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CINCINNATI CALL FOR PAPERS

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Cretaceous-Tertiary Events and the Caribbean Caper

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ABSTRACT

Over the past year or so a number of impact sites have been proposed in the Caribbean region with ages approximating that of the Cretaceous-Tertiary boundary. Assuming that the paleontological record can also be accounted for, the presence of a large crater could be taken as lending credence to the argument that extinctions and impacts may be related. However, the available geologic information suggests that all sites proposed thus far for a K-T impact lack merit.

INTRODUCTION

Thomson (1988), in an essay entitled "Anatomy of the Extinction Debate," commented:

> Inevitably, with most subjects there is also the silly season, usually of unpredictable duration and of an intensity correlated with the acceptance of the new idea. . . . [It includes] the proposal of ideas even more far-out than the original one.

The impact theory as a cause for extinctions of organisms, including the dinosaurs, at the K-T boundary was based on the reasonable interpretation of an excess of iridium at the K-T boundary as extraterrestrial (Alvarez et al., 1980). The original model proposed a giant dust cloud that blocked the Sun, stopping photosynthesis. This model was followed by others suggesting that an asteroid impact on a carbonate terrane vaporized the limestone, leading to a flux of carbon dioxide to the atmosphere and global warming (O'Keefe and Ahrens, 1988); that a comet traversing the atmosphere created nitrogen oxides, leading to acid rain (Prinn and Fegley, 1987); that the larger animals died in response to heat stress following cometary impact, while calcareous plankton were done in by cyanide poisoning (Hsü, 1980, 1981); and that trace elements in the asteroid led to poisoning of the biological food chain (Erickson and Dickson, 1987; Hsü et al., 1982). The paleontological record does not appear to support a single short-term event as measured in human terms of either terrestrial or extraterrestrial origin, a flaw shared by these corollaries as well as by the original hypothesis.

The relatively small number of dinosaur specimens in the geologic record complicates determination of the time of their extinction. Dinosaurs of western North America showed a rapid decline in number of species over the past 500,000 years of the Late Cretaceous (Van Valen and Sloan, 1977), but detailed studies in Montana and North Dakota conclude that the record is not incompatible with a final, abrupt extinction event (Sheehan et al., 1991). Other nonmarine vertebrates in western North America show a geologically rapid but noncatastrophic change during the Late Cretaceous (Archibald and Bryant, 1990). Five extinction events in the floral record of western Canada have been found over several metres of section both predating and postdating the K-T boundary defined by an iridium anomaly (Sweet et al., 1990).

In a shallow-water marine K-T section in Antarctica, shellfish extinctions occurred over a 30–50 m interval and preceded the planktonic extinctions (Zinsmeister et al., 1989). In Tunisia and Texas planktonic foraminiferal extinctions occurred in a stepwise fashion over 1–4 m, or about 200,000 yr (Keller, 1989; MacLeod and Keller, 1991). Benthic foraminifera are less affected than surface foraminifera, and nannofossils show a longer period of transition than do the foraminifera.

In a seldom cited, generally overlooked paper, Jaeger (1986) has made the most complete study of K-T extinctions known to us. Jaeger analyzed in painstaking detail all species of ammonites, belemnites, mollusks, bryozoans, brachiopods, echinoderms, microplankton, nannoplankton, ichthyosaurs, mesosaurs, pterosaurs, and dinosaurs. The tetrapods show a gradual stepwise pattern of extinctions, with few species remaining at the K-T boundary, most of them having become extinct well before the boundary. Many of the marine biotas passed through the K-T boundary intact, in many cases with more than 50% of the taxa of each family.

Though the record does not appear to support instantaneous extinctions, iridium anomalies and quartz grains with microscopic dynamic deformation features suggest to some workers that there was, nevertheless, an asteroid impact at K-T boundary time. These have been considered diagnostic of an impact, but recent studies have shown that iridium anomalies can be associated with present-day volcanic eruptions and that shocked minerals are associated with structures of terrestrial origin. Iridium enrichment comparable to that in K-T sections has been found in Hawaii (Zoller et al., 1983; Olmez et al., 1986), in the Antarctic (Koeberl, 1989), in Kamchatka (Felitsyn and Vaganov, 1988), and on Réunion Island (Toutain and Meyer, 1989). The only iridium anomaly associated with known impact craters is from the Precambrian Acraman structure, South Australia (Gostin et al., 1989). Furthermore, microscopic dynamic deformation features in quartz grains are associated with terrestrial structures of volcanic, internal explosive, and high-strain-rate tectonic origin (Officer and Carter, 1991; Sage, 1978; Currie, 1969; Tona, 1985; Pagel et al., 1985; Carrigy, 1968; Winzer, 1972; Hoppin and Dryden, 1958; Bunch, 1968; Carter et al., 1986, 1990; Heuberger et al., 1984; Masch et al., 1985; Erismann et al., 1977; Storzer et al., 1971; Gratz and Kurat, 1988). Some of these structures have been presumed to be of impact origin because of the presence of shocked minerals, although their structure is not compatible with that of known craters (Halls and Grieve, 1976; Hartung and Anderson, 1988).

Summing up, iridium anomalies are associated with present-day volcanic activity but are lacking in known impact structures (with one possible exception). Shock features are found in terrestrial structures of nonimpact or enigmatic origin. This suggests that impacts are not required to produce these features unless one makes the circular argument that they are diagnostic of impacts.

Figure 1. Palagonite-smectite spherules from the Haiti K/T spherule layer. Most of these are tan or brown; but a few are white. Smectite is the only phase identifiable on X-ray diffractograms. Note that the broken spherules are almost invariably hollow and that many of these have secondary microspherules on the interior. Width of photo is 8 mm. From Lyons and Officer (1992).

Figure 2. Bottom half of an accretionary lapillus outlined by the dark concave-upward semicircle tangent to the bottom edge of the photo. Angular smooth-surfaced fragments in lower central and right central parts of the photo, the former cut by a thin palagonite veinlet, are black glasses. Rough-surfaced angular fragment in upper left of photo is a smectized clast of a different chemistry from the black glasses. Circular fracture surrounding it is probably of hydration-contraction origin. Aside from some white zeolite, the remainder of the photo is palagonite-smectite of varying opacity and shades of brown. Width of photo is 2.5 mm. From Lyons and Officer (1992).

CRETACEOUS-TERTIARY GEOLOGIC SECTIONS IN THE CARIBBEAN

The search for the site of the proposed K-T asteroid impact has continued since the hypothesis was first proposed in 1980. Over the past year or so, particular attention has been placed on the Caribbean region. At least four possible Caribbean sites have been suggested, including the Colombian Basin, the Yucatán peninsula, western Cuba, and Haiti. A fifth site that has been suggested is the Manson structure in Iowa, some 2000 km to the north.

The geologic evidence that stimulated these various conjectures has

Caribbean Caper *continued on p. 70*

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Caribbean Caper *continued from p. 69*

come from two sections, one in Cuba and the other in Haiti.

Western Cuba Section

Bohor and Seitz (1990) suggested that a boulder bed represented an "impact ejecta blanket" proximal to a large crater off southwestern Cuba. Because no such impact ejecta blanket has been reported before, one is at considerable liberty to hypothesize what it should look like. The boulder bed is a hard, weakly bedded, steeply jointed marine calcarenite that weathers into large spheroids of up to 1 m diameter (Brönnimann and Rigassi, 1963). Iturralde-Vinent (1992) of the National Museum in Havana studied the geology of the deposit and found the boulders to be of local, in situ weathering origin—representing an exfoliation process, a conclusion confirmed by other investigators (Dietz and McHone, 1990; Robin Brett, Carl Bowin, personal communications; extensive field work by Meyerhoff).

Haiti Section

The boundary layer in Haiti is characterized by palagonite alteration products, including brown globules. In some of the outcrops there are black glass particles that appear unaltered. The layer or, more appropriately, layers are not in an original depositional sequence but in a secondary sequence of turbidity-current or gravity-flow origin.

An iridium anomaly of 1-2 ppb was reported for the 30 cm layer, as well as a comparable anomaly in a marl lens above the layer (Maurrasse et al., 1985). Quartz grains amount to less than 0.01% of the total sample, but about half of them have microscopic dynamic deformation features in the form of single and multiple intersecting sets of planar elements (Izett et al., 1990; Lyons and Officer, 1992).

These sections were originally interpreted as volcanogenic turbidites (Maurrasse et al., 1985) but have recently been reinterpreted as impact-generated deposits, the black glass particles being called tektites and the brown globules being referred to as "clay altered tektites" (Hildebrand and Boynton, 1990; Izett et al., 1990; Izett, 1991; Kring and Boynton, 1991).

Volcanic glasses are known to be metastable, although unaltered volcanic glasses of Cretaceous (Byerly and Sinton, 1980), Jurassic (Shervais and Hanan, 1989), Triassic (Brew and Muffler, 1966), Carboniferous (Schmincke and Pritchard, 1981), and Precambrian (Palmer et al., 1988) age have been found. Over 95% of the Haiti section consists of palagonite, smectite, and the zeolites clinoptilolite and phillipsite (Lyons and Officer, 1992), characteristic volcanic glass decomposition products (Kennett, 1981; Heiken and Wohletz, 1985).
A striking characteristic of tektite and microtektite glasses is their resistance to alteration (Ewing, 1979; O'Keefe, 1976; Glass, 1984). Even for the oldest accepted tektites, extending back to 35 Ma, the H_2O contents are less than 0.02% (Glass, 1984).

The abundant brown globules have two compositional types—darker spherules with low CaO (0.95%) and high SiO_2 (66.19%) and lighter spherules with high CaO (5.36%) and low SiO_2 (62.13%) (Lyons and Officer, 1992). Some globules are nested inside others and are clearly diagenetic; others are hollow, probably because of dissolution of marine zeolites in the present terrestrial ground-water environment. An example of some brown globules is shown in Figure 1. Some workers have suggested that these represent pseudomorphs of tektites (Hildebrand and Boynton, 1990; Izett et al., 1990; Izett, 1991), despite the resistance of tektites to alteration.

The unaltered black glasses, representing 1%–5% of the total deposit, are vesicular. Volcanic glasses are quite vesicular (Kennett, 1981; Heiken and Wohletz, 1985); tektites are not. With a few exceptions, such as the large Muong Nong type, they are devoid of bubbles and vesicles; bubbles and vesicles typically amount to only 0.1% of most tektites (O'Keefe, 1976). The glasses are of an andesitic-dacitic composition with an average SiO_2 content of 62%–63% (Izett et al., 1990; Izett, 1991; Sigurdsson et al., 1991; Lyons and Officer, 1992; Jéhanno et al., 1991); tektites and microtektites are characterized by their high SiO_2 content, with average values of 68%–79% (Glass, 1984).

Clasts of black glass also occur within accretionary lapilli, as do hydrated white clasts and shards, which have a composition different from that of the black glasses (Lyons and Officer, 1992). An example of such a particle is shown in Figure 2. There is no counterpart to such features in the literature on tektites; on the other hand, globular ignimbrites with an accretionary lapilli texture can be associated with volcanic eruptions (Hay et al., 1979).

Rare vesicular yellow glass particles averaging 20%–24% CaO (Sigurdsson et al., 1991; Lyons and Officer, 1992) constitute less than 0.1% of the total sample and less than 1% of the glass fraction. These contain microcrystals of melilite and have a distinct flowage pattern comparable to that in the abundant brown palagonite shards (Lyons and Officer, 1992). Tektites are usually devoid of crystals except for occasional refractory minerals like zircon. Sigurdsson et al. (1991) hypothesized that the yellow and black glasses represent mixing from an impact on a limestone terrane overlying a crust of argillitic composition, degassing of the limestone, and mixing of released CaO into the melted argillite. If so, why should more than 99% of the mixture have the chemistry of dacite or andesite, why do the yellow glasses have SiO_2 contents clustering close to 48%, and why is there a sharp chemical gap in the range of 52%–57% SiO_2 where one might expect strong mixing?

A detailed study by Jéhanno et al. (1992) adds further information. During an impact, most ferric iron is reduced to the ferrous state because of the high temperature and the low oxygen partial pressure. The oxidation state of iron in the Haiti glass relics is close to the average value measured in andesites (Fe^{3+}/Fe^{2+}, 0.67 for andesites; 0.7 ±0.1 for Haiti glasses; 0.03–0.15 for tektites). In addition, Haiti glasses do not contain any lechatelierite, a phase found in all tektites that indicates a brief time during which the temperature was well above 1710 °C, the melting temperature of quartz. The presence of sulfur in the rare yellow-glass fraction, implying a temperature not exceeding 1300 °C, is inconsistent with the high-temperature formation of tektites. Since Haiti glasses remained for a long time at moderately high temperatures in an oxidizing environment, Jéhanno et al. (1992) concluded that these conditions clearly indicate a volcanic origin.

Jéhanno et al. (1992) also studied a 1-cm-thick, gray-green clay layer well above the globule layer with which the shocked minerals are associated at two of the Haiti sections. The clay layer had an iridium value of 8 ppb at one section and 28 ppb at the other; these values are well above values found elsewhere in the sections. The layer contains an enhancement in nickel-rich spinels. Jéhanno et al. (1992) considered that the globule bed and iridium-rich clay layer represent two distinct events and that the clay layer represents a deposition of cosmic origin and the globule bed a deposition of volcanic origin.

The sedimentology of the Haiti outcrops indicates that there have been several depositional events and not a single event of either terrestrial or extraterrestrial origin (Lyons and Officer, 1992). The large particles and the variations in the spherule layers along strike indicate that the source or sources were of relatively local origin. An alternative interpretation by Maurrasse and Sen (1991) suggests that the observed depositional sequence may be due to reworking from a succession of tsunamis caused by an impact.

The data above argue for a volcanic origin. On the other hand, the absence of crystals in the black glasses and the preponderance of globular shapes have led Izett et al. (1990), Izett (1991), Sigurdsson et al. (1991), and Larue and Smith (1992) to the conclusion that the layer is of impact origin. The processes of redeposition in sorting out various size fractions and palagonitization in favoring alteration of shards over globular shapes make interpretation of the original deposit difficult.

Other Sections

Two other geologic sections in the general region of the Caribbean and Gulf of Mexico have received attention recently.

DSDP Site 540 is located in a deep-water channel between the Yucatán peninsula and Cuba (Buffler, Schlanger, et al., 1984a). The cores show interspersed episodes of erosion and deposition during the Tertiary and Cretaceous, with transportation by mud flows, debris flows, and turbidity currents.
A crudely graded 3-m-thick sequence is described as containing altered volcanic glass (60%) with unspecified carbonate (25%) and pyrite (15%). Overlying the altered volcanic glass unit is a light-colored volcanic and calcareous sandstone that may have been deposited at the same time. The chalk above the unit contains fossils of late Paleocene age, and the chalk below contains fossils of middle Cenomanian age. Alvarez et al. (1991) have suggested that this unit may correlate with the Haiti K-T section and that the altered volcanic glass particles may be of tektite origin. They further suggested that the Chicxulub structure in Yucatán, interpreted as an impact crater, was the source for this unit.

Swinburne et al. (1991) and Smit, et al. (1992) have described a geologic section at Mimbral, northeastern Mexico. It is reported to consist of a spherule-containing bed up to 1 m thick, overlain by a bed containing wood at its base, grading to fine sandstone upward, in turn overlain by rippled calcarenite. The middle part is reported to contain shocked quartz. Above this section are deep-water foraminiferal marls of Paleocene age, and below are marls of Maastrichtian age. Margolis et al. (1991) and Smit et al. (1992) described the spherules as being similar in morphology and composition to those found in Haiti, including glasses with a high CaO content. There are also glasses with still different compositions, including some with a high K_2O and SiO_2 and low CaO content. The alteration products, in this case, are reported as being smectite and calcite. Both sets of investigators suggest that Chicxulub was the source for this depositional sequence.

Previous studies in the same area have shown that the Cretaceous-

Caribbean Caper *continued on p. 73*

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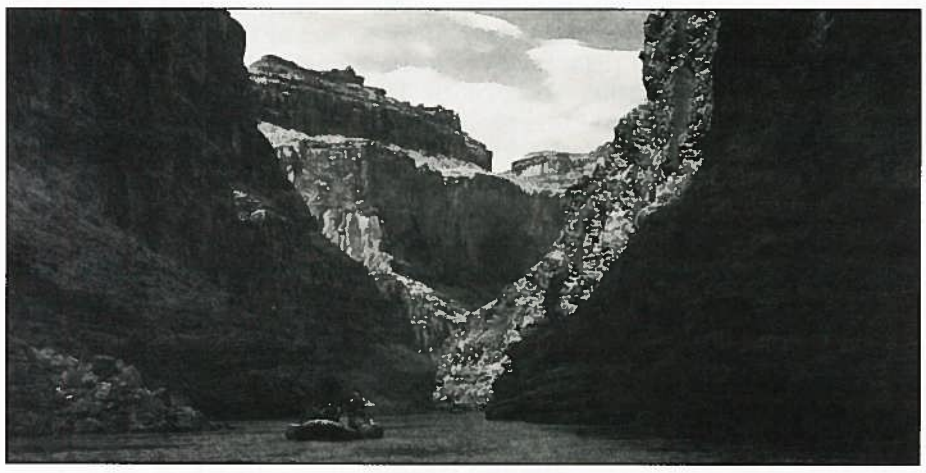

Photo courtesy of Jay Temple, Grand Canyon Trip, 1991

GSA GEOTRIP

Grand Canyon Educational Adventure

A Spring Educational Adventure: Rafting, Hiking, and Camping
Eight Days, Seven Nights on the River
Lee's Ferry to Pierce Ferry—250 Miles of River Ride
April 25–May 3, 1992

Scientific Leaders

Stanley S. Beus, Northern Arizona University
Ivo Luchitta, U.S. Geological Survey, Flagstaff
Richard A. Young, SUNY, College at Geneseo
Frederick W. Bachhuber, University of Nevada, Las Vegas

Program Schedule

April 25, Saturday	Travel day from home to Las Vegas
April 26, Sunday	Depart Las Vegas for arrival at Lee's Ferry
April 27–May 3, Monday through Sunday	River days
May 3, Sunday	Take-out Pierce Ferry (Lake Mead) for bus trip back to Las Vegas
May 4, Monday	Travel day from Las Vegas to home

Fee

Minimum age: 18. Limit: 35 persons.

GSA Members	$1290
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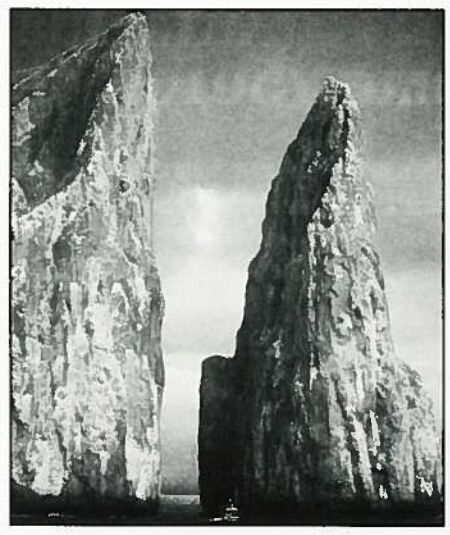
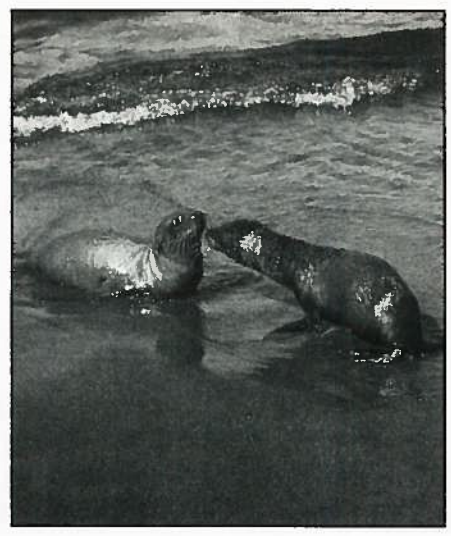




Photos courtesy of Bob Evans, Galápagos Islands, 1991

GSA GEOTRIP

Galápagos Islands and Ecuador

Co-sponsored by American Association for the Advancement of Science
July 5–15, 1992

Scientific Leaders

William S. Wise, University of California, Santa Barbara, is a volcanic petrologist with extensive experience with volcanoes, magma evolution, and island formation. In addition to being a GSA Fellow, he is an able and experienced trip leader. The professional field naturalist accompanying the trip is Cynthia Manning, a field biologist familiar with tropical environments, currently a resident of Quito. In addition, scientists from the Darwin Research Station will provide informal lectures.

The purpose of this trip is to explore the remote and scientifically fascinating Galápagos Islands and the Andean highland of Ecuador. This geologic and natural history expedition offers an exceptional opportunity to experience the unique flora and remarkably approachable fauna of these islands, together with expanding awareness of the ongoing geological processes in the eastern Pacific region.

Co-sponsor: American Association for the Advancement of Science. GSA is offering this unique opportunity in co-sponsorship with AAAS in order to provide an opportunity for members of both scientific communities to travel and learn together. This educational excursion is to one of the most extraordinary locations on Earth; it is a place to remember—a trip of a lifetime.

Itinerary. Days 1 and 2 will be spent traveling to and getting familiar with Quito, which sits in an Andean valley at 9300 feet. Days 3 through 9 will be spent exploring eight of the Galápagos Islands, stopping at Plaza Island, Hood Island, Santa Cruz Island (home of the Darwin Research Station), Floreana, Barrington, Tower Island, Tagus Cove, Punta Espinosa, James and Bartholomew Islands. The day lectures on the geology of the region will be combined with field excursions to the habitats of marine iguanas, rare waved albatross, flamingos, red-footed and masked boobies, and many other exotic species. Between hikes there will be ample time for snorkeling in coves, with the strong possibility of sighting sea lions.

