munyan and Charles F. Park, Jr.)
R. W. Richter*
Ken Sageser*
Texaco
Virgil Winkler*

Engineering Geology Division Award
Richard E. Gray*

History of Geology Award
Donald Hoskins*

GEOSTAR Funds

Birdsall Fund
Robert Farvolden*

Gretchen Louise Blechschmidt Fund
Mildred Blechschmidt*
Robert F. Nelson

Allan V. Cox Scholarship Award
Stephen A. Kirsch

GEOSTAR
ARCO Foundation
Arten J. Avakian
Lee C. Armstrong*
Charles F. Bisbee
Roy M. Huffington*
Lincoln R. Page*
WAAIME T/A Section (honoring Thornton L. Neathery)

Institute for Environmental Education
William E. Wertz

John T. Dillon Alaska Research Award
ARCO Foundation
James Dillon

John C. Frye Environmental Award
Don U. Deere*

Lunar and Planetary Science Award
Anonymous*

Memorial
Carolyn Biggs* (memory of Donald L. Biggs)
Lawrence Wu* (memory of Donald L. Biggs)

Minority
Cesar I. Delgado
Jeff Miller
Frederic H. Wilson

Research
ARCO Foundation
Richard A. Davis, Jr.
Ralph M. Feather, Jr.
Timothy D. Herbert
David B. Rowley
Leon T. Silver*
C. John Suen*
Lee J. Suttner

SAGE
William R. Hackett*

Unrestricted
Robert P. Bryson
Frederick H. Leonhardt Foundation*
Jene D. Michaud
Carl W. Myers

Women in Science
Valerie-Ann K. Eagan
Albert C. Holler*

*Second Century Club—gifts of $100 or more.

Forum *continued from p. 147*

and faults of the Alps and the outcrops with evidence of glaciation, but we actually spent more time at the local stream and on slopes exhibiting soil erosion. The teachers felt more comfortable learning about processes when they knew they could show the same process to their students at home. For example, almost every school yard has some slope where soil erosion can be illustrated. Once teachers understood the basic concepts of erosion and deposition, geologic time, and change, they could tackle other topics, not found in the present field area, such as shoreline processes.

Teachers wanted to understand why geologists seemed to be fascinated by roadcuts. When they learned that it was more than just looking at rocks that draws us to these exposures, but rather our desire to decipher earth history, then they too wanted to develop the skills necessary to participate. At the summer institute, the teachers acquired field observation skills that they could pass on to their students. Kids in elementary school are avid explorers and, when provided with investigative techniques, should be set free to explore their physical environment.

A major concern of the DODDS educators was whether they would be able to answer the variety of questions that students were bound to ask about the local geology around their schools. Because these teachers were teaching in a foreign country and many did not speak the language, the most powerful tool available to them was the geologic map of their area and of the country. Because the map symbols are universal, once the teachers developed map-reading skills, these maps proved to be an invaluable source of information on local rock type, fossils, and structural geology. Although teachers in Europe are faced with unique language problems, the solution of using geologic maps would be a useful aid for all teachers in answering their own and their students' questions about local geology.

At summer institutes, teachers have an opportunity to see the wide range of publications, laboratory kits, and software available in the earth sciences. Last, but not least, the institute environment is ideal for learning how to link up to computer networks and bulletin boards. These links will enable teachers to have access in the future to earth science information systems.

By the end of the summer workshop, the teachers were inspired to teach earth science and even talked about mentoring other teachers in their school districts. Of course, such a multiplier effect is highly desirable. With more institutes teaching more teachers who then proceed to mentor other teachers, a dent can be made in the dire state of earth science preparation nationwide.

The National Science Foundation is allocating more funds for teacher preparation and enhancement, which is most encouraging. The concerns of earth science teachers have in the past been ignored or neglected. It is now time to respond with appropriate and empowering field institutes. ■

Planetary Geology Division Offers Student Award

The GSA Planetary Geology Division has instituted a student paper award, which is made possible through a donor committed to excellence in planetary geosciences. The award is intended to provide encouragement, motivation, and recognition to outstanding future scientists. It is administered through the Planetary Geology Division.

The award is open to students enrolled in a U.S. college or university at any level of their education in the field of Planetary Geosciences. A student must be the senior author of the abstract accepted for the GSA Annual Meeting (this year in San Diego, California, October 21–24). The paper may be presented orally or in a poster session. Judging for both types of sessions will emphasize the same attributes: quality of the scientific contribution, including methods and results, clarity of the material presented, and methods of delivery, be they oral or display.

To apply for the Planetary Geology Division student paper award, send two copies of your accepted abstract to Harry Y. McSween, second vice-chairman of the Division, by *July 3, 1991*: H. Y. McSween, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410.

Please *do not* send any application material to GSA Headquarters; the award is being handled strictly at the division level. A panel of judges will make the final decision following the San Diego meeting, and notification will take place in mid-November. The award consists of a citation and $500.

The Planetary Geology Division awarded the first of these prizes to a Ph.D. student, Laurinda Chamberlin, at the California Institute of Technology for a paper she presented in March 1991 at the 22nd Lunar and Planetary Science Conference.

GSA Council Actions—Spring 1991

New Honorary Fellows

Valdar Jaanusson
Naturhistoriska Riksmuseet
(Swedish Museum
of Natural History)
Stockholm 50, Sweden

Hans Laubscher
Geologisch-Palaontologisches
Institüt der Universität
Bernoullistrasse 32
Basel Ch-4056, Switzerland

Richard L. Stanton
Department of Geology
and Geophysics
University of New England
Armidale, N.S.W., 2351 Australia

Medal and Award Recipients—1991

Penrose Medal
William R. Dickinson
Department of Geosciences
University of Arizona
Tucson, AZ 85721

Day Medal
Ian S.E. Carmichael
Department of Geology
and Geophysics
University of California at Berkeley
Berkeley, CA 94720

Donath Medal (Young Scientist Award)
Brian P. Wernicke
Department of Earth
and Planetary Sciences
Harvard University
24 Oxford Street
Cambridge, MA 02138

GSA Distinguished Service Award
Dorothy M. Palmer
Geological Society of America
P.O. Box 9140
Boulder, CO 80301

Archaeological Geology Division Award
Henry P. Schwarcz
Department of Geology
McMaster University
Hamilton, Ontario
Canada L8S 4M1

Gilbert H. Cady Award
(Coal Geology Division)
John C. Ferm
Department of Geological Sciences
University of Kentucky
Lexington, KY 40506-0059

E. B. Burwell, Jr., Award
(Engineering Geology Division)
Richard M. Iverson
Cascades Volcano Observatory
U.S. Geological Survey
5400 MacArthur Boulevard
Vancouver, WA 98661

Jon J. Major
Department of Geological
Sciences, AJ-20
University of Washington
Seattle, WA 98195

George P. Woollard Award
(Geophysics Division)
Norman H. Sleep
Department of Geophysics
Stanford University
Stanford, CA 94305

History of Geology Division Award
William A.S. Sarjeant
Department of Geological Sciences
University of Saskatchewan
Saskatoon, Saskatchewan
Canada S7N 0W0

O. E. Meinzer Award
(Hydrogeology Division)
Christopher E. Neuzil
Water Resources Division
U.S. Geological Survey
431 National Center
Reston, VA 22092

G. K. Gilbert Award
(Planetary Geology Division)
John E. Guest
University of London Observatory
Observatory Annex
33/35 Daws Lane, Mill Hill Park
London, England NW7 2QS

Kirk Bryan Award
(Quaternary Geology
and Geomorphology Division)
Milan J. Pavich
U.S. Geological Survey
928 National Center
Reston, Virginia 22092

Structural Geology and Tectonics
Division Career Contribution Award
Clinton D.A. Dahlstrom
Chevron Corporation
225 Bush Street
San Francisco, CA 94104

Call for Geologic Papers for 1992 GSA Section Meetings

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

Abstract Deadline: November 6, 1991

Submit completed abstracts to James E. Wright, Dept. of Geology & Geophysics, P.O. Box 1892, Rice University, Houston, TX 77251; (713) 527-4880.

Northeastern Section
Harrisburg Hilton & Towers Hotel
Harrisburg, Pennsylvania
March 26–28

Abstract Deadline: December 5, 1991

Submit completed abstracts to Jeffrey W. Niemitz, Dept. of Geology, Dickinson College, Carlisle, PA 17013; (717) 245-1355.

Cordilleran Section
Eugene Hilton Conference Center
Eugene, Oregon
May 11–13

Abstract Deadline: January 21, 1992

Submit completed abstracts to Jack M. Rice, Dept. of Geological Sciences, University of Oregon, Eugene, OR 97403-1272; (503) 346-4573.

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

Abstract Deadline: November 26, 1991

Submit completed abstracts to John J.W. Rogers, Dept. of Geology, C.B. 3315, Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315; (919) 966-4516.

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

Abstract Deadline: December 30, 1991

Submit completed abstracts to Greg Ludvigson, Iowa DNR, Geological Survey Bureau, University of Iowa, 123 North Capital, Iowa City, IA 52242; (319) 355-1575.

Rocky Mountain Section
Ogden Park Hotel, Ogden, Utah
May 14–16

Abstract Deadline: January 29, 1992

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

1992 ABSTRACT FORM REQUEST

To: GSA Abstracts Coordinator
P.O. Box 9140
Boulder, CO 80301

Please send ____ copies of the 1992 GSA abstract form. I understand that the same form may be used for all 1992 GSA meetings—the six Section Meetings and the Annual Meeting.

Name _____
Address _____
Address _____
City _____ State _____ ZIP _____

Looking for a New Job?

Are you looking for a new position in the field of geology? The GSA Employment Service offers an economical way to find one. Potential employers use the service to find the qualified individuals they need.

You may register any time throughout the year. Your name will be provided to all participating employers who seek individuals with your qualifications. If possible, take advantage of GSA's Employment Interview Service, which is conducted each fall in conjunction with the Society's Annual Meeting. The service brings potential employers and employees together for face-to-face interviews. Mark your calendar for October 21–24 for the 1991 GSA Annual Meeting in San Diego, California.

To register, complete the application form below, prepare a one- to two-page résumé, and mail it with your payment to the address given below. A one-year listing for GSA Members and Student Associates in good standing is $30; for nonmembers it is $60.

