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GSA TODAY

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INSIDE

Evidence of Collisional Processes Associated with Ophiolite Obduction in the Eastern Mediterranean: Results from Ocean Drilling Program Leg 160

Scientific Participants of Leg 160:
A. H. F. Robertson and*
K.-C. Emeis (Co-Chief Scientists),
C. Richter (Staff Scientist),
M.-M. Blanc-Valleron, I. Bouloubassi,
H.-J. Brumsack, A. Cramp,
G. J. De Lange, E. Di Stefano,
R. Flecker, E. Frankel, M. W. Howell,
T. R. Janecek, M-J. Jurado-Rodriguez,
A. E. S. Kemp, I. Koizumi,
A. Kopf, C. O. Major, Y. Mart,
D. F. C. Pribnow, A. Rabaute,
A. P. Roberts, J. H. Rüllkotter,
T. Sakamoto, S. Spezzaferri,
T. S. Staerker, J. S. Stoner,
B. M. Whiting, J. M. Woodside

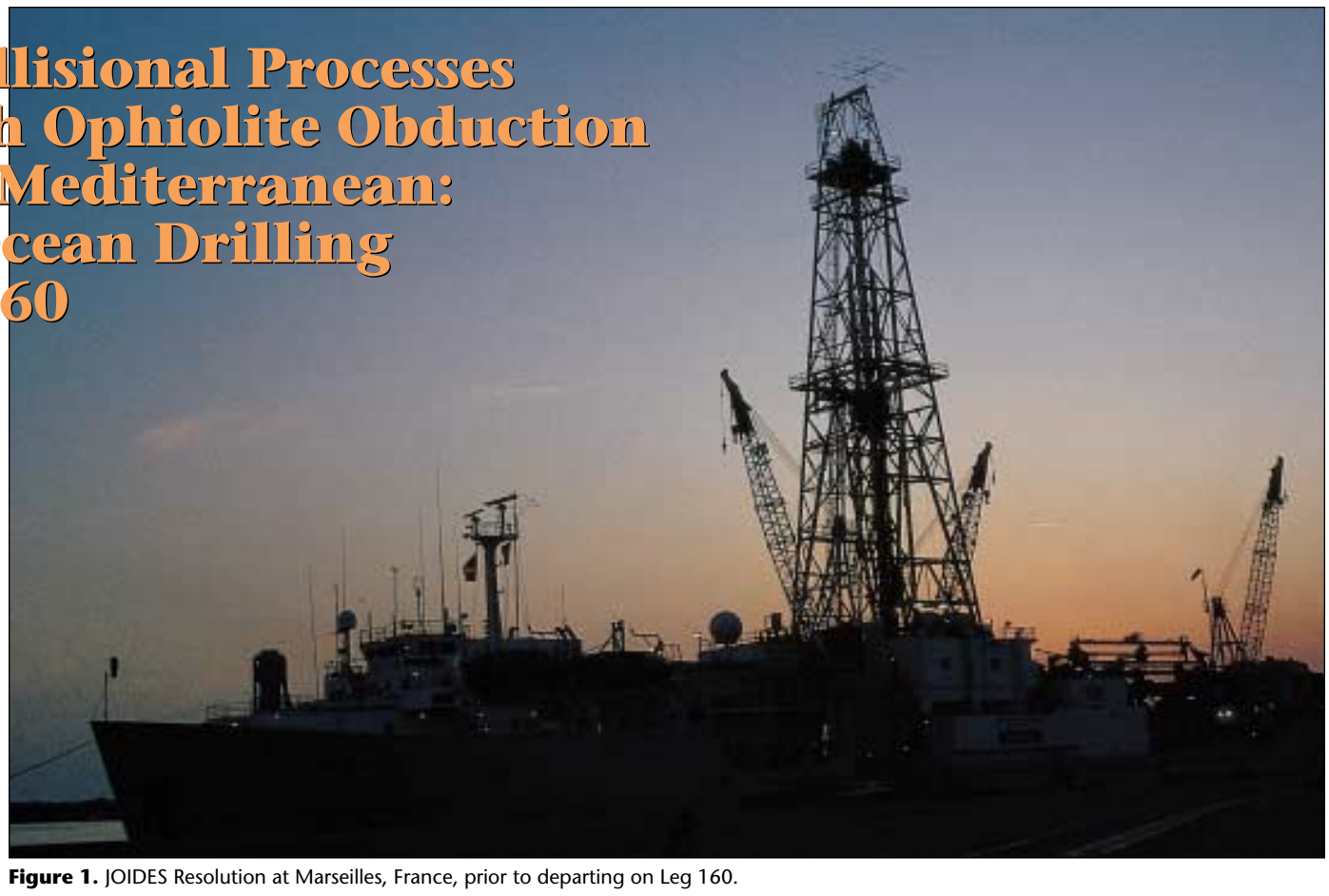

Figure 1. JOIDES Resolution at Marseilles, France, prior to departing on Leg 160.

ABSTRACT

Recent drilling in the eastern Mediterranean Sea south of Cyprus has revealed important insights into fundamental tectonic processes associated with continental collision and ophiolite emplacement. A transect of four sites was drilled across the Africa-Eurasia plate boundary. The results show that the African plate, represented by the Eratosthenes Seamount, underwent rapid subsidence and related faulting in Pliocene-Pleistocene time. The driving force was tectonic loading by the Eurasian plate. In this area the leading edge is represented by the Troodos ophiolite. The breakup and subsidence history of the Eratosthenes Seamount, as revealed by drilling during Leg 160, is clearly linked with the emplacement of the Troodos ophiolite. This underwent strong surface uplift during active tectonic emplacement, associated with collision of the seamount with the Cyprus margin.

INTRODUCTION

Many ophiolites were emplaced long ago by processes that are no longer active (e.g., the Upper Cretaceous Oman ophiolite). However, the Troodos is an example of an ophiolite that is undergoing active emplacement today, in an area that is easily accessible and geologically well known. Much of the evidence for this emplacement is recorded beneath the sea to the south of Cyprus, along the boundary between the African and Eurasian plates. This area was a target of drilling during Leg 160 in March and April 1995 (Figs. 1 and 2).

The eastern Mediterranean Sea (Fig. 3) is a remnant of the Mesozoic Tethys ocean (Dercourt et al., 1993). Different areas record various stages of Tethys closure, ranging from fully collisional settings on land to the east to areas of incipient collision on the Mediterranean Ridge in the west (Cita and Camerlenghi, 1990). One such area of incipient collision includes the Eratosthenes Seamount, south of Cyprus. Previous geophysical studies (Woodside, 1977, 1991; Krasheninnikov et al., 1994) suggest that the Eratosthenes Seamount is a fragment of continental (or transitional-type) crust that is undergoing subsidence and breakup in a zone of incipient collision between the African and Eurasian plates (Robertson, 1990; Kempler, 1993; Limonov et al., 1994; Robertson et al., 1994, 1995).

Obduction *continued on p. 219*

*Corresponding author—Alastair Robertson, Department of Geology and Geophysics, University of Edinburgh, Edinburgh, EH9 3JW, UK.

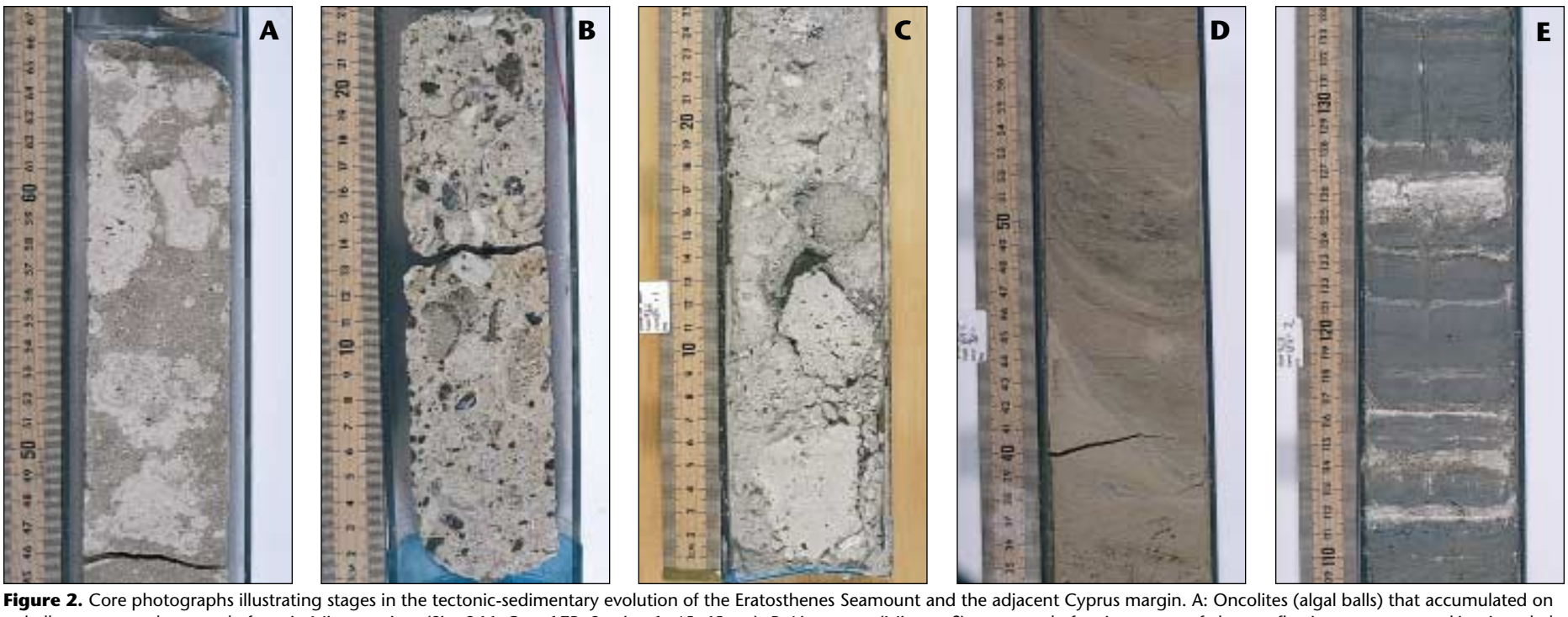

Figure 2. Core photographs illustrating stages in the tectonic-sedimentary evolution of the Eratosthenes Seamount and the adjacent Cyprus margin. A: Oncolites (algal balls) that accumulated on a shallow-water carbonate platform in Miocene time (Site 966, Core 17R, Section 1, 45–65 cm). B: Limestone (Miocene?) composed of various types of clasts, reflecting current reworking in a shallow-water shelf setting (Site 966, Core 13R, Section 1, 1–21 cm). C: Debris flow composed of clasts of altered shallow-water limestone in a matrix of muddy nannofossil ooze of early Pliocene age (Site 966, Core 8H, Section 1, 1-23 cm). D: Clast-rich nannofossil ooze of Pliocene age showing slumping and color banding. The slumping is related to collapse of the Eratosthenes Seamount (Site 965, Core 3H, Section 3, 35–58 cm). E: Calcareous silty mud with detrital gypsum of Messinian(?) age, possibly deposited in a saline lake located at the foot of the Cyprus slope (Site 968, Core 25X, Section 2, 108–132 cm).

IN THIS ISSUE

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A Year-End Message from the President

Investments Come in More Forms than Merely Stocks and Bonds

David A. Stephenson

For all of you who dabble, or dream of dabbling, in the stock market, to know the *cost* and the *value* of your investment is paramount. By your membership in this Society, you have become a "shareholder"—with a vested interest in the success and dividends of GSA. As in any corporation, you, the shareholder, are asked annually to elect the board of directors—who in turn are responsible to the shareholders. (The function of the GSA Executive Committee and Council is similar to that of a board of directors, and GSA's president and executive director function collectively very much like a CEO/corporate president.) Therefore, as shareholders of this corporation, you rightfully would expect (1) some return (the *value*) on your investment (the *cost*) of time and money, and (2) some communication of how the firm has performed.

Cost and Value

Costs associated with membership in GSA include dues (required), publications, registration for section and all-society (annual) meetings, contributions to GSA Foundation funds, and time allocated to GSA activities. The actual funds that GSA generates are broken down as shown on p. 215.

The true value of your invested time and money in GSA has far-reaching effects both for you professionally and for the geoscience community as a whole. GSA's existence has been centered on publications and the opportunity for its membership to enter scientific discussions. Can GSA be more, do more, for its membership? For example, can GSA become a unified voice on resource-related issues affecting the general public? What GSA is or could be—what its value could be—for its membership must continuously evolve. GSA's leadership—and, most importantly, its membership—are urged to identify new directions and participate in realizing the integration of these ideas.

In attempting to zero in on ways to increase the true worth and effectiveness of this organization, GSA's long-range planning group will be reviewing the Society's operations; in particular, should and could more members participate in the governance of the Society? Since the early 1970s, there has been a trend within GSA to concentrate decision-making within the Executive Committee. In contrast, the tendency within business and industry today is to empower. *Empowerment,* in essence, spreads the responsibility for decision-making to a broader group and can increase productivity and decrease overhead costs. The current long-range planning activities by the GSA Executive Committee, Council, and others will explore the issues of whether and how a broader percentage of membership (shareholders) can become more active in GSA via some form of empowerment action.

Annual Report

This past year did not start out to look very promising for the geosciences community. The very existence of several venerated institutions—in particular, the U.S. Geological Survey and the U.S. Bureau of Mines—was threatened. GSA representatives took the position that the majority of its membership would support activity to preserve the USGS and USBM. Thus, GSA joined with others in the American Geological Institute to talk to U.S. representatives and senators, and their staffs, in an effort to avert abolishment. Our goal was to encourage maintenance of strong agency programs while conceding that some changes could and should be made. Within reason, that goal was attained. A continuing goal will be to reduce the gap between what is known by geoscientists and what is used by governments and by individuals.

Other 1995 milestones for GSA have included:

- Newly appointed Executive Director Donald M. Davidson, Jr. became immersed in developing and managing headquarters staff and functions;
- The GSA annual budget was brought within Council-directed guidelines for expenditures, following several years off-budget, largely related to DNAG costs;
- The Second Century Fund drive and other GSA Foundation funding activities had a dramatic and positive turnaround;
- Daniel Sarewitz was hired as the new Insitutute for Environmental Education (IEE) program manager.

President's Message
continued on p. 215

In Memoriam

Cornelia C. Cameron
Winchester, Virginia

Robert S. Dietz
Tucson, Arizona
May 19, 1995

W. C. Fallaw
Greenville, South Carolina
March 17, 1995

Robert N. Farvolden
Dublin, Ohio
September 13, 1995

James Hume
Londonderry, New Hampshire
August 2, 1995

John E. Kilkenny
Alhambra, California
July 29, 1995

Porter A. Montgomery
San Antonio, Texas
July 8, 1995

John Mason Parker III
Raleigh, North Carolina
April 25, 1995

Memorial Preprints

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

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Morris S. Petersen, W. Kenneth Hamblin

Philip Chenoweth
Allan P. Bennison

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J. C. Harksen
Laurie J. Bryant

Donald William Levandowski
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Arthur A. Meyerhoff
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Marie Morisawa
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R. E. Gray, Brian Greene

Martin L. Stout
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Ada Swineford
James R. Underwood, Jr., Page C. Twiss, Grace E. Muilenberg, Paul C. Franks

GSA ON THE WEB

What's new on the GSA home page on the World Wide Web? If you haven't yet connected to the Web, the Uniform Resource Locator (URL) is **http://www.aescon.com/geosociety/index.html.**

If you want to know more about the GSA Employment Service or about becoming a GSA Campus Representative, check the **Membership** section, which also has information on nominating a member to fellowship and on obtaining forms for applying to become a GSA Member or Student Associate.

See the **Geoscience Calendar** section for a listing of meetings of general geological interest.

The **Publications** section has a monthly table of contents and abstracts of articles for the *GSA Bulletin* and *Geology.* Also in this section is a guide for authors preparing manuscripts for submission to GSA publications. *GSA Today* issues are posted here for downloading and viewing.

For Congressional Contact Information, see the **Administration** section. ■

President's Message *continued from p. 214*

	Percent of GSA Operation Income
Membership Dues	14.1
Annual Meeting Income	28.2
Publications—Members	21.4
Publications—Nonmembers	14.7
Other Sales	21.1
Miscellaneous Income	0.5
	100%

Total Income Percentages ***(average)***:

Operation Income	75%
GSA Foundation and Endowment	25%

His charge is to oversee a growing program left in excellent condition by Fred Donath;

- The SAGE and other educational programs continued to thrive under the able leadership of Ed Geary;
- Publications and their editors were highly visible for continued excellence in performance;
- Membership has continued to be fairly steady, with purposeful increases in the number of Fellows; and
- Graduate students exercised newly acquired voting rights for the first time in GSA history.

Little Known Facts (Geo-Trivia)

- The first use of a word similar to "geology" was in 1473, in *The Love of Books* by Richard deBury, Bishop of Durham. The word "geologia" was used by deBury in an entirely different sense than for the study of the earth. He used the term to designate the study of law, the earthly science, as opposed to "theologia," the study of spiritual sciences. The apparent first use of a "geologic" word (in its present sense) was a label on a package of papers in the will of Ulisse Aldrovandus, a naturalist and chair of natural history at the University of Bologna. The phrase "Geologia Ovvero de Fossilibus" was used in his will dated 1605. The term "fossil" included metals, earth, and stones. (F. D. Adams, 1938, *The Birth and Development of the Geological Sciences,* Dover Press, p. 165–166.)
- There have been 107 GSA presidents. One (Gilbert) served twice. The oldest was the first president, James Hall (78). The youngest was the eighty-sixth president, Clarence Allen (49). The average age of all 107 GSA presidents has been 61.5 years.
- There have been 14 executive directors of GSA. The first was John Stevenson (who was also the tenth GSA president). The youngest was Fairchild (41); the oldest were Eckel and Frye (62). The average age has been 51.8 years.
- Four GSA presidents have died in office: Winchell (1891), Berry (1945), Stock (1950), and Curtis (1991).

This president made it through alive and wiser … and very glad to have had this opportunity. ■

WASHINGTON REPORT

Bruce F. Molnia

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

OTA — Gone Tomorrow

"The basic function of the Office shall be to provide early indications of the probable beneficial and adverse impacts of the applications of technology and to develop and coordinate information which may assist the Congress."

— Public Law 92-484, which established the Office of Technology Assessment

On October 1, 1995, the U.S. Congress Office of Technology Assessment (OTA) became the first federal agency to be eliminated in response to Congress's ongoing effort to reduce government and to balance the budget. Earlier this year, the abolishment of OTA was identified in the appendix that accompanied the Contract with America (see April 1995 Washington Report) as one of more than 70 cost-cutting mechanisms that collectively could save the nation tens of billions of dollars. OTA's FY 1995 budget was all of $22 million. A skeleton crew of fewer than 20 will stay on through early next year to complete several dozen assessments, close up the offices, and turn off the lights.

OTA was established by Congress in 1972, during the Nixon Administration. OTA's job was to provide congressional committees with objective analyses and assessments of the emerging difficult and often highly technical issues of our time. Typically, according to OTA's implementation legislation, an OTA assessment would: identify existing or probable impacts of technology or technological programs; ascertain cause-and-effect relationships; identify alternative technological methods of implementing specific programs; identify alternative programs for achieving requisite goals; make estimates and comparisons of the impacts of alternative methods and programs; present findings of completed analyses to the appropriate legislative authorities; identify areas where additional research or data collection is required to provide adequate support for the assessments and estimates described; and undertake such additional associated activities as the appropriate authorities may direct.

OTA's analyses were prepared in a style and at a technology level where they were of value to members of Congress, the scientific and technical

OTA *continued on p. 218*

CALL FOR NOMINATIONS REMINDERS

Materials and supporting information for any of the following nominations may be sent to GSA Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. For more detailed information about the nomination procedures, refer to the October 1995 issue of GSA Today, or call headquarters at (303) 447-2020, extension 136.

Penrose and Day Medals, and Honorary Fellowship

Nominations for 1996 Penrose and Day Medals and for Honorary Fellowship in the Society are due by **FEBRUARY 1, 1996.**

Young Scientist Award (Donath Medal)

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

For the year 1996, only those candidates born on or after January 1, 1961, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1996 award must include

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

Deadline for nominations for 1996 is **FEBRUARY 1, 1996.**

Officers and Councilors

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

Deadline for nominations for 1997 is **FEBRUARY 15, 1996.**

Distinguished Service Award

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the annual meeting of the Society. Deadline for nominations for 1996 is **MARCH 1, 1996.**

John C. Frye Environmental Geology Award

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a $1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund. The 1996 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in Denver.

Nominations can be made by anyone, based on the following criteria: (1) paper must be selected from GSA or state geological survey publications, (2) paper must be selected from those published during the preceding three full calendar years, (3) nomination must include a paragraph stating the pertinence of the paper.

Nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers). Deadline for nominations for 1996 is **APRIL 1, 1996.**

National Awards

The deadline is **April 30, 1996,** for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award.

Enhanced Earth Science Research and Public Education in the U.S. National Park System

Paul K. Doss, Department of Geology, Colby College, Waterville, ME 04901
Heidi J. Doss, Acadia National Park, Bar Harbor, ME 04906

ABSTRACT

More of the knowledge gained from geological research conducted in national parks or other federal lands should be ultimately transferred to the public. The most obvious pathway for such transfer is existing channels at individual parks. Typically, the passing of knowledge from an interpreter (naturalist) to the public occurs through public education programs. However, comparable established methods for the transfer of new scientific conclusions from a scientific researcher to the interpreter do not exist. Increasing the transfer of results from geological research in national parks and other federal lands directly to interpreters by researcher-initiated training programs would increase dissemination of new information and benefit the public, the interpreters, and scientists. Researchers would transfer new knowledge to the interpreters, who in turn would design new programs or incorporate new information into existing programs for the benefit of the public. Researchers could also facilitate education in parks by conducting public programs as guest naturalists. Park staff and the public are usually enthusiastic about interacting directly with scientists. Clearly, academic geoscientists have the opportunity, and perhaps an obligation, to expose the public and park educators to the results of their research on public land. National parks are an important resource for many academic researchers. Geoscientists would benefit by participating in education efforts, perhaps primarily by increasing public exposure and an improved understanding of our contributions to society.

INTRODUCTION

National parks and other public lands, including national forests, wilderness areas, and state and municipal parks, constitute a significant resource for earth scientists. Many of the geologists who conduct research on these lands are not directly employed by the resident land-management staff. The presence of these scientists, including academic researchers and employees of other agencies, on public lands provides a valuable opportunity, and perhaps an obligation, for enhanced education and interaction with the public.

National parks, most of them having unique geologic features, are sites for much "cutting-edge," fundamental, and applied geological research, much of it conducted by research scientists who are not park employees (for example, tectonics in Glacier National Park—Yin and Kelty, 1991; the role of fractures in arch development in Arches National Park—Cruikshank and Aydin, 1994; climate change in Yellowstone National Park—Whitlock and Burtlein, 1993; the role of petrology on slope stability in Hawaii Volcanoes National Park— Clague and Denlinger, 1994; carbonate beach development at Acadia National Park—Barnhardt and Kelley, 1995). Not all geological research is applicable to public education efforts, but most new research improves the understanding of issues that are pertinent to natural history, landform interpretation, ecosystem function and integrity, economic geology, or natural hazard interpretation and prediction. Because these topics often form the significant aspects of environmental education in national parks, current research results, and their implications, should be a significant component of the public education programs that operate within the national park system.

The call for geoscientists to participate in public affairs has become more frequent, stronger, and clearly more necessary (e.g., Stephenson and Zen, 1995; Schneiderman, 1995). In addition, the ability simply to conduct scientific research on some public lands is under scrutiny by strict interpretations of the Wilderness Act. One particular case involves the rejection of the Katmai Scientific Drilling Project in Katmai National Park, Alaska (Eichelberger and Sattler, 1994). In another example, the "Vessel Management Plan and Environmental Assessment" developed for Glacier Bay National Park, Alaska, may exclude research vessels from part of Glacier Bay (R. D. Powell, 1995, personal commun.). The vessel exclusion would effectively remove Muir Glacier from any scientific investigations, an apparent direct contradiction of the foundation for the original Glacier Bay National Monument: to promote scientific study and protection of the dynamic glacial environment.