Daily Transport. Motorcoach is the mode of transport in Ecuador, but the exploration between islands is aboard the *Isabela II*, the newest (and many say best) of the ships serving these islands. The air-conditioned, 162' motorboat provides comfort and convenience. It has a maximum of 34 cabins, which all face outside and have twin or double beds (no bunk beds), and each has a private bath. Three full, excellent meals are served daily aboard ship. A skiff takes small groups ashore for morning and afternoon field exploration of between one and two hours each.

Expedition Cost. The land cost for GSA members is $3290 U.S. plus airfare. The nonmember fee is $3390. *If a guest has previously traveled on a GSA GeoTrip, the nonmember $100 additional fee will be waived.* We find the price to be quite reasonable compared to similar offerings. In addition, Betchart Expeditions, Inc., has earned an excellent reputation with other scientific groups. The fee includes double occupancy lodging in Quito and aboard the *Isabela II*; transfers and ground transportation; meals as indicated, including three meals per day aboard the *Isabela II*; entrance fees; baggage handling; leadership; and reading materials.

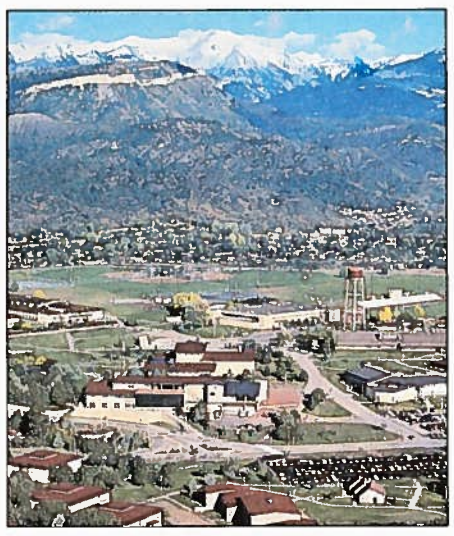
The expedition fee does not include airfare; some meals (estimated cost to participants is $40); tips to Galápagos guide or boat crew; any personal items such as alcoholic beverages, laundry, snorkeling equipment, phone calls, snacks, personal insurance, or foreign airport departure taxes.

Airfare and Airline Ticketing. Airfare roundtrip from Miami to Quito is currently $734 plus tax based on an excursion fare with Ecuatoriana Airlines. All air bookings and ticketing will be handled by Betchart Expeditions Inc., (800) 252-4910. PLEASE NOTE: All expedition members will fly as a group; limited independent travel arrangements are available. Airfares are subject to change, and are generally lowest when booked early.

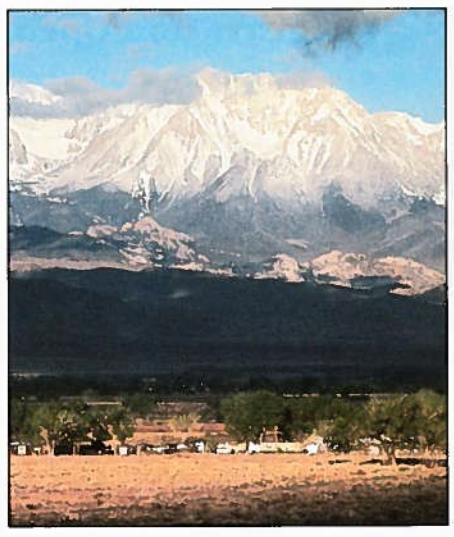
Single Accommodations. Single rooms are available for an additional $125 in Ecuador and $650 in the Galápagos. If you do not have a roommate or we cannot assign you one, you must pay the extra cost of a single. (The single fee is exceptionally high because the second space in the cabin could be purchased by another full-paying traveler.)

Registration, Deposits, and Payments. Registration is open to everyone, but ***GSA Members will be given preference. Full payment is due now***. This amount is *nonrefundable* unless your place is resold; then, a $100 processing fee will apply. Minimum age: 18. Limit: 30 persons. ***Spaces may still be available. Please call today.***

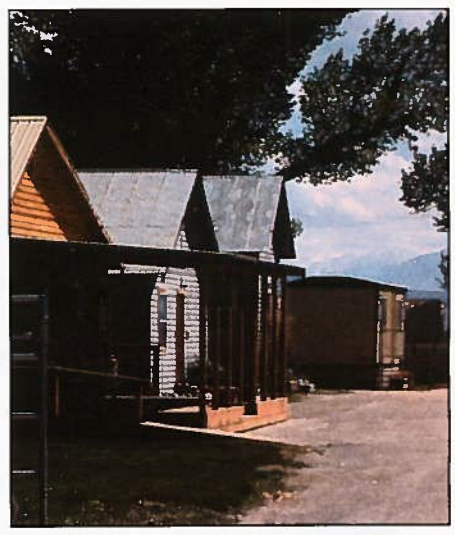
Animas River Valley and Narrow Gauge Train, Silverton, Colorado. *Courtesy of Ken Kolm*



San Juan Mountains and Fort Lewis College, Durango, Colorado. *Courtesy of Fort Lewis College*



White Mountains, Bishop, California. *Courtesy of White Mountain Research Station*



Field Cabins, Bishop California. *Courtesy of White Mountain Research Station*

GSA GEOHOSTEL

Geology of the Southwestern San Juan Mountains

Fort Lewis College, Durango, Colorado
Five Days and Six Nights: June 27–July 2, 1992

Scientific Leaders
Kenneth E. Kolm and Gregory S. Holden, Colorado School of Mines

The Durango townsite was the terminus to the ice age Animas River glacier, largest to drain the San Juan icefield. Fort Lewis College sits 300 feet above the town on the remnant of an outwash terrace. Views of the mountain peaks and down the valley are impressive. Rocks of the area record a geologic history from Precambrian crystalline basement, through deposition of a Paleozoic and Mesozoic sedimentary sequence, to culmination in Tertiary volcanism, caldera formation and mineralization, all deeply eroded and exposed during Neogene uplift.

A combination of classroom lectures and daily field trips will emphasize the geology of the area from Precambrian to present with discussions of hazards and resource issues. We will visit Mesa Verde National Park, ride the Durango and Silverton Narrow Gauge Railroad, and visit the high peaks. Local activities available outside of class include golfing, hiking in spectacular scenery, touring ghost towns, and rafting.

Program Schedule

June 27, Saturday ..... Welcoming get-together
June 28–July 1, Sunday through Wednesday..... Morning classes and field trips
July 2, Thursday ..... Full-day field excursion and farewell party

Fee and Deposit

Cost: $325 for GSA Members. Nonmembers $25 more.
$75 deposit is due with your reservation, which is refundable until April 1; less $20 processing fee.
Total balance due: May 1
Minimum age: 21 years. Limit: 30 persons.

Fee includes classroom programs and materials, train ride to Silverton, Colorado, on the Narrow Gauge Railroad, lodging (double occupancy, dormitory suites), breakfast, welcoming, and farewell events. **Not included** are transportation to and from Colorado, transportation during non-class hours, meals or other expenses not specifically included.

GSA GEOHOSTEL

Geology and Natural History of Eastern California

White Mountain Research Station, Bishop, California
Five Days and Six Nights: July 25–July 30, 1992

Scientific Leaders
Clemens A. Nelson, University of California, Los Angeles, Emeritus
Bruce A. Blackerby, California State University, Fresno
Contributing Leaders: W. Gary Ernst, Stanford University
Steven R. Lipshie, Los Angeles County, Department of Public Works

The town of Bishop lies between the eastern scarp of the Sierra Nevada and the equally impressive White-Inyo Range, which is often referred to as "God's Country." The White Mountain Research Station, used by the University of California campuses for their field camps, is located four miles from Bishop at the base of the White Mountains. The geologic diversity includes complexly folded and faulted Precambrian and Paleozoic rocks, plutonic and metamorphic rocks of the Sierra, the young volcanic rocks of Long Valley and the Inyo and Mono Craters, abundant evidence of glaciations—*and* recent earthquake activity. The natural history of this scenic region also encompasses petroglyphs, the ancient bristlecone pines, and the tufa towers of saline Mono Lake.

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July 25, Saturday ..... Welcoming get-together
July 26–29, Sunday through Wednesday..... Morning classes and field trips
July 30, Thursday..... Full-day field excursion and farewell party

Fee and Deposit

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Total balance due: May 1
Minimum age: 21 years. Limit: 30 persons.

Fee includes classroom programs and materials, field excursions; lodging in barrack style dormitories; breakfast and lunch each day; welcoming and farewell events. **Not included** is transportation to and from California (Reno makes a good airport destination with travel by car to Bishop); transportation during non-class hours; meals or other expenses not specifically included.

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Caribbean Caper *continued from p. 70*

Tertiary transition occurs between the Mendez Formation and the overlying Velasco Formation and that the boundary between these two formations is a hiatus marked in some places by an angular unconformity (Hay, 1960). The Velasco Formation has a sequence of sandy layers at its base and the contact with the Mendez Formation is marked by a bentonitic conglomerate with many small calcareous nodules in the bentonitic matrix (Morgan, 1931; Muir, 1936). Other bentonitic layers also occur within the underlying latest Cretaceous Mendez Formation. Morgan (1931) continues with the following commentary on the bentonitic conglomerate and calcareous nodules. "It is generally agreed that bentonite is the result of alteration of a glassy, igneous rock, usually a tuff.... Explanation of the calcareous nodules which are characteristic of the conglomerate offers more difficulties. However, it is believed that their origin is secondary, being the result of some process of solution and substitution of potash feldspar by alkaline or carbonated waters. The fact that foraminiferal tests are found embedded in these nodules and heavily coated by the same calcareous materials which compose the nodules points toward a secondary origin."

On a regional scale the Paleocene formations around the Gulf of Mexico record the widespread tectonism of the Laramide orogeny. In eastern and southern Mexico, within and east of the present-day Sierra Madre ranges, the Paleocene commonly is represented by a thick, discontinuous, terrigenous clastic turbidite sequence called the Chicontepec Formation (Busch and Govela, 1978; Cantú-Chapa, 1985). It consists of alternate beds of sandstones and shales with minor conglomeratic beds. In places, the Chicontepec was deposited in deep paleocanyons along the flanks of which strata ranging in age from Tithonian (latest Jurassic) to Maastrichtian were exposed (Busch and Govela, 1978; Cantú-Chapa, 1985). The paleocanyons had depths >1300 m in some places. Away from the paleocanyon areas the Chicontepec Formation grades into its more shaly and calcareous equivalent, the Velasco Formation.

During early to middle Eocene time, uplift of the Sierra Madre ranges continued, with a new cycle of canyon cutting along the eastern margin of Sierra Madre Oriental. In one of these paleocanyons, middle Eocene sandstone and shale overlie strata that range from Tithonian through Paleocene (Cantú-Chapa, 1987).

The Haiti, DSDP 540, and Mimbral sections all represent redepositional sequences into deeper waters by gravity flows and/or turbidity currents from an original nearby shallow-water source. If there is any merit to the suggestion that all three of these sections represent impact debris fallout from a presumed K-T impact in the western Caribbean region, then those other DSDP and geologic sites in the same region which have recovery across the K-T boundary should also show, to some extent, the same fallout material.

This does not appear to be the case. The single DSDP site in the region, which cored a continuous section across the K-T boundary with no apparent hiatuses, is Site 536, located at the base of the Campeche Escarpment to the east of the Yucatán peninsula. The report on Site 536 describes complete recovery of the K-T boundary, well defined by both nannofossil and foraminifera and with no significant lithologic variations across the boundary (Buffler, Schlanger, et al., 1984b). No other DSDP sites in the Caribbean and Gulf of Mexico show a sequence at or around K-T time similar to that found at Site 540 or at Haiti and Mimbral. The well-studied geologic sections along the Brazos River, Texas (Keller, 1989) and at Braggs, Alabama (Jones et al., 1987), at similar paleodistances from the Chicxulub structure, also do not show a volcanogenic-tektite sequence at K-T boundary time.

SUGGESTED IMPACT SITES IN THE CARIBBEAN AND VICINITY

Isle of Youth (Pines), Cuba

The metamorphic complex on the Isle of Pines southwest of Cuba was suggested as the K-T impact site on the basis of a ring fault pattern there (Bohor and Seitz, 1990) and the boulder bed mentioned previously. This is difficult to accept, because the curved faults that rim the island are of Tertiary age and are associated with the deformations of the "Laramide" (Campanian–middle Eocene) orogenic and postorogenic stage in its development (Iturralde-Vinent, 1988). Other investigators have also recently studied the geology of the island and find no evidence of a shock event (Dietz and McHone, 1990).

Massif de la Hotte, Haiti

The Massif de la Hotte on the southern peninsula of Haiti, a mountainous region consisting in part of Cretaceous sediments, has also been suggested as the K-T impact site (Maurrasse, 1990). From the geologic description (Lewis and Draper, 1990) and the Haiti K-T sections, we can see no discernible evidence of an impact event such as a crater, circular faulting, or impact debris.

Colombian Basin, Caribbean Sea

The Colombian Basin of the western part of the Caribbean Sea was suggested as a possible impact site by Hildebrand and Boynton (1990). As shown in Figure 3, the basement topography has a semicircular aspect, and they presumed that it continues to the southeast to form a basement topographic feature of about 300 km diameter. Magnetic anomalies do not indicate a circular feature but rather a linear, east-west anomaly trend (Christofferson, 1973, 1976). Seismic reflection and refraction data show the basement surface continuing to deepen on approach to the South American continent (Kolla et al., 1984; Ludwig et al., 1975; Ewing et al., 1960). At nearby DSDP Sites 151, 152, and 153 on the Beata Ridge there are 139, 202, and 165 m, respectively, of Upper Cretaceous sedimentary strata overlying the basement (Edgar et al., 1973), and these strata can be followed as conformable seismic horizons to the western part of the Colombian Basin (Moore and Fahlquist, 1976; Ludwig et al., 1975; Stoffa et al., 1981; Bowland and Rosencrantz, 1988; Kolla et al., 1984; unpublished seismic reflection lines from Lamont-Doherty Geological Observatory). With conformable seismic horizons of Upper Cretaceous age overlying the basement, it is a stratigraphic impossibility for the topography of the underlying basement itself to have been formed by a later event of K-T age.

Chicxulub Structure, Yucatán Peninsula

The Chicxulub structure on the northwestern coast of the Yucatán peninsula has also been suggested as an impact site (Hildebrand and Boynton, 1990, 1991). It is described as a circular structure about 200 km in diameter, defined by magnetic and gravity anomalies suggestive of igneous materials at depth. A central zone 60 km in diameter, with short-wavelength magnetic anomalies approaching 1000 gamma and a gravity high of 10–20 mgal, is surrounded by an outer zone 200 km in diameter, with low-amplitude magnetic anomalies of 5–20 gamma and a gravity low in turn surrounded by a weaker gravity high (Penfield and Camargo, 1982). There are other circular magnetic and gravity anomalies of comparable magnitude on the Yucatán peninsula, in particular, the Tizimín gravity anomaly 150 km east of Mérida and the Puerto Juárez magnetic anomaly on the northeastern coast (Lopez-Ramos, 1975).

Drilling has shown that the anomalies at Chicxulub are related to an andesitic body at a depth of 1500–2000 m. Well data (Fig. 4) across this part of the Yucatán peninsula show a continuous sequence of Cretaceous limestones and dolomites (Lopez-Ramos, 1975; Weidie et al., 1980). The Yucatán No. 6, Chicxulub No. 1, and Sacapuc No. 1 wells, on the Chicxulub structure, have Upper Cretaceous sedimentary strata overlying the andesite, and the Yucatán No. 6 well penetrated the andesite and bottomed in Cretaceous limestone, dolomite, and anhydrite. Yucatán No. 2, 120 km southeast of the center of the Chicxulub structure, shows a similar sequence of Upper Cretaceous sediments continuing from Maastrichtian down to Albian-Cenomanian. Lopez-Ramos (1973) listed the following Late Cretaceous microfauna from the interval 920–1270 m in the Chicxulub No. 1 well: *Globotruncana calciformis, G. fornicata, G. lapparenti bulloides, G. rosetta, G. ventricosa, Gümbelina excolata, G. globocarinata, G. ultimatumida, Pseudotextularina varians, Ventilabrella caseyae,* and *Globigerinella voluta*. This fauna encompasses a Campanian through late Maastrichtian age range. It was recovered in an undisturbed sequence of flat-lying beds of compact, fossiliferous, light and dark gray to grayish green marl with two conglomerate interbeds and, toward the base, with angular andesite clasts (Villagómez, 1953). The conglomerate intervals, one at 1075–1090 m and, the other at 1105–1150 m, separated by slightly sandy marl and shale, contain rounded clasts up to 1.5 cm in diameter of gypsum, carbonate, shale, and marl and are intraformational conglomerates. Below 1150 m to the top of the andesite at about 1200 m, the marl and shale contain angular clasts of gypsum, carbonate, hard shale, and pyroclastic (andesitic) material.

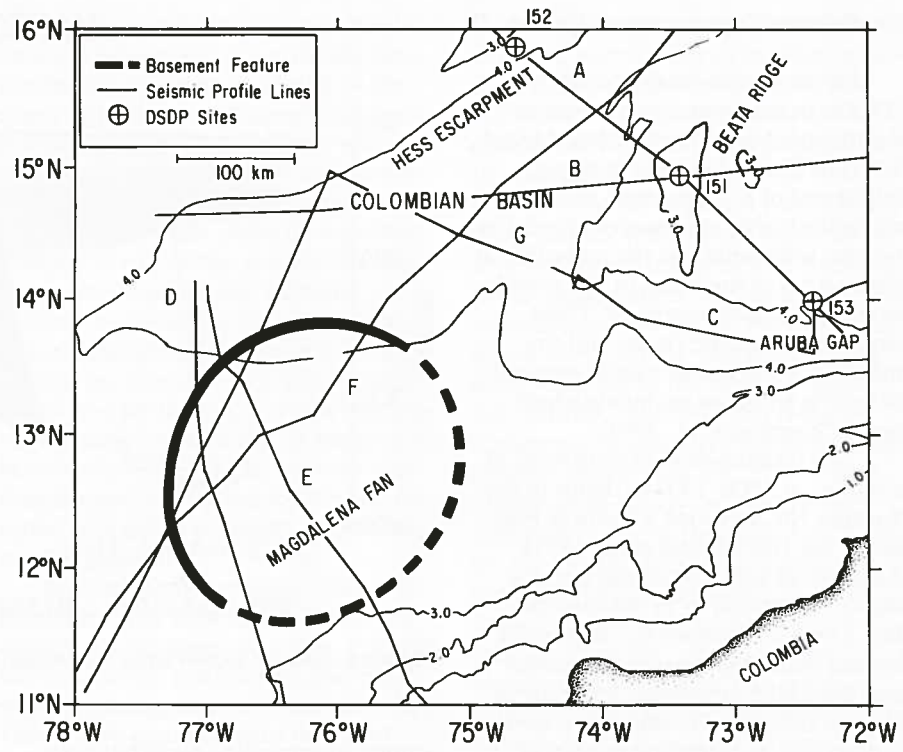

Figure 3. Outline of presumed impact crater in the Colombian Basin from Hildebrand and Boynton (1990). Also shown are Deep Sea Drilling Project Sites 151, 152, and 153; seismic reflection profiles A (Moore and Fahlquist, 1976), B (Ludwig et al., 1975), C (Stoffa et al., 1981), D and E (Bowland and Rosencrantz, 1988; Kolla et al., 1984), and F and G (unpublished profiles from Lamont-Doherty Geological Observatory). Bottom contour interval is 1.0 km.

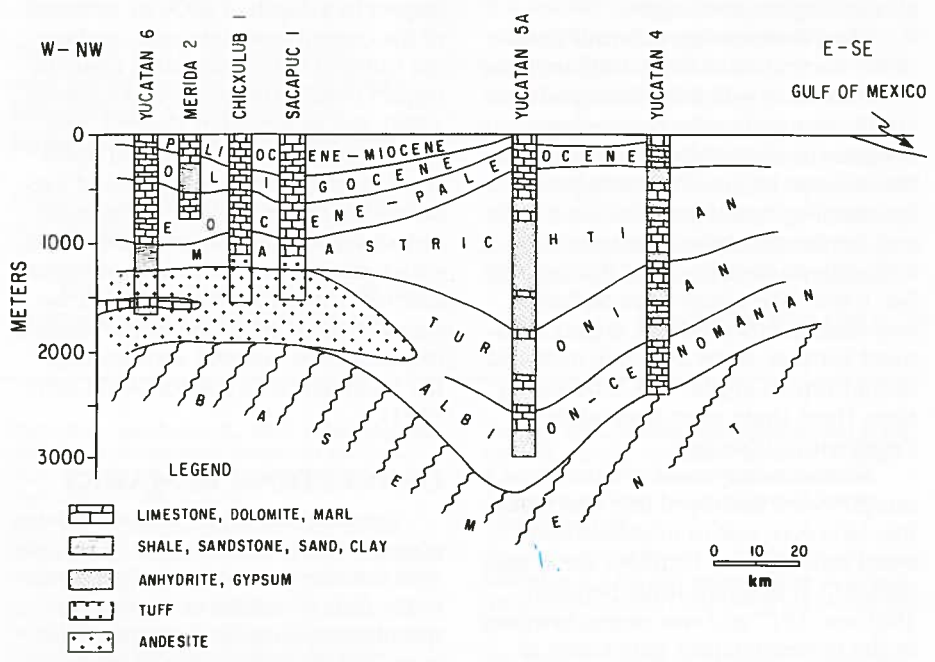

Figure 4. Inferred correlations from well control along an east-west section in the northern part of the Yucatan Peninsula. The Chicxulub structure is to left in the diagram. From Lopez-Ramos (1975).

Caribbean Caper *continued on p. 74*

Caribbean Caper *continued from p. 73*

For an impact creating a crater 200 km in diameter, the excavation depth would be around 10 km (Melosh, 1989). If Chicxulub were of impact origin and of K-T age, there would be no conformable sequence of Upper Cretaceous sediments and the anhydrite at the bottom of the Yucatán No. 6 well would have been vaporized. There would be a gigantic crater, and the infilling debris would consist primarily of breccia from the underlying basement (Sharpton et al., 1991).