NOTE: If you plan to interview at the GSA Annual Meeting, GSA *must* receive your material **no later than August 15, 1991**. If we receive your materials by August 15, your record will be included in the information the *employers* receive prior to the meeting. Submit your forms early to receive maximum exposure! Don't forget to indicate on your application form that you would like to interview in October. Good luck with your job search! ■

For additional information and submission of forms, please contact

T. Michael Moreland
Manager, Membership Services
Geological Society of America
P.O. Box 9140
Boulder, CO 80301
(303) 447-2020

Empl
Se

APPLICANT FORM

GSAT 0791

FOR ACCOUNTING USE ONLY

Rec. $30 $60

Ck # _____
GSA _____
Add. _____
Ltr. _____

The Geological Society of America

3300 Penrose Place • P.O. Box 9140 • Boulder, Colorado 80301

APPLICATION FOR EMPLOYMENT MATCHING SERVICE

(Please type or print legibly with **black ink**)

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

NAME (last name first) _____ **DATE** _____

MAILING ADDRESS _____

CITY _____ **STATE** _____ **ZIP CODE** _____

DATE AVAILABLE _____ **TELEPHONE** ( ) _____ / _____ **VISA** _____
area code Business Home If not U.S. citizen, list visa

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

PRESENT SPECIALTY
Choose one from codes listed below _____
YEARS EXPERIENCE IN THIS SPECIALTY _____

PRESENT EMPLOYER _____

TYPE OF POSITION DESIRED (Check as many boxes as apply.)
Interested in: ☐ Academic ☐ Government ☐ Industry ☐ Other
Specific interest: ☐ Administration ☐ Exploration/Production ☐ Field ☐ Research ☐ Teaching
Will accept employment in: ☐ U.S. only ☐ U.S. with foreign assignments ☐ Either

GIVE NUMBER OF YEARS EXPERIENCE FOR ANY OF THE FOLLOWING THAT ARE APPLICABLE
Administrative_____ Exploration/Production_____ Field_____ Research_____ Teaching_____ Total geological experience_____

KNOWLEDGE OF FOREIGN LANGUAGES: ☐ French ☐ German ☐ Russian ☐ Spanish ☐ Other_____

ACADEMIC TRAINING

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

Postgraduate work beyond highest degree in (field) _____ **Number of years** _____

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

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

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

Fee: $30 if you are a Member or Student Associate of GSA in good standing (Member #_____), $60 if you are not a member of GSA. Payment in U.S. funds (check, money order, or charge information ***must accompany form).***

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

☐ Check / Money Order ☐ MasterCard ☐ VISA ☐ Diners Club ☐ American Express ☐ Barclay Card ☐ Carte Bleue ☐ Access Card ☐ EuroCard or Optima

Card Expires (Mo/Yr) ☐☐☐ Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Signature _____
Required for credit card payment Date

I agree to release GSA or their representatives from responsibility for errors that may occur in processing or distributing this data. I understand that GSA makes ***no guarantee*** of contact by an employer in this service. I agree to notify GSA Employment Service immediately of (1) change of address, (2) acceptance of a position.

Signature ***(required)*** _____ I will/will not attend the 19_____ GSA Annual Meeting in _____

5/91

A
yment
ice

Searching for a New Geoscientist?

When was the last time you hired a new employee? Did you waste time and effort in your search for a qualified geoscientist? Let the GSA computerized search file make your job easier.

How does it work? Complete the Employer's Request for Earth Science Applicants form below. Remember to specify educational and professional experience requirements as well as the specialty area or areas of expertise your applicant should have. The GSA computer will take it from there.

You will receive a printout that includes the applicants' names, addresses, phone numbers, areas of specialty, type of employment desired, degrees held, years of professional experience, and current employment status. Résumés for each applicant are sent with each printout at no additional charge. In 1991, the cost of a printout of one or two specialty codes is $150. (For example, in a recent job search for an analyst of inorganic materials, the employer requested the specialty codes of geochemistry and petrology.) Each additional specialty is $50. A printout of the entire applicant listing in *all* specialties is available for $350. (Specialty codes printed in boldface type are considered major headings. If you select a specialty code printed in boldface type, your listing will contain applicants within the related subspecialties as well. If you request a listing of one of the subspecialties, applicants coded under the major category will be included but not those coded under the other related subspecialties.) If you have any questions about your personalized computerized search, GSA Membership Services will assist you.

The GSA Employment Service is available year round. However, GSA also conducts the Employment Interview Service each fall in conjunction with the Society's Annual Meeting (this year in San Diego, California, October 21–24). You may rent interview space in half-day increments from GSA. Our staff will schedule all interviews with applicants for you, the recruiter. In addition, GSA offers a message service, complete listing of applicants, copies of résumés at no additional charge, and a posting of all job openings. ■

EMPLOYER FORM

The Geological Society of America

3300 Penrose Place • P.O. Box 9140 • Boulder, Colorado 80301

EMPLOYER'S REQUEST FOR EARTH SCIENCE APPLICANTS

(Please type or print legibly)

NAME _____ **DATE** _____

ORGANIZATION _____

MAILING ADDRESS _____

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

MEMBERS OF GSA ONLY: Check here if you do not wish to have this number included in the Membership Directory ☐

SPECIALTY CODES (see list below)

List the specialty code numbers that you wish to order, or ☐ check here if you want the entire file of applicants in *ALL* specialties.

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

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

In what area(s)? _____

Degree requirements _____ Number of positions available _____

SPECIALTY CODES

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

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

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

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

Experience desired (years):

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

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

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

I am interested in interviewing applicants through the GSA Employment Service at the 19_____ Annual Meeting in _____.

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

See attached sheet for current fee schedule

Total fee enclosed ..... $ _____

or invoice requested ..... $ _____

Signature (required) _____

5/91

NEW GSA MEMBERS

The following 534 Members have been elected to Membership by Council action during the period from August 1990 through February 1991 (*indicates transfer from Student Associate to Member).