The current climate of a negative public perception and lack of awareness of scientific research, the tenuous status of research funding, and many environmental, natural hazard, and resource-related problems make it clear that scientists must proactively disseminate their research-generated knowledge, particularly research conducted with public funding or conducted on public lands. The fact that the U.S. Geological Survey was recently targeted for abolishment as part of spending cuts in the "Contract with America" underscores the negative (or perhaps absent) public perception of geological research. Even though the U.S. Geological Survey appears safe at the moment from dismantling, the fundamental role of continued federal funding for basic and applied research is under intense scrutiny.

For those of us who conduct research on public lands, there is a perfect opportunity to disseminate research results and participate in education efforts; the potential benefits of scientist participation in public education are extensive.

An environmental education program developed for schoolchildren visiting Acadia National Park.

Heidi Doss leading a field-based, interpretive program for Acadia National Park visitors.

Natural Resource Management and Research in National Parks

At least three distinct divisions within the National Park Service deal directly with research and education issues about natural resources in national parks, including Resource Management, Interpretation, and Research (many research-grade positions within the National Park Service were recently incorporated into the new National Biological Survey). The level of communication among these three divisions varies significantly both within parks and among different parks. Communication between Research and Resource Management is often productive. In fact, an internal, national publication of the National Park Service, *Park Science: Integrating Research and Resource Management*, is, as the title indicates, dedicated to the relationship between those two divisions. This important linkage must remain productive; however, inclusion of the Interpretive Division as an integral link in the relationship seems equally important, albeit for different goals. For instance, acknowledging that interpreters and environmental educators are valuable players in natural resource management, Wells (1995) noted that "... there are tremendous opportunities for research and interpretation to partner in closing the gap between science and public understanding of natural resource issues."

Excellent examples of interaction of external researchers with interpreters and the public in national parks do exist. Acadia National Park in Maine has two programs that provide scientific training for staff interpreters and, in one case, the interested public. The training program "Interpwoods" brings together internal and external researchers to provide half-day and full-day workshops on selected scientific issues within the park. This program, also in place in other national parks (e.g., Everglades National Park, Florida; Cape Cod National Seashore, Massachusetts) functions as a form of training for park interpretive staff. Acadia has also received federal and private funding to support the Resource Acadia program, a series of educational seminars on scientific and resource issues of current significance within the park. Similar programs (Yosemite Institute, Yellowstone Institute) are in place in other national parks. Led cooperatively by various scientists and interpreters, Resource Acadia programs are generally directed toward the local public (as opposed to the visiting public) as well as park staff. These educational programs are enormously successful at Acadia and other national parks.

At least one park has also highlighted natural science and cultural research in a publication that is available to the public. *Yellowstone Science*, a quarterly publication by the Yellowstone Center for Resources, Wyoming, includes brief reports and essays by park and nonpark scientists. Articles focus on formal research that is conducted within the Yellowstone area.

Natural Resource Education and Interpretation in National Parks

Environmental and natural resource education directed toward the public in national parks occurs in different modes. Education programs may be nonpersonal—the learning process is controlled and motivated by the visitor. Nonpersonal services are aided only by pamphlets, nature trail displays and guides, wayside exhibits, and static displays in nature centers and visitor centers. The more personal or active education modes in parks include narrated slide shows, campfire and amphitheater programs, ranger-led hikes, and field-based interpretive programs. Also, topical environmental education programs are developed specifically for off-site presentations, for schoolchildren or special groups. Both education modes provide the opportunity for researcher involvement.

Winter (1993) presented a series of recommendations for establishing and maintaining a communications link between researchers and educators in national parks. These recommendations include research liaisons staffed by the interpretive division, and requirements that science division employees provide research information to the interpretive staff and that a

NPS *continued on p. 217*

NPS *continued from p. 216*

formal and sustained line of communication be established between the regional chiefs of interpretation and science. Although these recommendations could likely be instituted with little difficulty, at least three problem areas are evident. First, the recommendations were not widely disseminated. Second, the likelihood of additional funding for a research liaison within the interpretive division is low. Third, there is no mention of direct involvement of nonpark scientists in the process. Some mechanism to incorporate academic scientists into the educational process on public lands would provide benefits to the scientific community, the public, and park personnel.

INVOLVEMENT AND PARTICIPATION OF EXTERNAL RESEARCHERS

Although a few excellent programs have been organized in some parks for transfer of information to rangers and the public by researchers, there is no established protocol or obligation for involvement, specifically of external researchers, in knowledge transfer within the system of national parks and other federal lands. Although geologists and other scientists who apply for and receive a National Park Collector's Permit are requested to submit a brief "Annual Investigator's Report" to the Resource Management staff, the content of those summaries is not particularly well suited, nor are they readily available, for use by the educational staff.

Not all scientists are able to develop educational programs, based on their research, that would be applicable to public education. However, we strongly believe that earth scientists should consider public exposure to scientific research and education of the public about environmental and scientific issues to have a much higher priority for the profession than they generally do now.

Active participation in public education can be difficult and time-consuming, but the potential benefits from such participation can be extensive—and realized by all parties involved, including park personnel (interpreters and educators), the public, and the researcher.

Benefits to Park Personnel

Park staff would benefit considerably if external researchers were to become more consistently involved with public and naturalist education. Perhaps the most significant benefit would be the exposure of park educators to current research methodology and results. Depending on the nature of the relationship between the scientist and the park staff, interpreters may actually participate in data collection. During the course of hydrogeologic research at Indiana Dunes National Lakeshore, northwest Indiana, (Doss, 1993), environmental education and interpretive rangers at the Paul H. Douglas Environmental Education Center provided invaluable assistance by collecting, nearly daily, data on water levels from a staff gage mounted along a public boardwalk. The educators were an integral and important part of current scientific research. Periodically, the education staff would be provided hydrographs of the water levels they monitored and brief reports that would help put the work into perspective; their appreciation of the value of their efforts increased over the course of the study.

In addition to participation in the research project, the rangers were also given training on the overall aspects of the research. In that context, the educators were enlightened on aspects of hydrogeologic research. When educators are involved in the salient aspects of ongoing research, a very real result may be ranger-initiated enhancements of existing educational programs. For example, in some cases Indiana Dunes rangers were observed using the boardwalk-mounted staff gage during the course of their school group and public programs to discuss water-level fluctuations in wetland ecosystems.

Finally, an active relationship between scientists and park interpreters leads to a better understanding of the role each plays. With understanding comes mutual respect and appreciation for the importance of scientific research and public education about that research.

Benefits to the Public

Involvement of external researchers in education efforts in national parks would provide significant benefits to the public, with immediate positive effects on the scientific community. If geologists were involved in public and educational programs in national parks, the park visitor would gain an increased awareness and knowledge of current geoscience, natural resource, resource management, and environmental issues. In general, the public perception of scientific research in the United States is less than ideal. If the general public were given the opportunity, in a comfortable and relaxed setting, to "see" the application of "real" science and, perhaps, their first opportunity to interact with a research scientist, the response would likely be positive; our experience is that the interaction is productive.

Education of the public about current research in national parks may be that public's first—and only—direct exposure to taxpayer-funded science. With a well-developed and understandable explanation of current research and of any potential applied implications of those studies, the public may truly understand the nature of earth science research. This could result in a public that is more aware and supportive of federal funding of science and research budgets. The public may also become more supportive of private, local groups that provide funding and assistance to national parks.

Many national parks are currently implementing changes in resource management policy as a direct result of the conclusions developed from scientific research. For example, hydrogeologic restoration of predevelopment water flows in Everglades National Park (Fennema et al., 1994; Van Lent and Johnson, 1993), wetland restoration at Indiana Dunes National Lakeshore (Childers et al., 1995) and National Capital Parks—East, Washington, D.C. (Syphax and Hammerschlag, 1995), surface-water usage and resource allocation near Grand Teton National Park, Wyoming (Elder et al., 1994), and land-use and resource management plans at Great Basin National Park, Nevada (Brown and Davila, 1993) have resulted from on-site geological research. These types of significant policy and management plans and their relation to scientific research must be included in educational programming in the parks. Knowledge of the "real-life" application of scientific research and its benefits will certainly raise the level of public acceptance of science. That acceptance may also extend to the very important research that is not "applied" or completely understood by the lay public.

Benefits to the Researcher

Some of the many and varied benefits to the researcher from educational involvement result directly from the positive impacts on the educator and the public. As at least a secondary priority after pure scientific inquiry, researchers want their work to be known. Park education programs are a perfect opportunity to get that research out and disseminate results. Another important benefit of research exposure is researcher exposure. It is clearly a mutual benefit when scientists and the public are able to interact in a setting that is comfortable to both parties. A national park where the public visits and the geologist conducts research is just that setting.

Research that is dependent on federal funding for completion would be well served by the unbiased voice of the nonscientific public advocating congressional support in budget development. It is in the best interest of the academic research community to make its own best effort to gather public support of research endeavors. For those of us who often work there, national parks are a great "foot in the door" for that type of support.

Any involvement by scientists in education efforts in parks will promote a higher level of accuracy in programs. During educational program development, interpreters and naturalists typically depend on limited and sometimes outdated references. By providing current and continually updated information, researchers can be more confident that accurate information is being provided to park visitors.

Finally, geologists may be directly assisted by park staff in the course of conducting research. Of course, this benefit depends upon the nature of the working relationship between the investigator and park personnel. Staffing and availability of assistance are also extremely important, and may not always be available. Park staff, however, are on-site daily, whereas that may be impossible for the researcher.

A training session for park rangers, focusing on beach geomorphology and coastal wetland development. *(Photo by Kathie M. Petrie.)*

Paul Doss leading a training session on geological history for park educators and the local public at Acadia National Park. *(Photo by Kathie M. Petrie.)*

Potential Problems

Given the realities of field research and park management, the ideal relationship between scientific research and public education will not always be easily obtained. Geological field work is time-consuming, and finding the time to develop and lead public programs or ranger training sessions may be difficult. In addition, with tight research budgets and limited time and funds available to park personnel, implementation of programs and material development can be problematic.

Not all current research is well suited to inclusion in public education programs, and care must be taken in educating the public about research that may not be easily perceived as important and necessary. The scientific community appreciates the need for all types of research, both pure and applied. The general public may not be as receptive to that concept. Similarly, not all researchers are adept at communicating their scientific investigations to a nonscientific audience. This difference among scientists is unavoidable and in no way reflects poorly on any individual investigator. The participation in public education is perhaps best left to those scientists who are comfortable with and capable of developing a productive discourse and rapport with park naturalists and the park-visiting public. Those geologists who choose not to participate publicly might simply, yet actively, provide appropriate research results and interpretations to the park educational staff.

Recommendations

Geoscientists who conduct research in our national parks and on other public lands should consider the opportunity to participate in public education efforts about science and natural resource issues. Geologists could train park interpreters in the significant facets of their research using standard pedagogical techniques such as field hikes and slide shows. Scientists may also work directly with the public by conducting educational programs

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NPS *continued from p. 217*

on site. The public is generally most enthusiastic about direct interaction with active scientists, whether it be in the context of a slide presentation, field hike, or amphitheater program.

Less interactive involvement could consist of preparation of understandable summaries and reports of significant findings and interpretations, preparation of new or improved trail guides, wayside exhibits, written material, and static visitor-center displays, or donations to park slide collections. The geologist could furnish progress reports and copies of published or unpublished manuscripts to the interpretive staff. Even better, the researcher could prepare more "user-friendly" reports or executive summaries that would be more easily understood by park educators (for example, Tabor, 1987; Mattox, 1994). These summaries decrease the likelihood of misinterpretation of data by educators and the public.

In a more active sense, scientists can participate directly in the same education programs performed by park interpreters. With appropriate consultation with park interpretive staff, geologists themselves can lead field hikes, give slide shows, and lead campfire discussions. In one noteworthy case, researchers implemented an interactive visitor-education program about ground-water contamination at Wind Cave National Park, South Dakota (Hahn and Venezky, 1994). By the use of the Mosaic program, the display is also offered on the Internet to a larger audience.

In cases where park staff is able and willing to assist a researcher in the field, a positive interaction can develop. Best suited for assistance would be simple measurements, at a single site, that could easily be incorporated into established duty assignments. This working relationship could be best developed by a mutual exchange of assistance. In return for help provided by park staff, the researcher could develop and present a public program, narrate a slide show, improve an existing trail map, or provide training sessions for new and seasoned rangers. Offering assistance as a reviewer and editor for revised or new written information may also be productive.

One mechanism currently exists that could very easily be modified to ensure external researcher involvement in education in national parks. Any research conducted in a national park that includes collection of samples of any kind requires that a scientist obtain a National Park Service Collectors Permit. The permit (approved by the Resource Management Division or Protection Division and the park superintendent) informs the park staff of intended research and nature of sample collection. The permit process could be modified to require a statement by the researcher of her or his planned, voluntary efforts to educate naturalists or park visitors on the nature of the research, expected results, and the conclusions. Such a statement of voluntary involvement might motivate the researcher who is capable of public and naturalist education, while at the same time identifying those scientists and research projects not particularly well suited to public education. Clearly, the response to this inquiry should not, at least initially, have any bearing on approval or denial of the collection permit.

Conclusions

We have restricted the scope of this discussion to geological research in national parks, but the same conditions exist for other disciplines and on other federal lands, state parks, county and municipal lands, and nature preserves. We recommend that geoscientists conducting research on any public land do their best to become active participants in educational programs within those settings. Geological research on local public lands may have an even greater positive impact on the public than research conducted on the typically farther removed national parks.

The concepts proposed here advocate at least partial transfer of responsibility from educator to scientific researcher. Historically, interpreters have sought out the scientist for new information for inclusion in public programs. Perhaps it is in the best interest of the scientific community for the individual researcher to take additional responsibility for initiating and fostering a productive, and mutually beneficial, relationship between geologist and interpreter.

Acknowledgments

We thank all of the National Park Service staff, visitors, and geologists with whom we have had the privilege to work over the years; Bob Corbett and Barbara Manner for their development of the GSA North-Central Section symposium where we first had the opportunity to discuss our work; Virgil Frizzell, for motivating us to prepare the manuscript; and Donald Davidson, Shirley Beccue, and Steven Mattox for their thoughtful reviews of the manuscript.

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OTA *continued from p. 215*

community, and the general public. OTA also offered a variety of other services to the Senate and House of Representatives. These included providing briefings, presenting testimony, and preparing major assessment reports, which were made widely available to others. Through October 1995, more than 750 such assessment reports were prepared. A typical OTA assessment took one to two years and focused on a complex science and technology issue, attempting to identify policy options and provide foresight about new developments that could have implications for future federal policy. An OTA assessment did not advocate a particular policy or action. Rather, it pointed out the pros and cons of the identified spectrum of possible actions, sorted out the facts, and provided options. Often, the consequences of each policy option might be presented. Often, during hearings and floor debates, OTA reports were quoted by parties on both sides of an issue.

An OTA assessment could only be initiated at the request of OTA's Technology Assessment Board (TAB) or by the chair or the ranking minority member of a congressional committee. All projects had to have the authorization of the TAB. OTA staff would then plan, direct, and draft the assessment, drawing broadly on the technical resources of the private sector. An advisory group was almost always drawn from the academic community, nongovernmental public interest groups, state and local governmental representatives, and citizenry at large. At its demise, OTA had a multidisciplinary staff of 143 employees. A recent article in the *Christian Science Monitor* stated that without the OTA, "Congress would be flying blind through the sci-tech jungle."

OTA's bipartisan 12-member TAB was composed of an equal number of Republicans and Democrats and an equal number of senators and representatives. The OTA director was also a nonvoting board member. During the past decade, I have been a participant in four OTA assessments, the most recent, earlier this year, an assessment of spent nuclear fuel and its disposal. Each of these four assessments, as all of the other OTA reports that I have reviewed, was a complete and professional analysis of the issue at hand.

You may ask why a productive, effective agency such as OTA would be eliminated. A number of reasons have been given by OTA workers and the media. They range from concerns that OTA assessments duplicated work done by other government agencies, such as the General Accounting Office (GAO) and the Congressional Research Service (CRS), and by private-sector advisory bodies, such as the National Research Council (NRC) of the National Academy of Sciences (NAS); that OTA took so much time to produce its assessments that legislation was already voted upon before the related report would appear; that OTA, which worked for committees and not members of Congress, was poorly known by the large number of new members of Congress, and hence its value was not known in the current Congress; or that given a choice between cutting their own staffs or the staff of committees to which they belong, members would rather look out for their own interests and cut a third party such as OTA.

Some said that Congress needed to show it was serious in its efforts by eliminating one of its own agencies before taking on other agencies such as the Department of Commerce. Some pointed out that Senator Ted Kennedy (D—MA) was instrumental in the founding of OTA and that he still serves as chair of its advisory board. By association, this may label OTA as being too liberal. Some point out that OTA is perceived as being too close to the Clinton White House, with former OTA Director John Gibbons serving as the President's science advisor and head of the Office of Science and Technology Policy. Others point out that OTA was the first entity to clearly question many of the basic premises of the Strategic Defense Initiative (SDI) and that without OTA, it might be substantially easier to restart SDI. For whatever reason, OTA is gone.

In the District of Columbia, a group of former OTA employees have incorporated a consulting firm called the Institute of Technology Assessment. They hope to keep the concept of OTA alive with funding provided by foundations and from contracts. They will expand their sphere of coverage to respond to policy issues of interest to state and local governments as well as the nation. Ultimately, they hope that Congress will see the folly of its ways and realize that a life without OTA is a life devoid of factual options. ■

Obduction *continued from p. 213*

This hypothesis could be tested by drilling a transect of relatively shallow holes (most <300 m) across the Africa-Eurasia plate boundary. One hole was drilled on the northern part of the seamount plateau (Site 966), one on the upper northern slopes (Site 965), one on a small high at the base of the northern slope of the seamount (Site 967), and one on the lower slope of the Cyprus margin to the north (Site 968; Fig. 4, inset).

In this article we summarize the new information gained by drilling, and we demonstrate how this can be used to test a model of collisional processes and ophiolite obduction that is of general importance. The details of the recovery at the individual sites are recorded elsewhere (Emeis, Robertson, Richter, et al., 1995).

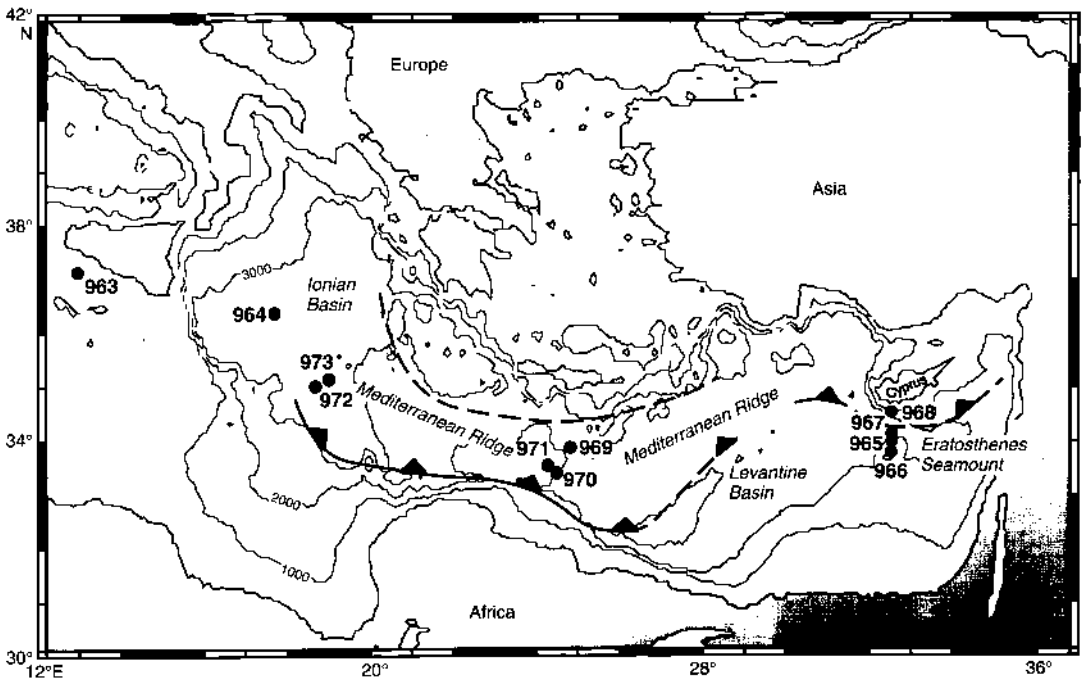

Figure 3. Outline map of the Mediterranean showing the main tectonic features and the locations of the sites drilled during Leg 160. This article deals only with the transect of sites drilled between Cyprus and the Eratosthenes Seamount (Sites 965, 966, 967, and 968). The line with teeth marks the deformation front between the African and Eurasian plates.

SUMMARY OF DRILLING RESULTS

The nature of the basement of the Eratosthenes Seamount is unknown, but it might represent transitional crust of a rifted passive margin. The presence of mafic igneous intrusions at depth is suggested by the existence of a strong magnetic anomaly beneath the seamount and adjacent seafloor areas (Woodside, 1977, 1991). The oldest sediments recovered during Leg 160 are undated shallow-water carbonates that underlie Upper Cretaceous pelagic carbonates at Site 967 (Fig. 4). In the pre–Upper Cretaceous, the Eratosthenes Seamount formed part of a carbonate platform, as widely exposed around the eastern Mediterranean (e.g., in southern Turkey and the Levant). Overlying pelagic carbonates, of Upper Cretaceous and middle Eocene age at Site 967 and of exclusively middle Eocene age at Site 966, indicate accumulation in a quiet deep-water (bathyal) setting. The absence of gravity input (e.g., turbidites) within the Upper Cretaceous and middle Eocene pelagic sediments is consistent with deposition on a submerged platform or promontory, isolated from terrigenous input. The Eratosthenes Seamount area was probably then still located well to the south of areas of Tethys that experienced ophiolite emplacement and active margin deformation in the latest Cretaceous (Campanian-Maastrichtian; Şengör and Yilmaz, 1981).

Middle Eocene pelagic carbonate accumulation was followed by shallow-water carbonate deposition. The carbonates accumulated in a near-reef, platform setting and are dated as early Miocene at Site 967, on the basis of benthic foraminifera (I. Premoli-Silva, 1995, personal commun.). Water depths must have decreased by more than several hundred meters between the middle Eocene and the Miocene, which implies that surface tectonic uplift of the Eratosthenes Seamount must have taken place, in addition to the effects of any eustatic sea-level change. This uplift is not likely to have been collision-induced, because the subsequent Miocene shallow-water deposition took place under relatively tectonically stable conditions, but it could instead reflect tectonic movements related to an earlier history of subduction. Regional and local evidence (e.g., in Cyprus and Crete) suggests that the present-day Africa-Eurasia plate boundary was already in existence in the eastern Mediterranean by the Miocene (Dewey and Şengör, 1979; Şengör et al., 1985; Robertson et al., 1991; Meulenkamp et al., 1994).

During the Messinian salinity crisis, shallow-water marine deposition on the Eratosthenes Seamount gave way to erosion and/or local accumulation of gypsum and ferruginous muds in small marginal lagoons and/or lakes, as recorded at Sites 965 and 967 (Fig. 5). By contrast, a much thicker (~150 m) succession of inferred Messinian age was deposited at Site 968 on the lower Cyprus slope. This was probably deposited in a large lake or inland sea, well below eustatic sea level. The existence of Messinian lakes was previously inferred in the western Mediterranean Tyrrhenian Sea (Kastens, Mascle, et al., 1990).

Distinctive matrix-supported breccias occur between underlying shallow-water carbonates and overlying nannofossil oozes of early Pliocene age at Site 966. They formed by mainly mass-flow processes during the early Pliocene (pre–4.5 Ma). The source of many of the clasts was a shallow-water limestone, similar to the underlying succession. Pliocene accumulation took place in a relatively deep-marine setting (more than several hundred meters), based on microfossils in the matrix. Erosion of the limestones that are redeposited as clasts in the lower Pliocene might have been subaerial, subaqueous, or both, but there is little evidence of clast rounding via sedimentary transport. A tectonic fabric present within several clasts could suggest derivation from a faulted rock (e.g., an erosional fault scarp). The presence of nannofossil mud clasts also indicates that deep-marine sediments were reworked in an unstable slope setting.