The foraminiferal examination of a sample at 1000–1003 m depth in the Yucatán No. 6 yielded a fauna of Paleocene age (Hildebrand et al., 1991). A sample of Late Cretaceous age at a depth of 300–303 m in the Yucatán No. 2 well is described as a bentonitic breccia with fragments of calcareous and dolomitic limestone. A sample of the tuff from the Yucatán No. 6 well is described as consisting mainly of igneous clasts (65%). There are a few xenoliths, and quartz grains in two of them have multiple intersecting sets of planar features. A sample of the underlying andesite is described as being just that, consisting of plagioclase feldspars, alkali feldspars, and augite.

The Paleocene age determination of the core taken at 1000–1003 m in the Yucatán No. 6 well led Hildebrand et al. (1991) to question the previous age assignment of marl directly overlying the andesite in the Chicxulub No. 1, Sacapuc No. 1, and Yucatán No. 6 wells and for the dolomite, limestone, and anhydrite at the bottom of the Yucatán No. 6 well. The age of these sedimentary strata is crucial to the impact argument because, if the andesitic rocks did result from an impact at K-T boundary time, these strata must necessarily be Paleocene or younger.

Unfortunately most of the critical samples were destroyed in a warehouse fire. However, one of us (Meyerhoff) was a consultant to Petróleos Mexicanos (PEMEX) at different times between 1965 and 1977 and was closely involved in the biostratigraphic correlation of the Yucatán wells. The ages and depths to various units given below are based on examinations of well cuttings and cores before the warehouse fire, as well as on Villagómez (1953).

In the Chicxulub No. 1 well, the top of the andesite was reached at a depth of about 1270 m and the top of the Cretaceous at 920 m. Thus, there are approximately 350 m of conformable Upper Cretaceous strata above the andesite. The age of the highest Cretaceous stratum is Maastrichtian; farther down the age is Campanian. Campanian (probably middle Campanian) strata directly overlie the andesite. In addition to the genera and species listed previously in this paper (Lopez-Ramos, 1973), the following additional planktonic taxa were recovered (none of them ranges above the Cretaceous): *Pithonella ovalis*, *P. grandis*, *Calcisphaerula innominata*, *C. gigas*, *Stomiosphaera gigantica*, *S. diffringens*, and *S. cardiformis*.

In the Yucatán No. 6 well, in addition to the shallow-water carbonates and anhydrite found at the bottom of the well, bedded limestone was found in the andesite between 1594 and 1605 m. Volcanic breccia and thin-bedded limestone strata are interspersed above this interval to a depth of approximately 1586 m.

Manson Structure, Iowa

A fifth structure that has been suggested for a K-T impact is the Manson structure in Iowa (Izett et al., 1990).

It is difficult to accept Manson as an impact crater. As indicated in Figure 5, the central Manson core of Precambrian crystalline rocks has been uplifted through 6000 m of Proterozoic red clastic rock, 670 m of Paleozoic limestone, and 45 m of Cretaceous shale (Hoppin and Dryden, 1958). Impact origin of the central uplift at Manson calls for excavation by the impact to a depth of 6000 m, rebound of the central basement core, and partial infilling of the excavated crater by impact debris (Hartung and Anderson, 1988). But as shown in Figure 5, the region surrounding the central uplift consists of an orderly sequence of Cretaceous shales underlain by Paleozoic limestone, rather than of mixed debris, which should consist mainly of Proterozoic red clastic rock. Furthermore, no shock features are found in the reputed impact debris material surrounding the basement core (Officer and Carter, 1991).

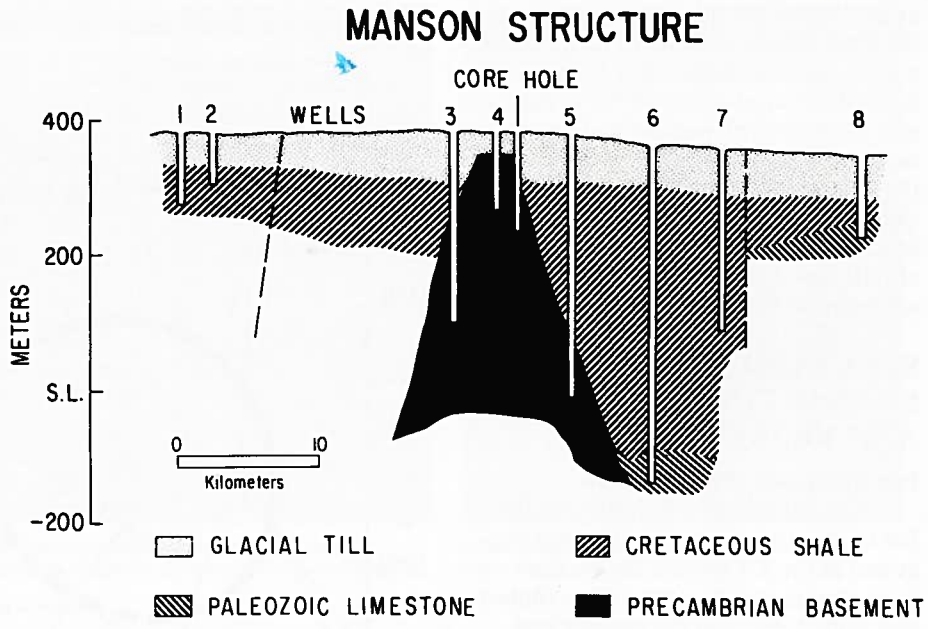

Figure 5. Geologic section across the Manson structure, Iowa. From Hoppin and Dryden (1958).

CONCLUDING REMARKS

Speculations are an important component of science and are to be encouraged but they must eventually answer to the facts. For these examples, the speculations have far outstripped the facts, and the facts, many of them rather obvious, simply do not support the speculations.

The original Alvarez et al. hypothesis, whether right or wrong, has been a boon to the geologic sciences in refocusing attention on one of the more basic questions in geology: the cause of mass-extinction events. It has received a great deal of attention in the scientific literature and in the media because it had "everything going for it except sex and the royal family." However, it has many problems, and it has not proved possible to eliminate such terrestrial factors as relative sea-level changes, atmospheric climatic and oceanic circulation changes, anoxic events, and large-scale volcanism as contributors.

So on we struggle, bearing in mind the wisdom of Charles Darwin, who wrote, in *Descent of Man*,

> False facts are highly injurious to the progress of science, for they often endure long; but false ideas, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness; and when this is done, one path towards error is closed and the road to truth is often at the same time opened.

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GSA FORUM

Bruce Molnia, Forum Editor

Forum is a regular 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: How Do We Improve Earth Science Education?

Many of us are aware of, and concerned about, the current crisis in precollege science education, but few of us know what the real problems or potential solutions are. In this Forum, precollege earth science teachers and professional science educators share their perspectives on what it's like to teach and learn in today's earth science classroom.

PERSPECTIVE 1: Geology Phobia

Carolyn Flanagan, Hacienda Science Magnet, San Jose Public Schools, San Jose, California

Why are teachers afraid to teach geology? It's those boxes of unidentified rocks and minerals the kids bring in that the teacher doesn't have a clue about; teachers are not comfortable when they don't have a clue. As an earth scientist you may have a clue, so perhaps you could take one day a year to help teachers with identification of these mysterious samples. Rocks in a box, however, unlike rocks in the field may be difficult for even trained geologists to easily identify.

It would be even more useful if college geology departments would prepare and make available identified collections of local rocks and minerals, so that teachers could teach about the rocks their students would be most likely to find. These collections could be donated to neighboring school districts to be checked out by the teachers. If the colleges could also offer a mini-course (not a semester one) for teachers on local geology, the kits would be even more useful.

Teachers and children also need easy-to-understand, scientifically accurate books on geology, similar to the many wonderful volumes available on animals. A geology newsletter with updates on the latest ideas and discoveries would help keep everyone current. Perhaps there could be a geology column in one of the popular teacher magazines, such as *The Instructor* or *Mailbox*. A collection of experiments to demonstrate principles of geology written by someone who can be understood by a lay person, but still containing accurate information, is begging to be written. For example, how do you demonstrate the dynamics of plate tectonics to a group of fourth, eighth, or twelfth graders?

Environmental geology is also an important new field that teachers are usually not equipped to cover. Perhaps environmental consultants and engineering geologists could visit schools. There, they could explain how and why they do their jobs, including what society can do to prevent or remedy the environmental problems that face us. The result would be a great service—educating the future voter. What could be more important!

PERSPECTIVE 2: Problems and Solutions in Earth Science Education: A Geologist-as-Resource-Person's Perspective

Leslie C. Gordon, U.S. Geological Survey (USGS), Menlo Park, California

The two most pressing needs in earth science education today are (1) teacher training, and (2) dissemination and accessibility of existing education, materials, and resources. These two needs are related and should be considered together. As a geologist and the education coordinator for the USGS's Western Region, I have almost daily contact with school administrators, classroom teachers, and students (from kindergarten to 12th grade). The concerns and needs they have expressed to me are strikingly similar from one school district to the next, all across the country. The two most frequent comments or requests I get from teachers who contact me are (1) "I'm looking for good hands-on earth science activities to use in the classroom," and (2) "I'm really interested in geology but I don't know anything about the subject matter and have to teach a class on Monday." After ten years of working with teachers, I've come to realize that the second comment is frequently implicit in the first one. No one ever says to me "I have a lot of old, ineffective methods for teaching earth science. What is there new and improved for me to use?" Asking for activities to use is sometimes a mask for a lack of subject-matter knowledge. If a teacher can follow a recipe for a well-written classroom activity, then it is often assumed that there is no need for background knowledge and that the teacher can learn along with the students. While there is some validity to this approach, even the best activities need content and background information. In the absence of this background knowledge, the teacher

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GSA Today Correction

In "The Ross Orogen of the Transantarctic Mountains in Light of the Laurentia-Gondwana Split" by Edmund Stump (*GSA Today*, v. 2, no. 2, February 1992), on p. 27, in the right-hand column, the 20th line from the top should read: "...with a crystallization age of 550 +4 Ma..." (the printed date was in error in that line).

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lacks sufficient confidence to effectively guide the students in learning.

Most teachers who teach earth science in California do not consider themselves earth science teachers, but simply teachers or science teachers who happen to be teaching earth science this semester (sometimes by choice, many times by assignment). Although I do know several earth science teachers with advanced degrees in geology, they are the rare exception. Most elementary school teachers have liberal arts backgrounds, and most high school science teachers have degrees in biology, chemistry, or physics. Currently, the State of California only offers secondary science teaching credentials in either life science or physical science. Those with physical science credentials (required to teach earth science) usually have undergraduate degrees in physics or chemistry. Recently, a new California state science curriculum framework, with emphasis on teaching earth science on a par with life and physical science, has sent teachers scrambling to prepare themselves. In the past, earth science rarely has been taught or offered at any level of school with the same weight and importance as other sciences, so teachers themselves have been cheated out of earth science knowledge.

Professional geoscientists can contribute a great deal by being involved with teacher training, but care must be urged. When scientists get involved with teacher education there is a temptation to cover only the current research and hot global topics in the news, while neglecting the basics. It is important for scientists to convey the message that earth science is a continuing, vibrant, changing field with new exciting things going on relevant to our daily lives and the future of our planet, while also emphasizing the basics the teachers need. There is a great demand for training teachers in such fundamental subjects as plate tectonics, rocks and minerals, the geologic history of local areas, and earth processes such as erosion and sedimentation.

Effective teacher training should combine earth science content, along with examples of methods and activities for teaching the subject matter. Information about existing curriculum materials must also be incorporated into the training by letting teachers know how to obtain good resources and materials and how to use them. Geoscientists should work to combine their content knowledge with science specialists, resource people, and mentor teachers who have the knowledge about teaching methods and familiarity with curriculum materials.

Disseminating and implementing (via teacher training) existing earth science education materials is far more important than writing or publishing new materials. One of the most common pleas from teachers is they can't find good activities and materials. Too often it is assumed that the activities don't exist, when the real problem is that people don't know about the materials or they are difficult to obtain.

As a geologist, I find some of this puzzling. Why don't teachers know about existing earth science teaching materials? Why are they so difficult to locate and acquire? For example, the National Science Teachers Association (NSTA) publishes some superb earth science materials. They also publish a newsletter and journals that contain information about curriculum materials and ideas of other groups. Why don't more teachers participate in their own professional societies, or communicate more among themselves sharing ideas and resources? When I remember that the teaching profession isolates individual teachers in a classroom with dozens of children and doesn't allow them individual time for professional development, it's less of a puzzle to me. With school districts as financially strapped as they are, teachers are rarely given release time, travel allowances, or training money for professional development. As it is, it takes time and effort for anyone to find these materials. Overworked teachers rarely have the time or a support system necessary to do a complete and thorough job of classroom preparation.

Person-to-person contact (between teachers, and between teachers and scientists) is the key to chipping away at some of these problems. So the next time you have the opportunity, get involved in a teacher training or visiting scientist program in your community!

AGI Appoints Craig Schiffries as Coordinator for Government Affairs Program

GSA Member Craig M. Schiffries has been appointed Coordinator of the Government Affairs Program of the American Geological Institute. The appointment is effective as of January 1, 1992.

Schiffries, who was the Geological Society of America's Congressional Science Fellow for 1990–1991, most recently was a professional staff member for the U.S. Senate Judiciary Committee. One of few geologists on Capitol Hill, he worked on legislation to ensure that laws keep pace with changes in technology. Before that, he was Carnegie Fellow at the Geophysical Laboratory, Carnegie Institution of Washington (1988–1990).

Schiffries' main responsibilities in his new position are to identify, track, and analyze federal legislation, policies, and programs affecting the geosciences and affected by geoscience information; to network with policy-level staff members of Congressional committees and Executive agencies; to make geoscience expertise readily available to Congressional committees and Executive agencies; to provide information on relevant issues to AGI member societies and the geologic community; to coordinate the preparation and distribution of position papers; and to interact with other science-policy programs and groups.

"I look forward to working with AGI's member societies to advance the interests of the geoscience community and to make geoscience expertise readily available to policy makers in the federal government," Schiffries said, upon accepting the new position.

Schiffries received a Ph.D. in geology from Harvard University and his undergraduate degree from Yale University, where he graduated summa cum laude with a double major in geology-geophysics and economics–political science. He also received master's degrees from Harvard and Yale. In addition, he was a Marshall Scholar at Oxford University and earned an honors B.A. in philosophy, politics, and economics.

The author of numerous scientific publications, Schiffries has been a speaker at conferences in the United States, Russia, and Africa. He has also been an invited speaker at Oxford, Cambridge, the Australian National University, and other institutions.

The American Geological Institute is a nonprofit federation of 20 member organizations that represent geologists, geophysicists, and other earth scientists. ■

PERSPECTIVE 3: The Role of University Faculty in Precollege Geoscience Education

Ellen P. Metzger, San Jose State University, San Jose, California

Improving K–12 earth science education has become a priority for professional geoscience societies. National recommendations for the reform of science education such as "Science for All Americans, a Report of Project 2061 of the AAAS," call for a thematic approach to teaching science stressing connections and contexts rather than isolated facts. Earth science, with its interdisciplinary nature and relevance to everyday life, is ideally suited to improving science literacy for all students. Unfortunately, most precollege science teachers lack the background to teach an effective earth science course, and in high schools, geoscience continues to be deemed less important than the "real" sciences: physics, chemistry, and biology.

University geology faculty can't afford to ignore the quality of precollege geoscience education. We have all experienced dismay at the level of ignorance encountered in any freshman geology class. It is easy to assign blame, but more productive to help remedy the situation.

The motivations for contributing to precollege science education are many. In times of declining enrollments, we worry about where future geology majors will come from. Underprepared science teachers represent a new, crucial audience for geology departments. Quality precollege earth science classes will help to attract more students to the field of geology. In a broader sense, the future of society depends on the ability of all citizens to make informed decisions about issues such as nuclear power, land-use management, and waste disposal.

How can university faculty make quality precollege earth science education a reality? There is a broad spectrum of possible contributions, ranging from an occasional guest lecture in a local high school to a long-term commitment of personnel and resources. For example, the Department of Geology at San Jose State University has made a long-term commitment by hiring a geologist and science educator, the position I hold. A metamorphic petrologist by training, my appointment is as Associate Professor of Geology and Science Education; half of my academic assignment is in geology and half in science education. This assignment and serving as Co-Director of the Bay Area Earth Science Institute, a year-round program for K–12 teachers, have provided a unique perspective on practical approaches to improving earth science instruction in our schools.

The first and most important step is to provide teachers with new opportunities to increase their knowledge of earth science concepts. These may take many forms, from offering evening classes to establishing comprehensive teacher training institutes. If time is at a premium, occasional evening seminars can be a contribution. University faculty can serve as advisers and/or leaders for local field trips or visit classrooms and lecture on topics ranging from earthquakes to the greenhouse effect.

Second, many teachers are doing their best to teach earth science, but lack the resources needed to teach an effective course. University geology departments can help by making rocks, minerals, maps, compasses, and slides available for loan. Your department can establish an earth resource center to support the efforts of local teachers. A less tangible, but equally important, contribution is to treat secondary school teachers as fellow professionals. In addition to needing adequate preparation to teach earth science, science educators need an acknowledgment of their importance which may soften, somewhat, the blows of continuing budget cuts and overcrowded classrooms.

As a final observation, it is quite rare for geology majors to consider teaching as a career option; I can think of only two who have completed the secondary science credential program at San Jose State University. Times have changed since the petroleum company boom years. Perhaps you know a geology major who would make a good teacher. The need is there.

This is an exciting time for geoscience education which offers a potentially unprecedented opportunity to improve the quality and quantity of geoscience instruction offered in the nation's schools. Let's not let the opportunity pass us by.

PERSPECTIVE 4: The Status of Earth Science Education as Seen by a Classroom Teacher

Jo Ann P. Mulvany, Mills E. Godwin High School, Richmond, Virginia

The status of earth science education across the United States varies more than any other precollege science; when assessing its role in the curriculum, one finds interstate variations as well as diversity within a state or local school division. In most high schools throughout the nation, the traditional offerings of biology, chemistry, and physics are taken by students in grades 10–12. If earth science is offered, it is as likely to be offered at the middle school level as in the high school. Survey data obtained in 1987–1988 by Joe Exline, Lead Science Specialist for the Commonwealth of Virginia, and recently reported in the *Journal of Earth Science Education*, indicated that 27 states had "established" earth science programs, while eight had no such programs. Fifteen did not report. The data showed that 990,000 students were enrolled in these classes in the states that reported.

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Geological Society of America

1992 ANNUAL MEETING

THE VOYAGE CONTINUES

From Columbus to Magellan

Discovery: From Columbus to Magellan

The Geological Society of America will hold its Annual Meeting in Cincinnati from October 26 through 29. The meeting will take place in the newly remodeled and enlarged downtown convention center, which is connected by skywalks to almost all of the downtown hotels. Join us in a celebration of new discoveries in the geological sciences on the quincentenary of Columbus landing in the Bahamas, which revealed to Europe the existence of another, unexpected world. In the same spirit, the Cincinnati meeting will present images of unexpected new worlds from the surface of Venus to the subsurface of Ohio. Come to examine the new discoveries ranging from those made by the Magellan spacecraft to the detection of a large rift basin a mile beneath Cincinnati.

Field trips will not visit either of these two localities, but you will be able to visit San Salvador to see Columbus' landing site as well as the spectacular modern carbonates of the Bahamas. Ancient carbonates will be on display in several trips around Cincinnati, and you will be able to visit, in upper Michigan, a well-exposed rift sequence of an age similar to that of the one beneath Cincinnati.

Peebles Dolomite (Silurian) exposed along Paint Creek, Highland County, Ohio. *Photo by Tomi Lou Spyker.*

Technical sessions will feature new discoveries in the Neoproterozoic history of Earth, K-T boundary sequences in the Caribbean, the effects of melting glaciers on the oceans, the structures of minerals using transmission electron microscopy (TEM), and the newly appreciated extent of a giant Ordovician volcanic eruption that can be followed from Estonia to the U.S. midcontinent. And don't miss our Keynote Symposium, "From Columbus to Magellan–Discovery," that explores some of the latest concepts in earth and planetary geoscience.

– J. BARRY MAYNARD
1992 CO-CHAIRMAN

ABSTRACTS DUE JULY 8: For abstracts forms (303) 447-8850

TRANSPORTATION, HOUSING, AND PROGRAM INFORMATION: (303) 447-2020 or 1-800-472-1988

PREREGISTRATION DUE SEPTEMBER 25: Registration and Housing Forms available August 1

ASSOCIATED SOCIETIES: Association for Women Geoscientists • Association of Geoscientists for International Development • Cushman Foundation • Geochemical Society • Geoscience Information Society • Mineralogical Society of America • National Association of Geology Teachers • National Earth Science Teachers Association • Paleontological Society • Sigma Gamma Epsilon • Society of Economic Geologists • Society of Vertebrate Paleontologists

REGISTRATION AND FULL DETAILS: August *GSA Today*

CINCINNATI

CINCINNATI, OHIO · OCTOBER 26–29

Technical Program

CALL FOR PAPERS AND ANNOUNCEMENT OF SYMPOSIA AND THEME SESSIONS

ABSTRACTS DEADLINE FOR INVITED AND VOLUNTEERED PAPERS WEDNESDAY, JULY 8, 1992

Technical sessions consist of both invited and volunteered papers organized in one of three presentation formats: symposia, theme sessions, and discipline sessions. All abstracts are due for review by July 8.

The Joint Technical Program Committee (JTPC) will select abstracts and determine the final session schedule. The JTPC consists of approximately 30 geoscientists representing each of the associated societies and GSA divisions participating in the technical program. The JTPC chairs, nominated by the Cincinnati Annual Meeting Committee and approved by the GSA Council, also serve a four-year term on GSA's ongoing Program Committee, which oversees all technical program activities.