* Gary D. Acton
* Shirley J. Adams
Xavier A. Alcala-Herrera
Gil R. Alexander
Paul B. Alexander
Scott C. Alexander
Christopher S. Alger
* Mark W. Allen
* Jeffrey A. Alpert
Gregg W. Altimari
* Kristin M. Alvarez
Jeffrey A. Ambrose
* Joachim E. Amthor
* David Anderson
* Theodore G. Apotria
Alfredo Arche
* Arten J. Avakian
* Diane K. Baclawski
James F. Baichtal
Margaret C. Bain
Judith M. Baker
* Nathan L. Bangs
* James T. Bateson
* Todd F. Battey
* David L. Beadle
* Steven C. Beadle
Weldon H. Beauchamp
* Normand J. Begin
* Margaret E. Berry
* Arnold F. Bierschenk
Judi C. Blake
* Daniel F. Blankenau
* Allan R. Blaske
William L. Blewett
* Randy C. Blomquist
* Joel D. Blum
Patricia Bobeck
* Mark C. Boehm
Hendrik J. Bosman
Michael J. Bovis
Peter Bowers
Leonard R. Brand
David E. Broach
Michael Broecker
* John A. Brooks
* Shirley M. Brown
* Steven E. Brown
Richard M. Brownell
* Robert A. Brozdowski
James G. Buchanan
David A. Budd
Patricia F. Buis
George V. Burbach
Thomas A. Bush
* Donald P. Butcher
* Ann Bykerk-Kauffman
* Rosemary C. Capo
Cipriano Carcano
Maura L. Carlisle
* Christopher P. Carlson
* David L. Carr
* Sharon D. Carr
Alejandro Carrillo
Ralph E. Carson
Loretta J. Cartner
Richard E. Casey
Mary E. Cast
Stephen P. Catlin
* Kerry D. Cato
William F. Cavan, Jr.
* Philip F. Cerveny III
George T. Chandler
Chang-Hwa Chen
John P. Chitwood
* Tammy Suter Christopher
Gong S. Chung
John J. Cipar
* William S. Clendenen
* Jean S. Cline
* William W. Clopine
Stanley R. Clowers
Timothy C. Coburn
Rodolfo Coccioni
Michael L. Coffey
* Robert D. Cole
* Janet M. Coleman
James M. Conrad
* Jon W. Cooper
* Peter C. Copeland
Richard Corfield
* Jeffrey D. Corrigan
* Jeffrey T. Cottingham
* Brian L. Cousens
Kathleen L. Cox
* Steven G. Crews
Salvatore Critelli
* Douglas E. Crowe
James E. Cunliffe
Kenneth A. Cunningham
Pamela S. Current
Eileen M. Cwienk
Peter S. Dahl
* Dennis E. Dahms
* Joanne Danielson
* David A. Davis
* Patrice de Caritat
* Loren K. Demaree
* Anna M. Dennis
* David S. Diamond
Albert B. Dickas
* Joseph A. DiPietro
* Paul R. Dixon
* Karen A. Dolan
Stephen K. Donovan
* Ted P. Doughty
Doug Dresser
* Mark A. DuBois
* Debra L. F. Duffy
* Diana G. Duncan
William R. Dupre
* Carol A. Eddy
* Michael J. Egan
Carol L. Ekstrom
Sandra N. Eldredge
* Maya Elrick
David J. Engel
Marcia A. Engle
* Robert V. Enright
Richard M. Eppihimer
Jay B. Erickson
Kenneth E. Erickson
* Stuart G. Erickson
Carl L. Eriksson
* Emmett Evanoff
* Gordon C. Evans
* Randy L. Farmerie
* Paul A. Ferguson
Terry A. Ferguson
* Benjamin A. Ferrill
Joe P. Ferry
* Joseph G. Filosa
Valentine Finn-Sumin
* Sheila M. Fooshee
Eric R. Force
* Joanne T. Fredrich
* Kevin M. Freeman
Leigh W. Freeman
Thomas M. Freese
Geoffrey A. Freeze
Eric G. Frost
Scott D. Gaffri
Joe A. Galemore
Cheri L. Garlinger
* John I. Garver
Shemin Ge
* John R. Gelting
Annette L. Gibson
Wyatt G. Gilbert
* Raymond F. Gildner
Craig R. Glenn
* Mark A. Glenn
Emily F. Gloeckler
* Venice L. Goetz
* Douglas Francis Goff
Kimberley E. Goffman
Glenn A. Goodfriend
* Jonathan C. Goodmacher
* Emery D. Goodman
* Ian R. Gordon
* Paul F. Gottler
Kenneth B. Grabman
John P. Graham
* John A. Grant III
* Thomas X. Grasso, Jr.
John S. Graves
* Benjamin J. Greenstein
Haus J. Gregor
* Robert Grenier
Robbie R. Gries
* Thomas E. Griggs
Jeffry D. Grigsby
Michael M. Grimm
* Jeffrey A. Groen
* Marilyn A. Grout
* Kristin L. Gunckel
Shirley A. Haehn
* John M. Hanchar
Tiit Hang
Diane J. Hanley
Eric T. Hanssen
Timothy J. Hargreaves
Mary K. Harris
William D. Hart
Diane Y. Hattler
Bernard R. Hawke
Garry F. Hayes
John K. Heckman
Robert L. Heiremans
* Elizabeth A. Heise
Roland Hellmann
Julie D. Herman
* Ronald F. Herrygers
Peter J. Herzberg
Patricia M. Hester
* Ezat Heydari
* Richard M. Hill
Gregory T. Himes
* Michael P. Hingston
Robert J. Hinkel
* Paul F. Hodkiewicz
David Hoffman
* Kenneth M. Hoffmann
* John P. Hogan
* Norio Honjo
Bruce G.D. Hooper
Enamul Hoque
Juske Horita
* Katherine J. Howard
Dennis K. Hubbard
* Michael Robert Hudec
Alan R. Huffman
* Carey C. Huggins
* Alan G. Hull
* Carter D. Hull
* Jacqueline E. Huntoon
* Thomas L. Hurst
* Matthew M. Huston
Diane B. Hyatt
William J. Iams
* Robert P. Ilchik
M. Frank Watt Ireton
Kathleen A. Isaacson
Andrei D. Ivanciu
* Neal R. Iverson
* Ross Iverson
* Joseph D. Jablinski
* Garrett W. Jackson
Mark Jancin
* Allan W. Johnson
* Kathleen E. Johnson
* Peggy S. Johnson
Scott A. Johnson
* Stephen T. Johnston
Dean J. Jones
* Lawrence S. Jones
Melvyn T. Jones
* David W. Jorgensen
Ismail E. Kaka
Takhiro Kamiya
* Edward J. Kandl
Ellen S. Kappel
Toshio Kawamura
Steffanie M. Keefer
Alan F. Keiser
* Mike J. Kelley
Scott W. Keyes
* Nazrul I. Khandaker
* Jon R. Kirkpatrick
R. James Kirkpatrick
* Ellen K. Kirschner
Hugh E. Klein
* Steven R. Koehler
Anthony J. Kolodziej
John W. Kosztowny
Constantina N. Kotopouli
Keith M. Kowalski
Hemin Koyi
Jean Kozul
* Scot W. Krueger
Leonard Kubicek
* Diane E. Kurlich
* Richard A. Kurlich III
* Timothy M. Kusky
* Kevin J. Kveton
Thomas E. Lachmar
John H. Lake
* John M. Lake
Gregory J. Lanchman
H. Richard Lane
Eiliv A. Larsen
Matthew C. Larsen
* David M. Latin
* Jeffrey Lee
Benedikt L. Lehner
* Robert E. Lemmer
Alfred C. Lenz
Dennis G. Lewellen
Linda S. Linden
* Daniel Linder
* Ching-Hua Lo
* Donald L. Lofgren
* Andrew J. Lonergan
Robert M. Lorkowski
* Karen M. Love
Chia-Yu Lu
* Robert D. Lucci
* John A. Lucio
Steve Ludington
Heidi Mack
Kristen E. Main
* Kevin Mallin
Jan Mangerud
W. Andrew Marcus
David E. Marek
Marcelo J. Marquez
John D. Marr, Jr.
* Robert A. Marryott
* Barton S. Martin
Monty G. Martin
* Bruce R. Martini
Malcolm Mason
* Anne M. Matherne
Kevin J. Mathews
* Joseph R. May
* Stephen M. Mayer
Kenneth J.W. McCaffrey
* Mark A. McCaffrey
* Thomas J. McCahon
* William C. McClelland
* Thomas A. McClurg
Timothy P. McCrink
* Kimberly A. McGeehan
* Allen J. McGrew
* William C. McIntosh
W. N. McKinney, Jr.
Marjorie D. Medrano
* Keith H. Meldahl
Flemming C. Mengel
John Menzies
* Leal A. K. Mertes
Rodney V. Metcalf
James H. Meyers
Michael M. Michlik
Vincent E. Mikulski
* Gregory H. Miller
* Patricia Miller
Susan H. Miller
June E. Mirecki
Zdenek Misar
* Richard W. Mitchell
* H. Curtis Monger
* Rogelio Monreal
Joseph M. Montello
* Jeffrey M. Moore
John C. Morrison
* Jon Mosar
Jo Ann P. Mulvany
* Kevin B. Murphy
* Peter S. Mustard
* Wayne Narr
Franz R. Neubauer
* Jay R. Neuhaus
* David K. Nicholson
* Elliot J. Nightingale
* David A. Nimick
* Gregory J. Nimz
Sibylle U. Noe
* Jay S. Noller
* Henry C. Nowak
* Mohamed A. Noweir
* Glenda A. Nunnally
Murray R. Nunns
William J. O'Braitis
* David K. O'Brien
Erin K. O'Connell
Koji Okumura
* Jim L. Oliver
* Lynn K. Oliver
Gomaa I. Omar
* Bradley N. Opdyke
Randall C. Orndorff
* Robin E. Osborn
* David A. Osleger
Bette L. Otto-Bliesner
Deems C. Padgett
Amanda A. Palmer-Julson
Steven P. Pappajohn
* Suzanne Paradis
Charles H. Pardini
John W. Parker
John B. Parsons
* Alberto E. Patino-Douce
* Penny E. Patterson
* Vicki A. Pedone
Bruce E. Phillips
* Jay F. Piper
* Margaret L. Plank
Roy E. Plotnick
* Kevin R. Pogue
David S. Powars
Mitchell J. Pretner
* Robert J. Pruett
Randy J. Pulley
* Marilyn E. Quas
Thomas J. Quick
James P. Quinn
* Tina Quo
* Michael P. Raffoni
* Alison E. Rautman
* Jeremy P. Richards
Carl Richter
David A. Rightmer
* John B. Ritter
Stephen M. Ritz
* Benoit J. Rivard
* Thomas T. Roberts
Robert W. Rodgers
* Robert M. Rohlfs
* J. Edward Rooks
Makoto Saito
Takayuki Sakamoto
Carlos I. Salvador-Gonzalez
Philip A. Sandberg
* Lynne A. Saunders
* Lauret E. Savoy
* John F. Sawyer
* Roy W. Schlische
* Robert V. Schneider
* Richard A. Schultz
Mark T. Segars
* W. Patrick Seward
S. Llyn Sharp
Christopher A. Shaw
* Jonathan D. Shenk
Lisa A. Shevenell
* Hugh M. Shipman
Daryl L. Shoemake
* William C. Sidle
Wolf Siewert
* Elisabeth L. Sikes
* Gregory C. Simones
* William W. Simpkins
* David T. Simpson
* Deanna L. Skapiak
Catherine F. Slater
* L. Cirbus Sloan
* John L. Smale
* Alison Jean Smith
Glenn A. Smith
* Gretchen L. Smith
Linda V. Smith
* Michael S. Smith
William P. Snavely
* J. Kent Snow
* Gregory A. Snyder
Jill M. Sotsky
* Cinzia Spencer-Cervato
Howard Spero
Michael T. Spevak
* Thomas R. Spinek
John G. Spray
* Linda S. Spry
* John A. Stamatakos
Jeffrey M. Stanek
Phyllis S. Stanin
Clifford R. Stanley
* Scott W. Starratt
James R. Staub
Bruce G. Stearns
Robert C. Steckley
George C. Stephenson
S. Michael Sterner
Duane A. Stillings
Christian J. Strohmenger
John F. Sulik
* Mark J. Sutherland
Nils B. Svensson
* Ann B. Tabony
Christopher J. Talbot
Hisao Tanaka
* Lawrence H. Tanner
* Dan L. Taranik
Norman W. Tenbrink
* Stephanie L. T.-Harrison
Roy H. Therrien
John H. Thompson
Kathryn W. Thorbjarnarson
* Janet Bauder Thornburg
Peter B. Thurston
Susan M. Todd
Christopher E. Torrey
Richard K. Traeger
Robert C. Trahan
Peter J. Treloar
* Alain Tremblay
* Robert B. Trumbull
Hitoshi Tsukamoto
Preston J. Turner
Ryan Turner
* Jeffrey R. Unruh
Ronald T. Urbanik
Myra K. Vaag
* Michael J. Valentine
Joe N. Van
John A. Van Couvering
* Robert S. Van Pelt
Arthur M. Van Tyne
* Scott K. Vetter
Anne E. Volmer
Alan M. Volpe
William J. Wade
John R. Wagner
* J. Daniel Walker
Malcolm W. Wallace
Simon R. Wallis
* Kathryn A. Walter
David L. Warburton
* Malcolm A. Ward
Jeffrey B. Warner
* Craig S. Wavra
* David M. Wayne
* Robert S. Webb
* James T. Wells
Rosalyn J. Wilhelm
* Debra A. Willard
James H. Willemin
Garnett P. Williams
Lyman O. Williams
John H. Winter
Timothy S. Woelk
* Roy A. Wogelius
Rachel A. Wood
Thomas L. Woodzick
* Gilles H. Wust
* Hongbin Xiao
* Linda L. York
Toshikazu Yoshioka
* Edward D. Young
* Sung Hyo Yun
* Paul D. Zahn
Alexander D. Zekulin
Chunmiao Zheng
Erik N. Zinn
* J. David Zuber

NEW GSA STUDENT ASSOCIATES

The following 497 Student Associates became affiliated with the Society during the period from August 1990 through February 1991.