The Pliocene-Pleistocene successions at each site are composed of nannofossil oozes interbedded with calcareous muds, numerous sapropels, and minor volcanic ash. The Eratosthenes Seamount sites (Sites 965, 966, and 967) are now at water depths ranging from 700 to 2900 m. These differences in water depth are the result of differential subsidence of the seamount area. Much of this subsidence took place relatively rapidly. The early Pliocene sediments accumulated in deep water, without evidence of a gradual upward transition from shallow-water conditions. Benthic foraminifers indicate a further deepening after the late Pliocene, at least at Site 967.

TECTONIC MODEL OF COLLISION AND OPHIOLITE EMPLACEMENT

The new information obtained by drilling can be used to test and substantiate a model of incipient collision and ophiolite emplacement. The tectonic model to be tested maintains that, following a more than 85 m.y. evolution

Obduction *continued on p. 220*

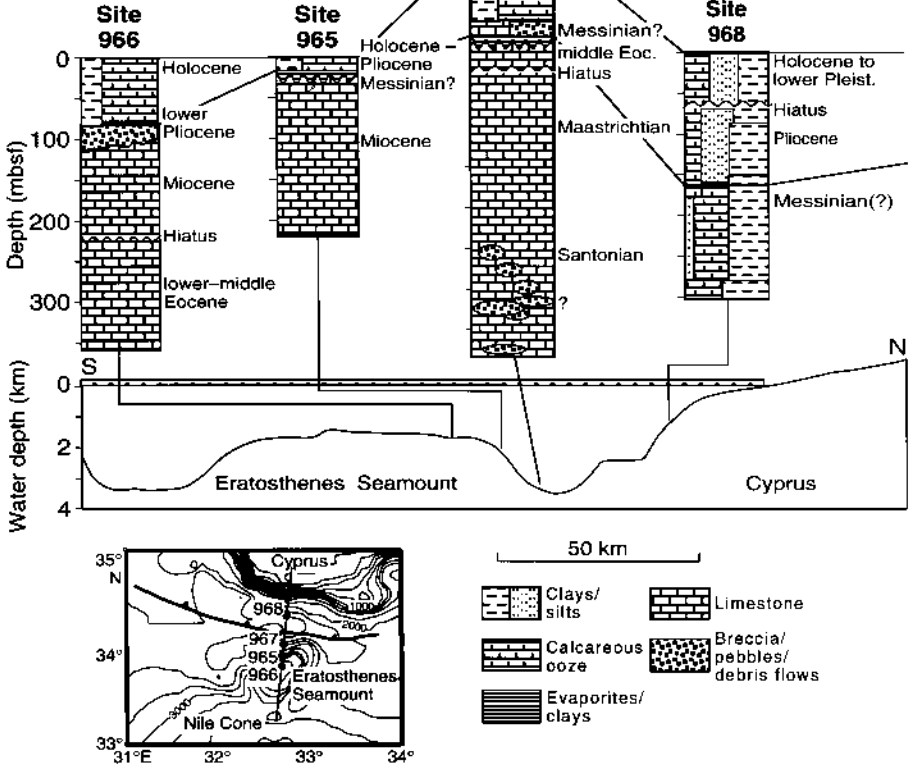

Figure 4. Summary of the successions drilled on the Eratosthenes Seamount and lower slope of the Cyprus margin. Lower left: Simplified bathymetry of the transect area.

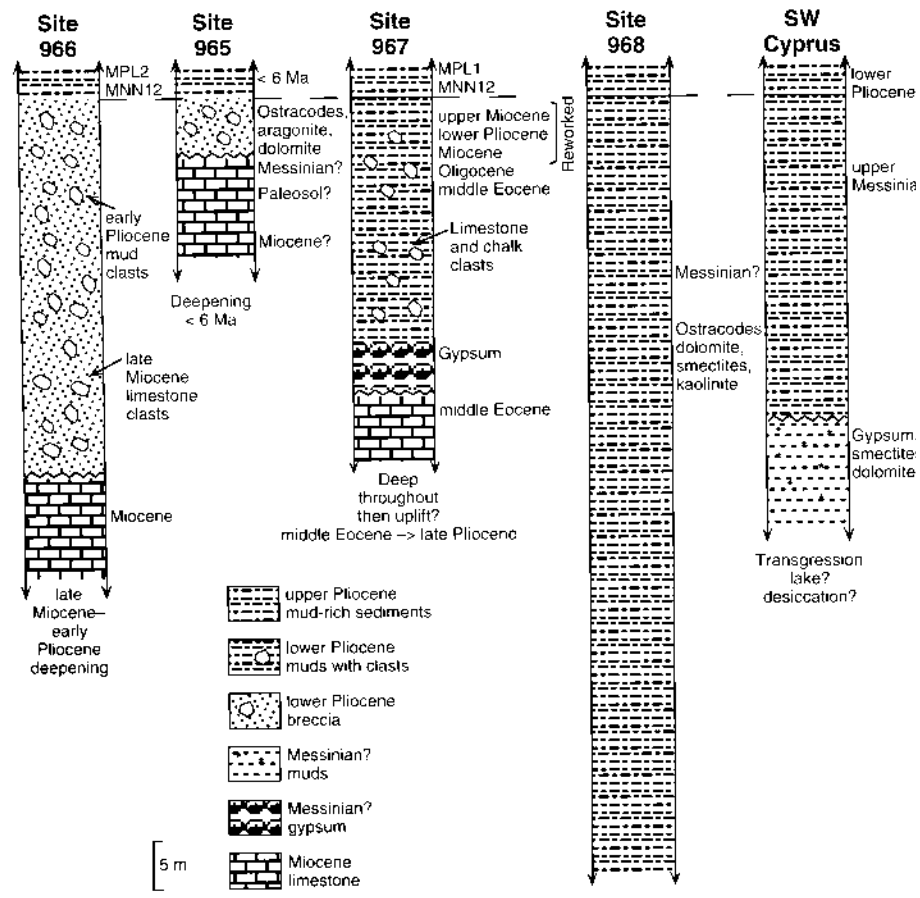

Figure 5. Logs summarizing only (from south to north) the mainly Messinian and lower Pliocene intervals of successions recovered during Leg 160. Southwest Cyprus is added for comparison (Orszag-Sperber and Elion, 1989). Rapid subsidence of the Eratosthenes Seamount took place during the early Pliocene, associated with mass wasting and fault activity (Sites 966, 965, 967). Site 968 on the lower Cyprus slope and onshore Cyprus, however, documents a contrasting sedimentary and tectonic history (see text).

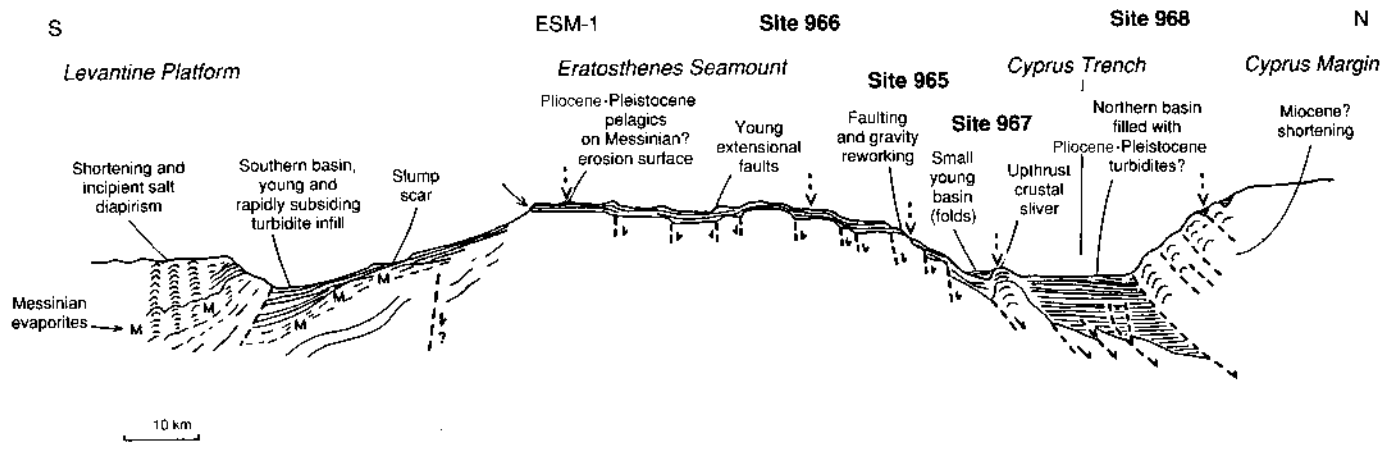

Figure 6. Tectonic model of collision and ophiolite emplacement prior to Leg 160 drilling (Limonov et al., 1994; Robertson et al., 1994, 1995). The Eratosthenes Seamount is being thrust beneath the Troodos ophiolite to the north. The seamount plateau area is undergoing load-induced extensional faulting. There is a transition from extensional tectonics in the south to shortening in the north. This model was tested and substantiated during Leg 160. In addition, the interpretation of the seismic profiles suggests that the Eratosthenes Seamount is also being thrust beneath the Levantine platform to the south, an aspect that was not investigated during Leg 160.

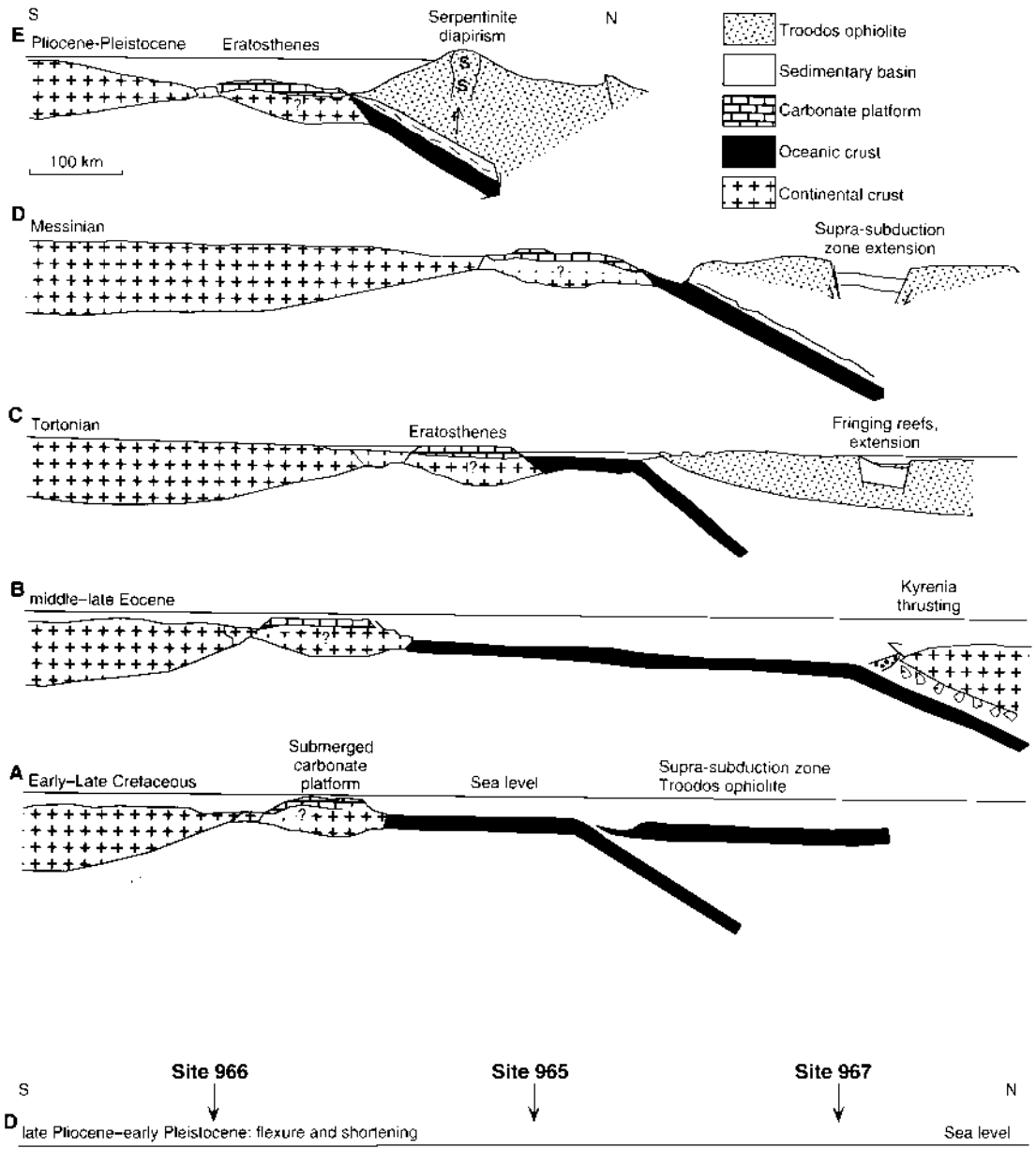

Figure 7. Plate tectonic model of the evolution of the Eratosthenes Seamount in relation to Cyprus. A: The Troodos ophiolite formed possibly above an earlier north-dipping subduction zone. The Eratosthenes Seamount is shown as a rifted marginal continental fragment of the North African plate. B: The northern plate was strongly deformed in middle to late Eocene time, while Eratosthenes was unaffected. C: Northward subduction in the Miocene was reflected in supra–subduction zone extension in Cyprus. Eratosthenes was uplifted and overlain by shallow-water carbonates. D: Eratosthenes was emergent during the Messinian salinity crisis, and initial collision with Cyprus possibly began. E: The Eratosthenes Seamount was thrust beneath the Troodos ophiolite, triggering surface uplift and relative southward displacement, accompanied by serpentinite diapirism.

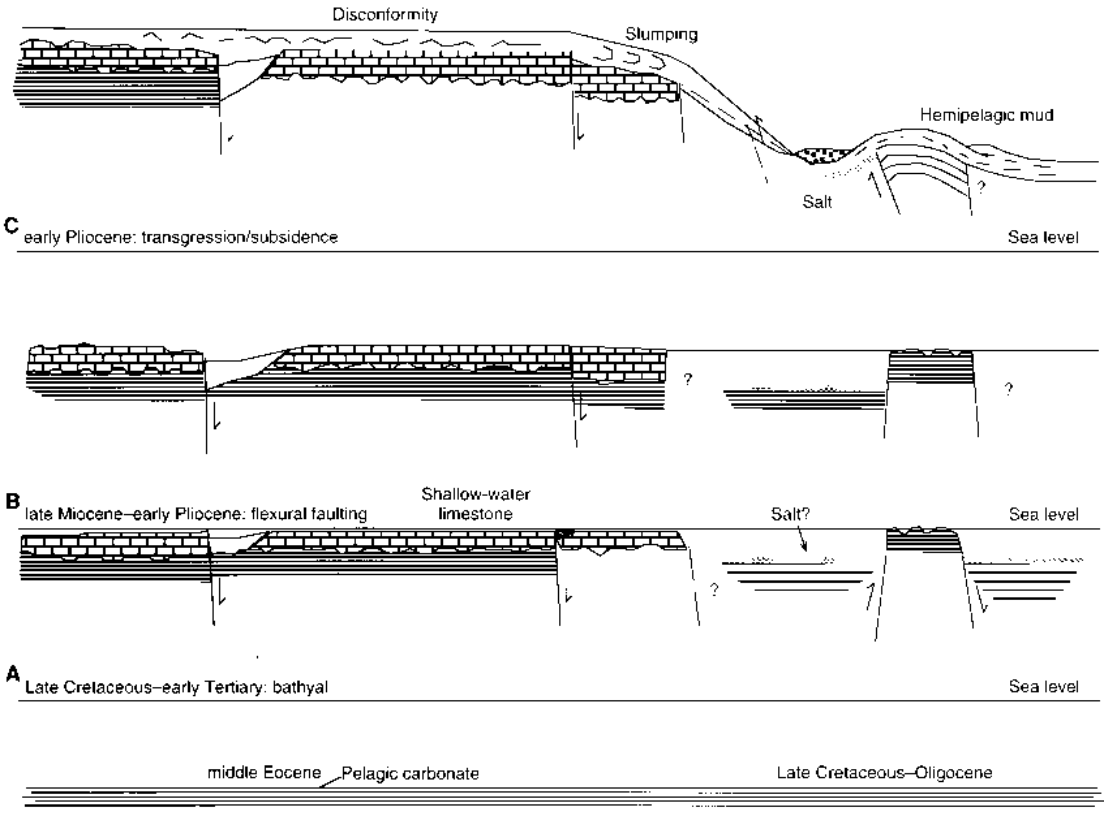

Figure 8. Inferred tectonic history of the northern margin of the Eratosthenes Seamount. A: A stable bathyal carbonate-depositing setting. B: Flexurally induced faulting related to onset of collision and the start of southward ophiolite emplacement, probably during the Messinian salinity crisis. C: Subsidence continued following the end of the Messinian salinity crisis. D: The northern extension of the Eratosthenes Seamount collapsed as a result of flexural loading by the overriding Troodos ophiolite, with a switch to shortening in the north.

Obduction *continued from p. 219*

as part of the passive margin of Gondwana, the Eratosthenes Seamount is being thrust beneath the Troodos ophiolite to the north. Related to this collision there is a transition from extensional tectonics and collapse of the Eratosthenes Seamount in the south, to shortening in the north, beginning near the lower northern slope of the Eratosthenes Seamount (Fig. 6; Limonov et al., 1994; Robertson et al., 1994, 1995). The new information gained during Leg 160 largely substantiates this model (Fig. 7).

Evidence of Load-induced Subsidence

The Eratosthenes Seamount is inferred to have collided with the active margin of the Eurasian plate to the north, including Cyprus, resulting in subsidence and collapse of the seamount. An exponential increase in subsidence rate with time would be predicted theoretically, as in the case of foredeeps associated with thrust and nappe emplacement in mountain belts (e.g., Beaumont, 1981; Stockmal et al., 1986; Whiting and Thomas, 1994). The paleontological evidence indicates that rapid subsidence of the Eratosthenes occurred in the early Pliocene, and it may have begun earlier (Fig. 8). In addition, the early Pliocene matrix-supported breccias at Site 966 are indicative of masswasting and accumulation on relatively steep submarine slopes.

Evidence of Related Faulting

Interpretation of seismic data suggests that the northernmost part of the Eratosthenes Seamount is now thrust beneath Cyprus, including the overriding Troodos ophiolite (Limonov et al., 1994; Robertson et al., 1994, 1995). The seamount thus forms the footwall of an overriding thrust load. To what extent did the footwall deform by faulting during load-induced collapse? This is a current question for many on-land foredeep settings (e.g., Alps and Himalayas). If the effects of thrustloading exceeded the flexural rigidity of the crust, then normal faulting would be anticipated. The incoming Eratosthenes slab represents old (Mesozoic or older) crust that would be expected to behave in a relatively rigid manner, on theoretical grounds (Stockmal et al., 1986). Nevertheless, flexurally induced faulting can be facilitated by preexisting zones of structural weakness in crust of any age.

Seismic evidence indicates that the plateau area of the Eratosthenes Seamount is currently tectonically active. A set of roughly east-west-oriented fault zones, up to several hundred meters wide, cuts the uppermost Pliocene-Pleistocene sedimentary strata. Some of these faults exist as large open cracks on the seafloor. Several of the faults on the Eratosthenes Seamount plateau predate accumulation of the Pliocene-Pleistocene deep-sea sequence. These faults are interpreted to represent the result of flexurally induced faulting (Limonov et al., 1994; Robertson et al., 1994, 1995). Seismic data also suggest that a small ridge at the base of the lower northern slope of the Eratosthenes Seamount is underlain by a northward-dipping fault zone (a reverse fault or thrust; Fig. 6). Both this ridge and the adjacent lower slopes of the Eratosthenes Seamount appear to be undergoing tectonic shortening. The ridge is apparently being detached from the downgoing Eratos-

Obduction *continued on p. 221*

Obduction *continued from p. 220*

thenes Seamount and is being accreted to the overriding thrust wedge. The seismic evidence is interpreted to reflect a switch from flexurally induced normal faulting in more distal (i.e., southerly) areas of the footwall, to shortening in areas closer to the overriding thrust load (i.e., more northerly).

Drilling during Leg 160 provided additional evidence in support of the role of faulting in collision-related deformation of the Eratosthenes Seamount, as follows: (1) Evidence of predominantly extensional faulting is present in the Upper Cretaceous and middle Eocene sequences drilled at Site 967, and to a lesser extent in the middle Eocene sequences recovered at Site 966. For example, numerous small normal faults are present within well-cemented limestone. Unfortunately, the timing of fault movement cannot be determined. (2) Extensional faulting was probably active in generating the highly immature matrix-supported breccias of early Pliocene age at Site 966. (3) At Site 965, Pliocene-Pleistocene nannofossil muds and oozes show evidence of widespread slumping and reworking as debris flows that may have been triggered by faulting. This area today forms part of the steep upper slopes of the Eratosthenes Seamount and is bounded by large normal faults; these faults may have had an earlier history of movement that was reflected in sediment instability. (4) Fine-grained mud turbidites in the upper part of the sequence at Site 966 may reflect tectonically induced redeposition from within the plateau area. In addition, drilling at Site 967 penetrated 700 m into the small compression-induced basement ridge mentioned above. The recovered section ends with a tectonic breccia that is mainly composed of limestone. Geophysical logs (e.g., Formation MicroScanner) suggest that numerous zones of deformation and brecciation are present within the Upper Cretaceous and middle Eocene intervals at Site 967. At present, it seems likely that Site 967 had a complex tectonic history that may have involved, first, flexure-related extensional faulting resulting from thrust loading of the Eratosthenes Seamount, and then large-scale compressional deformation and local surface uplift related to underthrusting beneath the overriding slab.

Link with Ophiolite Emplacement

Load-induced collapse and underthrusting of the Eratosthenes Seamount was generally synchronous with emplacement of the Troodos ophiolite (Fig. 9). The collapse and underthrusting of the footwall represented by the Eratosthenes Seamount took place from early Pliocene (or late Miocene?) to Pleistocene time, whereas the main uplift of the Troodos ophiolite occurred in the late Pliocene and Pleistocene (McCallum and Robertson, 1990; Poole and Robertson, 1992). The two events are clearly inextricably linked. However, in detail, strong surface uplift of the Troodos ophiolite appears to have been delayed up to several million years after collapse of the Eratosthenes Seamount began. This could reflect a time delay during which sufficient crustal thickening took place at depth to promote buoyant uplift of the overriding ophiolite. However, it seems unlikely that uplift of the Troodos ophiolite was driven by collisional processes alone. Modeling of gravity data has revealed that the Troodos ophiolite has a deep-rooted serpentinite core

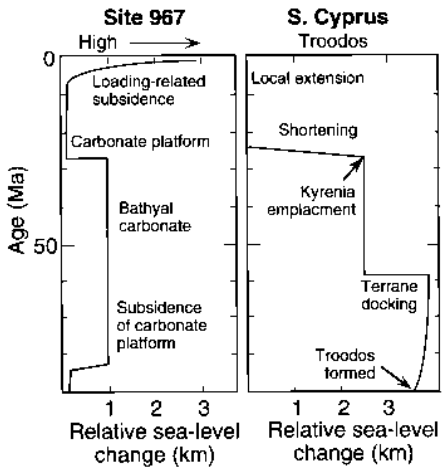

Figure 9. Indication of relative sea-level change through time. A: Site 967 on the Eratosthenes Seamount. B: Southern Cyprus (data from Robertson et al., 1991). The timing and extent of relative sea-level change differs, reflecting locations on different plates until the Pliocene-Pleistocene, when the Eratosthenes Seamount and the Troodos ophiolite began to collide.

(Gass and Masson-Smith, 1963). Moores and Vine (1971) related the uplift of the Troodos ophiolite to the effects of diapiric protrusion of serpentinite. Ultramafic rocks of the lower levels of the ophiolite sequence were hydrated and rose diapirically, uplifting the ophiolite. It is now known that this event took place in the context of collisional deformation within a large area of the eastern Mediterranean (e.g., the Kyrenia Range of northern Cyprus and onshore southern Turkey). In summary, documentation during Leg 160 of the breakup and subsidence of the Eratosthenes Seamount as a result of collision between the African and Eurasian plates clearly links these events with emplacement and uplift of the Troodos ophiolite.

CONCLUSIONS

Drilling during Leg 160 indicates that one of the world's most accessible and best documented ophiolites is in the process of active tectonic emplacement. This active emplacement is accompanied by loading and collapse of the footwall, represented by the Eratosthenes Seamount to the south of Cyprus. This collapse is accompanied by widespread extensional faulting that developed in response to crustal flexure ahead of the advancing thrust load. The collapse and ophiolite obduction are taking place in a zone of incipient collision between the African and Eurasian plates. The tectonic processes documented during Leg 160 may thus help us to understand tectonic processes associated with ophiolite obduction and the early stages of collision in many other mountain belts.