The JTPC meets August 7–8 in Boulder, Colorado. Speakers will be notified within 14 days following that meeting.

The final session schedule will appear in the September issue of *GSA Today.*

1992 Technical Program Chairmen

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Presentation Modes

Papers may be presented in one of two modes:

ORAL—This is a verbal presentation before a seated audience. The normal length of an oral presentation is 15 minutes, including time for discussion. Projection equipment consists of two 35 mm projectors, one overhead projector, and two screens.

POSTER—Approximately 40% of volunteered papers are presented in poster mode. Each poster-session speaker is provided with three horizontal, free-standing display boards approximately 8' wide and 4' high. The speaker must be present for at least two of the four presentation hours.

Papers for discipline sessions may be submitted in either oral or poster mode.

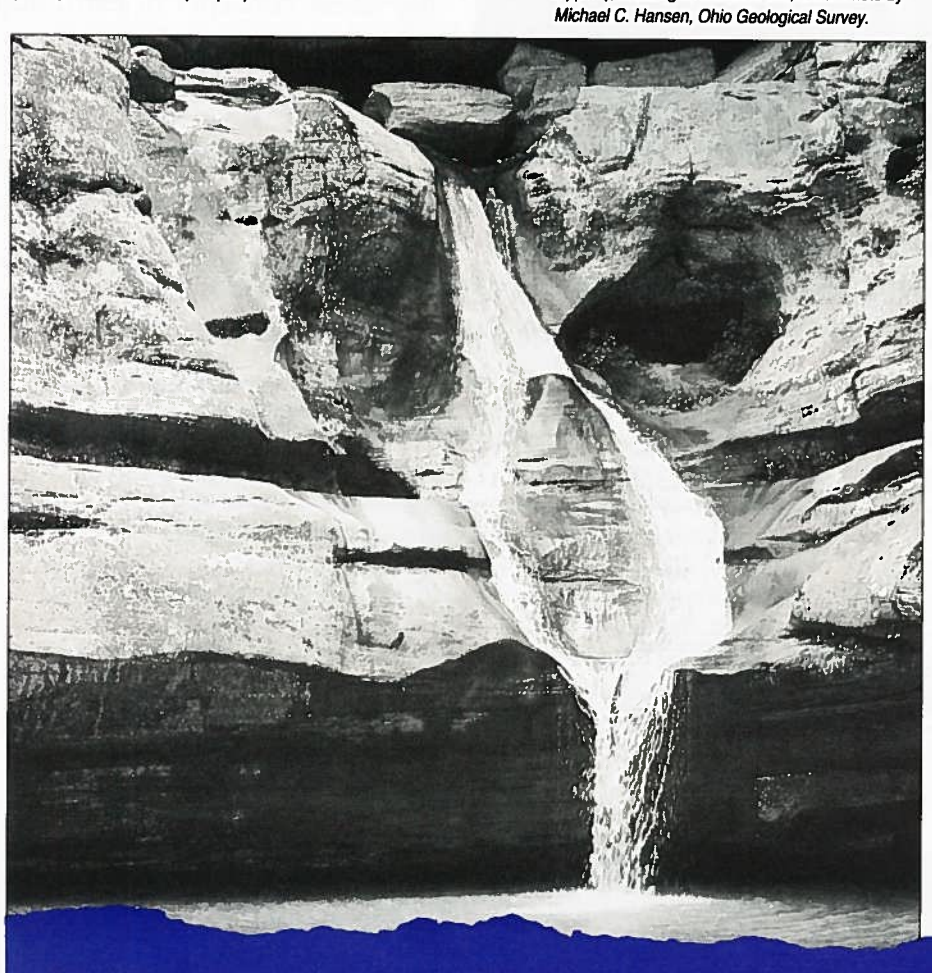
Papers for theme sessions are to be submitted in oral mode only. The exception is Theme Session #24, which is to be submitted in poster mode only. If the abstract is submitted in the incorrect mode, the abstract will NOT be considered for the theme session, but will automatically be considered for a discipline session instead.

Abstract Forms

All abstracts must be submitted on the 1992 Abstract Form, available from the Abstracts Coordinator at GSA headquarters, from the conveners of symposia, from the geoscience departments of most colleges and universities, and from the main survey offices. The abstract form will be used as camera-ready copy for publication of *Abstracts with Programs.*

Speaker/Author Limits

You may be designated speaker (presenter) for only one invited abstract and only one volunteered abstract, regardless of format or mode.



Cedar Falls, Black Hand Sandstone (Lower Mississippian), Hocking Hills State Park, Ohio. *Photo by Michael C. Hansen, Ohio Geological Survey.*

From Columbus to Magellan—Discovery 1992 Annual Meeting Theme

The impetus of geological sciences can only be sustained if new and pertinent discoveries are made and become widely known. These discoveries then become parts of the whole body of knowledge and can be employed both in the development of new ideas and in the utilization of these ideas in practice.

Discoveries have always been at the heart of geological sciences and have always been promoted by GSA. In 1992, the quincentenary of Columbus discovering America, and a year in which the Magellan satellite is still mapping Venus from space, the theme is particularly pertinent. In 1492, Columbus journeyed to discover a new world on Earth. We are now discovering and charting a new world in space, and in the process we are exploring worlds of new ideas. To modern geoscientists the impact of new ideas is not only of theoretical importance, but also of practical and progressively more environmental importance.

Keynote Symposium: From Columbus to Magellan—Discovery

Monday, October 26
8:00 a.m. to 12:00 noon

Leading off the theme on Monday morning will be a special Keynote Symposium sponsored by the Cincinnati Annual Meeting Committee and organized by Nicholas Rast, University of Kentucky. This symposium marshals some salient features of recent discoveries in geological sciences.

Umberto G. Cordani,
IUGS Past President
Instituto de Geosciéncias
Universidade de São Paulo, Brazil
Introduction: Post-Columbus Discovery

William R. Muehlberger
Dept. of Geological Sciences
University of Texas at Austin
Geological Maps

Thomas E. Krogh
Royal Ontario Museum
University of Toronto, Canada
On the Importance of Precise U/Pb Time Measurements in Geological Correlations

Mary Lou Zoback
Office of Earthquakes,
Volcanoes and Engineering
Branch of Seismology
U.S. Geological Survey
Menlo Park, California
State of Stress in the Crust

Lee R. Kump
Dept. of Geosciences and
Earth System Science Center
Pennsylvania State University,
University Park
Geological Perspectives of Climate

Simon C. Morris
Dept. of Earth Sciences
Earth System Science Center
University of Cambridge, United Kingdom
Bursts in the Evolution of Life

James W. Head III
Dept. of Geological Sciences
Brown University
Providence, Rhode Island
The Magellan Project

John Rodgers
Dept. of Geology and Geophysics
Kline Geology Laboratory
Yale University
New Haven, Connecticut
Summary and Closing Remarks

GSA's Institute for Environmental Education (IEE) Sponsors 1992 Programs

The IEE offers a geoscience interface between the private and public sectors and the geological community on matters of the environment through programs directed at the applied geological sciences in the areas of geologic hazard mitigation, land use management, mineral and energy resource management, waste management, and water resource management.

The IEE will be sponsoring its first Annual Environmental Forum on Sunday afternoon, October 25. The subject will be *Ground-water Cleanup vs. Ground-water Protection: Where Should the $$$ Go?* Speakers will present viewpoints of environmental and public interest groups, regulatory agencies, and private industry, as well as of geoscientists dealing with the subject. Focus will be on the incompatibilities that exist between relevant science and technology, policy, and public perception, and on the trade-offs that will necessarily be required. The forum is intended to inform attendees of various societal, technological, economic, and regulatory considerations that need to be addressed in dealing with ground-water contamination problems and ground-water protection.

In addition to the Forum, the IEE is cosponsoring several technical programs with GSA's divisions and Geology and Public Policy Committee. These are identified with the global symbol IEE.

Invited Papers (Symposia)

This format includes only abstracts that have been invited by the convener of a symposium. Abstracts are sent directly to the convener by July 8. The convener is responsible for obtaining two independent reviews of each abstract, and for sending the reviews and the abstracts to GSA headquarters prior to the JTPC meeting.

The list of 1992 symposia appears on the following page. A preliminary schedule will be available by May 15. Please call the GSA Meetings Department for information.

S1. **From Columbus to Magellan—Discovery.** *1992 Technical Program Committee.* Nicholas Rast, University of Kentucky.

S2. **History of Late Glacial Runoff from the Southern Laurentide Ice Sheet.** *Quaternary Geology and Geomorphology Division.* James T. Teller, University of Manitoba, Winnipeg, Canada.

S3. **The History of the Use of Art and Photography in Geological Literature.** *History of Geology Division.* Donald M. Hoskins, Pennsylvania Geological Survey, Harrisburg.

S4. **Preserving Geoscience Imagery.** *Geoscience Information Society.* Louise S. Zipp, University of Iowa.

S5. **Frontiers of Chemical Mass Transport in Contaminant Systems.** *Hydrogeology Division, Institute for Environmental Education.* Yu-Ping Chin and Frank W. Schwartz, Ohio State University.

S6. **Reform in Science Education.** *National Association of Geology Teachers.* Charles Q. Brown, East Carolina University, North Carolina.

S7. **Mineralization Related to Continental Rifts (full day).** *Society of Economic Geologists.* Richard E. Beane, Oro Valley, Arizona.

S8. **Black Shales and Related Ore Deposits.** *Society of Economic Geologists.* Richard I. Grauch, U.S. Geological Survey, Denver; Holly Huyck, Denver, Colorado.

S9. **Ground Truth: Geology of the Earth and Planets from Rocks and Analogs.** *Planetary Geology Division.* Harry Y. McSween, University of Tennessee, Knoxville.

S10. **Applications of Stable Isotope Geochemistry to Problems in High-Temperature Petrogenesis.** *Geochemical Society.* Theodore C. Labotka, University of Tennessee, Knoxville.

S11. **Geologic Aspects of Development Projects in Latin America and the Caribbean Basin.** *International Division, Engineering Geology Division.* Jerome V. DeGraff, USDA Forest Service, Clovis, California; John S. Oldow, Rice University.

S12. **Instability on Clay and Shale Hillslopes.** *Engineering Geology Division.* William C. Haneberg, New Mexico Bureau of Mines, Socorro; Robert W. Fleming, U.S. Geological Survey, Denver.

S13. **Physical and Chemical Responses to Allocyclic Processes in Carboniferous Coal-Bearing Strata.** *Coal Geology Division.* Cortland F. Eble, Kentucky Geological Survey, Lexington; C. Blaine Cecil, U.S. Geological Survey, Reston.

S14. **Controls on Carbon Preservation (full day).** *Organic Chemistry Division* of the *Geochemical Society.* Cindy Lee, State University of New York at Stony Brook.

S15. **The Role of Fluids in Crustal Deformation.** *Structural Geology and Tectonics Division.* Jan A. Tullis, Brown University; Terry Engelder, Pennsylvania State University, University Park.

S16. **Synergism: Archaeological and Geological Sciences.** *Archaeological Geology Division.* Bonnie A. Blackwell, Purdue University.

S17. **Paleosols: Their Geologic Applications.** *Sedimentary Geology Division.* Mary J. Kraus, University of Colorado; David E. Fastovsky, University of Rhode Island.

Volunteered Papers

This format includes all abstracts that are not specifically invited for a symposium. Each paper will have a minimum of three reviews. Two types of sessions are available:

1. Discipline Sessions

Papers are submitted to one scientific category (discipline). The JTPC representatives select and schedule the papers in sessions focused on this one discipline, e.g., hydrogeology, geochemistry.

2. Theme Sessions

Papers are submitted to a specific pre-announced title and to ONE scientific category. Theme sessions are interdisciplinary; each theme may have as many as three categories from which authors may choose ONE. After each theme description below, the categories are identified by name and number as they appear on the 1992 Abstract Form.

Theme submissions must include:
- the theme number (T6),
- five key words of the theme title (Environmental Geology: The Voice/Warning), and
- one category (Environmental Geology—#6 on abstract form).

Papers for theme sessions are to be submitted in oral mode only. The exception is Theme Session #24, which is to be submitted in poster mode only. If the abstract is submitted in the incorrect mode, the abstract will NOT be considered for the theme session, but will automatically be considered for a discipline session instead.

Each theme session has been proposed by an advocate. *Advocates may not invite speakers; however, advocates may encourage colleagues to submit abstracts, with the understanding that there is no guarantee of acceptance.* Each theme advocate evaluates abstracts initially only on the basis of topical relevance.

All abstracts will then be evaluated by three appropriate JTPC reviewers in the discipline for which they are submitted; a fourth review will be provided by the theme advocate.

If an abstract is submitted to but not accepted for a theme session, it will continue through the evaluation process to be considered for the appropriate discipline session.

During the August 7–8 JTPC meeting, the designated JTPC representative (in consultation with the theme advocate) will organize theme sessions from the abstracts approved for presentation.

Schedules for theme sessions will be available immediately after the JTPC meeting and will appear in the September issue of *GSA Today*.

Glacial grooves, Columbus Limestone (Middle Devonian), Kelleys Island, Lake Erie, Ohio. *Photo by Michael C. Hansen, Ohio Geological Survey.*

Theme Topics

T1. **Tectonic Settings and Paleoenvironments of the Paleo-Pacific Margin—Antarctic and Related Gondwana Sequences.** James W. Collinson and David H. Elliot, Ohio State University.

This session is aimed at linking the paleoenvironments of glacial, fossiliferous and volcanic strata with the tectonic settings inferred from the evolution of the depositional basins and the Gondwana plate margin, and thus addressing the paleoclimate of the middle to high southern latitudes from late Carboniferous to mid-Jurassic time.

Paleoceanography/Paleoclimatology (19), Paleontology/Paleobotany (20), Tectonics (33).

T2. **New Discoveries in Neoproterozoic Earth History.** Nicholas Christie-Blick, Lamont-Doherty Geological Observatory; Samuel A. Bowring, Massachusetts Institute of Technology.

Our understanding of one of the most remarkable intervals in Earth history will be focused in this session on the implications of specific data for general interdisciplinary problems and phenomena. Examples include the identification, correlation, and calibration of global events, and new insights about paleoenvironmental variations and evolutionary changes in early fossil assemblages (metazoans, ichnofossils, and microorganisms).

Paleontology (20), Sedimentology (30), Tectonics (33).

T3. **Intraplate Neotectonics.** Roy B. Van Arsdale, University of Arkansas, Fayetteville; Eugene S. Schweig, U.S. Geological Survey, Memphis.

This theme session will explore the kinematics, dynamics, and Quaternary history of intraplate deformation, and the relation between intraplate deformation and seismicity.

Geophysics/Tectonophysics (11), Quaternary Geology (28), Structural Geology (32).

T4. **Hydrogeochemistry and Isotope Hydrology of Regional Aquifer Systems.** Songlin Cheng, Wright State University.

The chemical composition of water in regional aquifer systems evolves through physicochemical and biological processes in the subsurface over thousands and even millions of years. Appropriate topics include water-rock interactions and diagenesis in sedimentary basins, subsurface production of radionuclides, groundwater age determination, and isotopic signatures of paleoclimatic conditions.

Geochemistry, Aqueous (7), Hydrogeology (15), Paleoclimatology (19).

T5. **Hydrogeology, Hydrogeochemistry, and Ground-Water Contamination in the Midwest Basin and Arches Region.** *Hydrogeology Division.* Robert W. Ritzi, Wright State University; Ed Bugliosi, U.S. Geological Survey, Columbus.

Ground-water flow and transport in glacial and carbonate terrains will be emphasized in this session. Local and regional problems include quantifying the hydrogeologic framework and processes within heterogeneous glacial and glaciofluvial sediments and within fractured carbonate bedrock. Related issues include radon, anthropogenic contamination, minerotrophic wetlands, and the development of ground-water protection.

Hydrogeology (15), Sedimentology (30), Structural Geology (32).

T6. **Environmental Geology: The Voice of Warning.** *GSA Geology and Public Policy Committee, Institute for Environmental Education.* Monica E. Gowan, GeoLogic, Bellingham, Washington.

By alerting and informing citizens about environmental concerns, we can promote wiser use of Earth and better community decision-making. The session goal is to encourage the participation of geologists in the development of an informed citizenry for involvement in environmental issues at the grass-roots level.

Engineering Geology (5), Environmental Geology (6), Hydrogeology (15).

T7. **Environmental Geology: The Voice of Reason.** *GSA Geology and Public Policy Committee, Institute for Environmental Education.* Monica E. Gowan, GeoLogic, Bellingham, Washington.

By advocating scientific truth, the geologist can contribute to responsible decision-making on matters dealing with complex environmental issues. The session goal is to encourage geologists to actively assume responsibility for ensuring the appropriate application of geoscience information in environmental agendas, policy formulation, and regulatory development.

Engineering Geology (5), Environmental Geology (6), Hydrogeology (15).

T8. **Gulf Coast Cretaceous Project: Biostratigraphy and Correlation; Sea-level Change and Paleogeography; Depositional Environments and Diagenesis.** *Global Sedimentary Geology Program.* David T. King, Jr., Auburn University; Suzanne D. Weedman, U.S. Geological Survey, Reston.

This initiative of the Cretaceous Events Resources and Rhythms program will bring together workers in facies analysis, sequence stratigraphy, sea-level analysis, and depositional environments to share new interdisciplinary advances in research on the Gulf Coast Cretaceous System. Applications of sea-level stratigraphy to subsurface exploration are encouraged.

Paleontology/Paleobotany (2), Sedimentology (30), Stratigraphy (31).

Examples of current research will be presented.

Geochemistry, Other (8), Mineralogy (18), Petrology (22).

T11. **Paleozoic Depositional Sequences; Contrasts in Environments and Fossil Diversity.** *Cushman Foundation for Foraminiferal Research.* Charles A. Ross, Chevron USA, Houston, Texas; Paul L. Brinckle, Amoco Production Co., Houston, Texas.

This session will examine the composition and diversity of marine faunal and floral communities, relationships within and among these communities (both synecological and autecological aspects), and biotic changes that took place throughout the Paleozoic. Focus will be on response of various communities to fluctuations and rates of change of sea level and to interpreting sequence stratigraphy. The Cushman Foundation chose this theme to include all marine faunal and floral groups, not only foraminifera.

Micropaleontology (17), Paleontology (20), Stratigraphy (31).

T12. **Origin and Nature of Meltwater Release from the Laurentide Ice Sheet and Its Impact on Late Glacial Oceans.** *Quaternary Geology and Geomorphology Division.* James T. Teller, University of Manitoba, Winnipeg, Canada.

This session will investigate the origin, magnitude, storage, release, and modeling of runoff from the Laurentide Ice Sheet and will examine the impact that this discharge had on oceans adjacent to North America. The effect that these waters had on the continents will be examined in the related symposium (S2).

Global Change (13), Paleoceanography/Paleoclimatology (19), Quaternary Geology (28).

T13. **Environmental Issues in Urban Settings.** *Quaternary Geology and Geomorphology Division, Institute for Environmental Education.* John D. Vitek, Oklahoma State University; John R. Giardino, Texas A&M University.

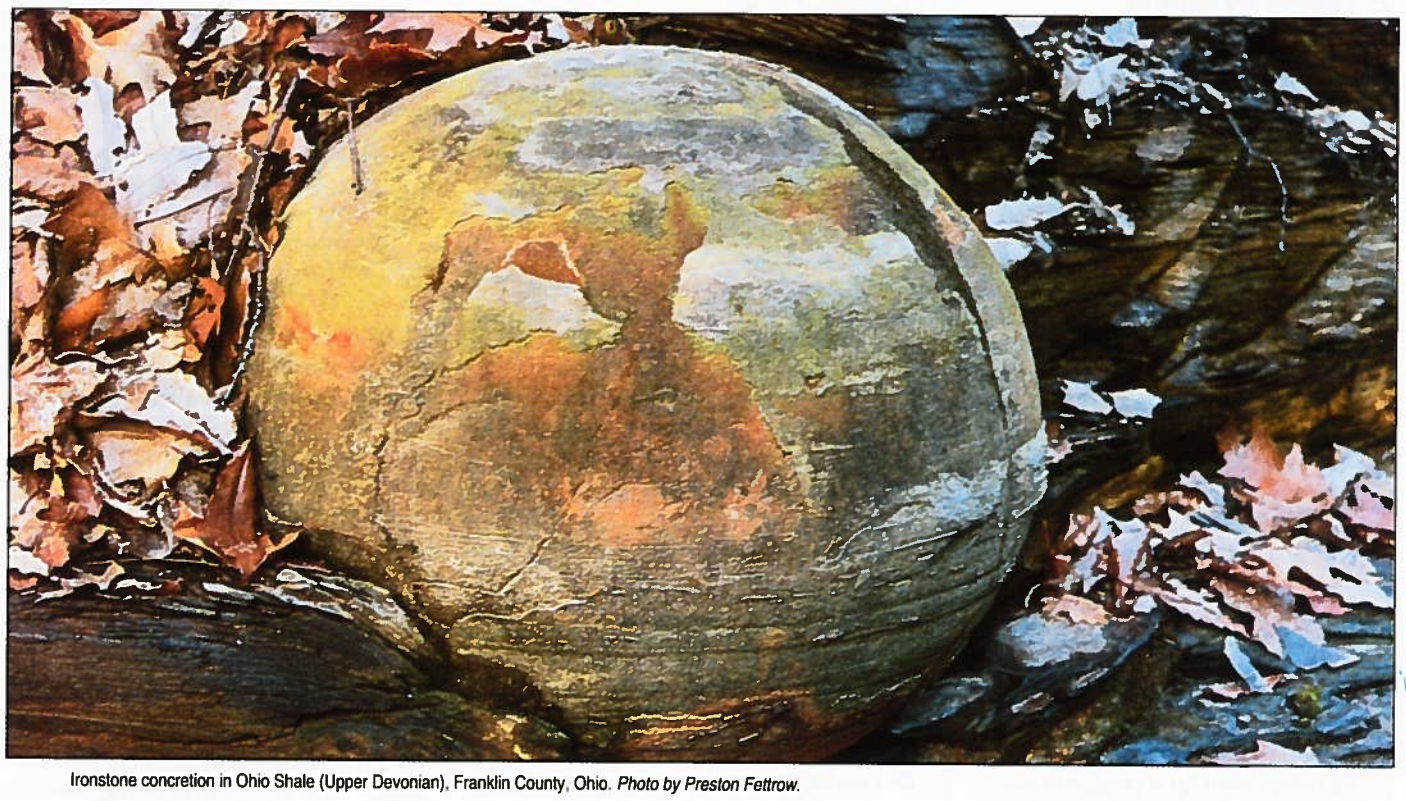
This session will address environmental issues related to urban population density, such as water supply, and trash and garbage disposal, as well as adaptation to geomorphic processes such as floods, landslides, and coastal processes; local examples will be used. Geologists have a wealth of knowledge which must be incorporated into urban decision-making processes.