Terry J. Aaron
Scott B. Aby
Abdul G. Afridi
Irshad Ahmad
Keyvan Ajdary
Hakan Aktas
Saeid Alizadeh
Jan P. Amend
Michael A. Anderson
Matina Angelakos
T. Bruce Appelgate, Jr.
Omid H. Ardakani
John C. Ayers
Tania S. Bacchus
Joseph M. Bahde
Christopher A. Baird
Ronald J. Bakker
Denis M. Balcer
Michael M. Barbour
Robert F. Barminski, Jr.
David A. Barnett
Barbara A. Batchelor
Patricia N. Bauer
Nellena Beedle
Bryan E. Bemis
John E. Bendixen
Laura M. Benninger
Brent N. Bergeron
Katherine J. Bergk-Hall
Peter Birkle
Charles C. Blair, Jr.
Andree P. Blais
Isaac O. Boadi
Karen E. Boelling
Joseph S. Boesenberg
Cleone D.S. Botelho
Susan Q. Boundy-Sanders
Nancy E. Bowers
Robert P. Bradford
Robert J. Brashear
Timothy A. Brieske
Andrew L. Brill
Henk Brinkhuis
Greg J. Brooks
Clint M. Brown
James M. Browning
Brenda J. Buck
Geoffrey T. Buckner
Michael P. Bunds
Susan M. Burbidge
Samuel C. Burks
Isac Burstein
Anthony J. Caldanaro, Jr.
Greg A. Caron
Kenneth Carpenter
Tracey E. Cascadden
Daniel A. Cenderelli
Margaret M. Chauncey
Jian Chen
Ta-tsun Chen
Xingzhi Chen
John T. Chesley
Gregory P. Chludzinski
Chris T. Christensen
Karen E. Christensen
Jean M. Chytil
Annette Ciccateri
Dennis A. Clark
Valerie J. Clote
C. A. Clowe
David M. Clowes
Eric W. Cochrane
Scott E. Coffey
Benito Colon
David H. Cook
John R. Cook
Kent J. Cook
Glenn M. Coon
Phyllis D. Cooper
Erich S. Cowgill
Peter A. Craig
Gregg A. Crandall
Robert C. Crawford
James C. Crellin
Marykate Crombie
Yao Cui
Patchin C. Curtis
Karen L. Custard
John M. Cuthbertson
Laura L. Dale
Andrew J. Davidoff
John S. Davis
Cole M. Davisson
Nancye H. Dawers
Robert M. DeConto
Qingping Deng
Pauline R. Denham
Janice E. Denney
Charles C. DeVoll
Wayne C. Dickerson
Jurgen Dirscherl
Amy L. Dobson
Michael Dolan
Scott S. Dolvin
Joseph J. Donovan
Matthew R. Doubrava
Pierre Doucet
Bernard E. Dougan
Cheryl L. Dressler
Louis-Martin Dube
Patty F. DuBois
David S. Duncan
Stephanie L. Duncan
Dolores G. Durant
Soren B. Durr
James A. Dvorak
Edward P. Eastburn
Ben R. Edwards
Craig M. Ehde
Rebecca Elwood
Jean-Luc Epard
William T. Erdei
Marcia A. Escamilla
Javier Escartin
Dominic Esker
Martin D. Essex
Elizabeth K. Estes
Frank M. Estes
Gregory Evancio
Mitra J. Fattahipovr
Miriam L. Fearn
Paul M. Feinberg
Doneivan F. Ferreira
Carlos E. Ferro
Robert J. Finch
David B. Finkelstein
Christopher D. Finton
Joan F. Flinch
Joyce L. Foegelle
Grace L. Ford
John E. Fortier
Haakon Fossen
Stan P. Franklin
Henry C. Fricke
Nicoletta Fusi
Alfredo S. Galvez-Sinibaldi
Helena Gamero de Villarroel
Gini Gandhok
Glen T. Garland
Jose R. Garrido
Robert A. Gass, Jr.
Kathryn K. Gauthier
Wayne J. Gautreaux
Christopher A. Gellasch
Ann E. Gibbs
Cliff P. Gill
Beth A. Gillespie
Yuriko Gima
Katherine T. Glaser
Clare P. Glover
Changrui Gong
Yuri Gorokhovich
M. Torabi Goudarzi
Dayna Grabeklis-Frost
Karen K. Graber
Gregory R. Grant
Stephen E. Grasby
Charles J. Greig
James M. Gridley
Scott A. Hageman
Catherine A. Hajcak
Larry M. Hakes
Jeffrey R. Hale
Allen J. Hall
Lee F. Halverson
Kimberly A. Hannula
Mustafa M.M. Hariri
Douglas E. Harris
Donald W. Harrison
H. Cliff Harrison
Holly R. Harrison
Charlotte A. Hass
Margaret J. Hastedt
Tina M. Hatton
Diane L. Hawley
Karl P. Hayden
Thomas H. Hayden, Jr.
Anne Haynes
Phillip D. Hays
Norman A. Haywood
Lisa A. Heizer
Eileen A. Herrstrom
Franz K. Hiebert
Robert C. Hinsch
Margaret M. Hiza
Joanna E. Hofle
Karin A. Hoover
Robert F. Hopson
Eric W. Hovanitz
Anthony Howes
Blythe L. Hoyle
Kevin P. Hoyle
Nick W. Hudyma
Audrey D. Huerta
David K. Huffaker
Donna L. Hunt
Chloe C. Hutto
Karen Inman
Ronald B. Irvin
Roy A. Jameson
Tina Y. Jeffers
Patrick J. Jenks
Susan P. Jennings
John W. Jenson
Randon M. Jerris
David D. Johnson
Dawn M. Johnson
Megan H. Jones
Mischelle D. Julien
Steven D. Kadel
Tom J. Karnuta
Bodo Katz
Lewis E. Kaufman
Kamil Kayabali
Timothy R. Keen
Myra Keep
Joel P. Keiser
Charlotte E. Kelchner
Walton R. Kelly
Paul R. Kelso
Tom K. Kelty
Lori A. Kennedy
Laszlo P. Keszthelyi
Kelly G. Kindelberger
James R. King
Janette A. Knittel
Susan D. Knox
Karen S. Kontra
Marianne Kozuch
Brian L. Kramer
Prokopis Kranidiotis
Joseph R. Krieg
Tim J. Kroeger
Kevin D. Krogstad
Gerald J. Kuecher
Angela La Grange
Terry D. Lahm
John D. Landoll
Nina Landow
Kenneth E. Landrum
Timothy J. Leary
Michael A. LeClair
James J. Leder
F. Wesley Lee, Jr.
Mary A.K. Lee
Jonathan D. Leinhos
Sara Lely
Stephen A. Leslie
Zebao Li
Ching-Weei Lin
Jonathan K. Linn
Braddock K. Linsley
James B. Litchfield
Linda D. Locke
Bradley A. Loewen
Jennifer L. Loomis
Frank E. Lovejoy, Jr.
Francesca Lozar
Changsheng Lu
Tina G. Luce
Juliette K. Lucy
Thomas J. Lutterman
Dennis J. Lynn
David F. MacConnell
Tyler MacCready
Michael W. MacDonald
James W. MacLean
Kenneth G. MacLeod
David J. Mallinson
Jeffrey F. Mann
Elizabeth H. Marlies
Alan D. Martin
Bonnie M. Marzo
Kimberley S. Mathiasen
Reza Matinpanah
Lawrence D. Matson
Sandra D.V. Matthews
Scott Matyac
William T. Maul
Anthony J. Mauriello
David J. Mauriello
Michael T. May
Duncan S. McCarthy
Sean E. McCauley
Jerry G. McCloskey
Robert W. McCrary
Eric V. McDonald
Thomas E. McKenna
Kevin M. McKeown
Garrett G. McLeish
Daniel P. McShane
Michael J.-H. Meister
Erik B. Melchiorre
Theresa A. Messina
Jean-Francois G. Metail
Horng-Sheng Mii
Shez L. Miller
Gwendolyn C. Miner
Virgilio A. Minino
Ali Misaghy
La Rae N. Mishler
Mohammad Mohsin
Angela M. Moore
Jorge A. Morales
Sven S. Morgan
Ellen Morris
Scott C. Morrison

Teresa A. Morse
Carlos A. Mortera-Gutierrez
Daniel W. Moser
John L. Mosley
Carol J. Motosicky
Theodore T. Mowers
Carmen Moy
Phillip J. Nabity
Ross H. Nehm
Philip E. Newton
Alice L. Nightengale
Eric Nold
Terry M. Noonan
Shirleen L. Nurmi
Ricardo A. Oliver
Karen A. Orlando
Jeffrey S. Oslick
Brent E. Owens
Felix R. Oyarzabal
Stephen L. Palmes
Katarin A. Parizek
Karla M. Parsons
Judy Passman
Charles T. Pattee
Aurie C. Patterson
Heidi Pelkey
Annette R. Peloquin
John C. Pinkerton
Michele D. Poe
Alexey Polyauov
Kathryn P. Pritchett
Mark S. Pyle
Sharon L. Qi
Linqing Qiu
Michael C. Rack
Fred W. Ramser
Eugene C. Rankey
Kommajosyula S. Ravi
Klaus Reicherter
Ronald E. Reid
Anne-Marie Reidy
Peter W. Reiners
Christopher J. Repsher
Ronald G. Resmini
Tina J. Rester

Linda S. Reust
Jeffrey W. Reynolds
Robert W. Reynolds
Kerry B. Rice
Grant A. Richardson
Mark J. Rigali
Kevin Righter
Dean N. Riley
Ulrich P. Riller
Scott D. Ritger
Keith E. Roberson
Bryan K. Roberts
Kim H. Roberts
Bret A. Robinson
Morgan E. Robinson
Judith J. Rochocki
Lorena M. Rosberg
Gregory T. Roselle
Bryan L. Roth
Steve P. Rowe
Joel C. Rowland
Jeffrey N. Rubin
Timothy R. Runnels
Lisa K. Rupp
Andrea L. Rutty
Andrew E. Sabin
Barbara L. Sahl
Susan E.H. Sakimoto
Thomas R. Sampson
Richard D. Sams
Peter E. Sauer
Jacqueline T. Scallan
Frauke Schafer
Stephen A. Schellenberg
Julie A. Scheve
Curt D. Schneider
John B. Schoger
Allen E. Scott
Earl C. Scott
Richard M. Sepulvado
Alex L. Sessions
Jennifer M. Seul
Laurel L. Shastri
John H. Shaw
Fan Shen
Michael K. Shepard

Christine D. Shivelle
Andy Shrock
John D. Shutak
Jack G. Siegel
Cynthia S. Skinner
William Slattery
Kevin J. Smart
J. Bailey Smith
Teri R. Smith
Yan Song
Christopher C. Sorlien
Juan I. Soto
Robert N. Spark
Krishnan Srinivasan
John K. Stacy
Steve A. Stadelman
Scott R. Stanley
Steven V. Stearns
Sharon M. Stern
John C. Stewart
Stephanie A. Stockman
Peter L. Sturdivant
Qi Su
Gareth B. Sullivan
Gregory M. Sullivan
Morgan D. Sullivan
Jeanine L. Sutherland
Jennifer L. Swenson
Andrea K. Sykora
Bahram Tafakory
Peter J. Talling
Yalan Tang
Michael D. Taraszki
Gabor Tari
B. Gregory Taylor
Craig T. Taylor
Matthew A. Taylor
Matthew J. Thomas
Owen T. Thornberry III
Harold J. Tobin
Richard S. Toomey III
Matthew W. Totten
Florence F. Tramoni
Beth A. Trust
Nikos Tzetos
Ashraf Uddin

Debra E. Vader
David W. Valentino
Pablo Valverde
Jennifer E. Van Pelt
Mari A. Vice
Terance L. Virtue
Koen R. Vogel
William G. Waggener
Eugene V. Wainwright
Erchie Wang
Kun Wang
P. Wang
Xiaomin Wang
Kathleen A. Ward
Erik K. Webb
Pia Weigel
Richard J. Weiland
Jonathan C. Weingast
Oona L.V. West
Patrick J. Whalen
Rick A. White
Richard S. Whitmarsh
Carol M. Wicks
Francis M. Wiggins
Amy C. Williams
John Williams
Mary A. Williams
David J. Wilmoth
Grace S. Winer
Jennifer E. Winkler
Kate M. Witthuhn
Eric E. Wright
Mark L. Wuest
Ning Xu
Suizhou Xue
Qingming Yang
John R. Young
Michaela N. Young
Pamela A. Young
John F. Zaengle
Xiaming Zhai
Etuan Zhang
Chen Zhu

NEW GSA FELLOWS

The following 17 Members were advanced to Fellowship in May, 1991.

David W. Andersen
Raymond E. Arvidson
John A. Breyer
Wilfred J. Carr
Phyllis M. Garman
James P. Hibbard
G. Randy Keller
Nicholas Lancaster
Jill McCarthy
David W. Moody
Hitoshi Onuki
Marc R. St-Onge
Richard H. Sibson
Ross S. Stein
Robert H. Webb
James A. Whitney
Martha O. Withjack

Washington Report *continued from p. 147*

process." The report acknowledges that, "growth in the size of the research work force supported by the Federal Government seems to account for the largest increase in Federal research expenditures." As confirmation of this dramatic increase in the number of scientists and engineers in the workforce, the report notes that between 1980 and 1990, the number of these professionals increased by an average of 7.8% per year—four times more than the growth of the total U.S. workforce—rising from less than 275,000 to more than 340,000. During this period, the average total compensation for academic Ph.D.s rose from $59,000 to more than $70,000.