ACKNOWLEDGMENTS

We thank all who sailed with us during Leg 160, particularly the marine technicians, for outstanding support.

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GSA International Division Seeks Funds

Pinar O. Yilmaz
President, International Division

Although few in numbers, GSA International Division members are an active group. The division is cosponsoring Theme Session 2, Geology and Tectonics of the Caribbean Region, at the GSA Annual Meeting in New Orleans. The session is on Tuesday, November 7. We believe that this kind of international exchange of ideas broadens our knowledge and gives us new insight into geoscientific problems. Travel costs for speakers from the Caribbean are funded by the International Division, the GSA Foundation, and Exxon Production Research Company.

Because it is relatively new and still small, the International Division has not yet reached a level of funding that would give it access to matching funds from the GSA Foundation. Therefore, the Division is requesting contributions, to supplement the dues paid by its members. These contributions will be used as part of the funding for symposiums at GSA annual meetings, to pay travel costs for non–North American speakers. All contributors will be listed in the symposium flyers. See the accompanying coupon, or contact Pinar Yilmaz at (713) 423-7465, fax 713-423-7719.

Officers of the International Division are President Pinar Yilmaz, Exxon Exploration Company, Houston; Vice-President (and president-elect) James Skehan, Boston University; Second Vice-President Sandra Barr, Acadia University, Nova Scotia; and Secretary-Treasurer Frederick Simon, U.S. Geological Survey, Reston.

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

International Division Award Fund

☐ Enclosed is my contribution in the amount of $_____ for the International Division Award Fund.

PLEASE PRINT

Name _____

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Theme for 1996 Annual Meeting in Denver:

EARTH SYSTEM SUMMIT

The scientific theme for the 1996 Annual Meeting in the mile-high city of Denver is *Earth System Summit*. As with previous themes for Annual Meetings, this one can be interpreted in several ways. We particularly wish to emphasize that the Earth is a complete system whose processes are complexly interrelated at a variety of scales. In addition, the theme emphasizes that we are all inhabitants of this complex system; our actions can significantly impact, or be impacted by, its dynamic behavior. Of course, we can view the gathering of scientists and engineers of the Society, the Divisions, and the associated societies as an intellectual summit focusing on the Earth system. Finally, the theme emphasizes our connection with the rugged peaks of the nearby Rocky Mountains.

In keeping with our theme, we are soliciting symposia and theme session proposals that feature aspects of multidisciplinary integrated studies of the Earth system, with special emphasis on the Rocky Mountain, High Plains, and Western Interior regions. Our intent is to develop symposia and theme topics that integrate a variety of disciplines around a broad topic. Indeed, we envision coupled symposia and theme sessions and field trips in which pre- or postmeeting field trips complement technical sessions presented during the meeting. Examples of such synergy might be the Yellowstone volcanic system, the San Luis Valley hydrologic system, or the Rio Grande rift system. Other systems might include, for example, the Cretaceous interior seaway, High Plains aquifer systems, or the San Juan volcanic system.

For each of the major systems, symposia or theme sessions could integrate state-of-the-art knowledge at all scales. For example, a session on the Rio Grande rift system might include remote-sensing studies, broad-scale tectonic behavior of continental rifting, associated volcanism, structural styles on the macro- to meso-scale, sedimentation patterns of the Rio Grande, and Quaternary geomorphology. In such a scenario, we expect that the approach will bring together multidimensional expertise and ideas from a variety of disciplines. We particularly encourage presentation of leading research methodologies that better contribute to our understanding of the Earth system. Integration of disciplines and themes may also be applied to understanding human interactions with the Earth system. For example, large numbers of mine closures in the Rocky Mountains are a major societal concern. Symposia or theme sessions in this context might encompass mine hydrology, water quality, remediation, contaminant transport, safety issues, and pertinent legislation. Other societal risks and concerns in the region include swelling soils, disposal of toxic and nuclear wastes, climate change, closure of military bases, urbanization, the Rocky Flats Environmental Technology site, the Rocky Mountain Arsenal Superfund site, and others. Solving or ameliorating these complex problems will surely entail an integrated systems approach. The *Earth System Summit* will provide a context within which to discuss the current state of knowledge, as well as the future needs and directions, of our stewardship of Earth.

We invite the Divisions of GSA and the associated societies to offer jointly coordinated activities, technical sessions, and field trips toward these ends. The Denver Field Trip Committee and Technical Program Committee will gladly assist representatives from the divisions and associated societies with coordination of these cross-disciplinary efforts. Please take the time now to consider appropriate theme sessions and symposia proposals in the context of the overall technical program for the 1996 Annual Meeting. The *Earth System Summit* promises to be an informative and exciting forum for showcasing integration of the Earth sciences.

—John D. Humphrey and John E. Warme
1996 Technical Program Chairmen

How to Propose Theme Sessions for the 1996 GSA Annual Meeting

DEADLINE FOR PROPOSALS: JANUARY 2, 1996

Please submit with Theme Proposal Form

THEME SESSION GUIDELINES

Theme sessions are a set of topically focused, volunteered abstracts. Theme sessions are a way of arranging ***volunteered*** abstracts into interdisciplinary groupings that make for scientific sense. Themes do not require formal sponsorship by an organization. The stronger theme sessions, however, do benefit from active support (hard work) by those interested in the success of the session.

The sessions, which can be either oral or poster, but not mixed, have variable lengths depending on the submitted number of pertinent and high-quality abstracts. *However,* ***a minimum of 16 abstracts*** *is usual for an oral theme session. If, at the abstracts deadline, sufficient abstracts have not been received, the theme session will be dropped, and the papers continued in the review process for standard discipline sessions.*

Please note: An abstract submitted to a theme session is a volunteered abstract, **not** an invited abstract. Please remind your colleagues that if an author submits more than one volunteered abstract with the same person as speaker, all abstracts listing that speaker may be rejected.

IF YOU SUBMIT AN IDEA FOR A THEME SESSION, PLEASE:

1. ***Designate a theme session advocate***. This person would encourage (*not invite*) abstracts that will fit the theme session's concept. Society or division membership may help the advocate in this process. No doubt, when the theme session title is announced, other papers will be voluntarily submitted in addition to those that were solicited or intended. The theme session advocate will serve as liaison with GSA's Joint Technical Program Committee (JTPC). Therefore, the name of the theme session advocate should be included with the proposal. The theme session advocate will generally contribute an abstract to the session and (for oral presentations) will usually assume the responsibility of session chairperson. The theme session advocate will not otherwise be identified or linked to the theme session in the published *Abstracts with Programs* volume.

2. After choosing a theme title, ***select no more than 3 of the categories*** that are listed in the right-hand margin of the 1996 Abstract Form. These should be the categories that best describe the interdisciplinary aspects of the theme session. Pick carefully, because authors who submit abstracts to a theme session will need to select both the theme session and one of the abstract categories.

3. ***Fill in the cover sheet and send it with your proposal***. Please include a brief (50 words) description of the theme session. It will be used for publication later, in the Call for Papers in *GSA Today* and other GSA mailings.

4. ***Advise authors to submit abstracts directly to GSA*** by the abstracts deadline, July 9.

5. ***Rank abstracts***. All volunteered abstracts (including those for the theme session) will go to scientific reviewers designated by members of the Joint Technical Program Committee.

The theme advocate will have the opportunity at this time to rank the abstracts and to arrange them into a tentative order of presentation. This will aid the JTPC in scheduling.

Please Remember: ABSTRACTS SUBMITTED FOR THEME SESSIONS ARE NOT INVITED. NONE CAN BE GUARANTEED ACCEPTANCE.

6. Theme sessions may also include a 15 minute ***introduction*** *OR a 15 minute* ***closing review***. (Abstracts will not be published for introductions and reviews.) Remember, however, that such time automatically reduces by one the number of abstracts that may be presented. Introduction and Review periods are best requested by the theme session advocate at the time of theme session submittal and are subject to approval by the Technical Program chairs.

7. An organization may ***choose to have its JTPC representative coordinate***, select, and schedule its theme papers from among the reviewed and accepted abstracts during the JTPC meeting, August 9–10. Please identify this person to the Technical Program Chairs by July 1. In the absence of a designated theme coordinator, the Chair will assign one of the JTPC representatives.

The JTPC will arrange the technical program keeping in mind suggestions from various societies and divisions as well as those from theme session advocates. In keeping with trying to accommodate the needs of many diverse groups, the Technical Chair makes the final scheduling decisions. The theme advocate does not control the time or date of the session. Themes are scheduled Monday through Thursday. Quality of the technical program as a whole takes precedence over all other considerations.

PRESENTATION MODES

Oral Mode

The standard mode of presentation is a half-day oral session scheduled Monday through Thursday. Usually 16 papers are presented, with slides or displays as visual support.

Poster Mode

Proposals for themes using the poster mode will be considered for *half-day* poster sessions. The poster mode has the same limitations as the oral mode: usually a minimum of 16 papers will be necessary to make the theme session viable.

DATE AND TIME PREFERENCES

Although exact times have not been finalized for the 1996 meeting, we might anticipate them to be similar to past meetings:

Sun. — 8:00 a.m.–12 Noon,
1:00–5:00 p.m.

Theme *continued on p. 223*

CALL GSA MEETINGS DEPARTMENT TO RECEIVE A

1996 THEME PROPOSAL FORM

1-800-472-1988 ext. 133 • fax 303-447-0648
E-mail: meetings@geosociety.org
or fill out and transmit on the Web
http://www.aescon.com/geosociety/index.html

1996 GSA Annual Meeting Field Trips

The theme of the 1996 GSA Annual Meeting, *Earth System Summit*, reflects both the complex interrelation of Earth system processes and the synergy of human adaptation to and effect upon Earth's dynamic systems. Annual Meeting field trips for 1996 build on this theme, offering considerable opportunity to observe and discuss complex geologic and hydrologic relations in the West, with special emphasis on the Rocky Mountains, High Plains, and Colorado Plateau–southern Great Basin regions. Many geological disciplines and specialties are represented, and the proximity to Denver of wide-ranging geologic terrain ensures something of interest to everyone.

All pre- and postmeeting field trips are technical in nature, last from one to four days, and are led by active field researchers. Professionals and students are strongly encouraged to take advantage of these offerings; with lower airfares for Saturday night stay-over flights, costs associated with field trip participation are significantly reduced. Trips begin and end in Denver unless otherwise indicated. The following list of trips is tentative and subject to change. Further details will be given in the April issue of *GSA Today*.

For further information, contact the 1996 Field Trip Co-Chairs Charles L. Pillmore and Ren A. Thompson, USGS, Box 25046 Federal Center, Mail Stop 913, Denver, CO 80225-0046. Pillmore: (303) 236-1240; Thompson: (303) 236-0929, E-mail: rathomps@usgs.gov, fax: 303-236-0214.

PREMEETING

- Rock Avalanches of the Flatirons Piedmont, Boulder, Colorado
- Geology of the Western San Juan Mountains and a Tour of the San Juan Skyway, Southwestern Colorado
- Tertiary Stratigraphy (White River Group) and Sedimentary Processes of the High Plains, Eastern Wyoming and Western Nebraska
- Kinematics of the Slumgullion Landslide, Lake City, Colorado
- Proterozoic Magmatism in Southeastern Wyoming, Evidence for the Cogenetic Relationship Between Anorthosites and Rapakivi Granites, Laramie Mountains, South-Central Wyoming
- Geology and Geologic Hazards of the Glenwood Springs Area, Central Colorado
- Gravity Detachment Structures of the Eastern Absaroka Range, North-Central Wyoming
- Cretaceous-Tertiary Boundary Impact Deposits on Haiti
- Braided and Meandering Stream Deposits, Morrison and Chinle Formations—Colorado Plateau of Southeastern Utah
- Synchronous Oligocene and Miocene Extension and Magmatism in the Vicinity of Caldera Complexes in Southeastern Nevada
- Precambrian Tectonics and Metallogeny of the Hartville Uplift, Wyoming
- A New Look at the Laramide Orogeny in the Seminoe and Shirley Mountains, Freezeout Hills, and Hanna Basin, South-Central Wyoming
- Neogene Geology of South-Central Colorado and North-Central New Mexico and Volcanic Geology of Los Mogotes and San Luis Hills, Northern New Mexico
- Laramide Orogeny and Cenozoic Erosional History, Front Range and Denver Basin, Colorado
- Sequence Stratigraphy and Petroleum Geology of the Central Denver Basin, Colorado

POSTMEETING

- Evidence for Early Proterozoic Reworking of Archean Rocks in the Central Laramie Range, South-Central Wyoming
- Soil-Geomorphic Relationships near Rocky Flats, Boulder-Golden, Colorado Area, with a stop at the pre–Fountain Formation paleosol of Wahlstrom (1948)
- Permian-Triassic Deposystems, Paleogeography, Paleoclimate, and Hydrocarbon Resources in Canyonlands and Monument Valley, Southeastern Utah
- Upper Cretaceous Coals of the Western Interior Seaway, Northwestern Colorado
- Geology of El Solitario Dome, Laccolith, and Caldera System, Southern Texas
- Sequence Stratigraphy of the Muddy Sandstone and Equivalent Rocks from North-Central Colorado to Northeastern New Mexico
- Depositional Environments and Hydrocarbon Potential of Codell–Juana Lopez Sandstones and Regional Structure and Stratigraphy of Canon City and Huerfano Areas and Northern Raton Basin, South-Central Colorado
- Sequence Stratigraphic Relationships of Coeval Shallow Marine and Nonmarine Strata, Kaiparowitz Plateau, Eastern Arizona and Southern Utah
- Hydrogeology of the San Luis Valley–Summitville Mine, South-Central Colorado
- Geology and Paleontology of the Gold Belt Backcountry Byway: Garden Park Fossil Area and Florissant Fossil Beds
- Tertiary Intrusive Rocks of the Spanish Peaks and the Laramide Structure of the Western Margin of the Raton Basin, South-Central Colorado
- Jemez Volcanic Field and Valles Caldera–Middle Rio Grande Rift
- Dunes, Rivers, Lakes and Wetlands: Tales from the Nebraska Sand Hills of Western Nebraska
- Oblique Laramide Convergence in the Northeastern Front Range of Colorado: Regional Implications from the Analysis of Minor Faults ■

GSA Offers Awards in Geomorphology and Micropaleontology

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

The amount of this award in 1996 will be $12,000.

The second award, the W. Storrs Cole Memorial Research Award, has been established to support research in invertebrate micropaleontology. This award will carry a stipend of $10,000 in 1996, and will be given to a GSA Member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

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

All applications must be postmarked on or before **February 15, 1996.** Actions taken by the Committee on Research Grants will be reported to each applicant in April.

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

Theme *continued from p. 222*

Mon. — 8:00 a.m.–12 Noon, 1:00–5:00 p.m.
Tues. — 8:00 a.m.–12 Noon, 1:30–5:30 p.m.
Wed. — 8:00 a.m.–12 Noon, 1:30–5:30 p.m.
Thurs. — 8:00 a.m.–12 Noon, 1:00–5:00 p.m.

ABSTRACT FORMS AND REVIEW

Abstract forms are now available from GSA: (303) 447-8850.

Theme advocates will automatically be mailed a set of forms in March.

ABSTRACT REVIEW SCHEDULE FOR ALL ABSTRACTS

July 9—Abstracts Deadline. Original and 5 copies due to GSA.
July 17–18—GSA mails abstracts to JTPC reviewers, theme advocates, and symposia conveners.
August 2—Reviews and abstracts due at GSA.

NOTIFICATION AND SUBMITTAL DEADLINE

The ABSOLUTE deadline for informing GSA about theme sessions for the Denver Meeting: January 2, 1996.

Please send submittals to 1996 Joint Technical Program chairs:

John D. Humphrey, Colorado School of Mines, Dept. of Geology & Geological Engrg., Golden, CO 80401, Office: (303) 273-3819, Dept.: (303) 273-3800, fax 303-273-3859, E-mail: jhumphre@.mines.edu

John E. Warme, Colorado School of Mines, Dept. of Geology & Geological Engrg., Golden, CO 80401, Office: (303) 273-3565, Dept.: (303) 273-3800, fax 303-273-3859, E-mail: jwarme@mines.edu

See the World Wide Web for invitation and proposal form. The World Wide Web address at the Uniform Resource Locator is http://www.aescon.com/geosociety/index.html. Theme proposal information appears on the Web in the *Meetings* area. An on-line form can be filled out and transmitted directly to the Technical Program Chairs. ■

The Geological Society of America

Research Grants Program 1996

The primary role of the Research Grants Program is to provide partial support for research by graduate students at universities in the United States, Canada, Mexico, and Central America. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program. Eligibility is not restricted to GSA members. New application forms are available each fall in the geology departments of colleges and universities offering graduate degrees in earth sciences. Forms are mailed in October to GSA Campus Representatives and department secretaries and chairpersons in the United States, Canada, and Mexico. They are also available upon request from the Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. *Please use only the 1996 application and appraisal forms.*

Confidential evaluations from two faculty members are required from candidates for the M.S. or Ph.D. degree and must accompany applications submitted. PLEASE USE THE "APPRAISAL OF APPLICANT" FORMS, WHICH ACCOMPANY THE 1996 APPLICATION FORMS. Application forms will not be accepted by facsimile.

The Geological Society of America awarded over $300,000 in grants in 1995. The grants went to 218 students doing research for advanced degrees. The average amount awarded was $1465. The largest grant was $2500, but there is no predetermined maximum amount.

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

ALL APPLICATIONS MUST BE SUBMITTED ON THE 1996 FORMS AND POSTMARKED BY FEBRUARY 15, 1996

GSAF UPDATE

Looking Back to the Origins of the Second Century Fund

Brian J. Skinner, Trustee and Membership Vice Chair, Second Century Fund

Brian Skinner

In December 1986 I received a request from GSA President Jack Oliver: Would I chair a group with the cumbersome title of Committee on the Path to the Year 2000? Our charge was "to examine … GSA in the broadest possible light and the broadest possible context and then develop a set of recommendations for innovative actions or changes in GSA over the period from the Centennial Year to the turn of the century, i.e., 1988–2000. The recommendations should be designed to enhance the performance of GSA so that it does the optimum job of serving the science and society."

My response was hesitant, even negative. I knew from long involvement with GSA that ad hoc committee recommendations had a habit of rapidly finding the circular file. Nevertheless, the charge was an interesting challenge, so when Jack told me that my committee colleagues were to be Paul Hoffman, Sue Kieffer, Chris Scotese, and Ed Stolper, I felt that our report might stand a chance to be given serious consideration. I accepted the charge and the challenge.

The committee met; we brainstormed, we argued, we discussed, and we wrote a bare-bones report that was presented to the Council of the Society in May 1987. Fortunately, our Society has been graced by a succession of officers and councilors who could take our rough suggestions and select what seemed to be practical and plausible in order to start to prepare the Society for the 21st century. Now, a little more than halfway through the 12-year period specified by Jack Oliver, it is interesting to look back and see what effect the report of the Year 2000 Committee has had and what suggestions have been implemented.

Many of the suggestions made by the committee grew out of concerns and ideas expressed by members of the Society—the ground had already been tilled and was ready for a favorable reception of committee recommendations. One such recommendation was for a new publication (called Publication X in the report). Such a publication would provide "a regular forum for communication of substantial information [among] members, and between [GSA] and members. Contributions could include timely review articles, national and international news of interest to earth scientists, summaries of meetings, announcements of meetings, announcements of funding opportunities, letters, etc." The result was *GSA Today,* the monthly publication now received by every member of the Society. I hardly need to point out how vital and effective this full-color publication is, and what a great role it now plays in the affairs of the Society.

The first recommendation to be implemented was not *GSA Today* but rather the establishment of an award for young geologists. The committee realized that awards existed for young mineralogists, paleontologists, geophysicists, geochemists, and other specialists, but no such award existed for geology, the core discipline. Such awards "tell bright young scientists that they and their work are respected." The award was funded with a generous gift to the Foundation endowment by Dr. and Mrs. Fred Donath, and seven of the brightest young scientists have now been recipients.

Short courses drew the attention of the committee. Our science "is changing so rapidly that professional education should be an important part of the program of meetings. Equally important, judicious choice of short course topics at annual meetings can attract colleagues from different disciplines to work together to produce the course, and students become exposed to these areas of research through GSA activity." The short courses were started the year after the report, and they play an important and growing role in Society activities.

One can argue quite correctly that the items I have mentioned—publication, an award, short courses—are hardly bold moves. True enough, but many bold moves were suggested, and two, so far, have borne fruit. The first was a recommendation for "the establishment of a public education office at GSA headquarters, staffed by a distinguished earth scientist." The goals of the education office would be "to develop and support educational programs at all levels," and specifically:

"1. To further an awareness of the earth sciences in an increasingly technical society;
2. To foster an interest in and appreciation of the natural world;
3. To provide educational material to all sectors and all age levels of the public;
4. To provide a resource to which teachers at all levels can turn for educational materials, including written, video, and film material."

The Council response to the Committee recommendation was SAGE—Science Awareness through Geoscience Education. Directed with great sensitivity and acuity by Ed Geary, SAGE has grown to be one of the most successful ventures GSA has ever launched.

Another bold move by Council was the founding of IEE—the Institute for Environmental Education. The recommendation by the Committee was for something even bolder—the founding of an institute where people could spend weeks or months being educated in special topics or working on difficult issues. So far, the full recommendation has proven to be too ambitious, but one of the reasons given for an institute was the need "to understand better the effects of human civilization on the global environment." The key word here is environment, and as both the committee and Council realized, success would necessarily require both education and training. IEE was founded in 1991 with Fred Donath as its first director, and like SAGE, IEE has been enthusiastically received. Under the leadership of its new program manager Dan Sarewitz, IEE is growing rapidly in size and effectiveness. Indeed, so successful have SAGE, IEE, and other recent initiatives of the Society been that the headquarters building has had to be expanded in order to accommodate the growing staff.

There were many additional suggestions in the Path to 2000 report—suggestions for megaprojects to capitalize on the momentum of DNAG, for example, for digital maps, joint GSA-AGU meetings, and others. I continue to hope that more of the committee's suggestions may eventually be implemented, but that can only happen when the important initiatives already undertaken have been securely funded.

These are the origins of the Second Century Fund for Earth • Education • Environment, a major capital campaign to provide the financial wherewithal to accomplish all that must be accomplished as the new millennium approaches. The Second Century Fund is absolutely essential to ensure that new initiatives for the 21st century can take root and flourish, while at the same time GSA's traditional activities can continue to grow. Although the response from major individual donors, companies, and foundations has been very gratifying, it is the participation of members during this campaign that will determine our final success. Will GSA be able to do all that it should do for science and society? In the final analysis, this can only be answered by the contributions and pledges of each and every GSA member. ■

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Preliminary Announcement and Call for Papers

NORTH-CENTRAL SECTION, GSA
30th Annual Meeting

Ames, Iowa
May 2–3, 1996

The Department of Geological and Atmospheric Sciences of Iowa State University at Ames will host the 30th Annual Meeting of the North-Central Section of the Geological Society of America. The meeting will be held on campus in the Scheman Building. Scientific sessions will begin at 8:00 a.m. on Thursday, May 2, and will end at 5:00 p.m. Friday, May 3. Societies that will meet in conjunction with the North-Central Section of GSA include the North-Central Section of the Paleontological Society, the Great Lakes Section of SEPM, and the Central Section of the National Association of Geology Teachers.

CALL FOR PAPERS

Technical sessions will include all topics listed on the GSA abstract form. Papers, poster sessions, theme sessions, and symposia on these and other subjects (including all symposia listed below) are solicited. Special sessions focused on specific themes or subjects will also be arranged by the local program committee after review of the abstracts. The time usually allotted for oral presentations will be 15 minutes followed by 5 minutes for discussion.

REGISTRATION

Preregistration Deadline: March 29, 1996

Preregistration by mail will be handled by the Geological Society of America Meetings Department, P.O. Box 9140, Boulder, CO 80301-9140. On-site registration will be held in the Scheman Center for Continuing Education on the campus of Iowa State University.

Please take advantage of the lower registration fees and **register by March 29.** Preregistration fees will be $50 for professional GSA members, or members of associated societies participating in this meeting, and $15 for GSA student members. For those not affiliated with GSA or associated societies, preregistration will be $55 for professionals, $20 for students, and $15 for K–12 teachers. On-site registration will be $10 more for professionals and students.