Engineering Geology (5), Environmental Education (6), Geomorphology (10).

T14. **Consultants/Industries Innovative Applications in Environmental Investigations.** *Institute for Environmental Education.* Lon C. Ruedisili, University of Toledo; A. Dwight Baldwin, Jr., Miami University, Oxford, Ohio.

The focus of this session will be on representative studies and case histories developed to solve environmental problems. This session will be extremely useful for students (future employees of these firms) and faculty (on review panels and technical advisory committees) who need to be familiar with new developments in environmental problem solving.

Engineering Geology (5), Environmental Geology (6), Hydrogeology (15).



Ironstone concretion in Ohio Shale (Upper Devonian), Franklin County, Ohio. *Photo by Preston Fettrow.*

T9. **Discovery in Hydrogeology—Heritage, Wisdom, and Vision.** *Hydrogeology Division, History of Geology Division.* John Van Brahana, U.S. Geological Survey, Fayetteville, Arkansas; Richard R. Parizek, Pennsylvania State University, University Park; Wilson M. Laird, Kerrville, Texas.

Seminal discoveries (concepts, tools, and events) have indelibly shaped hydrogeology. This session not only recounts the history of our science, but also presents an evolution of concepts and methods of puzzle solving from interdisciplinary sources, showcases the wisdom we have gained from this heritage, and points to the vision needed to address the questions that remain unanswered.

Engineering Geology (5), History of Geology (14), Hydrogeology (15).

T10. **Transmission Electron Microscopy in Mineralogy and Petrology.** *Mineralogical Society of America.* Peter R. Buseck, Arizona State University.

Transmission electron microscopy (TEM) has become integral for much research in mineralogy, petrology, and tectonophysics. A unique blend of structural and analytical capabilities permits multiple types of measurements on the same mineral grain, each on a finer scale than is possible by any other technique.

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T15. **Magellan, Galileo, and Planetary Frontiers: The Discovery of New Worlds Continues.** Larry S. Crumpler, Brown University.

On the 500th anniversary of Columbus' landing in the New World, we are again discovering and exploring new worlds: The Magellan spacecraft continues to orbit and explore the previously unknown global geology of Venus. The Galileo spacecraft continues its voyage through the inner Solar System, visiting the home planet and an isolated asteroid before voyaging beyond. As shown by planetary studies in general and these recent missions in particular, the geologic tradition of interdisciplinary research and basic geographic exploration continues to be an important part of the science of modern geology.

Geophysics/Tectonophysics (11), Planetary Geology (26), Remote Sensing (29).

T16. **Paleosols: Their Geologic Applications.** *Sedimentary Geology Division.* Mary J. Kraus, University of Colorado; David E. Fastovsky, University of Rhode Island.

Paleosols are an important aspect of terrestrial sedimentology. Paleopedology can be applied to diverse geologic problems including interpreting paleoclimates and paleoenvironments, estimating stratigraphic completeness, and evaluating biologic extinctions. This session will also address the difficulties of paleosol analysis and critically evaluate the interpretations that can be made from paleosols.

Paleoceanography/Paleoclimatology (16), Sedimentology (30), Stratigraphy (31).

T17. **Thrust Fault Sesquicentennial.** Paul A. Washington, North Carolina Dept. of Environment, Health, and Natural Resources, Raleigh.

This session covers historical, state-of-the-art, and innovative treatments of thrust-fault geometry and mechanics, and is a commemoration of the 150th anniversary of the first published description of a thrust fault (Champlain thrust, by Ebenezer Emmons in 1842). It also is the 100th anniversary of the publication of the first major American work on thrust-fault mechanics (Appalachian structure, by Bailey Willis in 1893).

History of Geology (14), Structural Geology (32), Tectonics (33).

T18. **Quantitative Chemical Hydrogeology: Calculation of Solute Transport and Water Rock Interaction in Geochemical Processes.** Peter C. Lichtner, Universität Bern, Switzerland; Eric H. Oelkers, Université Paul Sabatier, France.

Physical geochemistry and hydrogeology represent the natural extension of groundbreaking research in the fields of reaction-path modeling and ground-water flow. This work may lead to a better understanding of such processes as diagenesis, sedimentary basin development, metamorphism, ore formation, petroleum formation and migration, and transport and containment of radiogenic and toxic waste.

Computers (3), Geochemistry, Aqueous (7), Hydrogeology (15).

T19. **Ordovician K-bentonites.** Dennis R. Kolata, Illinois Geological Survey, Champaign; Warren D. Huff, University of Cincinnati.

Ordovician K-bentonite beds of eastern North America and northwestern Europe have received increased attention from geologists. Individual beds can now be correlated over long distances, providing an opportunity to test various hypotheses concerning age, origin, and distribution. These correlations also have implications for such subjects as tectonomagmatism, diagenesis, environments of deposition, and effects on organisms.

Geochemistry, Other (8), Stratigraphy (31), Tectonics (33).

T20. **Biotic Responses to Allocyclic Processes in Carboniferous Coal-Bearing Strata.** *Paleontological Society.* Ronald R. West, Kansas State University; Christopher Maples, Kansas Geological Survey, Lawrence; William A. DiMichele, Smithsonian Institution; Harold B. Rollins, University of Pittsburgh.

This session will focus on both terrestrial (plants, insects, vertebrates) and marine (invertebrates and vertebrates) realms. It will address ecological stability; threshold responses of guilds, communities, or ecosystems to changing extrinsic conditions; replacement dynamics of species under stress; and life-history responses to collapse of ecological associations.

Paleontology (20), Sedimentology (30), Stratigraphy (31).

T21. **Time and Place of Compressional Events in the Appalachian Orogen.** William A. Thomas, University of Kentucky; James W. Skehan, Boston College.

Along- and across-strike variations in ages of compressional events raise questions about time and place of initial convergence, definitions of boundaries of tectonic episodes, processes that separate tectonic episodes, and relation of events in different thermal regimes. Along-strike variations in the structural profile of the Appalachian orogen raise questions about the previous tectonic history of elements involved in compression, the polarity of subduction, and the time sequence of events along and across the orogen.

Stratigraphy (31), Structural Geology (32), Tectonics (33).

T22. **Formation of Fault Systems.** Mark H. Anders, Lamont-Doherty Geological Observatory.

The emphasis will be on how faults grow from incipience to a large fault system. We want to include some exciting recent theoretical and observational papers on how faults grow in both displacement and length.

Geophysics (11), Structural Geology (32), Tectonics (33).

T23. **Advances in Investigation, Characterization, and Monitoring of the Geologic Environment for Waste Disposal.** *Engineering Geology Division, Institute for Environmental Education.* John D. Rockaway, University of Missouri, Rolla.

Hazardous waste and regulatory pressures to prevent future contamination have created a dynamic environment for geologists working with waste-disposal sites, as well as for members of other engineering and scientific disciplines. Monitoring site responses now receives nearly equal emphasis with site characterization in waste-disposal projects. Let's share the advances in this field of endeavor.

Environmental Geology (3), Engineering Geology (5), Hydrogeology (15).

T24. **Metamorphism in North and Central America: Regional Studies and Digital Compilation Techniques (*Poster Mode only*).** Robert G. Berman, Geological Survey of Canada, Ottawa, Ontario.

The purpose of this session is to bring together those interested in regional metamorphic studies and those who may wish to continue to a metamorphic compilation of North and Central America. The focus will be on the results of regional metamorphic compilation as well as the development of digital compilation and cartographic techniques.

Computers (3), Metamorphic Petrology (24), Tectonics (33).

T25. **Late Proterozoic Rifting of the North American Craton.** James A. Drahovzal, Kentucky Geological Survey, Lexington; Lawrence H. Wickstrom, Ohio Division of Geological Survey, Columbus; Brian Keith, Indiana Geological Survey, Bloomington.

This session will focus on Late Proterozoic rifting and its relation to late Precambrian tectonics. We seek contributions that address the stratigraphy, sedimentology, structure, tectonics, igneous geology, geochemistry, geophysics, and economic potential of these rifts.

Precambrian Geology (27), Structural Geology (32), Tectonics (33).

T26. **New Cretaceous-Tertiary Boundary Discoveries—Caribbean and High Latitudes.** Charles B. Officer, Dartmouth College; Gerta Keller, Princeton University.

This theme session will provide a comprehensive and balanced interdisciplinary coverage of new discoveries at geologic sections in the Caribbean, including Cuba, Haiti, Mexico, and DSDP Sites 536 and 540, as well as high-latitude regions such as Denmark and the Antarctic Ocean. Problems addressed will include geochemistry, mineralogy, petrology, sedimentology, and biological and floral assemblage changes associated with the respective sections.

Geochemistry, Other (8), Sedimentology (30), Stratigraphy (31).

CINCINNATI

Field Trips

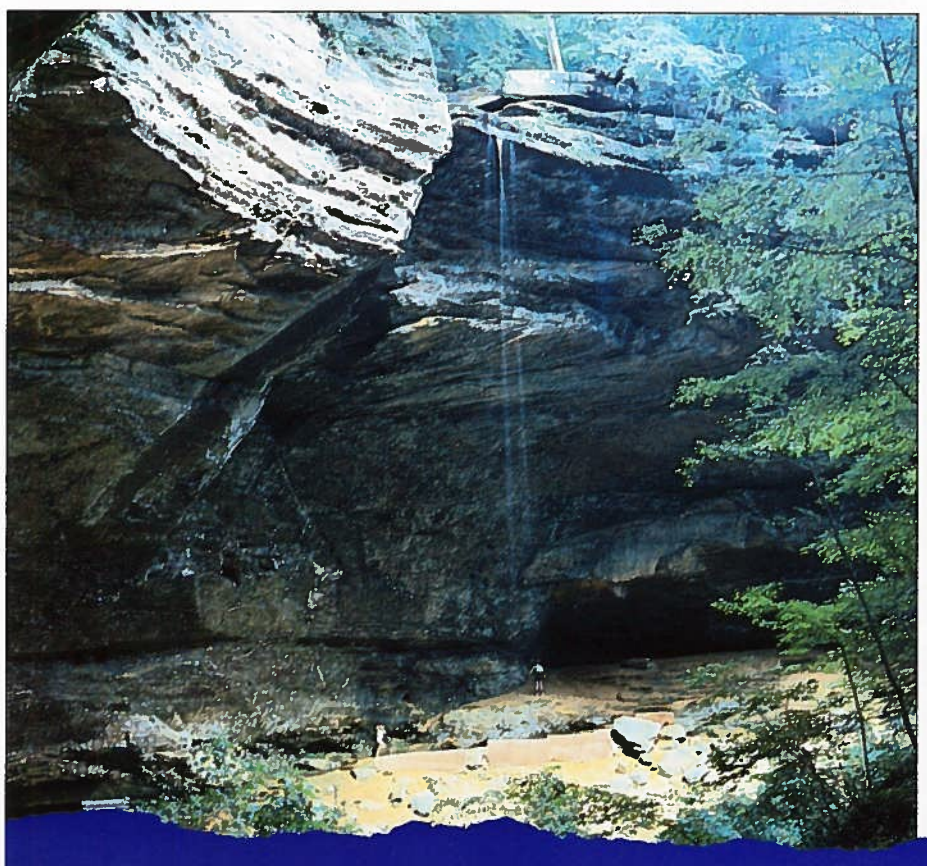
Cincinnati is central to classical Paleozoic successions of the Midcontinent and Appalachian Basin. The city is also a focal point for exceptional Pleistocene glacial and periglacial features that have been debated for decades. A wide variety of field trips have been planned for the Cincinnati Annual Meeting which will give participants exceptional opportunities to see classical sites as well as new ones that have been crucial to the interpretation of North American geology. We hope you will choose to participate in one or more of these excursions.

All trips begin and end in Cincinnati unless otherwise indicated. Further details will be given when registration begins in August. Costs are preliminary estimates.

For further information, contact the 1992 Field Trip Chairman, Thomas M. Berg, Ohio Dept. of Natural Resources Division of Geological Survey, 4383 Fountain Square Dr., Columbus, OH 43224-1362, (614) 265-6576, or the individual trip leaders.

Premeeting

Sampling the Layer Cake That Isn't: The Stratigraphy and Paleontology of the "Type Cincinnatian." October 23–24. Richard Arnold Davis, Cincinnati Museum of Natural History, 1720 Gilbert Ave., Cincinnati, OH 45202, (513) 621-3890, and Roger J. Cuffey. Cost: $85.



Ash Cave, Black Hand Sandstone (Lower Mississippian), Hocking Hills State Park, Ohio. *Photo by Michael C. Hansen, Ohio Geological Survey.*

Paleoclimate Controls on Carboniferous Sedimentation and Cyclic Stratigraphy in the Appalachian Basin. October 22–25. Cosponsored by the *Coal Geology Division.* C. Blaine Cecil, U.S. Geological Survey, 956 National Center, Reston, VA 22092, (703) 648-6415, and Cortland F. Ebel. Cost: $250. Trip begins in Morgantown, West Virginia.

The Geology of Columbus' Landfall. October 22–25. Mark R. Boardman, Dept. of Geology, Miami University, 114 Shideler Hall, Oxford, OH 45056, (513) 529-3216, and Cindy K. Carney, Don Gerace. Cost: $600. Trip begins and ends in Fort Lauderdale, Florida. Trip travels to San Salvador, Bahamas. Cost includes an overflight.

Regional Aspects of Pottsville and Allegheny Stratigraphy and Depositional Environments, Ohio and Kentucky. October 24–25. Charles L. Rice, U.S. Geological Survey, 926 National Center, Reston, VA 22092, (703) 648-6938, and Ronald L. Martino, Ernie R. Slucher. Cost: $75.

The Sangamonian-Wisconsin Transition in Southwestern Ohio and Southeastern Indiana. October 25. C. Scott Brockman, Ohio Dept. of Natural Resources Division of Geological Survey, 4383 Fountain Square Dr., Columbus, OH 43224-1362, (614) 265-6473, and Robert D. Hall, Thomas V. Lowell, Barry B. Miller. Cost: $35. Trip will be repeated after the meeting, on October 30.

Geology of Key Archaeological Sites in Northern Kentucky and Southern Ohio. October 24–25. Cosponsored by the *Archaeological Geology Division.* Timothy S. Dalbey, Dept. of Anthropology, Southern Methodist University, Dallas, TX 75275, (214) 692-2763. Cost: $130.

Karst and Cave Systems in the Stones River Group, Central Tennessee. October 23–24. Ray C. Gilbert, Tennessee Division of Geology, Room B370, 701 Broadway, Nashville, TN 37243-0445, (615) 742-6703, and Nicholas Crawford, Patricia Thompson. Cost: $100. Trip begins and ends in Nashville, Tennessee.

Ordovician, Silurian, and Middle Devonian Stratigraphy in Northwestern Kentucky and Southern Indiana—Some Reinterpretations. October 24–25. James E. Conklin, Dept. of Geology, University of Louisville, Louisville, KY 40292, (502) 588-6821, and Barbara M. Conklin, John Kubacko, Jr. Cost: $100.

Cincinnati's Geologic Environment: A Trip for Secondary School Science Teachers. October 25. Cosponsored by the *Engineering Geology Division.* William Haneberg, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801, (505) 835-5808, and Mary Riestenberg, Richard Pohana. Cost: $35. (Registration for secondary school science teachers only.)

Half-Day Mini Trips
(held during the meeting)

Geologic Glimpses from Around the World: The Geology of Monuments in Woodland Cemetery and Arboretum, Dayton, Ohio. October 26. Michael R. Sandy, Dept. of Geology, University of Dayton, Dayton, OH 45469-2364, (513) 229-2952. Cost: $25.

Excursion to Caesar Creek State Park in Warren County, Ohio: A Classic Upper Ordovician Fossil Collecting Locality. October 28. Douglas L. Shrake, Ohio Dept. of Natural Resources Division of Geological Survey, 4383 Fountain Square Dr., Columbus, OH 43224-1362, (614) 265-6473, and Michael Hansen, Robert Ferree, Dan L. Cooper. Cost: $45.

Postmeeting

Mississippian Paleosols, Paleokarst, and Eolian Carbonates in Indiana. October 30–31. Cosponsored by the *Sedimentary Geology Division*. Donald E. Hattin, Dept. of Geological Sciences, Indiana University, 1005 E. Tenth St., Bloomington, IN 47405, (812) 855-5582, and J. Robert Dodd. Cost: $125.

Fort Payne Carbonate Buildups of South-Central Kentucky. October 30–31. David L. Meyer, Dept. of Geology, University of Cincinnati, Cincinnati, OH 45221, (513) 556-4530, and William I. Ausich. Cost: $185.

Changing Interpretations of Kentucky Geology: Layer-Cake, Facies, Flexure, and Eustacy. October 29–31. Frank R. Ettensohn, Dept. of Geological Sciences, University of Kentucky, Bowman Hall, Lexington, KY 40506-0059, (606) 257-3758, and Donald R. Chesnut, Steve Barnett. Cost: $215.

Building Stone in Three Ohio Cities: Cincinnati, Columbus, and Cleveland. October 29–31. Joseph C. Hannibal, Cleveland Museum of Natural History, 1 Wade Oval Dr., Cleveland, OH 44106-1767, (216) 231-4600, and Richard Arnold Davis, Ruth Melvin, Garry D. McKenzie, Mark T. Schmidt. Cost: $100. Trip ends in Cleveland, Ohio.

Wilber Stout (left), State Geologist of Ohio (1928–1946) and Raymond E. Lamborn (right), Assistant State Geologist doing field work in eastern Ohio, 1930s. *Photo archives, Ohio Geological Survey.*

The Sangamonian-Wisconsin Transition in Southwestern Ohio and Southeastern Indiana. October 30. C. Scott Brockman, Ohio Dept. of Natural Resources Division of Geological Survey, 4383 Fountain Square Dr., Columbus, OH 43224-1362, (614) 265-6473, and Robert D. Hall, Thomas V. Lowell, Barry B. Miller. Cost: $35. Trip will also be run before the meeting, on October 25.

Structure and Tectonics of the Rough Creek Graben, Western Kentucky and Southeastern Illinois. October 30–31. Donald K. Lumm, Illinois State Geological Survey, Natural Resources Building, 615 E. Peabody Dr., Champaign, IL 61820-6964, (217) 244-2428, and W. John Nelson. Cost: $150.

Other Field Trips

Keweenawan Copper Deposits of Western Upper Michigan. October 20–23. Sponsored by the *Society of Economic Geologists*. Theodore J. Bornhorst, Dept. of Geological Engineering, Geology, and Geophysics, Michigan Technological University, Houghton, MI 49931, (906) 487-2721, and William Cannon, Jeffrey Mauk. Cost: $350 (members and students), $375 (nonmembers). Trip begins and ends in Houghton, Michigan.

Zinc Deposits in East Tennessee. October 29–November 1. Sponsored by the *Society of Economic Geologists*. Kula Misra, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37796-1410, (615) 974-2366, and Robert E. Fulweiler. Cost: $325 (members and students), and $350 (nonmembers).

Cyclic Sedimentation and Sequence Stratigraphy of a Storm-Dominated Carbonate Ramp: Kope and Fairview Formations of the Cincinnati Region. October 25. Sponsored by the *Keck Geology Consortium*. Thomas J. Algeo, Fisk Laboratory of Sedimentology, Dept. of Geology, University of Cincinnati, Cincinnati, OH 45221-0013, (513) 556-4195, and Ben Datillo, Sharon Diekmeyer. For information: Henry H. Woodard, Keck Consortium Coordinator, Dept. of Geology, Beloit College, Beloit, WI 53511, (608) 363-2222. Participation limited to faculty and students of the Consortium.

THE VOYAGE CONTINUES
From Columbus to Magellan

Professional Horizons

GSA-Sponsored Short Courses/Forum

Advanced registration for GSA Short Courses begins in May with the publication of the 1992 Short Course Brochure. To receive a copy of the brochure or for more information on any of the courses listed below, contact Edna Collis, Course Registrar, GSA headquarters.

Fees will be approximately $100–$125 for the first day, $75–$100 for the second day, and $50–$75 for the third day. Fees are listed below. Students will receive a $20 discount off the price listed. Course details and registration information will be published in the May issue of *GSA Today*. A *GSA Certificate of Completion* will be given to each registrant.

Note: The GSA shuttle service does not begin until Sunday, October 25. However, most downtown GSA hotels are within easy walking distance of the Convention Center.

Tax Deduction: Expenses for continuing professional education (including registration fees, travel, lodging, and meals) undertaken to maintain and improve professional skills are generally tax deductible in whole or in part (Treas. Reg. 1-162-5, Coughlin vs. Commissioner, 203F2d307).

Geographic Information System Software: Facts and Fiction. October 23–25. Stephen A. Krajewski, Industrial Ergonomics, Inc., Denver, Colorado; Betty L. Gibbs, Gibbs Associates, Boulder, Colorado. (Note: As a courtesy to the vendors involved in this course, *early* preregistration is requested. Please contact Edna Collis, Course Registrar, GSA headquarters.) Limit: 50. Fee: $275.