In conclusion, the report identifies four challenges that the research system must face in the 1990s. "First, new methods of setting priorities and increased use of existing methods are required at all levels of decision-making. Second, Federal expenditures for individual components of research projects have increased faster than inflation. Understanding and coping with these increases is imperative in research decision-making. Third, the development of human resources for the science and education work force must occur through Federal incentives and institutional programs that act on the educational pipeline (K–12 through graduate study). Finally, gaps and uncertainties in the data used to describe the Federal research system must be reduced, and replaced by more routine provision of policy-relevant information.... In summary,... the Federal Government must make tough choices, even beyond issues of merit and constricted budgets, in guiding the research system."

The report presents some very interesting statistics about Federally funded research. The six largest sponsors of research, in decreasing order are: (1) Department of Health and Human Services (HHS), (2) Department of Defense (DOD), (3) NASA, (4) Department of Energy, (5) National Science Foundation, and (6) Department of Agriculture. HHS, through its National Institutes of Health, provided nearly twice the research dollars furnished by DOD. In fiscal year 1990, 53% of all research funds went to institutions in five states (California, Maryland, Massachusetts, New York, and Virginia). On the low end of the distribution, 15 states received less than 2% of the funding. Ten universities received 25% of all funding, while thirty universities accounted for 50% of all funding. Johns Hopkins University was the leading recipient of federal funds, followed by Stanford University. ■

DNAG NEWS

Allison R. (Pete) Palmer

Lots of Good News

Several log jams have broken, and the number of unpredictable DNAG books is down to three: *Geology of Alaska; Precambrian: Conterminous U.S.;* and *Phanerozoic Evolution of North American Continent/Ocean Transitions*. The status as of early June is summarized below.

The Heritage of Engineering Geology and the two summary sheets of North American transects at 1:10,000,000 have been published and are now available. Final proofs have been checked for *Economic Geology of Mexico*, which should be published and available by the time you read this. The first of the U.S. Appalachian transects (*E4—Eastern Kentucky to the Carolina Trough*), the last of the Cordilleran transects (*A3—Gulf of Alaska to Canada Basin*), and the *Stress Map of North America* should also be available by July.

Page proofs have been checked for *Economic Geology: United States* and returned to the typesetter. As soon as the final camera-ready pages are received, this will be sent to the printer. It should be published and available before the 1991 GSA Annual Meeting. With the publication of this book, the DNAG project will have produced 24 volumes including 12,613 pages and 104 plates, most in color, since the appearance of *Geologists and Ideas* in 1985!

Roger Morrison was scheduled to go over the galleys for *Quaternary Nonglacial Geology; Conterminous U.S.* in early June; the last chapter is through copy editing and has been typeset. This book should also make the 1991 Annual Meeting.

Burt Slemmons was scheduled to go over the galleys for the volume *Neotectonics of North America* in mid-July, predicated on the receipt of his introduction, which he promised by mid-June.

Amos Salvador is scheduled to go over the galleys for *The Gulf of Mexico Basin* in late-July. He finally received the last pieces of the last chapter from Richard Nehring. This and one other chapter are in review and should be revised, received at GSA, copy edited, and typeset by the time of Amos's visit.

Bob Christiansen called in May to say his Cenozoic time-slice chapter revision for *The Cordilleran Orogen: U.S.* is "in the mail." The introduction to the volume, by Burchfiel, Lipman, and Zoback has been circulating among the editors for several months. When it gets here, we can schedule a visit by the editors to check galleys for the entire book by the end of the summer.

In September, I should be able to acknowledge the authors for at least the Slemmons and Salvador volumes.

Regarding the remaining unfinished volumes, Randy Van Schmus still needs some final pieces from Karlstrom and Bickford but now aims to have his Precambrian megachapter into review by early June—this is the last major chapter needed for the Precambrian volume; Grantz and Rankin are working hard on their chapters; the Buffler, Thomas, and Sawyer chapters are now in review; Saleeby's chapter lacks only illustrations; and Ortega's chapter still hasn't been received for the volume to accompany the Continent/Ocean Transects. The Alaska volume still needs a long-promised chapter to be written by Davy Jones. Other chapters by Moore, Wahrhaftig, and Plafker needed to complete the Alaska volume are somewhere in the USGS mill, along with several complex plates, some of which were only turned in for production earlier this year. The Alaska volume looks as if it will fulfill the editor's original promise to be the last one done (when the expected date was 1987!)—a dubious distinction. ■

Cohesive Sediments Research Newsletter

The *Cohesive Sediments Research Newsletter* is produced by the U.S. Army Engineers (USAE) Waterways Experiment Station, Hydraulics Laboratory and the USAE Committee on Tidal Hydraulics. The newsletter is a nonprofit, bi-annual (January and July) publication intended to provide open communication among international colleagues involved with cohesive sediments research and associated activities. It includes information about publications, meetings, and current research.

For more information, contact: U.S. Army Engineer Waterways Experiment Station, *Cohesive Sediments Research Newsletter*, Attn.: HE-P, 3909 Halls Ferry Rd., Vicksburg, MS 39180-6199; (601) 634-3057.

In Memoriam

Henry F. Donner
Cleveland, Ohio
January 25, 1991

James W. Bowler
San Diego, California
February 7, 1991

Robert I. Dickey
Ft. Worth, Texas
February 13, 1991

J. Edward Hoffmeister
Pompano Beach, Florida
March 10, 1991

Harold Meisler
Morrisville, Pennsylvania
March 6, 1991

Wallace M. Cady
Englewood, Colorado
April 4, 1991

Marion M. Fidlar
Salt Lake City, Utah
April 9, 1991

Doris Malkin Curtis
Bellaire, Texas
May 26, 1991

Henry Bell III
Reston, Virginia

Conrad O. Hage
Alberta, Canada

1991 ANNUAL MEETING

San Diego, California • October 21–24

San Diego
GLOBAL PERSPECTIVE

Get your first choices—REGISTER EARLY
Look for the August Issue of *GSA Today*

TRAVEL
Call Cain Travel Today!

Getting To San Diego

By Air. San Diego International Airport—Lindbergh Field is one of the few airports to be only 15 convenient minutes from the Convention Center. Most hotels have free shuttle pick-up. Consider staying over Saturday night in San Diego for significant airfare savings.

By Car. San Diego is about a 2 1/2-hour drive from downtown Los Angeles via freeway route Interstate 5, which stretches from Canada to the Mexican border. Interstate 8 serves drivers from Yuma, Arizona, and beyond from the East Coast. Interstate 15 provides access from Nevada, Utah, Idaho, and Montana.

By Train and Bus. Amtrak passenger trains provide service to and from Los Angeles. Greyhound and Trailways provide bus service. Call the offices in your area to get the best rates.

Getting Around In San Diego

An excellent freeway system makes travel by car or bus easy throughout the county. San Diego Transit Corporation buses serve the metro area. Taxi service, inexpensive rental cars, and tour buses are readily available. In San Diego, call The Transit Store, 233-3004, for schedule information.

San Diego Trolley. The modern San Diego Trolley provides an excellent, inexpensive service in the downtown area; between downtown and the Mexican border; and to San Diego's East County.

GSA Shuttle. The shuttle will supplement trolley access to the San Diego Convention Center and to the Marriott Hotel & Marina, which will be home to all the meeting events. The shuttle will provide convenient, free, day-time transportation serving the GSA-selected downtown hotels and the Convention Center. The shuttle will also operate on Sunday, Monday, and Tuesday evenings.

LODGING

Tight budget? We're on your side. We've gotten the best possible rates for October including discounts of 30% or more. We've booked 12 properties that include a good cross section of lodging in the downtown area that should appeal to almost everyone's budget and taste.

We have reserved 300 rooms in various small Travelodge properties either downtown or within three miles of the downtown area and negotiated a special flat rate of $45 for one to four people. You may need to provide your own transportation.

Over and above the 1000 rooms at the headquarters hotel, there are 700 single rooms priced between $70 and $85, and 425 single rooms between $50 and $69. There is an excellent set of options within this group, including four-star properties and basic motels. All meet GSA's standards for rate reliability, cleanliness, service, and location.

The most outstanding property in the luxury class is GSA's headquarters, the Marriott Hotel & Marina, which is truly an impressive property. Immediately adjacent to the Convention Center and Seaport Village, it offers first-class services, dining, and a resort atmosphere right on San Diego Bay. Rates at $125 single and $139 double are the best group rates available in October and worth the cost by California standards.

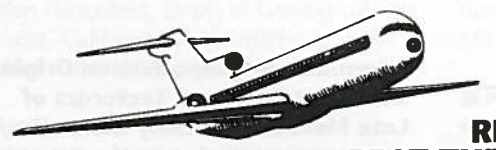
Be sure to register in August to get the hotel you want. Hotel information and reservation forms will be available in the August issue of *GSA Today*. All housing, except suites, will be processed by the San Diego Housing Bureau. Please call the GSA Housing Coordinator for suite information.

ALTERNATIVE HOUSING

Beating the high cost of housing is a high priority of GSA staff and the 1991 Local Committee. Here are some alternatives to downtown prices:

- Check your library copy of the Hotel and Motel Redbook, which lists metro properties. Because of the hundreds of properties in the area (some good, some bad), GSA does not provide a general list.
- Call 1-800-555-1212 or check the Yellow Pages to learn the 800 number for your favorite hotel chains, such as Motel 8 or Comfort Inns, which have properties outside the downtown area.
- Consider camping or taking the trolley to/from nearby El Cajon. The San Diego Local Committee has researched low-cost alternatives, including camping or other motels south of San Diego. Tent and RV campgrounds are available near the San Diego County foothills or on Mission Bay. Advanced reservations are required, and nightly fees range from $16 to $30. For additional information, contact Vanessa George, GSA Housing Coordinator. ■

Don't Forget—
Watch for the August issue of *GSA Today* and register early



RISING AIRFARES?
BEAT THEM WITH DISCOUNTS!

Call CAIN TRAVEL GROUP Today

(official travel agency for the San Diego meeting)

Cain offers up to 45% off coach*, and guarantees to meet or beat any airfare quote.

You can't lose. Book today. If airfares drop, Cain will automatically reissue your ticket at the lower rate!

1-800-346-4747 toll-free
(303) 443-2246 collect from outside U.S., fax 303-443-4485
8:30 a.m.–6:00 p.m. MDT, Monday–Friday

COMPETITIVE RATES, REASONABLE ROUTING, GREAT SERVICE.

BEAT THE HIGH PRICES.
SHOP AROUND, BUT BE SURE TO CALL CAIN.

* Restrictions and penalties may apply. As with all airline reservations, please use caution regarding change and cancellation penalties that accompany low-fare tickets. This applies especially to field trip participants, whose trips may be canceled after the September 20 preregistration deadline.

Special Discount Fares. Cain can handle your Special Discount reservations too with no additional charge.