GSA is committed to making every event at the 1996 North-Central Section Meeting accessible to all people interested in attending. If you have special requirements, such as an interpreter or wheelchair accessibility, there will be space to indicate this on the registration form, or you can call Carl F. Vondra at (515) 294-4477. If possible, please let us know by March 29, 1996.

Abstracts may be purchased with your GSA membership or on-site in the registration area. Cost for the abstracts volume will be announced later.

SYMPOSIA

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

1. **Applications of Hydrogeology in Agricultural Water Quality Studies.** William W. Simpkins, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-7814, fax 515-294-6049, E-mail: bsimp@iastate.edu; George R. Hallberg, University of Iowa Hygienic Laboratory, 102 Oakdale Campus, University of Iowa, Iowa City, IA 52242-5002, (319) 335-4500, fax 319-335-4600, E-mail: ghallber@uhl.uiowa.edu.
2. **Ground-water Consultants' Symposium: Role of Geology in the Characterization and Remediation of Contaminated Sites** (Joint with Great Lakes SEPM). Roger Bruner, Foth and Van Dyke Inc., 10340 Viking Dr., Suite 100, Eden Prairie, MN 55344, (612) 942-0396, fax 612-942-0865, E-mail: drbmn@aol.com; Doug Connell, Barr Engineering, Minneapolis, Minnesota, E-mail: dconnell@barr.com.
3. **Robert V. Ruhe Symposium: Recent Research in Soil Science and Quaternary Geology in the Mid-Continent.** Tom Fenton, Department of Agronomy, Iowa State University, Ames, IA 50011-1010, (515) 294-2414, fax 515-294-3517, E-mail: tefenton@iastate.edu; Gerry Miller, Department of Agronomy, Iowa State University, Ames, IA 50011-1010, (515) 294-1923, fax 515-294-3517, E-mail: soil@iastate.edu; Carolyn Olson, USDA, Lincoln, NE 68508-3866, (402) 437-5423, fax 402-437-5336, E-mail: agro202@unlvm.unl.edu.
4. **Subduction Zone Magmatism.** James Walker, Department of Geology, Northern Illinois University, DeKalb, IL 60115-1943, (815) 753-7936, fax 815-753-1945, E-mail: jim@geol.niu.edu; Shanaka L. de Silva, Department of Geography and Geology, Indiana State University, Terre Haute, IN 47809, (812) 237-2269, fax 812-237-8029, E-mail: GESILVA@scifac.indstate.edu.
5. **Mesozoic Paleoenvironments of the North America Western Interior** (Joint with Great Lakes SEPM). Greg Ludvigson, Geological Survey Bureau, Iowa DNR, Iowa City, IA 52242-1319, (319) 335-1761, fax 319-335-2754, E-mail: gregory-ludvigson@uiowa.edu; Brian J. Witzke, Department of Geology, University of Iowa, Iowa City, IA 52242-1319, (319) 335-1761, fax 319-335-2754, E-mail: brian-witzke@uiowa.edu; Carl F. Vondra, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-4477, fax 515-294-6049, E-mail: dfrisk@iastate.edu.
6. **Edge-wise Conglomerates** (Joint with Great Lakes SEPM). Roger Bain, Department of Geology, University of Akron, Akron, OH 44325-4101, (216) 972-7659, fax 216-972-6990, E-mail: rbain@uakron.edu.
7. **Earth Science Educators and National Standards.** Tim Cooney, Department of Earth Sciences, University of Northern Iowa, Cedar Falls, IA 50614, (319) 273-2918, fax 319-273-7124, E-mail: timothy.cooney@uni.edu; Frederick P. DeLuca, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50010-3212, (515) 294-7254, fax 515-294-6049, E-mail: fpdeluca@iastate.edu.
8. **Historical Perspectives on Mid-Continent Geology.** Wayne I. Anderson, Department of Earth Sciences, University of Northern Iowa, Cedar Falls, IA 50614, (319) 273-2759, fax 319-273-7124, E-mail: wayne.anderson@uni.edu.
9. **Geology and General Education** (cosponsored by NAGT). Robert Corbett, Department of Geography-Geology, Illinois State University, Normal, IL 61790-4400, (309) 438-7649, fax 309-438-5310, E-mail: rcorbett@rs6000.cmp.ilstu.edu.
10. **Undergraduate Research Results.** Robert W. Baker and Sam Huffman, Department of Plant and Earth Science, University of Wisconsin, River Falls, WI 54022, (715) 425-3345, fax 715-425-3785; E-mail: samuel.huffman@uwfr.edu; Robert D. Shuster, Department of Geography and Geology, 260 Durham Science Center, University of Nebraska—Omaha, Omaha, NE 68182-0199, (402) 554-2457, fax 402-554-3518, E-mail: bshuster@cwis.unomaha.edu.
11. **Geomicrobiology: From Basic Science to Implications for Bioremediation** (Joint with Great Lakes SEPM). Blythe Hoyle, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-6583, fax 515-294-6049, E-mail: blhoyle@iastate.edu; Pedro Alvarez, Department of Civil and Environmental Engineering, University of Iowa, Iowa City, IA 52242, (319) 335-5065, E-mail: pedro-alvarez@uiowa.edu.
12. **Recent Studies of Precambrian Geology in the Mid-Continent.** Raymond R. Anderson, Geological Survey Bureau, Iowa DNR, Iowa City, IA 52242-1319, (319) 335-1575, fax 319-335-2754, E-mail: randerson@gsbth-po.igsb.uiowa.edu; Kenneth E. Windom, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-2430, fax 515-294-6049, E-mail: kewindom@iastate.edu.
13. **Long–term Effect of Mass Extinction.** Patricia E. Kelley, Department of Geology and Geological Engineering, University of North Dakota, Grand Forks, ND 58202, (701) 777-2380, fax 701-777-4449, E-mail: patricia_kelley@mail.und.nodak.edu; Joanne Kluessendors, 116 West McHenry St., Urbana, IL 61801, (217) 367-5916.
14. **The Geology of Early Hominids.** James L. Aronson, Department of Geological Sciences, Case Western Reserve University, 10900 Euclid Ave., A.W. Smith #112, Cleveland, OH 44106-7216; Carl F. Vondra, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011, (515) 294-4477, fax 515-294-6049, E-mail: dfrisk@iastate.edu.

SHORT COURSE

1. **AutoCAD for Geologists.** A two-day workshop to be held Saturday and Sunday following the meeting. Fee: $50, including two box lunches. Carl E. Jacobson, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-4480, fax 515-294-6049, E-mail: cejac@iastate.edu.

FIELD TRIPS

The field trip coordinator is William W. Simpkins, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-7814, fax 515-294-6049, E-mail: bsimp@iastate.edu.

Premeeting

1. **Greenfield Quadrangle—Revisited** (1 day). Gerald A. Miller, Agronomy Department, Iowa State University, Ames, IA 50011-1010, (515) 294-1923, fax 515-294-3163, E-mail: soil@iastate.edu; Thomas E. Fenton, Agronomy Department, Iowa State University, Ames, IA 50011-1010, (515) 294-2414, fax 515-294-3163; E-mail: tefenton@iastate.edu.
2. **Mid-Cretaceous Fluvial Deposits of the Eastern Margin Western Interior Basin: Nishnabotna Member, Dakota Formation** (1 day). Brian J. Witzke, Iowa Department of Natural Resources—Geological Survey Bureau, Iowa City, IA 52242-1319, (319) 335-1575, fax 319-335-2754, E-mail: bwitzke@gsbth-po.igsb.uiowa.edu; Greg A. Ludvigson, Iowa Department of Natural Resources—Geological Survey Bureau, Iowa City, IA 52242-1319, (319) 335-1761, fax 319-335-2754, E-mail: gludvigson@gsbth-po.igsb.uiowa.edu.

During Meeting (Friday afternoon)

3. **Hydrogeology and Water Quality of the Walnut Creek Watershed** (1/2 day). William W. Simpkins, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-7814, fax 515-294-6049, E-mail: bsimp@iastate.edu; Michael R. Burkart, USDA-ARS, National Soil Tilth Laboratory, Ames, IA 50011, (515) 294-5809, fax 515-294-8125, E-mail: mburkart@iastate.edu; James M. Eidem, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-9672; Beth L. Johnson, 3030 Irving Ave. S., Apt. 313, Minneapolis, MN 55408, (612) 825-1802.

Postmeeting

4. **Hogs, Bogs, and Logs: Quaternary Deposits and Environmental Geology of the Des Moines Lobe** (2 days). E. Art Bettis III, Debra J. Quade, Carol A. Thompson, Robert D. Libra, Iowa Department of Natural Resources—Geological Survey Bureau, Iowa DNR, Iowa City, IA 52242-1319, (319) 335-1575, fax 319-335-2754, E-mail: abettis@gsbth-po.igsb.uiowa.edu; Timothy J. Kemmis, Rust Environment and Infrastructure, Sheboygan, Wisconsin, (414) 451-2657, fax 414-458-0550; Thomas E. Fenton, Agronomy Department, Iowa State University, Ames, IA 50011-1010, (515) 294-2414, fax 515-294-3163, E-mail: tefenton@iastate.edu.
5. **Jurassic-age Gypsum Deposits of North-Central Iowa** (1 day). Robert D. Cody, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011, (515) 294-1714, fax 515-294-6049, E-mail: rdcody@iastate.edu.

POSTER SESSIONS

Students and professionals are encouraged to take advantage of this effective means of presentation. Please indicate Poster Session on the GSA abstract form. Each poster booth will contain a 4' high × 8' wide board arranged at table height. Poster sessions will be located in the area near exhibits and will be available for viewing for one-half day.

Undergraduate students are especially encouraged to submit posters for symposium 10. Please contact one of the organizers listed for more information.

North-Central *continued on p. 226*

North-Central *continued from p. 225*

ABSTRACTS

Abstracts must be submitted camera-ready on official GSA abstract forms in accordance with instructions on the forms. Abstract forms are available from: Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140; (303) 447-2020, E-mail: ncarlson@geosociety.org; or from Kenneth E. Windom, North-Central Program Coordinator, Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011-3212, (515) 294-2430, E-mail: kewindom@iastate.edu. Forms are also available from GSA campus representatives at most colleges and universities and from symposium organizers.

ABSTRACTS DEADLINE: January 17, 1996

Send one original and five copies to Kenneth E. Windom, GSA Program Coordinator, Department of Geological and Atmospheric Sciences, 253 Science I, Iowa State University, Ames, IA 50011-3212. Abstracts submitted for inclusion in symposia should be sent directly to the symposium organizer listed first above for each symposium.

All abstracts will be reviewed for informative content, proper format, and originality. Contributors desiring acknowledgment of receipt of their abstract should include a stamped, self-addressed envelope or postcard. Authors will be notified of acceptance well in advance of the meeting.

STUDENT PAPERS AND TRAVEL ASSISTANCE

The North-Central Section of GSA will award $75 for each of the eight papers judged best whose principal author and presenter is a graduate or undergraduate student. Abstracts of papers submitted for consideration for these awards should be so indicated on the abstract form. In addition, awards for travel assistance of up to $200 may be made to students who are student members of the North-Central Section of GSA as of January 1, 1996. To be eligible for a travel grant, the student must present a paper (oral or poster) for which he or she is author or co-author. Applications for travel assistance awards may be obtained by writing to the General Chair, Carl F. Vondra, Department of Geological and Atmospheric Sciences, 253 Science I, Iowa State University, Ames, IA 50011-3212 or by calling (515) 294-4477. Applications for travel assistance must be received no later than **February 16, 1996.**

PROJECTION EQUIPMENT

Two standard 35 mm carousel projectors for 2" × 2" slides and one overhead projector for transparencies will be provided in each meeting room. Please bring your own loaded carousel tray(s) identified with speaker's name, session, and speaker number to your session room before the start of the session. A speaker-ready room equipped with projectors will be available for review and practice.

NORTH-CENTRAL SECTION BUSINESS MEETING

The GSA North-Central Section Management Board will hold its business meeting with breakfast in the Scheman Center for Continuing Education on May 2, 1996, at 7:00 a.m.

EXHIBITS

Exhibits of educational and commercial organizations will be on display in the Scheman Building in proximity to the symposia, technical, and poster sessions. Exhibit space must be reserved by *February 23, 1996*. For further information, contact Scott Thieben, Department of Geological and Atmospheric Sciences, 253 Science I, Iowa State University, Ames, IA 50011-3212, (515) 294-9686, fax 515-294-6049, E-mail: sthieben@iastate.edu.

SOCIAL EVENTS

A welcoming reception will be held on Wednesday, May 1, 1996. The annual banquet will be held Thursday, May 2, preceded by a social hour beginning at 6:00 p.m. A special address will be given by Gordon P. Eaton, Director of the U.S. Geological Survey, following the banquet in Benton Auditorium. The address will be open to all registrants. All social events will be held in the Scheman Building.

Spouse and guest activities will include visits to museums and other local attractions in Ames, Des Moines, and other nearby communities. A full list will be included in the final announcement.

The North-Central Section of the Paleontological Society and the National Association of Geology Teachers will hold separate luncheons on Thursday, May 2, at 12:00 noon. The North-Central GSA Campus Representatives will hold a breakfast on Friday, May 3, at 7:00 a.m.

HOUSING

Blocks of rooms have been reserved in several motels near the Iowa State Center for the dates of the meeting. Registrants are responsible for making their own housing arrangements directly with the participating motels. A list of names, telephone numbers, and room rates will be available in the February 1996 issue of *GSA Today*.

TRAVEL ARRANGEMENTS

Iowa State University is near I-35 and U.S. Hwy 30. Major commercial airlines serve Des Moines International Airport, located approximately 45 miles from campus. Ames Municipal Airport is an all-weather airport designed to accommodate general aviation, including small corporate jets. Bus service directly into Ames is provided by both Greyhound and Jefferson bus lines.

PARKING

The Scheman Center for Continuing Education has 100 parking spaces immediately adjacent to the building. An additional 900 spaces are available in the surrounding Iowa State center complex. There is no charge for parking in any of these locations.

DETAILED INFORMATION

Meeting functions will be held in the Scheman Continuing Education Center on the campus of Iowa State University. Information concerning registration, hotel and motel accommodations, and activities will appear in the February 1996 issue of *GSA Today* and in the North-Central Section *Abstracts with Programs* for 1996. Symposia, short courses, and field trips are in the planning stages, and further suggestions are welcome. More up-to-date information can be found on the World Wide Web at URL http://www.public.iastate.edu/~geat/ncgsa/intro.html. Inquiries, additional information, requests, or helpful suggestions should be directed to Carl F. Vondra, GSA General Chair, 253 Science I, Iowa State University, Ames, IA 50011-3212, (515) 294-4477, fax 515-294-6049, E-mail: dfrisk@iastate.edu. ■

ORDER FORM—1996 *GSA Abstracts with Programs*

For advance-copy purchases of GSA *Abstracts with Programs*, use this form and submit by the deadline listed for each section (deadlines vary). *Prepayment is required.* **Members,** check your records to make sure that you have not previously purchased any of these publications on either your dues statement or through Publication Sales. **No refunds for duplicate orders.** The *Abstracts with Programs* books will be mailed about three weeks prior to the meeting.

Meeting	Deadline	Price	Quantity	Amount
Southeastern	1/3/96	$12		$
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South-Central	1/11/96	$12		$
Cordilleran	2/15/96	$12		$
Rocky Mountain	2/19/96	$12		$
North-Central	2/29/96	$12		$
Annual Meeting (Denver)	8/15/96	$24		**$**
		Total		**$**

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ON-SITE PURCHASES may be made in the registration area. Supplies are limited.

Due to prohibitive postal costs and delays in overseas mailings, this offer for the advance copies is for U.S., Canada, and Mexico only.

GSA SECTION MEETINGS — 1996

SOUTH-CENTRAL SECTION

March 11–12, 1996
University of Texas, Austin, Texas

Abstract Deadline:
November 20, 1995

Submit completed abstracts to:
William F. Mullican, Bureau of Economic Geology, University of Texas, University Station Box X, Austin, TX 78712, (512) 471-1534, mullicanb@begv.beg.utexas.edu

SOUTHEASTERN SECTION

March 14–15, 1996
Ramada Plaza Hotel, Jackson, Mississippi

Abstract Deadline:
November 15, 1995

Submit completed abstracts to:
Darrel Schmitz, Department of Geosciences, Mississippi State University, P.O. Box 5448, Mississippi State, MS 39762, (601) 325-2904

NORTHEASTERN SECTION

March 21–23, 1996
Hyatt Regency, Buffalo, New York

Abstract Deadline:
November 20, 1995

Submit completed abstracts to:
Charles E. Mitchell, Department of Geology, SUNY at Buffalo, 876 Natural Science and Mathematics Complex, Buffalo, NY 14260-3050, (716) 645-6800, glgchuck@ubvms.cc.buffalo.edu

ROCKY MOUNTAIN SECTION

April 18–19, 1996
Rapid City Civic Center,
Rapid City, South Dakota

Abstract Deadline:
January 5, 1996

Submit completed abstracts to:
Alvis L. Lisenbee, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East St. Joseph St., Rapid City, SD 57701-3995, (605) 394-2463

CORDILLERAN SECTION

April 22–24, 1996
Red Lion Hotel at Lloyd Center,
Portland, Oregon

Abstract Deadline:
December 28, 1995

Submit completed abstracts to:
Richard Thoms, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207-0751, (503) 725-3379

NORTH-CENTRAL SECTION

May 2–3, 1996
Iowa State University, Ames, Iowa

Abstract Deadline:
January 17, 1996

Submit completed abstracts to:
Kenneth E. Windom, Department of Geological and Atmospheric Sciences, Iowa State University, 253 Science I Building, Ames, IA 50011-3210, (515) 294-2430, kewindom@iastate.edu

1996 ABSTRACT FORM REQUEST

To: GSA Abstracts Coordinator, P.O. Box 9140, Boulder, CO 80301-9140 or E-mail: ncarlson@geosociety.org

Please send ___ copies of the 1996 GSA abstract form. I understand that the same form may be used for all 1996 GSA meetings.

Name _____

Address _____

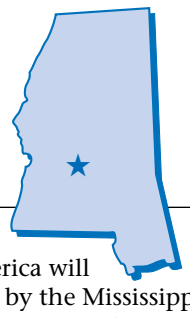
_____

City _____ State_____ ZIP _____

Final Announcement

SOUTHEASTERN SECTION, GSA
45th Annual Meeting

Jackson, Mississippi
March 14–15, 1996



The Southeastern Section of the Geological Society of America will meet in Jackson, Mississippi. The meeting will be hosted by the Mississippi Mineral Resources Institute (University, Mississippi) and the Mississippi State University Department of Geosciences.

SETTING

Jackson, Mississippi's State Capital, is located in the rolling plains of central Mississippi. In March, the temperatures are cool at night, but pleasingly warm during the day. It is an ideal time of year to visit Jackson's many attractions or nearby cities. Points of interest include the Mississippi Museum of Natural Science, the Mississippi Agricultural and Forestry Museum, and the Mississippi Art Museum. Historic sites associated with the Civil War and State Government are plentiful. Vicksburg, Mississippi, known for its historic structures, Civil War battlefields, and more recently, its riverboat gambling, is only a 30-minute drive from Jackson. The Southeastern Section meeting will be held in the Ramada Plaza Hotel, conveniently located near I-55. Interstate 20 also serves Jackson, and the beautiful Natchez Trace Parkway provides a more scenic trip into the capital city.

ACCOMMODATIONS

A large block of rooms at the Ramada Plaza Hotel, the site of the meeting, has been reserved for attendees, at the following rates: standard double (1 person)—$72; standard double (2 persons)—$81; standard king (1 or 2 persons)—$76.50. These rates are subject to 8% tax. Reserve your room by phoning (601) 957-2800.

REGISTRATION

PREREGISTRATION DEADLINE: FEBRUARY 6, 1996

Please preregister for lower registration fees and to assist the local committee in planning. On-site registration will also be available. A reduced registration fee is offered to students. Field trip participants must register for the meeting.

Full payment must accompany registration. Unpaid purchase orders are not accepted as valid registration. Charge cards are accepted as indicated on the preregistration form. If using a charge card, please recheck the card number given. Errors will delay your registration. The confirmation card will be your receipt for all payments. No other receipt will be sent.

Please register one professional or student per form. Students must show a current I.D. in order to obtain student rates. Students not having a current I.D. when registering on site will be required to pay the professional fee.

Cancellations, Changes, and Refunds

All requests for registration additions, changes, and cancellations must be made in writing and received by February 13, 1996. GSA will refund or credit preregistration fees for cancellations received in writing by that date. NO REFUNDS OR CREDITS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER FEBRUARY 13, 1996. Refunds will be mailed from GSA after the meeting. Fees paid by credit card will be credited according to the card number on the preregistration form. There will be NO refunds for on-site registratiuon and ticket sales.

On-Site Registration Schedule: Entrance to Display Hall

Wed., Mar. 13,	4:30 p.m. to 8:00 p.m.
Thurs., Mar. 14,	7:30 a.m. to 4:30 p.m.
Fri., Mar. 15,	7:30 a.m. to 11:30 a.m.

GSA is committed to making every event at the 1996 Southeastern Section Meeting accessible to all people interested in attending. If you have special requirements, such as an interpreter or wheelchair accessibility, please indicate this on the registration form in the space provided.

ABSTRACTS

ABSTRACT DEADLINE: November 15, 1995

Abstracts for all sessions must be submitted camera-ready on official 1996 GSA abstract forms. These forms are available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020; E-mail: ncarlson@geosociety.org.

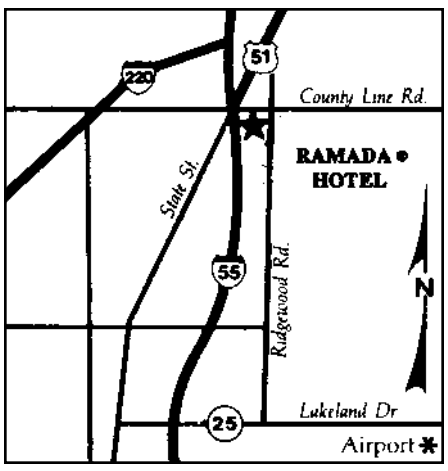
An original and five copies of all abstracts (volunteered and invited) should be sent to Darrel Schmitz, Department of Geosciences, P.O. Box 5448, Mississippi State University, Mississippi State, MS 39762. We encourage participants in symposia and theme sessions to send an extra copy to the convener of the session. Abstracts will be reviewed for information content, format, and originality. GSA rules prohibit individuals from presenting more than one volunteered abstract, although they can be coauthors on additional volunteered abstracts. Abstracts submitted for symposia are not affected by this limitation.

CONTINUING EDUCATION

One short course, "Practical Aspects of Hydrogeology," has been planned for Saturday, March 16. Instructors will be Paul E. Albertson, M.S. C.P.G. and David M. Patrick, Ph.D. P.E. This course will present geohydrologic data and methodologies for the assessment and mitigation of ground-water problems at waste sites. The course will address basic theory of ground-water flow, design of site exploration programs, drilling and sampling, monitoring wells and collection of ground-water data, data presentation and analysis, computer application, and compliance issues. For more specific information, contact Paul Albertson, U.S. Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; (601) 634-3153.

FIELD TRIPS:

1. ***Coastal Plain Stratigraphy and Fossil Collecting Localities in Central Mississippi.*** Wednesday, March 13, $50/person. Buses will leave the conference hotel at 8:00 a.m. Contact David T. Dockery, III, Mississippi Office of Geology, P.O. Box 20307, Jackson, MS 39289-1307, (601) 354-6328, for more information.
2. ***Cretaceous Chalk with Waste Disposal Applications.*** Saturday, March 16 and half day Sunday, March 17; $70/person. This trip will emphasize the stratigraphy at active and proposed waste disposal sites. You will visit an active mine to examine fresh exposures. Contact Darrel Schmitz, Department of Geosciences, P.O. Box 5448, Mississippi State University, Mississippi State, MS 39762; (601) 325-2904.