Introductory Rock and Paleomagnetism. October 24–25. Cosponsored by the *Geophysics Division*. Lisa Tauxe, Scripps Institution of Oceanography, La Jolla, California. Limit: 40. Fee: $150.

How To Do Anything with Mohr Circles (Except Fry an Egg): A Short Course About Tensors for Structural Geologists. October 24–25. Cosponsored by the *Structural Geology and Tectonics Division*. Winthrop D. Means, State University of New York at Albany. Limit: 30. Fee: $150.

Paleosols for Sedimentologists. October 25. Cosponsored by the *Sedimentary Geology Division*. Greg H. Mack, New Mexico State University, Las Cruces; W. Calvin James, Ohio State University. Limit: 30. Fee: $180.

Phase I—Preliminary Site Assessments. October 25. Jeffrey L. Peterson, GeoStrategies, Inc., Hayward, California. Limit: 40. Fee: $155.

Practical Tracing of Ground Water, with Emphasis on Karst Terranes. October 25. Cosponsored by the *Hydrogeology Division*. James F. Quinlan, Quinlan & Associates, Nashville, Tennessee; E. Calvin Alexander, Jr., University of Minnesota, Minneapolis. Limit: 50. Fee: $135.

Environmental Applications of Shallow Seismic Reflection. October 30. Cosponsored by the *Geophysics Division*. Don W. Steeples and Richard D. Miller, Kansas Geological Survey, Lawrence. Limit: 50. Fee: $145.

Geology & Public Policy Forum

The GSA Committee on Geology and Public Policy will hold a forum on **Economic Benefits and Public Policy Issues of Geologic Mapping**. Speakers will report succinctly on the status of geologic mapping programs in the United States, the benefits and costs of geologic mapping, and the status of pending legislation. The forum is open to everyone, including guests, press, and the general public, and will feature a question-and-answer session. For information, contact the Meetings Department, GSA headquarters.

Other Short Courses/ Workshops/Forums

High-Resolution TEM. October 23–25. Precourse reception the evening of October 22. Sponsored by the *Mineralogical Society of America*. For information: MSA Business Office, 1130 Seventeenth Street, N.W., Suite 330, Washington, DC 20036, (202) 775-4344.

Teaching Topics in Earth Science and Geology with Video as a Partner: *For Secondary School Teachers.* October 24, 9:00 a.m. to 12:00 noon. Sponsored by the *Annenberg/CPB Project, National Association of Geology Teachers*, and *Southern California Consortium*. Explore the use of video as a tool to teach geology in this "EARTH REVEALED" workshop. For information: Janice Ford, Annenberg/CPB Project, 901 E Street, N.W., Washington, DC 20004, (202) 879-9655.

Teaching Introductory Geology with Video as a Partner: *For College Teachers.* October 25, 1:30 to 4:30 p.m. Sponsored by the *Annenberg/CPB Project, National Association of Geology Teachers*, and *Southern California Consortium*. Learn to use video in prompting students to interact with geology concepts through the "EARTH REVEALED: Introductory Geology" series. For information: Janice Ford, Annenberg/CPB Project, 901 E Street, N.W., Washington, DC 20004, (202) 879-9655.

Organic Geochemistry of Sediments and Sedimentary Rocks. October 25, 8:00 a.m. to 5:00 p.m. Sponsored by *SEPM*. For information: SEPM, P.O. Box 4756, Tulsa, OK 47159-0756, (918) 743-9765.

Trace Fossils. October 25, 8:00 a.m. to 5:00 p.m. Sponsored by the *Paleontological Society*. For information: Christopher G. Maples, Kansas Geological Survey, University of Kansas, 1930 Constant Avenue, Lawrence, KS 66044-3896, (913) 864-3965; Ronald R. West, Dept. of Geology, Kansas State University, Thompson Hall, Manhattan, KS 66506, (913) 532-6724.

DataBase Forum. October 25, 3:00 to 5:00 p.m., Sponsored by the *Geoscience Information Society*. For information: Charlotte Derksen, Branner Earth Science Library, Mitchell Building, Stanford University, Stanford, CA 94305, (415) 723-1093.

GeoRef Workshop. October 26, 2:30 to 3:30 p.m. Sponsored by the *Geoscience Information Society*. For information: Marilyn Stark, U.S. Geological Survey Library, MS 914, Box 25046, Denver, CO 80225, (303) 236-1004.

Our Common Future: The Concerns of Earth Science Students. October 27. Sponsored by the *GeoSphere Alliance Committee*. The forum will consist of selected papers from students from around the world, on topics related to the wise use of Earth, resources, environment, land use and the like. Papers will be selected to illustrate the views of students with their roots and future in diverse geographic regions, each with its diverse opportunities for sustainable development. For information: William S. Fyfe, Dept. of Geology, University of Western Ontario, London, Ontario, Canada, N6A 5B7, (519) 661-3187.

Exhibits Open Sunday Night

All registrants and guests welcome.

Sunday, October 25	6:00 p.m. to 9:00 p.m.
Monday, October 26	8:00 a.m. to 5:00 p.m.
Tuesday, October 27	8:00 a.m. to 5:00 p.m.
Wednesday, October 28	8:00 a.m. to 3:00 p.m.

Beginning on Sunday evening during the Welcoming Party, see demonstrations of state-of-the-art computer hardware and software, scientific instrumentation, microanalysis, and camera equipment. Pick up the latest publications, maps, and other educational material. Shop for field equipment and supplies. Browse for gems, jewelry, and mineral and fossil specimens. Visit with the many universities and educational organizations about their current programs. Find out the latest on governmental programs and projects such as waste management.

GSA is proud to have an excellent group of exhibitors who return year after year. Their dedicated support has more than doubled the size of the exhibits since GSA was last in Cincinnati in 1981!

We invite the participation of new and innovative companies—particularly those with products and services that involve meeting the challenges of our environment. If a company's product or service is marketed to geoscientists, Cincinnati is the place to be! If you know of a company you would like to see represented at the Annual Meeting, contact Becky Martin, Exhibits Coordinator, GSA headquarters.

Employment Service

GSA will again be offering its Employment Interview Service. Each year, this program provides valuable job-matching opportunities in the geosciences. At last year's meeting in San Diego, participating employers conducted nearly 500 interviews with 250 applicants seeking employment.

As in the past, booths will be provided for employers to interview applicants registered with the Employment Service, and GSA staff will be on hand to coordinate the scheduling of interviews. In particular, students completing doctoral and masters theses during 1992 are encouraged to check the job offerings.

See the February issue of *GSA Today* for applicant and employer forms and further information, or contact T. Michael Moreland, Employment Service Manager, at GSA headquarters.

Guest Program

Cincinnati, aptly named the Queen City of the West, is famed for its hospitality as well as its many diverse attractions. The guest committee has planned a week of activities to welcome you to this wonderful city.

If you like tours, join us, along with your spouse, as we explore a local vineyard and enjoy a wine tasting. Or plan on an introductory highlights tour of the city as a great way to get oriented before exploring on your own. And for those ardent antiquarians, what better way to indulge yourself than with a day of antique hunting in historic Waynesville, with lunch at Ohio's oldest inn, in nearby Lebanon.

Also planned for your enjoyment are walking tours of the city, a visit to Music Hall for a backstage look at the Cincinnati Symphony Orchestra, a breakfast fashion show at Saks Fifth Avenue, and high tea at the spectacular Omni Netherland Plaza.

A series of interesting seminars will be offered, with topics ranging from planning for retirement to helping teenagers grow up in an ever-changing world.

In addition, guests are encouraged to participate in the rest of the meeting by taking a short course, visiting the exhibits, or attending technical sessions. Please plan to join us for a special week.

Highlights

GLORIA: Sonar Images of the Entire U.S. Seafloor

October 25–29

Using the long-range side-scan sonar GLORIA, the U.S. Geological Survey has obtained sonar images of all the U.S. coasts. The Cincinnati meeting is the first time all of these remarkable sonar mosaics will be displayed together.

This project was undertaken in 1984 in cooperation with the Institute of Oceanic Sciences, United Kingdom. The resulting sonar images show major fracture zones, giant Hawaiian landslides, thousands of submarine volcanoes, details of canyon morphology, and pathways of turbidite transport never before imagined. For more information, contact M. E. Field or J. V. Gardner, U.S. Geological Survey, Menlo Park, California, (415) 354-3184, or D. Twichell, U.S. Geological Survey, Quissett Campus, Woods Hole, Massachusetts, (508) 548-8700.

Welcoming Party

October 25

The 1992 GSA Annual Meeting kicks off with the Welcoming Party in the Exhibit Hall, Sunday evening from 6:00 to 9:00 p.m. Come and preview the exhibits while making contact with your friends and colleagues. Exhibitors will be on hand to welcome you, and some will be hosting delicious specialty foods from their booths. Dress is casual. A first-class start to an eventful meeting!

GSA Presidential Address and Awards Ceremonies

October 26

Returning to Monday evening, the GSA Presidential Address and Awards Ceremony will be from 5:30 to 7:00 p.m. After giving his address, President E-an Zen will award the Penrose Medal, Day Medal, and Young Scientist Award (Donath Medal).

Alumni Receptions

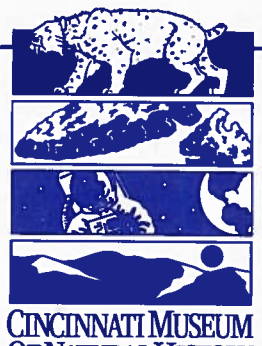
October 26

Everyone knows someone at the popular Alumni Receptions. This year the group parties begin at 7:00 p.m. at the Omni Netherland Plaza. Catch up with past colleagues and meet new friends. If you would like to schedule an alumni function, have your department chairman contact Vanessa George, Events Coordinator, GSA headquarters, by June 1.

Timeline 5K Run

October 28

Faster! Faster! Want to make up for lost time? Run the GSA 5K and experience 5 billion years of geology in about 16 minutes! River Front Park features a 1350' geologic timeline. The weather should be crisp and cool—perfect for an invigorating run beside the Ohio River. *Take the time* to join us for this annual fun event along a race route made for geologists!



CINCINNATI MUSEUM OF NATURAL HISTORY

A Taste of Cincinnati

October 28

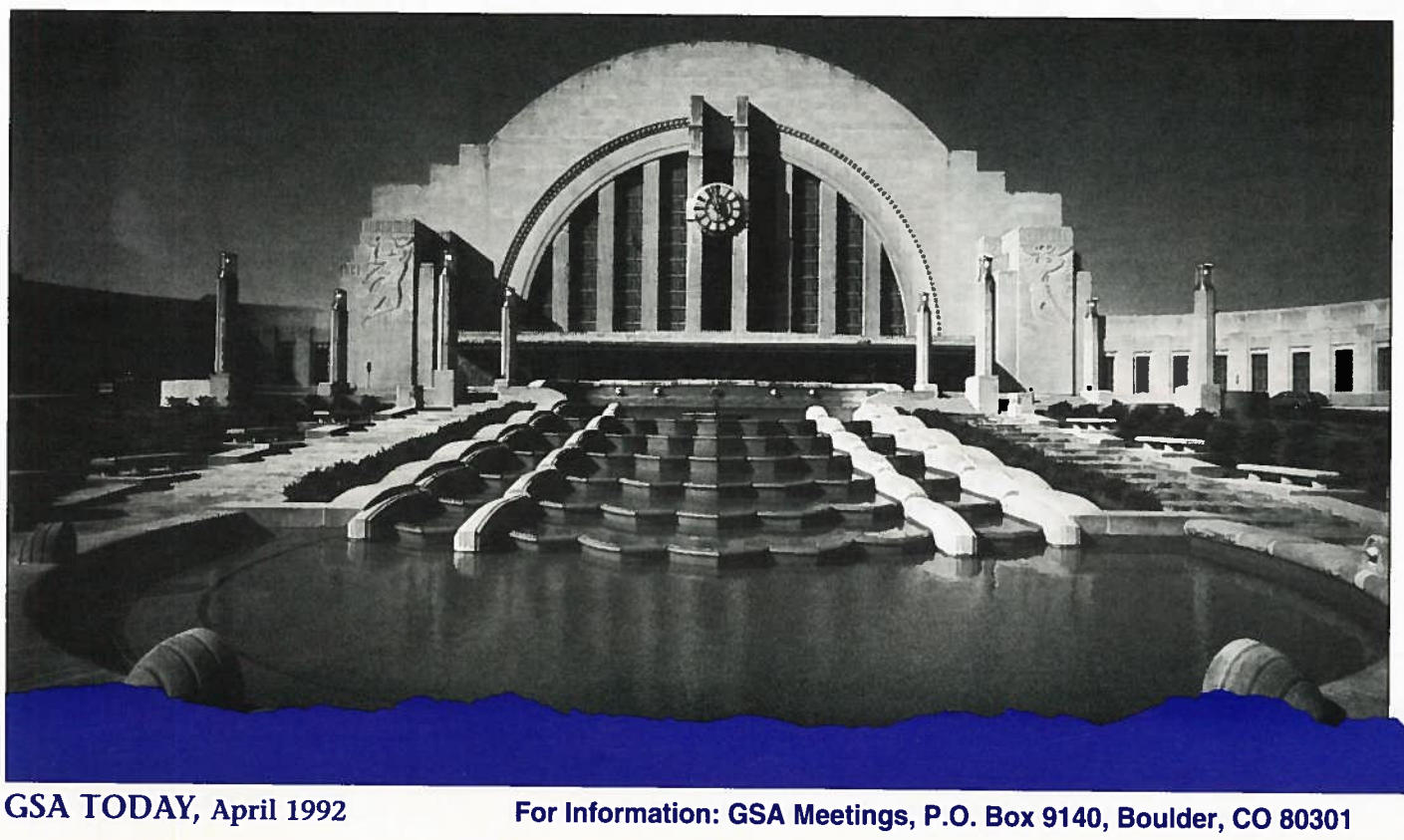
Join us for a special evening at the Cincinnati Museum of Natural History located at the renovated Union Terminal. From a delightful menu of activities, *you* can create the perfect evening. Delicious food, wonderful exhibits, good music, and more await you. After enjoying a true Cincinnati buffet, choose several of many activities offered. You will have a tough time fitting it all in! Explore the fascinating museum with a walk through the Ice Age or the incredible Kentucky limestone cave, take in the African Reflections exhibit, visit with friends while listening to quiet music, or try the latest dance steps to a livelier band. *You* decide how to spend the perfect evening!

Graduate School Information Forum

Do your undergrads need help in finding the right graduate program? Undergraduate students are invited to talk with representatives from various graduate schools participating in GSA's Graduate School Information Forum at the Cincinnati Convention Center.

University representatives will be on hand for one full-day session to answer questions and talk to (primarily) undergraduates. Graduate students might also find the service helpful. Individual appointments are not necessary, although students are welcome to contact the participating schools individually to arrange a meeting time. If you are searching for the right graduate school, look for the list of participating schools in the August issue of *GSA Today*.

Participating schools will be provided with one 6' table and chairs. Forum setups will be classroom style, with all participating schools in the same area during prescheduled sessions. Schools interested in participating are urged to contact Kathy Ohmie Lynch, GSA headquarters, today. Cost: $40. Firm deadline for school sign-ups is July 15.



The Museum Center at Cincinnati Union Terminal. *The Museum Center.*

GSA Hosts Top Geology Seniors

"My experience in San Diego strengthened my choice of geology as my career." "The meeting gave me concrete examples of what I want to do, and more direction." "Thank you GSA! It was the best thing you could have done for me."

These are just a few comments from last year's Top Seniors. The program is geared to exposing the best and brightest of the seniors to broader visions in geology. GSA will sponsor 25 top undergraduate seniors at the 1992 Annual Meeting, providing complimentary meeting registration and housing. Student travel to and from Cincinnati will be paid for by the student's university.

By necessity, the program will be carried out by invitation only. So that we may broaden participation, institutions that sponsored a Top Senior in 1991 will be ineligible this year. Schools will be rotated each year until all have had an opportunity to participate. Unfortunately, the program is limited to 25 students. Acceptance from those invited will need to be on a first-come, first-served basis.

For further information contact Kathy Ohmie Lynch, GSA headquarters. Firm deadline for participation is July 1.

Registration

PREREGISTRATION DISCOUNT APPLIES THROUGH SEPTEMBER 25.

Save by registering early.

Fight Inflation:
(1) Become a GSA member.
(2) Register before September 25.
Attention Students: Your fees are 64% less than professional fees.

GSA members automatically receive registration information and forms during the first weeks of August. Registration will begin at that time. If you are not a member and would like registration forms and further information, please write or call the GSA Registration Coordinator, GSA headquarters.

Meeting registration fees have not been established at this early date. However, for your budgeting and travel authorization requests, please use the following *estimates* of preregistration fees. Final fees will be announced in August.

Join GSA Now. Enjoy the Member Discount.

Professional Member	$160
One Day	90
Professional Nonmember	200
One Day	110
Student Member	60
One Day	35
Student Nonmember	80
One Day	45
Guest or Spouse	65

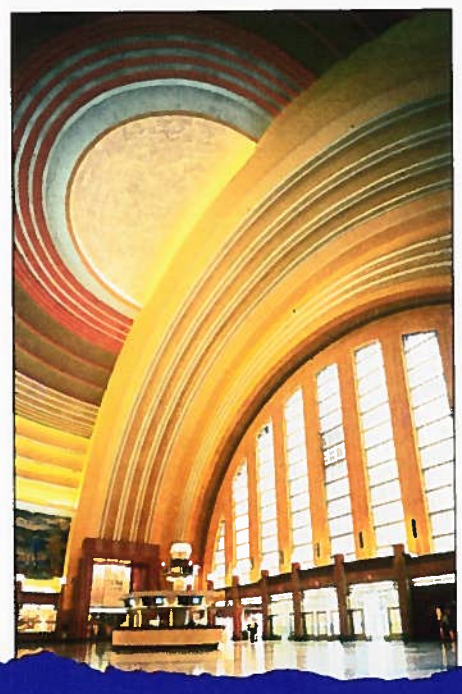
August preregistration is suggested for many of the short courses, field trips, guest tours, and special events because of participation limits.

Because the *Abstracts with Programs* is not included in the registration fee, please purchase it in advance with your GSA membership, through GSA Publication Sales, or on-site at the Convention Center.

Child Care

Due to prohibitive insurance costs and the legal issues that surround child care, daycare service will not be provided by GSA. However, we want to make it as convenient as possible for families to make arrangements. Among the options provided are:

- GSA coordinates a family cooperative service in which parents can share responsibilities for caring for their children. After August 1, the GSA Meetings Coordinator will accept names and addresses of interested parents. In early October, the information will be distributed to everyone who has responded. Participants are responsible for contacting one another and making arrangements.
- Cincinnati has several excellent private child-care agencies. Although GSA cannot endorse any of these agencies, we are happy to give the names and phone numbers to you. Call the GSA Meetings Coordinator.
- GSA will be providing a room for children and parents to relax together at the Convention Center. It will be a clean, quiet room with basic furnishings (no cribs or playpens).



Rotunda inside The Museum Center.
The Museum Center.

Travel

Getting to Cincinnati

By Air. The Cincinnati/Northern Kentucky International Airport is served by eight carriers offering over 650 daily arrivals and departures. Delta Airlines is the major carrier into this airport. Consider staying over Saturday night in Cincinnati for significant airfare savings. Call Cain Travel Group, GSA's official travel agency for the Cincinnati meeting, today. 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 25 preregistration deadline. Downtown Cincinnati is an approximate 20-minute cab ride (14 miles) from the airport. Jet-Port Express offers van service between the airport and downtown.

By Car. Cincinnati is located along major north-south Interstate Highways I-75 and I-71, and at the eastern terminus of Interstate I-74.

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

Getting Around in Cincinnati

An excellent freeway system makes travel by car easy. Transit Authority of Nothern Kentucky (TANK) provides bus transportation between northern Kentucky and downtown Cincinnati. Queen City Metro serves the suburban areas, and the Downtowner provides easy access to the downtown area.

GSA Shuttle. Rain or shine, access is easy from the downtown hotels to the Cincinnati Convention Center. Most hotels are within walking distance and accessible through the skywalk system that connects the downtown hotel properties, shopping malls, and the Convention Center. A GSA shuttle will be provided to the hotels on the Kentucky side of the river and to the one Cincinnati hotel located several blocks from the Convention Center. The shuttle will operate all day and into the evening beginning Sunday and ending Thursday. There is also a trolley that provides limited transportation throughout downtown and across the river.

Lodging

Cincinnati's downtown offers a wonderful convention setting, and most hotels are within walking distance of the convention center. GSA has blocked rooms at nine properties—five major hotels in the immediate downtown area, one hotel just over a mile from the convention center, and three properties across the Ohio River in Kentucky. These nine properties include a cross section of lodging that should fit almost everyone's budget and taste. If you will not have your own transportation, these will make the most sense for you.

Co-headquarters for the Cincinnati meeting are the Hyatt Regency Cincinnati and the Omni Netherland Plaza. Other participating downtown hotels are the Clarion, Terrace Hilton, Westin, and Holiday Inn Queensgate. In Kentucky, the Quality Inn, Travelodge, and Holiday Inn Riverfront will host GSA attendees. There is an excellent set of options within this group, including four-star properties and basic motels. Rates vary at each property; single rooms range from $41 to $97, and double rooms from $45 to $117. There are 450 single rooms priced between $40 and $55, and 850 single rooms between $70 and $80. All meet GSA's standards for rate reliability, cleanliness, service, and location.

Hotel information and reservation forms will be available in the August issue of *GSA Today*. Register early to get the hotel of your choice. All housing, except suites, will be processed by the Cincinnati Housing Bureau. Please call Vanessa George, GSA Housing Coordinator, for suite information.

Alternative Housing

Beating the high cost of housing is a high priority of GSA staff and the 1992 Local Committee. Here are some alternatives:

- 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. You will need to provide your own transportation.
- 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.