- There are several coupon offerings that are available as we go to print. Look for these and other specials in your area:
  - — American Express has been offering $129 roundtrip discount coupons to students who apply for the credit card. (You'll have to pay the annual dues of $55 upfront.) Check your campus bookstore.
  - —Gold "C" Coupon Book has a coupon with $100-off Continental fares.
- Over 55? Over 60? Several airlines offer 10% discounts.
- A few airlines still offer family discounts.
- Some airlines are dropping fares and offering no-penalty terms. Secure these special rates with a credit card reservation.

Visit the 1991 GSA Bookstore—
new products, special offers, and more!

See you at the Annual Meeting in San Diego

Radioactive Waste Conference

The **1992 International High-Level Radioactive Waste Management Conference** will be held April 12–16, 1992 in Las Vegas, Nevada.

This conference, sponsored and cosponsored by many scientific and engineering societies and organizations, including the Geological Society of America, is an information exchange meeting for management of high-level radioactive waste. The conference is interdisciplinary and brings together leading experts from around the world.

The deadline for extended summaries of papers for the conference is *September 4, 1991*. For more information or to request a form, contact James Tulenko, technical program chair, Attn: TRANSACTION Office, American Nuclear Society, 555 N. Kensington Ave., La Grange Park, IL 60525; (708) 352-6611, fax 708-352-6464.

MEETINGS

■ Indicates new or changed information

1991

July

Second International Conference on Industrial and Applied Mathematics (ICIAM 91), July 8–12, 1991, Washington, D.C. Information: SIAM Conference Coordinator, Dept. CC0990, 3600 University City Science Center, Philadelphia, PA 19104-2688; (215) 382-9800; fax 215-386-7999; E-mail siamconfs@wharton.upenn.edu.

11th International Symposium on Ostracoda, July 8–13, 1991, Warrnambool, Victoria, Australia. Information: Peter J. Jones, Bureau of Mineral Resources, P.O. Box 378, Canberra A.C.T. 2601, Australia; phone (06) 249 9737; fax 06-257-6465.

Former ENSO Phenomena in Western South America: Records of El Niño Events, July 10–13, 1991, Lima, Peru. Information: ENSO 1991 International Symposium, ORSTOM, Apartado 18-1209, Lima 18, Peru; fax 51-14-40-87-73.

Sixth International Symposium on the Ordovician System, July 15–19, 1991, Sydney, Australia. Information: Earth Resources Foundation, Edgeworth David Building, University of Sydney, Sydney, N.S.W., Australia, 2006; phone (02) 692 2038 (Int. 61+2); fax 02-692 0184 (Int. 61+2).

August

150th Anniversary Conference on the Permian System, August 5–10, 1991, Perm, USSR. Information: A.E.M. Nairn, Perm Conference, Earth Sciences & Resources Institute, University of South Carolina, Columbia, SC 29208; (803) 777-6484; fax 803-777-6437; telex 9102501347 USC ESRI UQ.

Sedimentary and Paleolimnological Records of Saline Lakes, August 13–16, 1991, Saskatoon, Saskatchewan. Information: Robin W. Renaut, Dept. of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada; fax 306-966-8593; W. M. Last, Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada; fax 204-261-7581.

SEPM Midyear Meeting—Continental Margins, Tectonics, Eustacy and Climate Change, August 15–18, 1991, Portland, Oregon. Information: Sam Boggs, Jr., Dept. of Geology, University of Oregon, Eugene, OR 97403; (503) 686-4573.

4th International Symposium on Borehole Geophysics, August 18–22, 1991, Toronto, Canada. Information: P. G. Killeen, 4th Symposium on Borehole Geophysics, c/o Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada; (613) 996-2312; fax 613-996-9295; telex 053-3117 EMAR OTT.

Third U.S. Conference on Lifeline Earthquake Engineering, August 22–23, 1991, Los Angeles, California. Information: American Society of Civil Engineers, Specialty Conference Dept., 345 E. 47th St., New York, NY 10017; (212) 705-7139.

1st International Meeting of Young Geologists, August 22–28, 1991, Budapest, Hungary. Information: Anna Balog, Dept. of Geology, Technical University of Budapest, H-1521 Budapest, Hungary; phone (36-1) 16-67-370; fax 36-1-16-66-808; telex 225931.

International Symposium on Origin, Sedimentation and Tectonics of Late Mesozoic to Early Cenozoic Sedimentary Basins at the Eastern Margin of the Asian Continent and Workshop of IGCP 245: Nonmarine Cretaceous Correlations, August 25–30, 1991, Fukuoka, Japan. Information: Hakuyu Okada, Dept. of Earth and Planetary Sciences, Kyushu University, Fukuoka, 812 Japan; 92-614-1101; fax 92-632-2736.

Fourth International Conference on Seismic Zonation, August 26–29, 1991, Stanford, California. Information: 4th International Conference on Seismic Zonation, John A. Blume Earthquake Engineering Center, Department of Civil Engineering, Stanford University, Stanford, CA 94305-4020.

Antarctica in Global Change: Ocean Drilling Perspective, August 28–31, 1991, Santa Barbara, California. Information: James Kennett, Marine Science Institute, University of California, Santa Barbara, CA 93106; (805) 893-3764; fax 805-893-8062.

September

International Symposium on Computer Applications in Geoscience, September 2–6, 1991, Beijing, China. Information: Zhang Bojun, 31 Xue Yuan Rd., Beijing 100083, China; phone 2012233, ext. 312; fax 2024674; telex 222484 GBCC CN.

Geometry of Naturally Deformed Rocks (John Ramsay Meeting), September 9–11, 1991, Zürich, Switzerland. Information: E. Pour, Geologisches Institut, ETH-Zentrum, CH-8092, Zürich, Switzerland; phone 256 36 80; fax 252-70-08.

International Symposium on Fossil Cnidaria Including Archaeocyatha and Porifera, September 9–14, 1991, Münster, Germany. Information: Fossil VI. Cnidaria, Pferdegasse 3, D-4400 Münster, Germany.

Gold and Platinum in Central Africa, September 11–13, 1991, Bujumbura, Burundi. Information: W. Pohl, Institute of Geosciences, Technical University, P.O. Box 3329, D–33 Braunschweig, Germany.

Wyoming Geological Association 42nd Annual Fall Field Conference: Mineral Resources of Wyoming, September 14–18, 1991, Laramie, Wyoming. Information: Gary A. Winter, General Chairman, P.O. Box 2957, Casper, WY 82602; (307) 261-5463, fax 307-261-5136.

Integrating Geographic Information Systems and Environmental Modeling International Conference, September 15–18, 1991, Boulder, Colorado. Information: GIS/Modeling Conference Secretariat, NCGIA, University of California, Santa Barbara, CA 93106; (805) 893-8224; fax 805-893-8617; E-mail ncgia @ncgia.ucsb.edu or ncgia@voodoo.bitnet.

Second International Conference on the Abatement of Acidic Drainage, September 16–18, 1991, Montreal, Québec. Information: Pamela Friedrich, Centre des Recherches Minérales, 1665, boulevard Hamel, Édifice 2, 1er étage, Québec, Québec G1N 3Y7, Canada.

2nd International Symposium on Environmental Geochemistry, September 16–19, 1991, Uppsala, Sweden. Information: Mats Olsson, Dept. of Forest Soils, Swedish University of Agricultural Sciences, Box 7001, S-750 07 Uppsala, Sweden; phone 46-18-672212; fax 46-18-300831.

■ **Rocky Mountain Association of Geologists Field Conference: Coalbed Methane of Western North America**, September 17–20, 1991, Glenwood Springs, Colorado. Information: Rocky Mountain Association of Geologists, 730 17th St., Suite 350, Denver, CO 80202, (303) 573-8621.

Geotechnica: International Trade Fair and Congress for Geosciences and Technology, September 18–21, 1991, Cologne, Germany. Information: Alfred-Wegener-Stiftung zur Förderung der Geowissen-Schaften, Postfach 20 14 48, D-5300 Bonn 2, Germany; phone (0228) 302-260 261; (0228) 302-270.

22nd Annual Geomorphology Symposium: Periglacial Geomorphology, September 21–22, 1991, Buffalo, New York. Information: John C. Dixon, Department of Geography, University of Arkansas, Fayetteville, AR 72701; (501) 575-5808.

Denver GeoTech/Geochautauqua '91, A Geocomputing Conference, September 21–24, 1991, Denver, Colorado. Information: Mark Cramer, GeoTech, 11100 E. Dartmouth Avenue, #190, Aurora, CO 80014; (303) 752-4951; fax 303-752-4979.

Hydrocarbon Contaminated Soils: Analysis, Fate, Environmental & Public Health Effects, and Remediation, Sixth National Conference, September 23–26, 1991, Amherst, Massachusetts. Information: Paul T. Kostecki, Division of Public Health, University of Massachusetts, Amherst, MA 01003; or Linda S. Rosen, Morrill Health Program, University of Massachusetts, Amherst, MA 01003-0081; (413) 545-2934.

Second Hutton Symposium on Granites and Related Rocks, September 23–28, 1991, Canberra, Australia. Information: ACTS, GPO Box 2200, Canberra City, ACT 2601, Australia.

15th International Cartographic Conference–9th General Assembly of the International Cartographic Association, September 23–October 1, 1991, Bournemouth, England. Information: James R. Carter, Academic Computing, Illinois State University, Normal, IL 61761; (309) 438-3758; fax 309-438-5319.

International Mine Water Association Fourth Congress, September 25–30, 1991, Ljubljana, Yugoslavia. Information: Miron Veselic, S.P. Geoloski Zavod Ljubljana, Dimiceva 14, 61000 Ljubljana, Yugoslavia; fax 38 61 371 557.

56th Annual Field Conference of Pennsylvania Geologists: The Geology of South Mountain, September 26–28, 1991, Carlisle, Pennsylvania. Information: Field Conference of PA Geologists, P.O. Box 1124, Harrisburg, PA 17108-1124; (717) 787-2169.

New England Intercollegiate Geological Field Conference, September 28–30, 1991, Princeton, Maine. Information: Allan Ludman, Department of Geology, Queens College, 65-30 Kissena Blvd., Flushing, NY 11367-0904.

1991 American Association of Petroleum Geologists International Conference and Exhibition, September 29–October 2, 1991, London, England. Information: 1991 AAPG International Conference, P.O. Box 979, Tulsa, OK 74101-0979.

Underwater Mining Institute, September 29–October 2, 1991, Honolulu, Hawaii. Information: Allen H. Miller, UMI Coordinator, Underwater Mining Institute, 1800 University Ave., Madison, WI 53705; (608) 262-0645; fax 608-263-2063.

Society of Organic Petrology 8th Annual Meeting, September 30–October 1, 1991, Lexington, Kentucky. Information: Jim Hower, Center for Applied Energy Research, 3572 Iron Works Pike, Lexington, KY 40511; (606) 257-0261; fax 606-257-0220.