REGISTRATION FEES

	Advance *(by 2/6/95)*		On-site	
	Full Meeting	One day	Full Meeting	One day
Professional—Member	$65	$40	$75	$40
Professional—Nonmember	$70	$50	$80	$50
Student—Member	$20	$15	$25	$15
Student—Nonmember	$23	$20	$28	$20
K–12 Professional	$20	N/A	$25	N/A
Guest/Spouse	$12	N/A	$15	N/A

Southeastern *continued on p. 228*

RAMADA HOTEL

I-55 at County Line Road • P.O. Box 12710 • Jackson, MS 39236-2710
(601) 957-2800 • (800) 227-5489 • fax 601-957-3191

PLEASE PRINT OR TYPE:

Name _____

Arrival Date: _____ No. of nights _____

Convention or group _____ No. in party _____

Address _____

City/State _____ ZIP _____

Phone Number (home) _____ (work) _____

Sharing with _____

Special requests
(Special requests filled as received. No special request is ever guaranteed.)

_____

Room Preference: ☐ Smoking ☐ Non-smoking

Number of Rooms Requested

Standard Room *(two double beds)*
☐ *Single* ☐ *Double* ☐ *Triple* ☐ *Quad*

King Size Room
☐ *Single* ☐ *Double*

Guaranteed by the following:

Credit Card No. _____ Type of Card_____

Name _____ Expiration Date _____

OR

Advance Deposit Enclosed for: $_____ *(list amount)*

Suites are available by calling the hotel directly.

Reservations must be received at least two (2) weeks prior to the convention date, otherwise, they will be subject to availability. You may call in your reservations to our office Monday–Friday, 8 a.m.–5 p.m. All reservations must be guaranteed by a deposit or credit card. A guaranteed payment on your room will assure you that a room will be held for the day of arrival only. Should you not arrive, the room will become available for resale at 7 a.m., on the following morining. It also means you will be billed for the first night's room rental if the reservation is not cancelled. Check out time is 1:00 p.m. This reservation will not be honored for persons under 21 years of age, unless accompanied by parents. Occupancy cannot be guaranteed until 3 p.m. on the day of arrival.

Preregistration Form

Preregistration deadline is February 6, 1996.

GSA Southeastern Section

Jackson, Mississippi • April 14–15, 1996

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (last name first)

Employer/University Affiliation

City State or Country

( ) - Business Phone

( ) - fax

( ) - Home Phone

Mailing Address (use two lines if necessary)

City State ZIP Code Country (if other than USA)

Please indicate if you or your guest will need services to accommodate a disability:

☐ Yes

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

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on your guest's badge

City/State or Country

REGISTRATION FEES:	**Full Meeting**	**One Day**	**Qty**	**Amount**
Professional Member*	(01) $65 ☐	(02) $75 ☐	1	$
Professional Nonmember	(03) $70 ☐	(04) $80 ☐	1	$
Student Member*	(05) $20 ☐	(06) $25 ☐	1	$
Student Nonmember	(07) $23 ☐	(08) $28 ☐	1	$
K–12 Professional	(42) $20 ☐	N/A	1	$
Guest/Spouse	(09) $12 ☐	N/A	____	$

*Member fee applies to any current professional OR Student Member of GSA. Discount does not apply to guest registrants.

SPECIAL EVENTS

Casino Trip to Vicksburg (transportation fee to be paid on-site)	March 14	(20) FREE	☐ check here if you plan to attend

FIELD TRIPS

1. Coastal Plain Stratigraphy and Fossil Collecting	March 13	(101) $ 50	$
2. Cretaceous Chalk with Waste Disposal Applications	March 16–17	(102) $ 70	$

CONTINUING EDUCATION

1. Practical Aspects of Hydrogeology	March 16	(150) $150	1	$

TOTAL FEES $

Remit in U.S. funds payable to: 1996 GSA Southeastern Section Meeting
(All preregistrations must be prepaid. Purchase Orders not accepted.)

Payment by (check one): ☐ Check ☐ American Express ☐ VISA ☐ MasterCard

Card Number

Signature Expires

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

PREREGISTRATION DEADLINE — FEBRUARY 6, 1996

CANCELLATION DEADLINE — FEBRUARY 13, 1996

FOR OFFICE USE

A ____ V ____ M ____

CK# ____

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Ref. A/P 2006		
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Southeastern *continued from p. 227*

SYMPOSIA

1. **The Alleghenian Orogeny in the Southern Appalachian Hinterland.** Gregory M. Guthrie, Geological Survey of Alabama, P.O. Box O, Tuscaloosa, AL 35486, (205) 349-2852.
2. **Marine Geology.** James L. Harding, P.O. Box 879, Richmond Hill, GA 31324, (917) 727-2519.
3. **Neotectonics of the Mississippi Embayment.** Roy Van Arsdale, Department of Geological Sciences, 429 J.M. Smith Bldg., University of Memphis, Memphis TN 38152, (901) 678-4356; E-mail: rbvanarsdale@cc.memphis.edu.
4. **Atlantic and Gulf Coastal Plain—Differences in Stratigraphy and Geologic Evolution.** Ervin G. Otvos, Gulf Coast Research Laboratory, P.O. Box 7000, Ocean Springs, MS 39564-7000, (601) 872-4200.
5. **Oligocene of the Eastern Gulf Coast.** Rick Fluegeman, Department of Geology, Ball State University, Muncie, IN 47306-0475, (317) 285-8267.
6. **Effective Teaching at the Introductory Level.** Gail Russell, Department of Geology, University of Southern Mississippi, P.O. Box 5044, Southern Station, Hattiesburg, MS 39406-5044, (601) 266-4077, E-mail: grussel@whale.usm.edu.
7. **Applied Paleontology.** G. Lynn Wingard, U.S. Geological Survey, National Center, Mail Stop 970, Reston, VA 22092, (703) 648-5352.
8. **Alternate Strategies and Opportunities for Geology Curricula in Environmental Sciences.** P. Geoffrey Feiss, Department of Geology, CB3315 Mitchell Hall, University of North Carolina, Chapel Hill, NC 27599-3315, (919) 966-0693.
9. **The Effective Communication of Geological Data to Decision Makers and the Public.** Cragin Knox, Mississippi Office of Geology, P.O. Box 20307, Jackson, MS 39289-1307, (601) 961-5500.
10. **Gravels to Loess: Tertiary to Quaternary Depositional Systems and Paleogeography of the Southeast.** Robert Self, Department of Geology, Geography and Physics, University of Tennessee at Martin, Martin, TN 38238, (901) 587-7430.
11. **Sequence Stratigraphy of Carbonate-Siliciclastic Strata, Eastern Gulf Coastal Plain.** Ernest Mancini, Geological Survey of Alabama, P.O. Box O, Tuscaloosa, AL 35486, (205) 349-2852.
12. **Renegade Tectonic Models and Other Geologic Heresies:** *A Session in Honor of Lynn Glover III.* David Valentino, Department of Physical Sciences, Box 19, Concord College, Athens, WV 24712, (304) 384-5238, E-mail: valentid@math.concord.wvnet.edu; and Alexander Gates, Department of Geology, Rutgers University, Newark, NJ 07102, (201) 648-5034, E-mail: agates@andromeda.rutgers.edu.
13. **Applied Geomorphology.** Paul Albertson, U.S. Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, (601) 634-3153.

THEME SESSIONS

1. **Engineering and Environmental Geology**
2. **Coal/Economic Geology**
3. **Structure/Tectonics**
4. **Paleontology**
5. **Mineralogy/Petrology**
6. **Computer Applications in Geology**
7. **Hydrogeology**
8. **Quaternary Geology/Geomorphology**
9. **Stratigraphy/Sedimentology**
10. **Marine Geology/Oceanography**
11. **Climatology/Meteorology**

POSTER SESSIONS

Four half-day poster sessions will be sponsored by the Council for Undergraduate Research and Sigma Gamma Epsilon.

EARTH SCIENCE EDUCATION PROGRAMS

Two half-day symposia are planned for teachers in K–12 and freshman and sophomore courses (See Symposia above).

PROJECTION EQUIPMENT

All slides must be 2″ × 2″ and fit a standard 35mm carousel tray. Please bring your own loaded carousel trays, if possible. Two 35mm slide projectors and screens will be available for each oral technical session. Overhead projectors will be available only by prior arrangement.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be located conveniently in the Ramada Plaza Ballroom, adjacent to technical session rooms. Beverages will be provided in the exhibit area for participants, and 24-hour security will be provided in the exhibit hall. Exhibits will be open all day Thursday and on Friday morning. For further information and space reservations, contact Steve Ingram, Mississippi Office of Geology, P.O. Box 20307, Jackson, MS 39289-1307, (601) 354-6328.

STUDENT TRAVEL GRANTS

Limited funds for support of travel expenses for students presenting papers at the meeting are available from the GSA Southeastern Section. For information, contact Harold Stowell, Department of Geology, University of Alabama, Tuscaloosa, AL 35486, (205) 348-5098. Travel grant requests must be postmarked no later than March 1, 1996.

SPECIAL EVENTS

In addition to the usual Jackson entertainment, several special events are planned. For many, the welcoming party is an event anticipated each year. This meeting will be no exception. An evening excursion to Vicksburg for riverboat gambling is planned. Please indicate your interest in this trip on the preregistration form. There will be an on-site charge for transportation.

The featured exhibit at the Mississippi Museum of Art will be "Palaces of St. Petersburg: Russian Imperial Style." The museum has extended a special invitation to conference participants to view the exhibit, which will display the coronation throne of Nicholas II, lapis lazuli furniture from the Lyon Room, and amber objects from the "missing" Amber Room of the Catherine Palace. ■

Geologic Division Reduction-in-Force

We received the article excerpted here on the recent U.S. Geological Survey reduction in force from USGS sources. We are printing it as the first of several articles dealing with the current state of the profession and how organizations such as the USGS are affected. This article reminds us all of how appropriate it is for those in the geosciences to be cognizant not only of the outstanding research contributions of the Geologic Division of the Survey over the past century but also of the necessity to adopt a unified effort in raising the visibility of our science and its contributions to society.

—Donald M. Davidson, Jr., Executive Director, GSA

BACKGROUND

The U.S. Geological Survey's recent Reduction in Force (RIF) in the Geologic Division was made necessary by insufficient funds to support operating expenses for program activities. The funding shortfall was not simply the result of program cuts in the past year or two or even of anticipated budget reductions in the 1996 fiscal year. For nearly a decade, the Division budget (in constant dollars) has been declining steadily, while salaries (with increases repeatedly authorized, but not funded, by Congress) and other fixed costs, such as space rental, utilities, and service contracts, have been going steadily upward. Operating expenses have dropped from a level of 20–25% of total program funds, the amount necessary to conduct necessary field and laboratory research, to only 5–10% and, in parts of the organization, funds were insufficient to pay salaries. By 1994, escalating salary costs exceeded 60% of total funds, despite the fact that a severely curtailed hiring policy for scientists and the termination of almost all temporary workers had reduced the Division work force by more than 1,000 employees in only ten years.

As early as 1988, the Chief Geologist had searched for ways to alleviate the budget squeeze. There was a constant pursuit of new funds from both direct Congressional appropriations and reimbursable sources, but these efforts were only minimally successful, in part because of the relatively lower priority that many Division programs had within the Department of the Interior and in part because most other Federal agencies were also experiencing funding restrictions and had limited funds to pass on. Many of the principal issues the Geologic Division has worked on traditionally are much less important now than they were in the past … for example, a profound and widespread reduction in domestic energy and mineral exploration….

The funding problem was exacerbated when Congress passed the Budget Enforcement Act in 1990 which set tight limits on Federal funding levels in an effort to contain the expanding national budget deficit. It was recently further impacted by the decision of both the Administration and the U.S. Congress to reduce significantly the size of the Federal workforce.

To reduce the spiraling payroll costs, the Division undertook several cost-cutting measures, including allowing early retirement, replacing resigned and retired employees on a very limited basis, encouraging the transfer of qualified individuals to positions in the Water Resources Division, and consideration of a furlough (which was not carried out because it did not represent a long-term solution to the underlying problem). In addition, the Division participated in three Federal government "buy-outs" in 1994 and 1995 that resulted in the voluntary separation of 400 employees. But the salary savings realized from all of these actions were still inadequate to cure the financial problem that the Division faced. From 1990 to 1994, the Division had annually considered the advisability of a RIF, but had declined to take this … drastic step until, by 1995, the cumulative effects of the budgetary restrictions left no alternative.

THE REDUCTION IN FORCE PROCESS

The RIF process in the Survey's Geologic Division began in March 1995, and [was] not … fully completed until October…. The first task was to assign all positions in the Division to "competitive levels." This required grouping together all positions in a local commuting area which were in the same grade and classification series, and which were similar enough in duties, qualification requirements, pay schedules, and working conditions, so that the incumbent of any position could be assigned to any number of research positions, many of which are highly specialized and unique and, thus, in single-position competitive levels….

Concurrently with determining competitive levels, National Program Plans and accompanying program staffing plans were developed and reviewed by committees consisting of scientific and support staff. At the same time, the Division prepared a reorganization plan that regionalizes program operations and management in order to better address customer requirements and the evolving nature of our scientific programs.

In May and early June, these plans were finalized and … of selected positions from the existing staffing list that were required in the new program staffing plans [were selected]. Those positions not selected were subsequently abolished. In addition, the reorganization called for the abolishment of a number of existing positions and the establishment of a number of new positions not present in the existing organization. Positions not included in the new staffing plans were abolished and the incumbents of those positions competed through the RIF process for encumbered and vacant positions.

The process of determining employees' RIF assignment rights was conducted during July 1995…. In general, the process consists of reviewing the qualifications of all employees released from their competitive level against all encumbered and vacant positions to determine the best possible reassignment. Determination of which employees will be separated from the Federal service is judged by comparing available positions with employees' qualifications and their retention standing as specified by RIF regulation.

Individuals who were impacted by the RIF, whether through separation, demotion, or change in assignment, were notified of the proposed action between August 7 and August 14…. The effective date for RIF actions, including separation of employees, [was] October 14, 1995. At that time, all employees in the Division who [had] been retained were assigned to new organizational units in the Division.

GENERAL RIF STATISTICS

As of early August 1995, the Division had 2,190 employees. Distribution by region was:

Eastern Region	
Permanent:	517
Other:	88
Central Region	
Permanent:	599
Other:	67
Western Region	
Permanent:	746
Other:	173

The RIF … result[ed] in separation of approximately 345 permanent employees and 180 nonpermanent employees. The number of separations is a maximum … as some employees are finding new Federal positions through outplacement programs. In addition to separations, the RIF … result[ed] in about 100 demotions and 100 reassignments….

NEGATIVE IMPACTS OF THE RIF

… Both bureau and Division management understand and appreciate the many outstanding contributions to the USGS and the Nation made by the many individuals affected by the RIF. Their efforts, during less uncertain and financially stronger times, made solid contributions to the earth sciences and clearly helped establish and nurture the reputation of the USGS…. As a result of the loss of highly skilled and experienced individuals, the Division will lose some technical and research capabilities. It will seek to offset those losses by maintaining and/or building the necessary skills most germane to the priority scientific activities that will be continuing or that will be required in the near future. Some of the losses will be addressed through contracting on an "as needed" basis or through the hiring of temporary staff, particularly post-doctoral scientists. Some examples of losses include:

TECHNICAL

- Analytical chemistry—The bureau-wide Analytical Chemistry Services Group will be eliminated…. Some program-specific techniques will be maintained, but most whole rock x-ray analytical analyses, for example, will be terminated.
- Geochronology—The Division will discontinue its calculation of routine C-14 age determination….
- Text editing and graphics preparation— … Programs will be directly responsible for funding most publication costs and many publication functions will be contracted to the private sector rather than maintaining in-house staff.

RESEARCH LOSSES

- Rhenium-osmium isotopic analysis and age determinations—Though the USGS has pioneered the development of this … technique, its high cost and limited utility do not … match existing program needs sufficiently to warrant its continuation.
- Development of ore deposit models—… Because of the relevance of this activity to understanding the nature of environmental contamination and the remediation of abandoned mine sites, research in this area will be continued, but at a significantly reduced level.
- Arctic marine investigations—The high cost of these investigations and the lack of funds to support them will result in a reduction in research…. Efforts will continue, however, to conduct joint research projects where multiple parties can contribute funding, personnel, and logistical support.
- Gas geochemistry laboratories—The work conducted by the USGS gas labs in Denver on environmental radionuclides … though of high quality, has been deemphasized. The labs lack, therefore, sufficient funds for continued operation and maintenance.
- Paleontological research and taxonomy—[F]ewer paleontologists [will be employed in the Division], … [but] paleontological capabilities are being retained in high-priority areas.

FUTURE DIRECTIONS

Though there is a natural tendency to dwell on what is lost when a negative event like a RIF takes place, we also need to look at what is left in place after a RIF. A great deal, in fact, has been left in place in the Geologic Division and it covers a far wider spectrum of the solid-earth sciences than that which was cut.

The Division has been reduced from approximately 2,200 employees to approximately 1,600 …, [but it] will now have adequate funds to conduct its work for the first time in a decade. In the long run, the Division will not be weaker, it will be a great deal stronger. The net effect of the RIF, therefore, will, insofar as the future is concerned, be positive…. Though the Geologic Division retained the cream of its research staff, there were very few technicians left to support field and laboratory studies, thus reducing its effectiveness and efficiency to accomplish mission objectives. With additional operational funds, the Division will be able to improve these ratios, and by reestablishing our post-doctoral program, will be able to provide creative new staff with fresh ideas and approaches…. [S]eparated employees who were eligible to retire will also be eligible to participate in a continuing highly successful emeritus program.

As the Geologic Division looks to the future, it is excited by the opportunities that lie ahead to meet the Nation's needs for earth-science information. To meet these needs, the Bureau is developing a strategic plan that will be [a] long-range comprehensive approach to its future endeavors. As a part of the strategic plan, the Geologic Division is changing the direction of many of its programs in anticipation of increased public demand for the unbiased, high-quality products that it can provide. Some important new directions include 1) increased emphasis on the understanding and mitigation of urban geologic hazards, 2) the characterization and remediation of abandoned mine lands, 3) a response to increased demand for natural resources to meet the needs of a growing population, 4) increased marine and coastal studies with an expanded effort to make the resulting scientific information readily available to users, 5) increased research efforts toward greater understanding of surficial geological processes, and 6) studies to better understand the geologic influences in sources of our Nation's drinking water supply.

To achieve the objectives of these new program directions, the Geologic

Reduction *continued on p. 230*

BOOK REVIEWS

Paleomagnetism of the Atlantic, Tethys, and Iapetus Oceans. *Rob Van der Voo. Cambridge University Press, Cambridge, UK, 1993, $89.95.*

From a slow and perhaps tumultuous beginning about half a century ago, the study of the paleomagnetism of relatively old (i.e., pre–Brunhes chron) rocks has substantially impacted many aspects of the geological sciences, and has provided a clearer understanding of, for example, the nature and origin of the geomagnetic field and core-mantle interactions, the growth and fragmentation of continents, the interaction between rocks and fluids, and the attending alteration of their magnetization record. Rob Van der Voo's recent and timely contribution to the paleomagnetic literature, *Paleomagnetism of the Atlantic, Tethys, and Iapetus Oceans*, provides an impressively thorough critique of the extant paleomagnetic data base bearing on the evolution of the continents bordering and microplates moving within the Atlantic, Iapetus, and Tethyan realm. The book will prove useful to a broad community, from structural geologists dealing with the evolution of many orogenic belts to paleontologists and plate reconstructionists interpreting the history of Earth. For those readers who are interested in a true "nuts and bolts" treatise on many of the practical and pertinent details of paleomagnetism, this book is not for you! Although Van der Voo provides a succinct and well-illustrated summary of paleomagnetism, based in large part on his numerous research experiences as an internationally recognized authority on the subject, the goal and veritable contribution of his book is the critical assessment of the paleomagnetism of major continental blocks and the integration of the reliable paleomagnetic data with geologic processes, specifically the evolution of the continents bordering and microplates moving within the Atlantic, Iapetus, and Tethyan realm.

The book can be divided into four parts. The first is a succinct discussion of paleomagnetic poles and their associated reference directions (Chapter 2) and different components of continental lithosphere, emphasizing the importance of and differences between scales of paleomagnetic investigations (Chapter 3). Together, these chapters demonstrate to the reader the overall reliability of the paleomagnetic database and set the stage for subsequent detailed discussions of data sets. The second part (Chapter 4) is a summary of paleomagnetic techniques, including a lucid explanation of demagnetization diagrams and their interpretation, and how the overall "quality" of a specific paleomagnetic pole determination may be at least partially quantified. The third part (Chapter 5) summarizes the paleomagnetic database for the major continents; one of the highlights is a historical review and modern assessment of the many proposed Pangea configurations. The fourth part is the heart of the contribution and focuses on the Mesozoic and Cenozoic history of the Atlantic Ocean (Chapter 6), the post-Triassic evolution of the Tethyan realm (Chapter 7), and the pre-Permian evolution of the continents surrounding and fragments within the Iapetus ocean (Chapter 8). The format of each of these chapters is appropriately varied. In detailing the formation of the Atlantic Ocean, Chapter 6 presents a time-slice view of data from the major continents. The current uncertainty in the Jurassic apparent polar wander path for the Atlantic-bordering continents is carefully presented. The paleomagnetic details of specific areas constituting the Tethyan realm, from the western Mediterranean to southeast Asia, are sequentially presented in Chapter 7. Because the pre-Permian paleomagnetic database for the major continents is less well defined than for younger times, the discussion of the evolution of the Iapetus Ocean is less concrete than those of the previous two chapters. The discussion focuses on the closure of Iapetus, where likely Laurentia-Gondwana configurations with time are presented, southern Great Britain, Armoire, and Appalachian displaced terranes as fragments within Iapetus, and the initial opening of Iapetus in the context of proposed Late Proterozoic supercontinent models.

This is a wonderfully written and much-needed contribution to the geological sciences. The reader (who gets to learn what "Go Blue" means) is made very comfortable with Van der Voo's up-front style from the beginning to the end, 273 pages later. Each chapter is prefaced by a particularly salient quotation, such as R. M. Pirsig's (1974, *Zen and the Art of Motorcycle Maintenance*) famous discussion of "quality," and Van der Voo's reaction in the context of a subject to follow. In the Epilogue (Chapter 9) the author most eloquently convinces the reader that a very great deal of progress has been made in a field with a most questionable beginning, one that continues to be filled with controversy and reinterpretation, as the geological sciences should and will.

John Wm. Geissman
University of New Mexico
Albuquerque, NM 87131-1116

The River Nile—Geology, Hydrology and Utilization. *Rushdi Said. Pergamon Press, Ltd., Oxford, UK, 1993, 321 p., £75.00 (US $120).*

A spate of books that focus on problems of water scarcity in North Africa and the Middle East, some geopolitical and others emphasizing environmental science, has recently crossed my desk. This volume, written by a former director of the Geological Survey of Egypt, differs in that a third of the contents is devoted to the recent geological history of the River Nile. This section sets the tone for a wider discussion of the river's hydrology and its utilization by the nine states along its banks, from Lake Victoria to the Mediterranean Sea. Although Said presented most of this geological information in an earlier volume (*The Geological Evolution of the River Nile*, 1981), he does raise several new issues. One of these pertains to oscillating wet and dry phases affecting former Nile flow, which could be related to El Niño events. The Nile is vital to the nearly 200 million persons using it as their primary water source. It is thus pertinent to evaluate geologic and climatic events that induced Nile fluctuations in the past, and especially those that could help explain present flow events and predict future conditions of this, the longest river in the world.

The arid northern Nile basin is singular in that this region is the home of enduring, record-keeping civilizations that for millennia have kept track of the Nile's flow, on which they are almost completely dependent. The section of the book emphasizing hydrology is perhaps the most useful, particularly where fluctuations of the Nile are correlated with both climatic events and the historical record. Periodic major failures of Nile floods, particularly those lasting as long as several decades, often had a direct shaping effect on Egyptian history by causing weakness in the central authority, increased political impotence, and even breakdown of the social order.

This topic leads to the volume's third part, utilization of Nile waters. Past episodes of low Nile flow, particularly in Egypt, led to recorded food shortages, excessive inflation, decline of the arts, mass emigration, and starvation and spread of disease that induced periodic reductions in population. In view of the current explosive population growth, now approximating 60 million persons in Egypt alone, present and predicted Nile conditions are a matter of more than academic concern. Egypt now has the lowest amount of arable land per capita of any country in Africa. Said points out that the per capita value of agricultural production in Egypt has not decreased during the past two centuries, but this is hardly encouraging, as Egypt must now run just to stay in place. Long-term environmental costs of some measures used by Egypt to increase current productivity of the land (e.g., damming of the Nile and controlled annual flow, widespread use of chemical fertilizers, and intensive irrigation) could be extremely detrimental to its future agriculture production.