Tourist Information

Information is available at the following contact numbers:

Northern Kentucky
Convention & Visitors Bureau
605 Philadelphia Street
Covington, KY 41011
(606) 261-4677; 1-800-354-9718

Cincinnati Convention & Visitors Bureau
300 W. Sixth Street
Cincinnati, OH 45202
(513) 621-2142; 1-800-344-3445

CINCINNATI

GSAF UPDATE

Robert L. Fuchs

Foundation Grant to Sigma Gamma Epsilon

The GSA Foundation has made a grant of $2000 to Sigma Gamma Epsilon in support of that organization's publication program. The money was given with the stipulation that SGE raise at least that much money from other sources; SGE has in fact been successful in obtaining more than $10,000 over and above the Foundation grant.

One of GSA's associated societies, SGE plays an important role in the geosciences as the national honorary society for the population of geology students. SGE affords for many new geologists their first opportunities to publish in a scientific journal, *The Compass*, and their first professional contacts with geoscientists in other areas through SGE's nationwide network of chapters.

In approving this grant, the Foundation Trustees noted that the support of the SGE publication program provided the Foundation with some very good leverage for the dollars spent. Much of GSA's support to geology is at the student level, and within the family of GSA's associated societies, SGE affords the best opportunity for very direct assistance to students. Of course, many of these students go on to become highly respected scientific leaders and lifetime members of GSA. A principal task in promoting the science of geology is to promote people into being productive scientists and involved members of GSA. A strong Sigma Gamma Epsilon is a platform from which young scientists can begin moving into the mainstream of geology.

Hydrogeology Division Lohman Memorial

Stanley W. Lohman, one of this country's leaders in hydrogeology, died in mid-January, 1992, at the age of 84. He was well known throughout his field and is considered one of the leaders of this branch of geology. He was an authority on the aquifer systems underlying the High Plains of the United States. Stan Lohman was one of a small group of scientists whose work established the fine reputation of the USGS in ground-water hydrogeology, which in turn is the basis for the excellence of ground-water science in the United States. This specialty has become very important in recent years because of the broad focus on environmental problems and preservation.

In addition to his scientific studies, Lohman maintained a strong interest in the training and development of ground-water scientists. He was an originator of USGS ground-water courses and an active participant in teaching these courses, both in the United States and internationally.

In 1985 Lohman was given the award for Distinguished Service in Hydrogeology, presented by the Hydrogeology Division at GSA's Annual Meeting in Orlando, Florida. Memorial contributions may be sent to the GSA Foundation; they will be placed in the Hydrogeology Division Fund.

Foundation Trustees Meet in San Diego

The Foundation Board of Trustees met in San Diego during the October 1991 GSA Annual Meeting. Much of the meeting was devoted to a review of the routine operations of the Foundation, and a spring meeting was scheduled for April 25, 1992, in Boulder.

The Trustees were advised that several new funds had been established, including the Claude C. Albritton Memorial Fund and the Stephen E. Dwornik Planetary Geoscience Award Fund. Also, contributions were being received in memory of deceased GSA President Doris Curtis.

The Trustees reviewed the financial activities of the Foundation and approved a direct operating budget of $124,000. In addition, there will be a 1992 allocation of indirect costs totaling $49,000 for various services and support provided by GSA. The five-year financial plan was discussed, with particular attention being given to the increasing endowment required to support SAGE, the Institute for Environmental Education, and the plan to expand the headquarters facility. The Trustees also debated the pros and cons of commingling all Foundation funds; they decided that for financial and money-management reasons the financial assets should be commingled but separate identification maintained for bookkeeping purposes.

The Trustees reviewed and approved the 1992 disbursement budget in the amount of $170,000, noting that there would be some reduction in principal, estimated at $30,000, in the IGC fund in order to provide for travel grants to the 1992 IGC meeting in Japan. The GSA Sections' student travel grant program was approved at the level of $21,000.

Previously, a grant of $2000 to Sigma Gamma Epsilon in support of its publications program had been approved. Several of the Trustees expressed the view that the Foundation should put in place a policy covering grants to organizations affiliated with but outside of GSA. The Board felt it appropriate to create a committee to study the long-term disbursement policy of the Foundation.

GSA Controller Leonard Cumley reported on the status of DNAG products, and the Trustees offered various ideas to increase sales of these items. GSA Education Coordinator Ed Geary summarized SAGE activities and reported on ongoing efforts to obtain program funding from foundations and government organizations. Executive Director F. Michael Wahl discussed the progress in expanding the headquarters facilities to accommodate the increased GSA staff and operations. The Trustees offered several ideas for raising funds and suggested that professional help may be required because of the scope of this project. The Trustees also felt that the current interest-rate environment made debt financing an attractive course of action.

Fred Donath reviewed the Institute for Environmental Education, particularly the programs that are planned at the next GSA Annual Meeting and the internship program. The latter shows great promise in developing an interface between the geological community and the private and public sectors. Fund raising for IEE is underway among companies and individuals.

In view of the expiration of trustee Forman's term, the Board appointed Paul A. Bailly, former GSA president, to fill this position. In addition, the Board elected Foundation officers, including Charles Mankin, chairman; William Heroy, vice chairman; Robert Fuchs, president; F. Michael Wahl, vice president; and Donna Russell, secretary/treasurer. Adjournment of the meeting was followed by the annual Senior Fellows Reception. ■

Fellowships Available For Research in India

The Indo-U.S. Subcommission on Education and Culture is offering nine long-term (6–10 months) and nine short-term (2–3 months) awards for 1993–1994 research in India. These grants will be available in all academic disciplines except clinical medicine. Applicants must be U.S. citizens and hold the Ph.D. or comparable professional qualifications. The fellowship program seeks to open new channels of communication between academic and professional groups in the United States and India and to encourage a wider range of research activity between the two countries than now exists. Scholars and professionals with limited or no prior experience in India are especially encouraged to apply. The program is sponsored by the Indo-U.S. Subcommission on Education and Culture and is funded by the United States Information Agency, the National Science Foundation, the Smithsonian Institution, and the Government of India.

Application deadline is *June 15, 1992*. Application forms and further information are available from the Council for International Exchange of Scholars, 3007 Tilden Street, N.W., Suite 5M, Box INDO, Washington, DC 20008-3009. Telephone: (202) 686-7877.

Donors to the Foundation, January 1992

Century Challenge
John L. Berry
Frank R. Luther

J. Hoover Mackin Award
E. N. Goddard

GEOSTAR FUNDS

Antoinette Lierman Medlin Scholarship
Frances W. Pierce

Donald L. and Carolyn N. Biggs Excellence in Education Fund
Barb Betcher
Douglas L. Biggs
F. Eyolf Bronner
James A. Dockal
Caroline E. Ellett
Charles and Hazel Hammer*
Mr. and Mrs. Keith M. Hussey
Mr. and Mrs. James J. Kiser
Garold and Lola M. Parks
John W. and Shirley A. Patterson
Chester D. and Dorothy B. Scott
Gretchen Wilhelm
D. Kent and Linda S. Woodworth
Lawrence Wu*

Building Expansion
Dorothy M. Palmer

Allan V. Cox Student Research
Dennis V. Kent

GEOSTAR
Alfred L. Bush*
Eiler L. Henrickson
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Lauren A. Wright

Institute for Environmental Education
Alfredo L. Leon

Carol G. and John T. McGill Fund
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Jeffrey K. Miller
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Research
Diane Bellis
Sterling S. Cook
Jennifer W. Harden
Arthur S. Knox
Marcus G. Langseth
Maureen P. Leshendok
Harmon D. Maher, Jr.
Mark S. Newton
Thomas B. Nolan
Gordon B. Oakeshott
Peter Robinson
David A. Seeland
Leon T. Silver*
Walter S. Snyder
John F. Sutter
G. D. Webster
Kenzo Yagi
Jay Zimmerman

SAGE
Thomas F. Carrington
Richard H. Mahard*

Unrestricted
Alice S. Allen
John Eliot Allen*
Zalman S. Altschuler*
ARCO Foundation*
Alfred L. Bush
Catherine C. Campbell*
Clement G. Chase
Bruce C. Comstock
Norman H. Donald, Jr.
Cyrus W. Field
Charles E. Graham
Ralph A. Haugerud
Milton T. Heald
Melvin J. Hill*
Alan D. Howard
Bryan L. Isacks
S. Benedict Levin
Robert L. Melvin
Gerald Meyer
F. Stuart Miller
James A. Peterson
Dewey D. Sanderson
R. Shagam
Phyllis Scudder Snow
David D. Tillson*
Victor Vacquier
Gerald J. Wasserburg

Women in Science
Holly L.O. Huyck

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

Forum *continued from p. 76*

In some arenas, earth science is viewed as a nonscience. The possible reason for this attitude is that college admissions catalogues often read "two credits of science required, to include biology, chemistry, physics." This leads the bright, scientifically gifted, academic students to forego earth science in favor of developing a high school transcript acceptable to the college community. The instructional problem for earth science is compounded by the lack of qualified earth science teachers throughout the nation. Earth science is commonly taught by teachers poorly qualified to instruct, motivate, and challenge students in earth science; teachers may be trained in biology, chemistry, or social studies, with very little knowledge or enthusiasm for earth processes. With inadequate instructional staff, earth science subsequently gets omitted from the program. I myself am a "recycled" biology major who over many years of teaching earth science, taking coursework, participating in field experiences, and becoming professionally involved, has developed a passion for the earth sciences.

In my home state of Virginia, Standards of Learning for earth science have been written so that earth science is a ninth grade laboratory science offering; individual school divisions can require earth science or allow students to take other courses deemed acceptable by the state department for satisfying secondary graduation requirements. Henrico County Public Schools, where I currently teach, encourages all students to take earth science. Yet, even within this framework, high school administrators still have the option of scheduling students directly into biology. This is done in several of our high schools so that students can take advance placement courses during their senior year.

As an earth science teacher, I find it encouraging to see a growing interest and action in the status of precollege science education. It gives me a sense that the college and research community value the work of precollege teachers and recognize that improving student scientific literacy and interest in science careers is a major responsibility for us all. Through personal involvement in the Everyday Weather Project, Project JEDI, AMS Project Atmosphere, and GSA's Education Committee, I have seen the outcomes of these efforts. Teacher participants, armed with updated content, innovative resource materials, and a sense of support from the scientific community, return to their classrooms better able to instruct and motivate students.

Opportunities for involvement abound for those interested in becoming a part of the growing effort to improve the status of earth science education:

- Earth science teacher training programs that incorporate field studies are desperately needed. These programs should focus on the problems of urbanization, erosion, and human impact on the planet, rather than on the more traditional topics. Offerings could be summer institutes, courses taught during the school year, or weekend seminar opportunities. Drawing new teachers into the earth sciences should be a major goal of these training programs.
- Scientists in the college and research community can share their expertise with the precollege earth science community by submitting articles to *The Earth Scientist* (Journal of the National Earth Science Teachers Association) and by offering to speak at local, state, and national educational meetings.
- Initiate efforts to have earth science accepted as a laboratory science by colleges and universities throughout the nation.
- Establish partnerships with local educators in which a scientist would serve as a resource agent, assist in the development of educational materials, or work to encourage students to enter the earth sciences.
- Involve earth science educators in chapter meetings of professional organizations and encourage teachers to bring interested students to these meetings.

It is the responsibility and mission of the geoscience community to insure that continued and improved earth science education is provided to our nation's students.

PERSPECTIVE 5: Earth Science Teaching: Through the Eyes of a Public School Teacher

Joe Beydler, Colorado Alliance for Science, Boulder, Colorado

The issues that face nearly all teachers in public schools today can be seen in the media on a regular basis: (1) too many students in a science lab class; (2) lack of money for specialized equipment and materials; (3) no money and little support for field trips; and (4) a perception by peers and students that earth science is a lesser science than physics, chemistry, or biology.

I will address these issues and try to offer some practical solutions.

(1) Too many students in a science lab class. This is basically a problem of safety. Numerous times in my teaching career I have been faced with 30–35 students in a lab built to accommodate 24. There is certainly a critical number. When the number of students exceeds lab capacity, problems arise, much as a chain reaction would proceed. This overcrowding poses a safety hazard when dangerous equipment (such as a Bunsen burner) or hazardous materials (e.g., hydrochloric acid as a test for calcium carbonate) are used. These situations may cause a teacher to forego "inquiry" teaching for an approach that is less interactive and more traditional (textbooks, paper and pencil, etc.). Science lab classes should have no more students than the room was built for, and not so many students as to alter what would be the normal style of the teacher.

(2) Lack of money in public schools. This is no secret. Experience has shown that in many schools the earth sciences have been relegated to the lowest dollar amount in a school's science budget. This could partly be due to the fact that a majority of the earth materials utilized in an earth science class are very durable. Sand and rock specimens last from year to year and commonly do not cost a lot to obtain. I have found that the price tag for one lab in a high school biology class (i.e., heart dissection) can eclipse an entire earth science budget for a year. Specialized equipment such as recording barometers, telescopes, and the like, which can carry a high price tag, can be put on hold for years. Earth science needs to be funded on an equal basis with chemistry, physics, and biology.

(3) Field trips. A general trend in education throughout the past years has been to reduce or eliminate field trips altogether. As an earth science teacher with a yearly budget of a few hundred dollars, I could easily spend my entire budget on one field trip for my students. The very nature of earth science is that of getting to the "field" to study the materials and processes that are covered by class work. A practical solution for this problem has been demonstrated by one of my teaching colleagues. He has organized a Science Club. He solicits parents to provide transportation for students on various weekend field trips. The field trips tend to take on a family outing character. These trips would be even better if more earth scientists volunteered to come along and discuss the local geology.

(4) Earth science being treated as a pseudo-science. This issue causes great concern. Earth science generally is not accepted as a lab science for college admission; it is viewed only as a natural science. This in itself may not seem to be too much of a problem. The way this issue manifests itself is by relegating a majority of the non–college-bound students to the earth science offering in a given school curriculum and by discouraging many college-bound students from taking earth science. Unfortunately, earth science is seen by many students only as a way to fulfill a science credit requirement for graduation. This misinformation is conveyed by counselors, by other teachers, and by the students themselves. To break this cycle and elevate the status of earth science, many groups from the college and precollege education community who traditionally ignore each other must come together, remove the roadblocks, and find a viable solution to this problem.

Love of the earth science curriculum and the people who are associated with earth sciences are what keep me going as a public school earth science teacher. I fully believe that all people need a basic understanding of the earth sciences in order to understand some of the complex issues that face Earth today. This understanding can lead to solutions, as yet not dreamed! ■

Special thanks to Ed Geary, GSA Education Coordinator, for his help in putting together this month's Forum.

Memorial Preprints

The following memorial preprints are now available, free of charge, by writing to GSA, P.O. Box 9140, Boulder, CO 80301.

Paul Averitt
S. Warren Hobbs

Rudolf Oskar Brunnschweiler
Keith R. Colwill, Ursula B. Brunnschweiler

Charles George Doll
Rolfe Stanley, Barry Doolan

George Edward Heim
Jerome S. Nelson

Waldo S. Glock
John T. Andrews

BOOK REVIEW

Atlas of Lithological-Paleogeographical Maps of the World: Mesozoic and Cenozoic of Continents and Oceans. *A. B. Ronov, V. E. Khain, and A. N. Balukhovsky, edited by V. L. Barsukov and N. P. Laviorov, Editorial Publishing Group, Moscow, 1989, 79p., $350. (Order from Editorial Publishing Group VNIIZarubezhgeologia, Novocheryomushkinskaya St. 96 B, Moscow, 117418, Russia.)*

This atlas is the culmination of the global compilations of lithofacies and paleogeographic information started by Alexander Ronov, Victor Khain, and their co-workers in the 1950s. It is a magnificent work: the maps use 23 colors to represent different paleogeographic features on land and in the ocean basins, 44 superposed black, red, or green patterns to represent different lithologic types, and a variety of line and number symbols for other features, including sediment thicknesses. Alternations of colors and patterns are used to indicate the presence of more than one rock type or paleoenvironment.

There are three sets of maps. The first two sets are for 13 time intervals: Early, Middle, and Late Triassic; Early, Middle, and Late Jurassic; Early and Late Cretaceous; and each of the epochs of the Tertiary. They show paleogeography of the continents and ocean basins in their present positions. Lithologic symbols appear only where the strata of a given age are preserved or can be inferred with a high degree of certainty to have existed. Areas of the ocean floor for which crust or sediments of that age did not exist are shown in pale green. The locations of Deep Sea Drilling Project sites are shown. The maps show at a glance where deep-water, slope, shelf, and terrestrial sediments are known to be present, and they distinguish between cratonic and geosynclinal settings. Legends for the maps are in Russian and English, and each map is accompanied by a description and discussion in Russian. The maps of the first set fold out to 46 × 71 cm, and show the world at a scale of 1:48 000 000, using an equatorial aspect polyconic projection centered on 40°E. The second set of maps consists of paired Arctic and Antarctic polar projections on a scale of 1:36 000 000, extending to 60°N and 60°S. Again, the continents and ocean basins are shown in their present configurations and lithologies indicated where they exist or can be inferred. The polyconic equatorial and polar projections are the same as those used in Gerasimov's (1964) Fiziko-Geograficheskiy Atlas Mira (Physical-Geographical Atlas of the World), so that the lithologic data of Ronov et al. can be tied directly back to the geologic maps in the Gerasimov atlas. The occurrences and interpretations are documented in a bibliography of 691 references covering the literature from 1970 through 1985.

The third set of maps consists of 11 global palinspastic reconstructions, using the plate-tectonic maps prepared by Gahagan, Scotese, and Larson in 1986, starting with the Late Triassic. Each map shows the entire globe in a Van der Grinten projection on a scale of 1:167 000 000. The maps display the paleogeography and indicate the locations of climate-sensitive sedimentary strata. This is a major contribution to global change studies because the maps show at a glance hemispheric asymmetry of climate and changes in climate belts that are characteristic of much of Earth history.

This is the first set of global maps to attempt to show both paleogeography, lithofacies, and climate-sensitive sedimentary strata in such detail, and it will be an invaluable reference for global geology for many years.

William Hay
Geowissenschaften der
Christian-Albrechts-Universität
Kiel, Germany ■

Needed: Geological Books

David G. Howell and Eldridge M. Moores

Recently we had a conversation with colleagues in a developing country, at a university with an up-and-coming geology department, with excellent talent in geology. They remarked on the difficulty of keeping abreast of developments in the field and of adequately educating their students, particularly in view of the high prices for books, which are simply out of the reach of their library and student budgets. To alleviate this problem, we have a proposal for the geological community.

If you are like us, your bookshelves are overcrowded with books you bought or that were sent for possible use, or with older editions of textbooks. As new books arrive, you are faced with the continual task of finding more shelf space. Those stuffed and groaning shelves may help create an office ambiance of intellectual comfort, but is this necessary—or even desirable? Many such books may be more clutter than asset, unopened residues of past projects rather than resources for your active research.

Can you put these unused extra books to productive use? Indeed yes! Our colleagues in many countries are in desperate need of good texts for teaching; their students simply cannot afford the $50–$150 price tags of most current geology texts.

We propose that you go through your collections and weed out books that you no longer need but that are reasonably current and in good condition. Send them to: David G. Howell, U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025.

We will mail bundles of these books to foreign university departments that need them. If you have suggestions as to who should get the books, please let us know. Happy spring cleaning! ■

International Division Sponsors GEOPALS Program

James W. Skehan
Chair, Student Committee of the GSA International Division

In his presidential report in *GSA Today* (October 1991, p. 220), International Division President Brian Skinner discussed the International Division Student Committee's first major activity, the GEOPALS program. The program was launched with gifts from Bruce Hanshaw, Bill Greenwood, and Brian Skinner, supporting the Student Associate memberships. The students nominated were from the University of Akron, the University of Idaho, and the Colorado School of Mines.

An important aspect of the program is that GSA sponsors are encouraged to communicate with their GEOPALS, seeking to reinforce the departments' educational efforts while they study in North America, and taking an interest in their professional development. We believe that GEOPALS will play an important role in helping to build professional and personal bridges to geoscientists in other countries.

The program consists of two separate but related parts, that of nominating and that of sponsoring a foreign student.

How to Nominate a GEOPAL

The Student Committee welcomes nominations of foreign graduate students, preferably those with strong credentials who otherwise wouldn't be able to afford GSA membership fees. We request that the sponsor and the student be from different departments, as an additional means of building bridges within North America on this collaborative project. A nominator or sponsor need not be a member of the International Division of GSA, but priority will generally be given to International Division members' nominations. An additional reason that we encourage you to join the International Division is so that you may help to provide us with guidance and may participate actively in some of its varied programs.

How to Sponsor a GEOPAL

The procedures for becoming a sponsor of a foreign student are as follows:

(1) If you are on a university campus, tell the chair or GSA Campus Representative that you want to be a sponsor. If you are not on a campus, or if you do not have a Campus Representative, call or write to Jim Skehan, who will send a sponsor's form and a student application form to the designated chair or Campus Representative in the student's department. You may also contact Skehan if you wish to sponsor and be paired with a nominated student on the committee's list.

(2) When the forms are complete and signed by the chair or Campus Representative in the student's department, they will be sent to the sponsor, who will enclose a check as a tax-deductible contribution, made payable to GSA Foundation—GEOPALS. The sponsor will check off one of two boxes:

Level of commitment: ☐ $40—dues and *Geology*
☐ $55—dues, *Bulletin*, and *Geology*

Length of commitment: ☐ 1992 dues, one year only
☐ 1992 dues and subsequent years as a student

The sponsor then sends the package to: GEOPALS Program, c/o Membership Services, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

Two Programs for Foreign and American Exchange

The Student Committee is involved in two other programs, the Ballarat-Golden project and the identification of an Americans to France facilitator. The Ballarat-Golden project was initiated by Ross Ramsey, Ballarat University College, Australia, by request to GSA President E-an Zen. The request went to the Student Committee which facilitated contacts in Colorado in order to bring a group of Australian students to that state to do field work this summer. Greg Holden, acting chair, and Bob Weimer, emeritus, Colorado School of Mines, approved the proposal, and it appears that the field project for the Ballarat students is moving on schedule. The Americans to France program was set up by J. Dercourt, Academy of Sciences, Paris, to facilitate contacts for American students who wish to work in France.