October

Association of Engineering Geologists, October 1–4, 1991, Chicago, Illinois. Information: Theodore R. Maynard, Bureau of Engineering, Department of Public Works, 320 North Clark Street, Room 700, Chicago, IL 60610; (312) 744-3530.

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

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

Association of Engineering Geologists Annual Meeting, October 6–11, 1991, Chicago, Illinois. Information: Theodore Maynard, Bur. Engr. Dept., 320 N. Clark Street, Rm. 700, Chicago, IL 60610; (312) 744-3530.

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

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

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

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

International Symposium on Debris Flow and Flood Disaster Protection, October 14–20, 1991, Emeishan City, Sichuan Province, China. Information: Tong Yuling, International Research and

Training Centre on Erosion and Sedimentation (IRTCES), P.O. Box 366, Beijing, China 100044; phone 8413372; telex 22786 ITCES CN; fax 8412539.

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

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

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

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

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

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

November

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

Carolina Geological Society 1991 Field Conference, November 8–10, 1991, Murphy, North Carolina. Information: Stephen A. Kish, Dept. of Geology B-160, Florida State University, Tallahassee, FL 32306; (904) 644-2065.

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

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

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

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

December

IGCP 264 Remote Sensing Spectral Properties (5th Meeting)—Geological Applications of Remote Sensing with Emphasis on Spectral Properties, December 2–12, 1991, Pune, India. Information: Dr. Melvin Podwysocki, Co-Chairman IGCP264, U.S.G.S., National Center, MS 913, Reston, VA 22092; fax 1-703-648-6057.

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

1991 Penrose Conference

October

Development and Evolution of Foreland Basins, October 6–11, 1991, Oliana, Spain. Information: James H. Meyers, Dept. of Geology, Winona State University, Winona, MN 55987; (507) 457-5266 (dir.), (507) 457-5000 (dept.), fax 507-457-5586; Douglas W. Burbank, Dept. of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0740; Lee J. Suttner, Dept. of Geology, Indiana University, Bloomington, IN 47405; Cai Puigdefabregas, Dept. de Politica Territorial, Servei Geologica de Catalunya, Diputacio, 92, 5e, 08015 Barcelona, Spain.

1992

February

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

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

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

March

■ **Circum-Pacific Council for Energy and Mineral Resources Symposium**, Sustainable Development: Energy and Mineral Resources and the Environmental Impact of Their Utilization in the Circum-Pacific Region, March 9–12, 1991, Bangkok, Thailand. Information: Mary Stewart, Circum-Pacific Council, 5100 Westheimer, Suite 500, Houston, TX 77056; fax 713-622-5360.

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

April

XVII General Assembly of the European Geophysical Society, April 6–10, 1992, Edinburgh, Scotland. Information: EGS Office, Postfach 49, 3411 Katlenburg-Lindau, Germany; phone (49) 5556-1440; fax 49-5556-4709; telex 965564 zil d; SPAN: LINMPI::EGS; EARN: U0085@DGOGWDG5.

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

May

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

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

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

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

June

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

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

July

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

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

August

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

September

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

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

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

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

October

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

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

1992 Penrose Conference

March

Continental Tectonics and Magmatism of the Jurassic North American Cordillera, late March 1992, Twentynine Palms, California. Information: David M. Miller, U.S. Geological Survey, 345 Middlefield Road, MS-975, Menlo Park, CA 94025, (415) 329-4923; or Richard M. Tosdal (same address), (415) 329-5423.

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

GSA *BULLETIN* and *GEOLOGY* Contents

The Geological Society of America
BULLETIN
Volume 103, Number 7, July 1991

CONTENTS

849–860 $^{40}Ar/^{39}Ar$ constraints on the emplacement, uplift, and cooling of the Coast Plutonic Complex sill, southeastern Alaska
D. J. Wood, H. H. Stowell, T. C. Onstott, and L. S. Hollister

861–875 Low-temperature deformation of sandstone, southern Appalachian fold-thrust belt
Schuman Wu and Richard H. Groshong, Jr.

876–885 Paleogeographic and structural significance of an Upper Mississippian facies boundary in southern Nevada and east-central California
Calvin H. Stevens, Paul Stone, and Paul Belasky

886–897 Eruption and depositional facies of the Whorneyside Tuff Formation, English Lake District: An exceptionally large-magnitude phreatoplinian eruption
Michael J. Branney

898–904 Tertiary brittle deformation in the central Sierra Nevada, California: Evidence for late Miocene and possibly younger faulting
Mary M. Lahren and Richard A. Schweickert

905–915 Detrital record of the early Central American magmatic arc: Petrography of intraoceanic forearc sandstones, Nicoya Peninsula, Costa Rica
Neil Lundberg

916–927 Open-system, constant-volume development of slaty cleavage, and strain-induced replacement reactions in the Martinsburg Formation, Lehigh Gap, Pennsylvania
R. P. Wintsch, C. M. Kvale, and H. J. Kisch

928–940 A potassic volcanic front in western Mexico: The lamprophyric and related lavas of San Sabastian
Rebecca A. Lange and Ian S.E. Carmichael

941–952 Paleogeographic implications of an erosional remnant of Paleogene rocks southwest of the Sur-Nacimiento fault zone, southern Coast Ranges, California
John G. Vedder, Hugh McLean, Richard G. Stanley, and Thomas J. Wiley

953–965 Stable-isotope stratigraphy of brachiopods from Pennsylvanian shales in Texas
Ethan L. Grossman, Chuanlun Zhang, and Thomas E. Yancey

966–969 Remagnetization and northward translation of Mesozoic red chert from Cedros Island and the San Benito Islands, Baja California, Mexico: Discussion and Reply
Discussion: *John A. Tarduno;* Reply: *Jonathan T. Hagstrum and Richard L. Sedlock*

970–972 Clastic lawsonite, glaucophane, and jadeitic pyroxene in Franciscan metagraywackes from the Diablo Range, California: Alternative interpretation
Loren A. Raymond

973–974 Bulletin Information

GEOLOGY
VOLUME 19
NO. 7
P. 673–768
JULY 1991

675 Galápagos Islands: A Holocene analogue to the Wallowa accreted terrane, western North America
David L. Malmquist

679 Organic-rich transitional facies in silled basins: Response to sea-level change
J. J. Middelburg, S. E. Calvert, R. Karlin

683 Miocene dextral shearing between Himalaya and Tibet
Arnaud Pêcher, Jean-Luc Bouchez, Patrick Le Fort

686 Major Northern Hemisphere deglaciation caused by a moisture deficit 140 ka
R. G. Johnson

690 SeaMARC II mapping of transform faults in the Cayman Trough, Caribbean Sea
Eric Rosencrantz, Paul Mann

694 Cretaceous/Tertiary boundary of DSDP Site 596, South Pacific
Lei Zhou, Frank T. Kyte, Bruce F. Bohor

698 Large-scale anisotropy within the crust in the Basin and Range province
Ramon Carbonell, Scott B. Smithson

702 Ocean nutrient distribution and oxygenation: Limits on the formation of warm saline bottom water over the past 91 m.y.
Timothy D. Herbert, Jorge L. Sarmiento

706 Sudden, probably coseismic submergence of Holocene trees and grass in coastal Washington State
Brian F. Atwater, David K. Yamaguchi

710 Zircon response to diamond-pressure metamorphism in the Kokchetav massif, USSR
J. C. Claoué-Long, N. V. Sobolev, V. S. Shatsky, A. V. Sobolev

714 Is the southeast Coast Plutonic Complex the consequence of accretion of the Insular superterrane? Evidence from U-Pb zircon geochronometry in the northern Washington Cascades
Nicholas W. Walker, Edwin H. Brown

718 Late Quaternary fault segmentation from analysis of scarp morphology
Julianne M. Turko, Peter L.K. Knuepfer

722 Zabargad peridotite: Evidence for multistage metasomatism during Red Sea rifting
Claude Dupuy, Catherine Mével, Jean-Louis Bodinier, Liliane Savoyant

726 Trackway preservation in eolian sandstones from the Permian of Scotland
Patrick J. McKeever

730 Crustal thinning recorded by the shape of the Namurian-Westphalian leucogranite in the Variscan belt of the northwest Massif Central, France
Michel Faure, José Pons

734 Internal-tide deposits in an Ordovician submarine channel: Previously unrecognized facies?
Gao Zhenzhong, Kenneth A. Eriksson

738 Late Paleozoic basin on the West Galicia Atlantic margin
Bernard Mamet, Maria C. Comas, Gilbert Boillot

742 Predicting facies architecture through sequence stratigraphy—An example from the Kaiparowits Plateau, Utah
Keith W. Shanley, Peter J. McCabe

746 Very high purity gold from lateritic weathering profiles of Nilambur, southern India
M. Santosh, P. K. Omana

750 Low sulfur content in submarine lavas: An unreliable indicator of subaerial eruption
Alicé S. Davis, David A. Clague, Marjorie S. Schulz, James R. Hein

754 Estuarine stream piracy: Calvert County, U.S. Atlantic coastal plain
Peter R. Vogt

758 Crustal-scale structure of the southern Rhinegraben from ECORS-DEKORP seismic reflection data
J. P. Brun, F. Wenzel, ECORS-DEKORP team

Forum

763 Northern Monashee Mountains, Omineca Crystalline Belt, British Columbia: Timing of metamorphism, anatexis, and tectonic denudation
Comment: *Barry P. Kohn, Roderick W. Brown, Andrew J.W. Gleadow*

764 Integrated model for Meguma Group lode gold deposits, Nova Scotia, Canada
Comment: *A. L. Sangster*
Reply: *D. J. Kontak, P. K. Smith, R. Kerrich, P. F. Williams*

766 U/Pb zircon and baddeleyite ages for the Palisades and Gettysburg sills of the northeastern United States: Implications for the age of the Triassic/Jurassic boundary
Comment: *David E. Seidemann*
Reply: *G. R. Dunning, J. P. Hodych*

768 Correction

GSA ANNUAL MEETINGS

■ 1991

SanDiego GLOBAL PERSPECTIVE

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

General Chair:
R. Gordon Gastil, Dept. of Geological Sciences,
San Diego State University, San Diego, CA 92182

Abstracts due: *July 3*
Joint Technical Program Committee meeting: *August 2–3*
Program, housing, registration information: *August 9*
Preregistration due: *September 20*

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

■ 1992

GSA Annual Meeting, Cincinnati, Ohio
October 26–29

Call for short course proposals:
GSA members and nonmembers are encouraged to submit short course proposals to be reviewed by GSA's Short Course Committee. All proposals are due by *December 1, 1991*. For short course proposal guidelines contact: Edna Collis, Short Course Coordinator, GSA, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020

■ FUTURE

Cincinnati	October 26–29	1992
Boston	October 25–28	1993
Seattle	October 24–27	1994
New Orleans	November 6–9	1995
Denver	October 28–31	1996

For general information on technical program participation (1991 or beyond) contact: Sue Beggs, Meetings Manager, GSA headquarters

GSA SECTION MEETINGS

■ 1992

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

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

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

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

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

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

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

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

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

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

Rocky Mountain, Ogden, Utah
Ogden Park Hotel, May 14–16

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

CLASSIFIED ADVERTISING

Published on the 1st of the month of issue. Ads (or cancellations) must reach the GSA Advertising office 1 month prior. Contact Advertising Department (303) 447-2020, 1-800-472-1988, fax 303-447-1133.