Said's geopolitical views are primarily centered on Egypt. The fact that Egypt is the most populous of the riparian states, uses 71% of Nile waters for agriculture, and is situated at the "end of the pipeline" justifies his position to some extent. The direct dependence of Egypt on water from a single source, the Nile, demonstrates that country's extreme economic vulnerability to its upstream neighbors. The emplacement of the High Dam at Aswan and creation of Lake Nasser behind it has helped to reduce this vulnerability by providing water on a more regular basis within

Book Reviews *continued on p. 231*

Reduction *continued from p. 229*

Division will be working to create stronger partnerships with its sister USGS Divisions and will be establishing new cooperative agreements with other Federal, State, and local agencies.

Not many months ago, the future of the entire USGS, not just the Geologic Division, was being challenged. The U.S. Congress was entertaining the notion that the Nation no longer even needed a geologic survey. Through the strong support of many friends and constituents, that view was eventually repulsed. It is, nevertheless, important to note that Congress clearly saw the societal value of the work of all of the Bureau's Divisions, including the work on geologic hazards, energy and mineral resources, geologic framework and processes, and marine and coastal surveys that is the responsibility of the Geologic Division. There was also a clear recognition that as a leader in earth sciences research the USGS needs to validate its scientific credibility on a continuing basis. This it intends to do through an approach that combines innovative scientific research and data collection with the production of timely, relevant scientific publications and data sets. The organization is well aware of the fact that to accomplish this goal the USGS needs more than funds. It requires a balanced, skilled, innovative, and experienced workforce. The USGS, the Geologic Division included, is committed to achieving this goal. ■

Book Reviews *continued from p. 230*

the boundaries of Egypt. The structure admittedly has induced negative side-effects, including near total cutoff of much-needed sediment and nutrient loads, intensified local coastal erosion, and increased salination of the cultivated valley and delta sectors. Yet the dam has protected Egypt from the effects of drought, which remains a threat to Sudan and Ethiopia.

It is ominous that a previous consensus among the riparian states regarding water distribution appears to be on the verge of disintegration. Potential consequences are serious, because Ethiopia possesses the headwaters of the Blue Nile and Atbara rivers, which provide almost 80% of Nile waters carried into Egypt. Ethiopia and Sudan, which together have a larger population than Egypt, are beginning to challenge agreements and water rights earlier allotted to Egypt. As their water needs increase, they are initiating works of their own upstream which will likely diminish Egypt's supply. Present political instability in Sudan and Ethiopia increasingly poses a threat to existing practices of Nile water allocation in the region. As Said portends, "the real test is yet to come."

A number of glaring errors mar the value of this book. For example, Said surprisingly denies subsidence of the northern delta margin, asserting that this region could not have been lowered in the recent geologic past, despite hard evidence to the contrary (measurement of local lowering of land relative to the sea by values as high as 5 mm/yr). He denies that major cutoff of Nile sediment by the Aswan High Dam has affected the Nile delta coast (now undergoing accelerated local erosion). Said indicates that Egypt need not fear salt-water intrusion into ground water from the coast, even though he illustrates salinity in excess of 1440 ppm penetrating the northern third of the Nile delta (locally by as much as 50 km inland). These and other facets will require rectification in future hard-science environmental and geological texts on the Nile basin.

Geologists interested in regional hydrology will appreciate those parts of the book which focus on the impact of agricultural and industrial expansion of upper Nile basin states on the quality of water reaching downstream states. The convergence of environmental and political factors in this region are likely to stir further destabilization, and possibly even conflict. Such threats are by no means new, however; I am reminded of the rhetorical question posed by the Greek historian Herodotus 25 centuries ago, when discussing a River Nile insufficiently high to flood fields: "What will be left for the Egyptians who live there but starvation?" It is indeed fortunate that we are now at a technological stage where some solutions can help meet the much-increased water needs in this part of the world. For starters, one could recommend that those coastal nations in need of fresh water consider transferring a part of their budgets now allocated for military spending to the development of more economical methods of desalinating sea water. This book, in any case, should help incite the can-do scientific community to turn what has become a proverbial lemon into lemonade.

Daniel Jean Stanley
Smithsonian Institution
Washington, DC 20560

Towards New Horizons: John Haller 1927–1984. *Edited by F. H. Schwarzenbach. Verlag der Fachvereine an den schweizerischen Hochschulen und Techniken AG, ETH Zentrum, 8092 Zürich, Switzerland (available from Mrs. P. Solomon, Harvard University, Earth and Planetary Sciences, Cambridge, MA 02138), 1993, 128 p., $59.*

This unusual book consists of 24 short essays about John Haller, the Swiss-American geologist. Haller grew up in Basel, Switzerland, spent many years working on the Danish East Greenland expeditions, and subsequently was a professor at Harvard University for 20 years, prior to his untimely death in 1984. In the course of his career, Haller, more than anyone else, established the foundation of our knowledge of the East Greenland Caledonides. Haller's talents were extraordinary, and his effect on his fellow workers, family, and friends was clearly profound. Haller exhibited boundless energy, an ability to plan ahead carefully, act decisively, and deal with unforeseen difficulties in a calm, conciliatory, and diplomatic manner. He had remarkable dexterity and "fix-it" abilities. For example, during one season, he repaired meteorological equipment, efficiently organized a very cramped work space, and filled teeth. Haller had unique graphic abilities, a sharp sense of observation, and almost limitless patience. His notebooks have been described as of publication quality. Ever careful, Haller was hesitant to form theories, and he never really unreservedly accepted the new plate tectonic paradigm.

This book is copiously illustrated with spectacular photographs of field situations and geology, as well as with numerous examples of Haller's sketches and maps. Anyone interested in the history of geologic exploration of Greenland or in the life and times of a legendary field geologist will find this book well worth reading.

E. M. Moores
University of California
Davis, California 95616

Natural Disasters. *David Alexander. Chapman Hall, New York, 1993, $39.95.*

In this book, Alexander makes an admirable effort to follow his stated philosophy that "natural disasters ... should be studied as complete entities," and "a continuing theme of this book is that natural hazards and disasters always involve a combination of physical impact and human vulnerability and response." The book indeed weaves together intricately the agents of disaster with resulting societal issues of hazard consequence, planning, response, and mitigation. It is specifically in the impressively complete, detailed treatment of human interaction with disaster that this book stands out from others.

The main body is divided into two sections, which are inevitably intertwined. In the first section, Geophysical Agents, without ignoring relevant concerns of societal impact (and causation), the wide-ranging chapters

Book Reviews *continued on p. 232*

Book Reviews *continued from p. 231*

mainly describe physical, geological, and meteorological causes and effects of hazards. Chapter 2, Earthquakes and Volcanoes, is dominated by a discussion of earthquakes; less attention is paid to volcanoes. As well as the eponymous phenomena, tsunamis are met here. In Chapter 3, we are introduced to events of direct or indirect meteorological origin, beginning with that most prevalent hazard, flooding, and its antithesis, drought. These are followed by familiar dangerous weather phenomena (hurricanes, tornadoes, lightning, etc.), but such is the breadth of coverage that some unanticipated topics appear, such as problems associated with glacial surges. Finally, Chapter 4, Disasters and the Land Surface, deals with landslides but also impresses on us that a serious hazard can develop gradually without the drama of the sudden events that often dominate discussions of disasters. In terms of long-term societal security, insidious processes such as soil erosion, coastal erosion, and desertification might be the greatest disasters.

Each chapter is endowed with an extensive and eclectic reference list. The text makes heavy use of citations, which helps offset the rather unsatisfying nature of this section. While there is much to be gleaned here, in my opinion Alexander often fails to make suitable compromise between the limited space allottable to each phenomenon and the technical level of the presentation. The abiding impression given by the book is that a unified approach to contending with hazards must bring together physical scientists with public administrators, physicians, sociologists, economists, etc. This wide audience of disparate professionals will not necessarily have the scientific background needed to find Alexander's descriptions useful. In general, this scientific discussion is often unclear, always incomplete, and sometimes simply incorrect.

I found the second section, The Human Impact and Response, to be by far the stronger part of the book. We move into societal issues, with Alexander now playing the role of various of the above mentioned professionals, in describing their input, actual and recommended, to the integrated approach to disaster. Common threads woven through these chapters involve issues of emergency management, warning, regulation, human perception, etc. Chapter 5, Damage and the Built Environment, covers structural performance in earthquakes, dam failures, and expected associated topics such as implementation of building codes. To document the breadth of treatment, I could mention such additional considerations as computer modeling of evacuation procedures or fracture patterns of glass during hurricanes. The remaining chapters are equally rich in scope and detail. Chapter 6, The Logistics of Planning and Emergency Action, should be among the most important for public officials; topics include hazard maps, remote sensing, disaster modeling, warning systems, and emergency shelter. Alexander adds desiderata to guide responsible parties in dealing effectively with disaster management. Chapter 7, a short one, deals with medical emergencies; the reference list shifts to an extensive tapping of sources from the medical and public health literature. Chapter 8 is particularly poignant, devoted to special problems of the Third World, where vulnerability is increased by "marginalization," involving "neglect, repression, or deprivation of the poor"; refugee issues as well as the specter of disaster-induced famine and starvation arise here. Finally, in Chapter 9, we become sociologists, economists, and even psychologists as we consider Disasters and Socio-economic Systems, focusing on individual and societal reactions to disaster.

Specific case histories play a role in this book, but compose quite a small fraction. Generally, they are set out in the discussion at points serving to illustrate particular principles of planning, impact, and response (or failures thereof). Thus, while by no means the only volcanic disasters mentioned in Chapter 2, only the eruptions of Mount St. Helens and Nevado del Ruiz are given their own short sections of text. The absence of large descriptive sections devoted to classic eruptions (Vesuvius, Krakatau, Pelée) is initially surprising, but consistent with Alexander's emphasis on policy and planning rather than geology and physics.

Much information is presented in figures, but the lack of weight placed on case histories is also manifested in a paucity of photographic figures, all of which are in black and white. As a final small complaint, Alexander favors codifying information in block diagrams, sometimes with elaborate networks of interconnected arrows; I found these visually unappealing and sometimes unilluminating. In spite of its weaknesses, however, this book should be on the shelf of any professional who must consider any of the legion of issues associated with natural hazards.

Stephen P. Huestis
University of New Mexico,
Albuquerque, NM 87131

CALENDAR

Only new or changed information is being published in *GSA Today* .
A complete listing can be found in the **Geoscience Calendar** section on the World Wide Web: **http://www.aescon.com/geosociety/index.html.**

1996 Penrose Conferences

April
April 16–21, **Tectonic Evolution of the Gulf of California and Its Margins,** Loreto, Baja California Sur, Mexico. Information: Paul J. Umhoefer, Department of Geology, Box 4099, Northern Arizona University, Flagstaff, AZ 86011, (520) 523-6464, fax 520-523-9220, E-mail: pju@nauvax.ucc.nau.edu.

Early Fall (date to be determined)
Exhumation Processes: Normal Faulting, Ductile Flow, and Erosion, The island of Crete. Information: Mark T. Brandon, Department of Geology and Geophysics, Kline Geology Laboratory, Yale University, P.O. Box 208109, New Haven, CT 06520-8109, (203) 432-3135, fax 203-432-3134, E-mail: brandon@milne.geol.yale.edu.

1996 Meetings

February
February 4–7, **North American Energy Summit 1996,** Houston, Texas. Information: Conference Coordinator, Institute for International Research, 708 Third Ave., 4th Floor, New York, NY 10017-4103, (212) 661-8740, fax 212-661-6677.

February 8–13, **American Association for the Advancement of Science Annual Meeting,** Baltimore, Maryland. Information: AAAS Meetings Office, 1333 H St., N.W., Washington, DC 20005, (202) 326-6450, E-mail: amsie96@aaas.org.

March
March 11–14, **Sixth West Coast Conference on Contaminated Soils and Groundwater—Analysis, Fate, Environmental and Public Health Effects, and Remediation,** Newport Beach, California. Information: Karen S. Morse, Association for the Environmental Health of Soils, 150 Fearing St., Amherst, MA 10100, (413) 549-5170, fax 413-549-0579.

March 14–15, **Michigan: Its Geology and Geologic Resources,** East Lansing, Michigan. Information: Symposium, Michigan Geological Survey Division, P.O. Box 30256, Lansing, MI 48909. *(Abstract deadline: December 1, 1995.)*

April
April 15–18, **Applied Geoscience Conference,** Warwick University, UK. Information: Geological Society, Conference Department, Burlington House, Piccadilly, London W1V 0JU, UK, phone 44-171-494-0579, fax 441-71-439-8975.

April 18–19, **Economic Aspects of Petroleum Exploration: An Approach to Rational Exploration,** Zagreb, Croatia. Information: Josipa Velić, Faculty of Mining, Geology & Petroleum Engineering, Pierottijeva 6, 10000 Zagreb, Croatia, phone 385-1-442-861, fax 385-1-440-008.

April 28–May 1, **11th Himalaya-Karakoram-Tibet International Workshop,** Flagstaff, Arizona. Information: Allison Macfarlane, Dept. of Geography & Earth Systems Science, George Mason University, 1E2, Fairfax, VA 22030-4444, (703) 993-1207, fax 703-993-1216, E-mail: amacfarl@osf1.gmu.edu.

May
May 30–June 3, **Eighth Symposium on the Geology of the Bahamas and Other Carbonate Regions, Bahamian Field Station,** San Salvador Island, Bahamas. Information: James L. Carew, Department of Geology, University of Charleston, Charleston, SC 29424, (803) 953-5592, fax 803-953-5446, E-mail: carewj@cofc.edu.

June
June 24–27, **Second International Airborne Remote Sensing Conference,** San Francisco, California. Information: ERIM/Airborne Conference, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123, E-mail: rrogers@erim.org, Internet Web site: http://www.erim.org/CONF/conf.html.

July
July 7–10, **Soil and Water Conservation Society 51st Annual Conference,** Keystone, Colorado. Information: Timothy J. Kautza, Soil and Water Conservation Society, 7515 NE Ankeny Rd., Ankeny, IA 50021-9764, (515) 289-2331, ext. 12.

July 14–17, **Watershed Restoration Management, Physical, Chemical, and Biological Considerations,** Syracuse, New York. Information: Peter E. Black, SUNY College of Environmental Science & Forestry, Syracuse, NY 13210, (315) 470-6571, fax 315-470-6956.

July 29–August 2, **Proterozoic Evolution in the North Atlantic Realm,** Goose Bay, Labrador. Information: Charles F. Gower, Newfoundland Department of Natural Resources, P.O. Box 8700, St. John's, Newfoundland, A1B 4J6, Canada, (709) 729-2118, fax 709-729-3493, E-mail: cfg@zeppo.geosurv.gov.nf.ca.

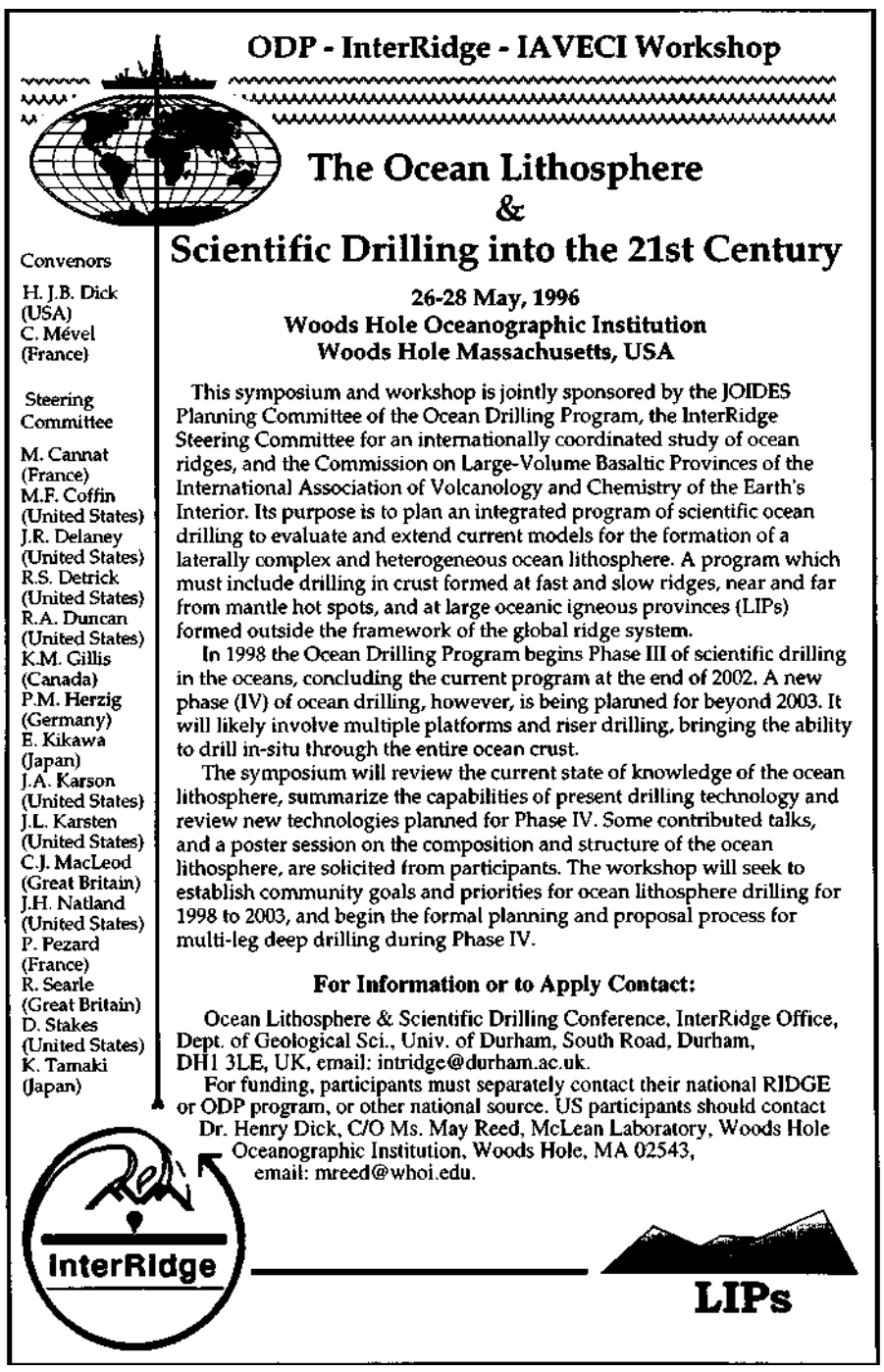
September
September 22–26, **American Water Resources Association 32nd Annual Conference and Symposium:** GIS and Water Resources, Ft. Lauderdale, Florida. Information: American Water Resources Association, 950 Herndon Pkwy., Suite 300, Herndon, VA 22070-5528, (703) 904-1225, fax 703-904-1228, E-mail: awrahq@aol.com.

September 22–27, **Environmental Hydrology and Hydrogeology, 3rd USA/CIS joint conference,** Tashkent, Uzbekistan. Information: Third USA/CIS Conference, AIH, 3416 University Ave. S.E., Minneapolis, MN 55414-3328.

September 25–28, **New Mexico Geological Society Fall Field Conference,** Jemez and Nacimiento Mountains, Albuquerque and Los Alamos, New Mexico. Information: Margaret Anne Rogers, MARA, Inc., 1753 Camino Redondo, Los Alamos, NM 87544, (505) 662-6574, fax 505-662-6574, E-mail: rogersmac@aol.com, Internet Web site: http://XRFMAC.lanl.gov/.

November
November 17–22, **Hydrology in the Humid Tropical Environment,** Kingston, Jamaica. Information: Secretariat, Humid Tropics Environment '96, A. Ivan Johnson, 7474 Upham Ct., Arvada, CO 80003.

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



Rock Stars

INTRODUCTION

Bernard of Chartres, an 11th-12th century philosopher and teacher, said that we are like dwarfs on the shoulders of giants, so that we can see more than they and for a greater distance, not by any virtue of our own but because we are carried high and raised aloft by their stature.

All of us have our geological heroes, those giants on whose shoulders we stand. To encourage recognition of these luminaries and to provide inspiration for students and young professionals, the GSA History of Geology Division presents Rock Stars, brief profiles of our geological giants. Here is the first one. If you have any comments on this or subsequent profiles, please contact Robert N. Ginsburg, University of Miami, RSMAS/MGG, 4600 Rickenbacker Causeway, Miami, FL 33149-1098, E-mail: rginsburg@rsmas.miami.edu.

—Robert N. Ginsburg, Chair, History of Geology Division

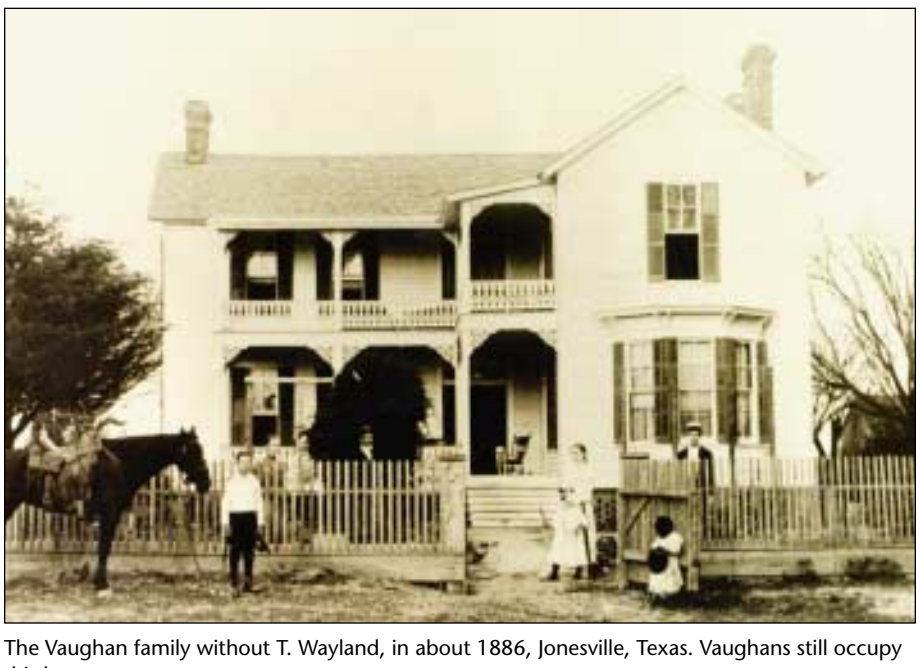
Formative Years of the Scientific Career of T. Wayland Vaughan

Robert N. Ginsburg

Soon after I came to Florida some decades ago to study recent carbonate sediments and reefs, I found references to publications by T. Wayland Vaughan. At first I thought they could not be of much value to me because they were already decades old and Vaughan's name was not linked with any major concepts in the geology of carbonates. Fortuitously, I did take two of his major papers with me on my first field trip to study reefs and sediments on Loggerhead Key in the Dry Tortugas off Key West. That island was the site of the Carnegie Institution's Marine Biological Laboratory, where Vaughan and other pioneers studied reefs during the first 40 years of this century. I had my first look at beach rock, coral reefs, and associated sediments; I snorkeled over the reefs that Vaughan studied; and I visited nearby Fort Jefferson, where he planted corals to study their growth rates. At the same time I was establishing a connection with the historical Vaughan, I was reading his major works on reefs and geologic history of Florida. I was amazed and impressed to learn how much he had done in less than 20 years when there was no scuba, no outboard motors or aerial photographs, and only primitive bottom-sampling gear. I found that Vaughan began the first effort to analyze the origin of grains in carbonate sediments from the sea floors of south Florida, and I was inspired to expand the effort in one of my first major research projects. Later, I discovered that he was also a pioneer in measuring the growth rates of corals, that he combined well logs and outcrop data to provide an outline of the geologic history of southern Florida, and that he posed most of the significant questions about the origin of ooids and lime mud in the Bahamas and the effects of Pleistocene lowstands of sea level on the margins of the banks.

The more I read of Vaughan's works, the more I was impressed with his accomplishments not just in Florida, but in the West Indies and Panama, as well as in the Pacific. In addition to his scientific accomplishments, he served with distinction as one of the early directors of Scripps Institution of Oceanography in California. He was a key player on two National Research Council committees that had seminal effects in oceanography and paleoecology. My appreciation for Vaughan's contributions, especially those in Florida and the Bahamas, led me to name the lab I established, in 1970, the T. Wayland Vaughan Laboratory for Comparative Sedimentology.