If the Student Committee of the International Division can be helpful in facilitating other contacts in international student-oriented projects, contact James W. Skehan, Chair, ID-GSA, Student Committee, Geological Society of America, Dept. of Geology and Geophysics, Boston College, Weston Observatory, 381 Concord Road, Weston, MA 02193, (617) 552-8300, fax 617-552-8388. ■

MEETINGS

GSA Penrose Conferences

May 1992

The Origin and Evolution of the Coast Mountains, British Columbia, Yukon, and Alaska, May 16–22, 1992, Bowen Island, British Columbia. Information: George E. Gehrels, Dept. of Geosciences, University of Arizona, Tucson, AZ 85721, (602) 621-6026, fax 602-621-2672; Maria Luisa Crawford, Dept. of Geology, Bryn Mawr College, Bryn Mawr, PA 19010, (215) 526-5111, fax 215-526-5086; James W.H. Monger, Geological Survey of Canada, 100 West Pender Street, Vancouver, B.C. V6B 1R8, Canada, (604) 666-6743 or 0529, fax 604-666-1124.

September 1992

Applications of Strain: From Microstructures to Mountain Belts, September 9–13, 1992, Liscomb Mills, Nova Scotia, Canada. Information: Mark Brandon, Dept. of Geology and Geophysics, Yale University, P.O. Box 6666, New Haven, CT 06511-8130, (203) 432-3135; Scott R. Paterson, Dept. of Geological Sciences, University of Southern California, Los Angeles, CA 90089-0740, (213) 740-6130.

Origin and Emplacement of Low-K Silicic Magmas in Subduction Settings, September 25–30, 1992, Chelan, Washington. Information: James S. Beard, Virginia Museum of Natural History, Martinsville, VA 24112, (703) 666-8611, fax 703-632-6487; George W. Bergantz, Dept. of Geological Sciences, University of Washington, Seattle, WA 98195, (206) 545-4972; Marc J. Defant, Dept. of Geology, University of South Florida, Tampa, FL 33620, (813) 974-2238, fax 813-974-2668; Mark S. Drummond, Dept. of Geology, University of Alabama, Birmingham, AL 35294, (205) 934-8130.

October 1992

Fluid-Volcano Interactions, October 4–9, 1992, Warm Springs, Oregon. Information: Steve Ingebritsen, U.S. Geological Survey, MS 439, 345 Middlefield Road, Menlo Park, CA 94025, (415) 329-4422, fax 415-329-4463; Bruce Christenson, Geothermal Research Centre, Private Bag 2000, Taupo, New Zealand; Craig Forster, Dept. of Geology and Geophysics, University of Utah, 719 W.C. Browning Building, Salt Lake City, UT 84112; Grant Heiken, Los Alamos National Laboratory, MS-D462, Los Alamos, NM 87545; Craig Manning, Dept. of Earth and Space Sciences, University of California, 405 Hilgard Avenue, Los Angeles, CA 90024.

Late Precambrian Tectonics and the Dawn of the Phanerozoic, October 18–23, 1992, Death Valley, California. Information: Ian W. D. Dalziel, Institute for Geophysics, University of Texas, Austin, TX 78759-8345, (512) 471-6156, fax 512-471-8844; Andrew H. Knoll, The Botanical Museum, Harvard University, Cambridge, MA 02138, (617) 495-9306 (on sabbatical in Cambridge, UK); Eldridge M. Moores, Dept. of Geology, University of California, Davis, CA 95616, (916) 752-0352 or 752-0350, fax 916-752-6363.

1992 Meetings

April

■ **11th Annual Princeton-Conoco Symposium in Geosciences: Volcanoes**, April 3–4, 1992, Princeton, New Jersey. Information: Triparna Das, Dept. of Geological and Geophysical Sciences, Guyot Hall, Princeton, NJ 08544, (609) 258-4104, E-mail: das@euwe.-princeton.edu.

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

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

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

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

■ **Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)**, April 22–26, 1992, Oak Brook, Illinois. Information: Mark Cramer, ExpoMasters, Contract Station 19, P.O. Box 207, Denver, CO 80231-4952, (303) 752-4951, fax 303-752-4979.

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

American Association of Petroleum Geologists—SEPM Pacific Sections, April 29–May 1, 1992, Sacramento, California. Information: Rich Boyd, Capitol Oil Corp., 1545 River Park Dr., #501, Sacramento, CA 95815, (916) 929-4141, fax 916-929-4534.

GSA North-Central Section Meeting, April 30–May 1, 1992, Iowa City, Iowa. Information: Raymond R. Anderson, Iowa DNR, Geological Survey, University of Iowa, 123 N. Capital St., Iowa City, IA 52242, (319) 335-1575.

May

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

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

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

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

15th Annual Symposium on Systematics and Process, May 9, 1992, Chicago, Illinois. Information: Vivian Ploense, Collections and Research, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605-2496, (312) 922-9410, x416.

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

■ **Hydrocarbon and Mineral Resources of the Uinta Basin Symposium**, May 11–13, 1992, Vernal, Utah. Information: Roger Bon, Utah Geological Survey, 2363 Foothill Dr., Salt Lake City, UT 84109-1491, (801) 467-7970.

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

International Congress on Technology and Technology Exchange, May 13–15, 1992, Evry, France. Information: Janet Weisgerber, (412) 391-2913; Ruby Glasgow, (412) 795-5300, 7125 Saltsburg Rd., Pittsburgh, PA 15235-2297, fax 412-795-5302.

■ **10th Industrial Minerals International Congress**, May 17–20, 1992, San Francisco, California. Information: Industrial Minerals, Park House, Park Terrace, Worcester Park, Surrey KT4 7HY, England, phone 081 330 4311, fax 081-337-8943, telex 21383, or Industrial Minerals, 220 Fifth Avenue, New York, NY 10001, 1-800-METAL 25, (212) 213-6202, fax 212-213-6273.

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

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; Martin R. Gibling, Dept. of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada, (902) 494-2355.

■ **Second International Symposium on Environmental Studies of Tropical Rainforests (UNCED '92)**, May 24–29, 1992, Rio de Janeiro, Brazil. Information: Organizing Committee, Caixa Postal/P.O. Box 3591, Av. Pasteur, 404/3º (CPRM) Urca, Rio de Janeiro, RJ, CEP 22290, Brasil, phone (021) 295-4347, (021) 295-0032, R 425/243, telex (021) 38806 SFLA BR, fax 021-262-5946.

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

■ **6th Congress of the Geological Society of Greece with Emphasis on the Geology of the Aegean**, May 25–27, 1992, Athens, Greece. Information: D. Papanikolaou, Dept. of Geology, University of Athens, Panepistimioupoli, Zografou, 15784 Athens, Greece, phone (01) 72.42.743, fax (+3.01) 72.42.743.

Geological Association of Canada–Mineralogical Association of Canada Joint Annual Meeting, May 25–27, 1992, Wolfville, Nova Scotia, Canada. Information: Wolfville '92, Gary Sonnichsen, Acadia University, Wolfville, Nova Scotia B0P 1X0, Canada, (902) 542-1902, fax 902-542-1454, E-mail: WFVILL92@ace.acadiau.ca.

Third International Conference on Engineering, Construction and Operations in Space, May 31–June 4, 1992, Denver, Colorado. Information: Stein Sture, SPACE 92 Technical Co-Chairman, Dept. of Civil, Environmental, and Architectural Engineering, University of Colorado, Boulder, CO 80309-0428, (303) 492-7651, fax 303-492-7317.

June

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

6th Symposium on the Geology of the Bahamas, June 11–15, 1992, Bahamian Field Station, San Salvador, Bahamas. Information: Donald T. Gerace, Executive Director, Bahamian Field Station, Ltd., P.O. Box 2488, Port Charlotte, FL 33949.

First Thematic Conference on Remote Sensing for Marine and Coastal Environments, June 15–17, 1992, New Orleans, Louisiana. Information: Nancy J. Wallman, ERIM/Marine Environment Conference, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, x3234, fax 313-994-5123, telex 4940991 ERIMARB.

Neotectonics—Recent Advances, June 16–17, 1992, London. Information: C. Vita-Finzi, Dept. of Geology, University College, Gower Street, London WC1E 6BT, England, fax 071-388-7614.

Geology of the Taconic Orogen: A Sesquicentennial Field Conference, June 20–21, 1992, Shoreham, Vermont. Information: Paul A. Washington, P.O. Box 242, Shoreham, VT 05770, (919) 733-1330.

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; AAPG Convention Dept., P.O. Box 979, Tulsa, OK 74101, (918) 584-2555.

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

July

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

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

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

Society for Organic Petrology, 9th Annual Meeting, July 23–24, 1992, University Park, Pennsylvania. Information: Jim Hower, Center for Applied Energy Research, 3572 Iron Works Pike, Lexington, KY 40511, (606) 257-0261, fax 606-257-0302.

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

XVII Congress of International Society for Photogrammetry and Remote Sensing, August 2–14, 1992, Washington, D.C. Information: XVII ISPRS. Congress Secretariat, P.O. Box 7147, Reston, VA 22091-7147, (703) 648-5110.

10th International Conference on Basement Tectonics, August 3–7, 1992, Duluth, Minnesota. Information: Richard Ojakangas, Dept. of Geology, University of Minnesota, Duluth, MN 55812, (218) 726-7238, fax 218-726-6360.

■ **International Geographical Union 27th Congress**, August 9–14, 1992, Washington, D.C. Information: IGU Congress Secretariat, 17th and M Streets, NW, Washington, DC 20036, (202) 828-6688.

13th Caribbean Geological Conference, August 10–14, 1992, Pinar del Rio, Cuba. Information: Grenville Draper, Florida International University, Geology Dept., University Park, Miami, FL 33199, (305) 348-3572, fax 305-348-3877, Bitnet: DRAPER@SERVAX.

Phanerozoic Basins of Southwestern Gondwana: Tectonics, Stratigraphy, and Seismic Expression, August 12–16, 1992, Santa Cruz, Bolivia. Information: Ramiro Suarez Soruco, Casilla 727, Santa Cruz, Bolivia, fax 591-3-34-6472; A. J. Tankard, Petro-Canada, P.O. Box 2844, Calgary, Alberta, T2P 3E3, Canada, (403) 296-5808, fax 403-296-5875.

Second International Conference on Asian Marine Geology, August 19–22, 1992, Tokyo, Japan. Information: Shin'ichi Kuramoto, Ocean Research Institute, University of Tokyo, 1-15-1, Minamidai, Nakano-ku, Tokyo, 164 Japan, phone 03-3376-1251, fax 03-3375-6716, telex 25607/ORIUT, E-mail: kuramoto@tansei.-cc.u-tokyo.ac.jp *or* kuramoto@jpnoriut.-bitnet.

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.

■ **GeoTech '92—Geocomputing Conference**, August 29–September 1, 1992, Denver, Colorado. Information: Mark Cramer, GeoTech, Contract Station 19, P.O. Box 207, Denver, CO 80231-4952, (303) 752-4951, fax 303-752-4979.

IAS/SEPM Research Conference on Carbonate Stratigraphic Sequences: Sequence Boundaries and Associated Facies (Emphasis on Outcrop and Processes Studies), August 30–September 3, 1992, La Seu, Spain. Information: Toni Simo, Dept. Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St., Madison, WI 53706, (608) 262-5987, fax 608-262-0693, E-mail: simo@geology.wisc.edu; Mark Harris, Dept. Geosciences, University of Wisconsin, P.O. Box 413, Milwaukee, WI 53201, (414) 229-5452; Evan Franseen, Kansas Geological Survey, 1930 Constant Ave., Lawrence, KS 66047, (913) 864-5317.

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

September

International Conference on Arctic Margins, September 2–4, 1992, Anchorage, Alaska. Information: David Steffy or Dennis Thurston, U.S. Minerals Management Service, 949 E. 36th Ave., Anchorage, AK 99508, (907) 271-6553, fax 907-271-6805.

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; A. G. Green, Geolgical Survey of Canada, 1 Observatory Crescent, Ottawa, Ontario K1A 0Y3, Canada, fax 613-992-8836.

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

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.

■ **Association for Women Geoscientists, 2nd National Convention**, September 11–13, 1992, Denver, Colorado. Information: Pam Goode, 6103 Alkire Ct., Arvada, CO 80004, (303) 424-2045.

3rd International Conference on Plasma Source Mass Spectrometry, Durham, England, September 13–18, 1992. Information: Grenville Holland, Dept. of Geological Sciences, The University Science Laboratories, South Road, Durham DH1 3LE, England, phone 091-374-2526.

Federation of Analytical Chemistry and Spectroscopy Societies Annual Meeting, September 20–25, 1992, Philadelphia, Pennsylvania. Infomation: FACSS, P.O. Box 278, Manhattan, KS 66502, (301) 846-4797.

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

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

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

October

Association of Engineering Geologists, Annual Meeting, October 2–9, 1992, Long Beach, California. Information: John W. Byer, 444 "A" East Broadway, Glendale, CA 91205, (818) 549-9959, fax 818-242-2442.

SEPM Midcontinent Section Annual Meeting: Paleosols, Paleoweathering Surfaces and Sequence Boundaries, October 9–11, 1992, Knoxville, Tennessee. Information: Steven G. Driese, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-2366, fax 616-974-2368.

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

American Institute of Hydrology Conference: Interdisciplinary Approaches in Hydrology and Hydrogeology, October 17–22, 1992, Portland, Oregon. Information: AIH, 3416 University Ave. SE, Minneapolis, MN 55414-3328, (612) 379-1030.

■ **Gulf Coast Association of Geological Societies and Gulf Coast Section of SEPM, Joint Annual Convention**, October 21–23, 1992, Jackson, Mississippi. Information: Cragin Knox, GCAGS Convention 1992, P.O. Box 2474, Jackson, Mississippi 39225-2474.

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. (*Abstract deadline: July 8, 1992.*)

■ **Geological Association of New Jersey 9th Annual Meeting and Field Trip**, October 30–31, 1992, New Brunswick, New Jersey. Information: Howard Parish, Jersey City State College, 2039 Kennedy Blvd., Jersey City, NJ 07305, (201) 200-3164, fax 201-200-2298.

November

28th Annual Conference and Symposia: Managing Water Resources During Global Change, November 1–5, 1992, Reno, Nevada. Information: Raymond Herrmann, NPS, WR-CPSU, WRD, Colorado State University, Ft. Collins, CO 80523, (303) 491-7825.

Joint Meeting of the Clay Minerals Society and the Soil Science Society of America, November 1–6, 1992, Minneapolis, Minnesota. Information: Jerry Bigham, Dept. of Agronomy, Ohio State University, Columbus, OH 43210, (614) 292-2001.

■ **Geological Society of New Zealand and New Zealand Geophysical Society Joint Annual Conference**, November 23–27, 1992, Christchurch, New Zealand. Information: David Shelley, Dept. of Geology, University of Canterbury, Christchurch 1, New Zealand, phone 64-3-667-001, fax 64-3-642-769.

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

GSA ANNUAL MEETINGS

CINCINNATI

THE VOYAGE CONTINUES
From Columbus to Magellan

■ 1992

GSA Annual Meeting, Cincinnati, Ohio
Cincinnati Convention Center, October 26–29

General co-chairmen: Raphael Unrug and J. Barry Maynard

Field trip chairmen: Thomas Berg and John Rupp

Technical Program chairmen: Nicholas Rast and Roy Kepferle

For information call the GSA Meetings Department, (303) 447-2020

■ 1993

GSA Annual Meeting, Boston, Massachusetts
Hynes Convention Center, October 25–28

Chairman: James W. Skehan, S. J.

Call for Field Trip Proposals: Please contact the field trip chairmen listed below

John T. Cheney
Dept. of Geology
Amherst College
Amherst, MA 01002
(413) 542-2233 (Dept.)

J. Christopher Hepburn
Dept. of Geology and Geophysics
Boston College
Chestnut Hill, MA 02193
(617) 552-3640 (Dept.)

For information call the GSA Meetings Department, (303) 447-2020

GSA SECTION MEETINGS

■ 1992

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
Radisson Suite Hotel, May 13–15

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

April *BULLETIN* and *GEOLOGY* Contents

Are you missing out? If you're not a *Bulletin* or *Geology* subscriber, you may miss the articles listed below. But it's not too late, you can still subscribe and receive all 1992 issues, even if you've already paid your 1992 dues. Just call Membership Services today at 1-800-472-1988.

The Geological Society of America
BULLETIN
Volume 104, Number 4, April 1992

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VOLUME 20
NO. 4
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Forum

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Consultants	$4.50	$3.80
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Opportunities for Students

Graduate Research Assistant/Tectonics of Active Banda Orogen, Indonesia. Field oriented research opportunity for MSc. or Ph.D. degree. Research focus involves structural restoration of the active Banda arc-continent collision, eastern Indonesia. The restoration integrates data from ongoing studies of temporal and spatial distributions of stress and strain, thermalchronology, paleomagnetism, hydrogeology processes of fluid expansion and transport, and neotectonics. Applicants should have experience with classic field mapping of remote regions or other studies related to the research problem.

Send resume and personal statement by April 15 to R. A. Harris, Dept. of Geology, 425 White Hall, West Virginia University, Morgantown, WV 26506 (FAX: 304-293-6522).

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.

Applications are available from the JOI office and should be submitted according to the following schedule: Leg 147: Hess Deep, 5/1/92; Leg 149: Iberian Abyssal Plain, 5/1/92; Leg 150: New Jersey Sea Level, 5/1/92; Leg 151: Atlantic Arctic Gateways, 5/1/92; Leg 152: East Greenland Margin, 5/1/92; All Shorebased Research (regardless of leg), 12/1/92.

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 20036-2102 (Robin Smith: 202-232-3900).

Undergraduate Fellowships in Marine Science and Global Change. Bermuda Biological Station for Research, Inc. The Bermuda Biological Station for Research has received National Science Foundation Research Experiences for Undergraduates funding to support 8 fellowships for undergraudate student research at BBSR during the 1992 fall semester (September 21–December 12, 1992). Students will design supervised but largely independent projects within several research areas including: the biology, chemistry, and physics of the open ocean; the biology, physiology, and biochemistry of reef building corals and reef ecosystems; the nutrient chemistry and biology of Bermuda's inshore waters; and the effects of global environmental change on these systems.

Eligibility and Terms of Fellowship. Students who have completed one to three years of study toward a bachelor's degree and who will still be undergraudates in the fall of 1992 are eligible to apply. Minorities and women are especially encouraged. Applicants must be U.S. citizens or permanent residents. We encourage all successful fellows to arrange for independent study credit through their home institutions.

Each successful fellow will receive a $250 per week stipend. Travel expenses will also be covered. Students will be housed and fed on the BBSR 15 acre campus at special REU rates of $70 per week for housing and $110 per week for cafeteria-style meals.

BBSR. The Bermuda Biological Station for Research is an independent U.S. marine research and educational institution located near the town of St. George's on the island of Bermuda. We are the site of a number of long-term ocean time-series projects related to the study of global change and have a 115 ft. research vessel, the R.V. Weatherbird II. There are 10 resident scientists at BBSR, plus a diverse group of visiting scientists from all over the world.

For more information and an application form, contact: Dr. Susan B. Cook, Education Office, Bermuda Biological Station, 17 Biological Lane, Ferry Reach, GE01, Bermuda. Phone (809) 297-1880, fax 809-297-8143, omnet telemail: bda.biostation.

Applications are due by April 15 with a program admission target date of June 1, 1992.

Master of Geology, University of Sonora at Hermosillo, Sonora, Mexico. The Department of Geology at the University of Sonora invites applications from students holding a Bachelor degree to its Master in Science program with main emphasis on: ore deposits of Northwestern Mexico, cartography and structural analysis, regional tectonic studies.

This is a good opportunity to get familiar with the exploration of ore deposits in the region and to learn Spanish. The Department has working connections with several countries and an international teaching corpus. Applicants should submit a curriculum vitae. Accepted students who are not fluent in Spanish are advised to plan a two month period in Hermosillo prior to classes. More information: Department of Geology, University of Sonora, P.O. Box 7386, Nogales, AZ 85628.

Abstract Forms Available Now

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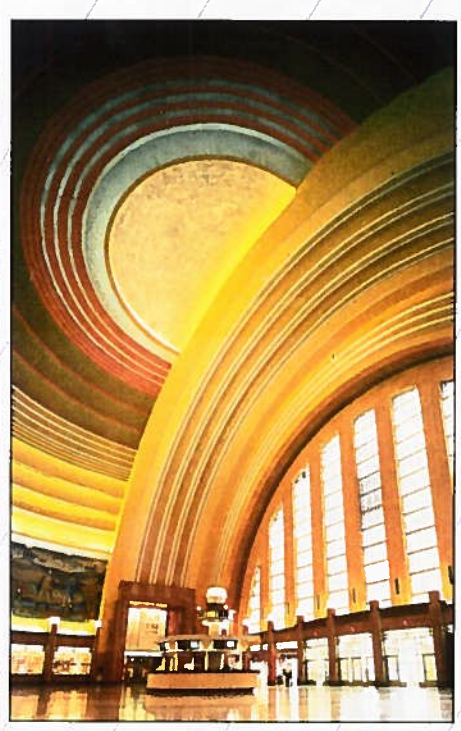
GSA ANNUAL MEETING
OCTOBER 26–29, 1992
CINCINNATI, OHIO

Abstracts Deadline: July 8

Abstracts must be typed on 1992 Abstract Forms, available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, or call (303) 447-8850. Volunteered abstracts must be mailed to the same address in time to arrive on or before July 8, 1992.

See pages 77–84.



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