Classification	Per Line for 1st month	Per line for each addt'l month (same ad)
Situations Wanted	$1.75	$1.40
Positions Open	$4.50	$3.80
Consultants	$4.50	$3.80
Services & Supplies	$4.50	$3.80
Opportunities for Students	$0.00	$1.35

Code number: $2.75 extra

Agencies and organizations may submit purchase order or payment with copy. Individuals must send prepayment with copy. To estimate cost, count 54 characters per line, including all punctuation and blank spaces. Actual cost may differ if you use capitals, centered copy, or special characters.

To answer coded ads, use this address: Code # ----, GSA Advertising Dept., P.O. Box 9140, Boulder, CO 80301-9140. All coded mail will be forwarded within 24 hours of arrival at *GSA Today* office.

Positions Open

INVERTEBRATE PALEONTOLOGY ASSISTANT PROFESSOR

The Department of Geology at Colgate University invites applications for a tenure-stream position at the Assistant Professor level in the field of invertebrate paleontology. We seek an individual with a modern approach which includes concepts of paleoecology, biogeography and/or biostratigraphy. The successful applicant would teach invertebrate paleontology, would contribute to the department's introductory offerings, and would have the opportunity to teach an upper-level course in his/her specialty. Of particular interest to us are individuals who could take advantage of the rich Devonian fauna of the Hamilton Group which is present in local exposures. We encourage applicants who could also contribute to departmental offerings in hydrology and surficial processes. Applications from women and minorities are strongly encouraged. Applicants should have the Ph.D. in hand by September 1, 1992.

Colgate University is a highly selective liberal arts institution in rural upstate New York with an enrollment of 2700 men and women, and offers B.A. and M.A.T. degrees. The Department of Geology consists of eight full-time faculty members plus a part-time laboratory instructor. We have excellent facilities including numerous microscopes and computers, a modern SEM with EDS, XRD, XRF, AA and ion chromatograph.

Interested persons should send a letter of application, a curriculum vitae, and three letters of recommendation by October 1, 1991 to: Dr. Arthur Goldstein, Chairman, Department of Geology, Colgate University, Hamilton, NY 13346, (315) 824-7201.

Colgate University is an Equal Opportunity/Affirmative Action Employer.

HYDROGEOLOGIST

Ph.D. in civil engineering and 3 years experience in the related occupation of Graduate Research Assistant/Associate and Assistant Teacher. Conduct investigations of ground water flow and contaminant transport for ground water system having complex boundary conditions using computer modeling. Develop numerical models and codes using FORTRAN and BASIC programming languages. Conduct conceptual designs for containment system for control of migration of ground water contamination. Conduct investigations in surface water and stream/aquifer interactions. Develop numerical models and FORTRAN codes for large scale integrated watershed models. Conduct investigation in conjunctive uses of surface water and ground water resources by numerical approaches and multi-objective optimization techniques. Prepare technical papers for presentation and publication. 40 hr. wk.; salary $35,000/yr. Application by resume to Colorado Department of Labor and Employment, Division of Employment and Training, 300 Grant Street, Suite 900, Denver, CO 80203. Refer to Order No. CO3195408.

OCEAN SCIENCES

Associate/Full Professors. Several openings in fishery biology, remote sensing in marine resources, marine natural product, marine mineral resources, isolation of precious elements from sea water. Qualifications: Ph.D. and fluent in Mandarin Chinese. Duties: research and teaching. Applicants are invited to send curriculum vitae and list of three references to: Dr. W. H. Wang, Institute of Marine Resources, National Sun Yat-sen University Kaohsiung, Taiwan, Republic of China.

ASSISTANT PROFESSOR SEDIMENTOLOGY/STRATIGRAPHY

The Department of Geology at Colgate University invites applications for a three year appointment to be filled at the assistant professor level. Duties will begin in the fall of 1992 and will include teaching sedimentology and stratigraphy and other courses which might include paleoecology and/or petroleum geology. Research involvement with undergraduates is strongly encouraged.

Colgate University is a small liberal arts college in rural upstate New York. The Department of Geology consists of eight full-time faculty members, a laboratory instructor, and a part-time technician. Analytical facilities include an automated Diano XRD/XRF; Cambridge-Tractor Northern SEM-EDS with cathodoluminescence and ion chromatograph. We are especially well equipped for clay mineralogy studies. Applications from women and minorities are strongly encouraged.

Interested persons should send a letter of application, a curriculum vitae, and three letters of recommendation by October 1, 1991 to: Dr. Arthur Goldstein, Chairman, Department of Geology, Colgate University, 13 Oak Drive, Hamilton, NY 13346, (315) 824-7201.

Colgate University is an Equal Opportunity/Affirmative Action Employer.

STRATIGRAPHER / PETROLEUM GEOLOGIST

The North Dakota Geological Survey invites applications for a newly created position in stratigraphy and petroleum geology. Applicants should have substantial well log correlation experience, as well as knowledge of core analysis, basin analysis, and sequence stratigraphy. Knowledge of Williston Basin stratigraphy and familiarity with computer applications in geology, particularly with GIS systems, are desirable.

Applicants should have either an M.S. or Ph.D. degree, preferably with petroleum industry experience. Starting salary for this position, which is classified Geologist II within the State Personnel System, will be between $26,000 and $30,000 plus benefits. Please submit a resume or letter stating qualifications, along with the names and addresses of at least three references, to Karen Gutenkunst, North Dakota Geological Survey, 600 East Boulevard, Bismarck, North Dakota 58505.

POSTDOCTORAL POSITION TYNDALL AIR FORCE BASE, FLORIDA

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

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

For information about the research project contact Thomas Stauffer at (904) 283-6059. For application materials contact Postgraduate Research Program at TAFB, Science/Engineering Education Division, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, TN 37831-0117, (615) 576-3456.

ENVIRONMENTAL PROFESSIONALS CAREER OPPORTUNITIES

McLaren/Hart is a nationwide team of over 700 environmental professionals specializing in solving large-scale, complex and milti-site problems for the private sector. Through our reputation of high quality services, commitment to technical excellence, and client responsiveness, we have built a solid client base of many Fortune 500 companies.

McLaren/Hart is expanding and is seeking strong, self-motivated and technically superior professionals to join our team of highly skilled staff. Openings now exist for: GEOLOGISTS. The right candidate will have a B.S. Geology or related degree, drilling, site characterization, soil sample collection, and report writing experience. HYDROGEOLOGISTS. Candidates should have a B.S. Geology, or M.S. Civil Engineering or related degree. Must be able to provide technical analysis and support in review and interpretation of chemical, hydrogeological and geological data. Also, provide technical guidance for project planning.

If you are dedicated to solving the environmental problems of today and tomorrow, join the company that shares your commitment. McLaren/Hart offers a highly competitive salary and benefits package which includes: medical, dental, life and long-term disability insurance, pension plan, 401(K), vacation, sick leave and holidays.

Please send your resume and salary history to: Dept. GSA, 1135 Atlantic Avenue, Alameda, California 94501. We are located iin the San Francisco Bay Area.

Affirmative Action Employer M/F/H/V.

Services & Supplies

6" MAP SCALES—Multiscale Products, 10558 Creston Drive, Los Altos, CA 94024 X5/92

FOR SALE: Kodak Starvue Reader/Printer S/N 11465. Enron Oil & Gas Company (303-793-4632), $700.

Opportunities for Students

VICTORIAN INSTITUTE OF EARTH AND PLANETARY SCIENCES. *Overseas applications now due.* For those students interested in Australia, the deadline for scholarships is fast approaching. The OPRS (Overseas Postgraduate Research Scholarship Program for Study in Australia) or SOPF (Special Overseas Postgraduate Fund for Study in Australia) awards are critical to meeting the cost of study in Australia but their deadline is *September 1991*. These awards can be combined with scholarships available from the host institutions. The Victorian Institute of Earth and Planetary Sciences (VIEPS) is located in the state of Victoria, Australia and provides students with graduate programs in Geology, Geophysics, Geography & Environmental Sciences, Meteorology and Atmospheric Physics. For more information contact The Coordinator, VIEPS, GPO Box 2729X, Melbourne, Victoria 3001 Australia or fax 61 3 565 5062.

JOI/USSAC OCEAN DRILLING FELLOWSHIPS. JOI/U.S. Science Advisory Committee is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both two-year and one-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward objectives of a specific leg or to broader themes.

Applications are available from the JOI office and should be submitted according to the following schedule: Leg 145: North Pacific Transect, 8/15/91; Leg 146: Cascadia, 8/15/91; All Shorebased Research (regardless of leg), 12/15/91.

These legs will be staffed in the next few months. Students interested in participating as shipboard scientists must apply to the ODP Manager of Science Operations in College Station, TX. An application form is available in the JOI/USSAC application packet.

For more information and to receive an application packet, contact: JOI/USSAC Ocean Drilling Fellowship Program, Joint Oceanographic Institutions, Inc. 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2101 (Robin Smith: 202-232-3900).

MOVING? Don't risk missing a single issue of *GSA Today*! If you're planning on changing your address, simply write in your new address below and mail this coupon along with your subscription mailing label (use label from this newsletter) to: GSA, Membership Services, P.O. Box 9140, Boulder, CO 80301-9140. Or you may call with your change of address information—(303) 447-2020 or 1-800-472-1988. (North American subscribers should report address changes six weeks in advance; all others, three months in advance.)

PLEASE PRINT

Name _____

Address _____

City _____

State/ZIP/Country _____

Phone (during business hours) _____ Change my voting section to _____

If you do not wish to have this number in the Membership Directory, check here ☐

Northeastern-Southeastern Section Meeting Photo Contest Winner

Iceberg off Kaj Kap, Skæpfjord, North-East Greenland (77°20"N). In 1937 and 1938, Louise Boyd, a wealthy American naturalist, hired the Norwegian ship *Veslekari* and led her own expedition to photograph the coast and ice forms of North-East Greenland. The Greenland Geological Survey's 1988–1990 North-East Greenland Expedition revisited Skæpfjord in 1990 to complete a 1:500,000 bedrock map of the little known region between 75° and 78° N. Armed with many rolls of Fujichrome 50 slide film, they realized Boyd's dream of producing lasting color images of the Greenland coast. Photo by Jane Gilotti, New York State Geological Survey. Published with permission of the Greenland Geological Survey.

This photo was the winner in a contest held at the 1991 combined meeting of GSA's Northeastern and Southeastern Sections, held in Baltimore, Maryland, in March 1991.

ISSN 1052-5173

The Geological Society of America
3300 Penrose Place
P.O. Box 9140
Boulder, CO 80301

SECOND CLASS
Postage Paid
at Boulder, Colorado
and at additional mailing offices