Jonesville, Texas (population about 300), near the Louisiana border, is not much larger than it was in 1870 when T. Wayland Vaughan was born to a prosperous family with distinguished ancestors back east. What Jonesville lacked in intellectual stimulation was more than compensated for by Vaughan's family. His physician-father was an ardent scholar who had one of the finest libraries in the region. This climate of interest in books is probably one of the sources of Vaughan's lifelong addiction to learning, which extended to poetry, philosophy, and language, as well as science. With this background, it is no wonder that he was precocious and entered Tulane University at age 15.



The Vaughan family without T. Wayland, in about 1886, Jonesville, Texas. Vaughans still occupy this house.

Field geologist T. Wayland Vaughan at 26, in Texas.

At Tulane, Vaughan intended to study medicine, following his father's example, but the emerging applications of electricity were what was exciting—New Orleans was just beginning to have indoor lighting when he arrived—and Vaughan, ever-sensitive to opportunity, enrolled in the physical science curriculum. At Tulane, his B.A. in physical science was only the tip of an iceberg of interests. At commencement he read a paper on 18th century author Oliver Goldsmith, and in later life he said he was thankful he spent his third year of French studying the *Chanson de Roland*. In his acknowledgment of the Penrose Medal from the Geological Society of America in 1946, Vaughan explained that he "read and still have all the recommended books" from his undergraduate days and annually reread reviews of Greek philosophy. The seeds of his future career were also planted at Tulane, where two of the faculty inspired his interest in the history of life that could be read in fossils.

His infatuation with electricity was probably dulled by two happenings in the summer of his junior year at Tulane, 1888. Partly, it may have been his first job of reading electric meters in the heat and humidity of a New Orleans summer, but more likely, it was his first discovery of fossils. Only eight miles from his father's farm, he and a crew of laborers excavated, with much excitement, specimens of fossil leaves and the skeleton of an elephantlike mammal; all were sent to the Tulane museum. Later, with additional collections, he prepared a paper on these Eocene fossils.

Graduating from Tulane before he turned 19, Vaughan took a teaching position in Mt. Lebanon, Louisiana, at a school so small that it combined junior college level with that of high school and elementary—not exactly the launching pad for a scientific career. But there his curiosity and opportunism led him to study all sorts of plants and animals in the surroundings, and thus began his scientific career at the border between geology and biology. There also were the turning points in his future, those seemingly insignificant circumstances that so often lead in one direction or the other. An interest in plants, inspired probably by the earlier discovery of fossil leaves, led to a summer course in botany at Harvard, where, as a result, he became a graduate student in 1892. The nearby outcrops of Eocene marine sediments near Mt. Lebanon are rich in corals and mollusks. Vaughan's collection of them provided the material for his doctoral dissertation, which in turn led to study of living reefs, carbonate sediments, and Cenozoic geology of the Caribbean.

Harvard in the 1890s must have been an exciting experience. It retained the aura of the Louis Agassiz years as the country's premier institution of natural history; it had a faculty that included N. S. Shaler, William Morris Davis, and Alpheus Hyatt at the nearby Boston Society of Natural History—all leaders in the study of sedimentary deposits; and it had the excitement of graduate-student participation in cruises led by Alexander Agassiz to explore the reefs of Florida and the Bahamas. One of these assistants was Vaughan's fellow student, Alfred G. Mayor, a biologist, who subsequently convinced the Carnegie Foundation to establish, in 1904, the first laboratory for tropical marine biology at the Dry Tortugas, reef-ringed islands off Key West, Florida. Given Vaughan's interest in corals, it is not surprising that he soon became a regular researcher at the Carnegie Laboratory on idyllic Loggerhead Key. There, during part of the year, he did pioneer research on corals and their growth rates, on reefs, and on calcareous sediments of both south Florida and the nearby Bahamas. The rest of the year found him studying Cenozoic counterparts of his beloved corals and mollusks in Cuba, the Dominican Republic, and Panama.

Vaughan's subsequent career expanded like the ripples from a pebble thrown into a lake. His publications extended from the corals, sediments, and geologic history of Florida and the Bahamas to the Cenozoic stratigraphy of the Caribbean and the Atlantic coastal plain. He helped to establish, and chaired, the National Research Council's influential Committee on Sedimentation that inspired research and led to the publication of the *Treatise on Sedimentation*, a milestone in the development of sedimentary geology. His interest in reefs and marine deposits led him increasingly into oceanography, and from 1924 to 1936 he was the director of the Scripps Institution of Oceanography, wrote an influential report on international oceanography, and was a member of the committee that was instrumental in founding the Woods Hole Oceanographic Institute. When he retired from Scripps, he resumed his scholarly career with studies of the larger Foraminifera, but he still found time to organize a Committee on Marine Ecology as related to paleontology that produced a seminal two-volume *Treatise on Marine Ecology and Paloecology*. He also continued to develop three hobbies: the study of comparative religions, old Teutonic legends, and oriental art. He was so taken with Japanese art and customs

Vaughan *continued on p. 234*

Vaughan *continued from p. 233*

that he learned the language when in his 60s, and he lectured often on oriental art.

A photograph of Vaughan hangs outside my office, and when students ask who he was, there is an opportunity to explain how curiosity, drive, and making the most of every opportunity helped him to become a leading scientist who, through his own works and leadership, left a lasting influence on sedimentary geology.

T. Wayland Vaughan was born on September 20, 1870 and died on January 16, 1952.

For more on Vaughan:

Thompson, T. G., 1958, T. Wayland Vaughan: Academy of Sciences Biographical Memoirs, National Academy of Sciences, v. 32, p. 399–437.

Vaughan, T. W., 1919, Corals and the formation of coral reefs: Smithsonian Institution Annual Report for 1917, p. 189-276.

Vaughan, T. W., 1946, Response to presentation of the Penrose Medal: Geological Society of America Proceedings, Annual Report, p. 69–76. ■

CLASSIFIED ADVERTISING

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

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Situations Wanted	$1.75	$1.40
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Situations Wanted

PH.D. IN GEOLOGY with postdoc experience and good publication record is looking for research/teaching position. Research interests include geochronology (its applications to various geological problems), morphotectonics, regional geology of Gondwana, Tethyan orogenies and Asia. Please reply to GSA Box 1060, GSA P.O. Box 9140, Boulder, CO 80301-9140.

Positions Open

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

The Department of Geography and Earth Sciences invites applications for a tenure-track geoscientist (Ph.D. required) at the assistant professor level with research expertise in surface/near surface processes, particularly in one of the following areas:

(1) water/rock/sediment/soil interactions from the perspective of paleoclimatology, global change, clay mineralogy, stable isotope geochemistry, or low temperature aqueous geochemistry;

(2) geophysics from the perspective of geotechnical and computational modelling applications in near-surface studies and environmental site characterization, or hydrogeology.

The successful candidate is expected to teach in areas of specialization, interact with existing faculty, and contribute to student research experiences. The ability to teach earth history is desirable.

The department offers B.A. and B.S. degrees in earth sciences, organized into four tracks: geology, geotechnology, atmosphere/hydrology and environmental science, and an M.A. in geography which includes an environmental analysis track. An M.S. in earth sciences is in the planning stages.

The position begins in August 1996. Interested individuals should submit a letter articulating qualifications, teaching interests, research goals, plus a curriculum vitae with the names and addresses of at least three references to Wayne Walcott, Chair, Department of Geography and Earth Sciences, University of North Carolina at Charlotte (UNCC), Charlotte, NC 28223. Review of applications will begin January 15, 1996, and will continue until the position is filled. AA/EOE.

COLLEGE OF WILLIAM AND MARY FACULTY POSITIONS

The Department of Geology at the College of William and Mary invites applications for two tenure-track positions to begin in August 1996. The successful individuals must possess a strong commitment to excellence in undergraduate teaching in the classroom, laboratory, and field. Courses which must be taught between them are Mineralogy, Igneous/Metamorphic Petrology, and Structural Geology. One person will teach at least one of these courses, and the other person will teach two of them. Other courses which may be taught include introductory geology courses and elective geology courses of the candidates' choice. Supervision of undergraduate research projects is required of each candidate. Both positions require the Ph.D. and a commitment to research involving undergraduates. One position is for an entry-level assistant professor, and the other will be filled at the assistant or associate professor level. Review of applications will begin on December 20, and will continue until the positions are filled.

Send a letter of application, statement of teaching and research interests and objectives, curriculum vitae, undergraduate and graduate transcripts, and three letters of reference to Bruce K. Goodwin, Chair, Department of Geology, College of William and Mary, Williamsburg, VA 23187-8795.

The College of William and Mary is an Equal Opportunity/Affirmative Action university. Members of under-represented groups (including people of color, persons with disabilities, Vietnam veterans and women) are encouraged to apply.

ARIZONA STATE UNIVERSITY MINERALOGY

The Department of Geology at Arizona State University invites applications for a faculty position in Mineralogy defined in the broadest sense. Applicants are sought whose research will complement existing programs in the department. Individuals with research interests in fields such as mineral microstructures, electron microscopy, cyrstallography, reaction kinetics, high-pressure mineralogy, mineral physics, mineral surfaces, or mineral interfaces are encouraged to apply. Interdisciplinary interests are encouraged. Preference will be given to applicants at the assistant professor level, but we will consider applications from outstanding individuals for a senior faculty position.

The successful candidate will be expected to develop a vigorous research program and to be strongly committed to quality teaching. A Ph.D. in geology or related science is required, with emphasis in mineralogy or a related field and evidence of research and teaching acheivement or potential appropriate to rank are required. Starting date: 16 August 1996.

Send letter of application describing current research and teaching interests, curriculum vitae, and names and addresses of three potential references to: Prof. James A. Tyburczy, Mineralogy Search Committee Chair, Department of Geology, Box 871404, Arizona State University, Tempe, AZ 85287-1404, (602) 965-2637, 602 965-8102 fax.

The closing date for applications is 1 December 1995 and the first day of each month thereafter until the position is filled. Arizona State University is an Equal Opportunity/Affirmative Action Employer.

PETROLOGIST/ GEOCHEMIST

The Department of Earth Resources at Colorado State University invites applications for a 9-month, tenure-track position in petrology at the assistant professor level starting August 1996. We seek individuals with a strong commitment to undergraduate and graduate teaching, research, and service. A Ph.D. in geology or a closely related field must be completed by time of appointment.

The Department of Earch Resources offers field-oriented undergraduate and graduate programs in geology and watershed science. Candidates should be able and willing to teach any part of undergraduate mineralogy-petrology sequence, introductory physical geology, and other courses. Candidates should complement and be able to interact with existing faculty in the department. Interest in and ability to teach geochemistry and/or economic geology are desirable.

Candidates are expected to establish an active research and graduate student training program with external funding. Diverse research opportunities and facilities are available to CSU and other academic, industry, and government organizations in the Front Range area.

Applicants should send a curriculum vitae, a statement of teaching and research interests, and three reference letters to: Petrology Search Chair, Department of Earth Resources, Colorado State University, Fort Collins, CO 80523. Applications must be received by December 15, 1995.

Colorado State University is an EEO/AA employer. E.O. Office: 21 Spruce Hall.

IGNEOUS/METAMORPHIC PETROLOGIST UNIVERSITYOF CALIFORNIA, SANTA BARBARA

The Department of Geological Sciences is opening a tenure-track position in Petrology at the University of California, Santa Barbara. Applicants should have demonstrated research potential and a strong commitment to undergraduate and graduate instruction. Teaching responsibilities to include field geology, undergraduate igneous and metamorphic petrology, and advanced graduate classes including kinetics and thermodynamics of petrological systems. It is expected that the candidate will oversee the Electron Microbeam Analysis Lab at UCSB, and be a primary user of same.

The appointment will be made at the assistant professor level and will be effective July 1, 1996. A Ph.D. is required at time of appointment.

Completed applications will be accepted through November 30, 1995. Submit resume, statement of research and teaching interests and objectives, and names of three referees to: Professor Frank J. Spera, Search Committee Chair, c/o Lou Anne Palius, Geological Sciences Department, University of California, Santa Barbara, Santa Barbara, CA 93106-9630.

UCSB is an Equal Opportunity/ Affirmative Action employer.

LAFAYETTE COLLEGE

Assistant Professor, tenure-track position beginning Fall 1996 to teach courses in Sedimentology/Stratigraphy, Earth History, Oceanography/Marine Geology, and to participate in Introductory Geology courses. Applicants are invited to describe additional courses that they might teach in an undergraduate geology and environmental geosciences curriculum. A Ph.D. is required and teaching experience is preferred.

Please send a resume, a statement of teaching and research interests, graduate and undergraduate transcripts, and three reference letters to: Dr. Lawrence L. Malinconico, Jr., Department of Geology and Environmental Geosciences, Lafayette College, Easton, PA 18042-1768. Women and minorities are encouraged to apply. We will interview candidates at the Geological Society of America meeting in New Orleans, LA. However, applications will be accepted until December 31, 1995, or until the position is filled. An equal opportunity employer.

PALEONTOLOGIST/PALEOECOLOGIST UNIVERSITY OF MIAMI, CORAL GABLES

Department of Geological Sciences, College of Arts and Sciences invites applications for a tenure-track position at the assistant-professor level from persons who use paleontology as a research tool in such fields as paleoecology, environmental geology, and global climate change. The department is particularly interested in expertise in shallow marine paleoecology and paleontology as a complement to our coastal stratigraphy and paleoenvironmental research program.

The position is located at the main campus in Coral Gables.

Applicants will be expected to teach undergraduate courses in invertebrate paleonotology, historical geology, and evolution of the biosphere. Also, the successful applicant will be expected to collaborate with other faculty, guide graduate students, advise undergraduate students, seek extramural research funds, develop and maintain an active research program, and participate in the general activities of the university.

Research interests of the current four faculty members range from coastal and shallow marine sedimentation to isotopic studies of the mantle, climatic and hydrologic modeling, Caribbean ore deposits, volcanism, tectonics, carbonate and organic sediment processes, and diagenesis.

The Department works closely with the 15 faculty members of the Division of Marine Geology and Geophysics at the Rosentiel School on the Key Biscayne campus approximately seven miles from the main campus.

Applicants should submit a letter summarizing their research interests, a curriculum vitae and the names of three references before January 15, 1996, to Dr. Harold Wanless, Chairman, Faculty Search Committee, Department of Geological Sciences, University of Miami, Box 249176, Coral Gables, FL 33124-0401.

We expect to fill the position by June 15, 1996, with a start date of August 15, 1996. The University of Miami is an equal opportunity affirmative action employer and a smoke/drug-free workplace.

ENVIRONMENTAL GEOSCIENTIST HYDROGEOLOGIST THE UNIVERSITY OF TEXAS AT DALLAS

We have an opening for a tenure-track, faculty position (rank open) in the field of Environmental Geosciences for Fall 1996. The successful candidate will complement our existing strengths in high resolution geophysics and geochemistry and will lead an expanding research effort in environmental geosciences. Applications are invited from hydrogeologists with strengths in environmental geophysics or low-temperature geochemistry. Teaching responsibilities will include graduate and undergraduate courses in hydrogeology, courses in the area of specialization, and supervision of graduate students. We expect to fill this position at the assistant professor level, but rank and salary are negotiable. A Ph.D. must be held at the time of appointment.

Formerly the Southwest Center of Advanced Studies, UTD was established in 1969. The Department has 14 faculty, 3 technical support staff, 5 research scientists, 5 research associates,and a well equipped laboratory and computational facilities. There are about 75 graduate and 50 undergraduate

students enrolled in a range of degree programs including B.S./B.A. to Ph.D.

Applicants should send a resume, a statement describing their teaching and research interests, and the names, addresses, and telephone and fax numbers of at least three references to the Chair, Search #2022, The University of Texas at Dallas, P.O. Box 830688, Richardson, TX 75083-0688. Review of applications will begin on January 15, 1996, and continue until the position is filled. Further information about UTD and the Department of Geosciences is available on our home page at http://www.utdallas.edu/dept/geoscience or by e-mail to mitterer@utdallas.edu. The University of Texas at Dallas is an equal opportunity/affirmative action employer and encourages applications from women and members of minority groups.

MIDLAND VALLEY SERVICES, INC., the U.S. subsidiary of Midland Valley Exploration Limited, Glasgow, Scotland, is seeking a structural geologist to fill an entry-level consulting position in Boerne, Texas. Applicants should have a Ph.D., be able to do applied research and technical work in structural geology, and be able to work in a small office environment. Unix-based computer skills, 2-D and 3-D structural modeling experience, and the ability to apply structural geology to the petroleum industry are desirable. Boerne is a small town, 30 miles northwest of San Antonio in the Texas hill country. Applicants should address their resumes to Midland Valley Services, Inc., 301 E. San Antonio Street, Boerne, TX 78006, (210) 249-8995 tel., 210-249-9809 fax. Closing date for applications is 30 November 1995.

SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE

The Department of Geology at Southern Illinois University at Carbondale invites applications for a tenure-track assistant professorship in environmental geology/geomorphology starting August 16, 1996. Applicants must hold the Ph.D. degree and must have demonstrated teaching ability and existence of, or potential for, developing an externally funded research program of high quality. Experience in fluvial geomorphology, climate change research, and the applications of GIS, image analysis, and remote sensing is preferred.

Applicants should submit a CV, statement of teaching and research interests, and names and addresses of four referees by 1 January to Dr. Michael A. Kruge, Search Committee, Department of Geology, Southern Illinois University at Carbondale, Carbondale, IL 62901-4324; (618) 453-3351; fax: 618 453-7393; e-mail: kruge@qm.c-geo.siu.edu.

Southern Illinois University at Carbondale is an equal opportunity/affirmative action employer.

SEDIMENTOLOGY
WILLIAMS COLLEGE

The Department of Geology at Williams College invites applications for a tenure-eligible position at the assistant professor level in the field of sedimentology, appointment beginning July 1, 1996. (Appointment at a senior level is possible in exceptional circumstances.) We seek an individual with demonstrated excellence in teaching and a strong commitment to field-based research involving undergraduates. A Ph.D. is required by start of appointment. The candidate will be expected to develop a vigorous research program in sedimentation; experience in the coastal environment is desirable, as well as familiarity with computer modelling and remote sensing techniques.

The position will include full responsibility for a one-semester course with labs in sedimentation and other advanced courses such as remote sensing, along with team-teaching in introductory courses such as oceanography and environmental geology, the supervision of undergraduate research, and the development of new courses.

Williams is an independent, residential liberal arts college of approximately 2,000 undergraduates located in a small town in the Berkshire Hills of northwestern Massachusetts. The Geology Department includes six faculty members (five full-time and one part-time) housed in its own building and in the adjacent science center.

Candidates are requested to forward a letter of application (including a statement of teaching and research interests and goals), curriculum vitae, and three letters of recommendation to Prof. R. A. Wobus, Chair, Department of Geology, Williams College, 947 Main St., Williamstown, MA 01267, by Dec. 15, 1995.

Williams College is an EEO/AA employer and especially encourages aplications from women and members of minority groups.

PETROLOGIST/STRUCTURAL GEOLOGIST

The University of Pittsburgh at Johnstown, a four-year, degree-granting institution, invites applications for a full-time, two-year appointment (nontenure stream) at the Assistant Professor rank beginning fall 1996. Teaching duties will include upper division courses in structural geology, mineralogy, and igneous & metamorphic petrology, and selected non-lab introductory courses (oceanography, meteorology, and/or introductory geology). Applicants should hold a Ph.D. by the time of appointment and have a strong commitment to excellence in teaching and field-oriented undergraduate research. Previous college-teaching experience, the ability to incorporate computer applications into the curriculum, and an interest in Appalachian geology are also desirable. Review of applications will begin on October 30, 1995, and the search will remain open until the position is filled. Applicants should send a letter of application and a resume with the names, addresses, and telephone numbers of three references to Dr. Jack D. Beuthin, Chairman, Department fo Geology and Planetary Sciences, University of Pittsburgh at Johnstown, Johnstown, PA 15904. UPJ is an affirmative action, equal opportunity employer. Women and minorities are encouraged to apply.

Services & Supplies

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

Opportunities for Students

Visiting Fellows and Students/Institute for Rock Magnetism. Applications are invited for visiting fellowships (regular and student) lasting for up to 10 days during the period from March 1, 1996, through August 31, 1997.

Topics for research are open, although fellows are encouraged to take advantage of the chosen focus for cooperative reasearch in a given year. During 1995-6, the focus for research will be the connections between the fundamentals of rock magnetism and paleomagnetic observations.

Short proposals (two pages, single-spaced text plus necessary figures and tables) are due by December 22, 1995, for consideration by the Institute's Review and Advisory Committee (Bob Butler, Chair).

Successful applicants will be notified in early February 1996.

A limited number of travel grants of $500 are available to researchers who can demonstrate no existing financial resources. No funds are available for per diem expenses.

The Institute Staff (Bruce Moskowitz and Pete Solheid) will be happy to provide application forms and information necessary for proposal preparation.

Deadline for submission is December 22, 1995, at the following address: Facilities Manager, Institute for Rock Magnetism, University of Minnesota, 291 Shepherd Laboratories, 100 Union St. SE, Minneapolis, MN 55455-0128, 612-624-5274; fax: 612-625-7502.

Graduate Traineeship: 4-year traineeships avalable for graduate study in conjunction with interdisciplinary Research Training Group (RTG) in ecology, geology, archaeology, geography, and soils to enhance training in "Paleorecords of Global Change." Only citizens, nationals, or permanent residents of the U.S. qualify for stipends. The University of Minnesota is an equal opportunity educator and employer. Application deadline January 1. For application contact Barbara Eastwold, RTG, University of Minnesota, Ecology, Evolution and Behavior, 1987 Upper Buford Circle, St. Paul, MN 55108. Phone: 612/624-4238; FAX: 612/624-6777.

GSA ANNUAL MEETINGS

1996

Denver, Colorado • October 28–31
Colorado Convention Center
Marriott City Center

General Chairs:
Gregory S. Holden *and* ***Kenneth E. Kolm,***
Colorado School of Mines

Technical Program Chairs:
John D. Humphrey *and* ***John E. Warme,***
Colorado School of Mines,
Dept. of Geology & Geological Engineering,
Golden, CO 80401,
(303) 273-3819, fax 303-273-3859,
E-mail: jhumphre@mines.edu

Field Trip Chairs:
Charles L. Pillmore, *(303) 236-1240 and*
Ren A. Thompson, *(303) 236-0929*
U.S. Geological Survey, MS 913, P.O. Box 25046
Denver Federal Center, Denver, CO 80225

EARTH SYSTEM SUMMIT Denver

CALL FOR
CONTINUING EDUCATION COURSE PROPOSALS
PROPOSALS DUE BY DECEMBER 1

The GSA Committee on Continuing Education invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines. Continuing Education courses may be conducted in conjunction with all GSA annual or section meetings. We are particularly interested in receiving proposals for the 1996 Denver Annual Meeting or the 1997 Salt Lake City Annual Meeting.

Proposals must be received by December 1, 1995. Selection of courses for 1996 will be made by February 1, 1996. For those planning ahead, we will also consider courses for 1997 at that time.

For proposal guidelines or information, contact: ***Edna A. Collis***
Continuing Education Coordinator, GSA headquarters
1-800-472-1988, ext. 134 • E-mail: ecollis@geosociety.org

1997

Salt Lake City, Utah • October 20–23
Salt Palace Convention Center, Little America

General Chair: ***M. Lee Allison,*** *Utah Geological Survey*

Technical Program Chair: ***John Bartley,*** *University of Utah*

Call for Field Trip Proposals: We are interested in proposals for single-day and multi-day field trips beginning or ending in Salt Lake City, and dealing with all aspects of the geosciences. Please contact the field trip chairs listed below.

Paul Link
Department of Geology
Idaho State University
Pocatello, ID 83209-8072
(208) 236-3365
fax 208-236-4414
E-mail: linkpaul@isu.edu

Bart Kowallis
Department of Geology
Brigham Young University
Provo, UT 84602-4646
(801) 378-3918
fax 801-378-2265
E-mail: bjk@geology.byu.edu

Field trip guides will be published jointly by Brigham Young University Geology Studies and the Utah Geological Survey. Review drafts of Field Guides will be due March 15, 1997.

FUTURE

Salt Lake City	October 20–23	1997
Toronto	October 26–29	1998
Denver	October 25–28	1999

For general information on any meeting call the GSA Meetings Department,
1-800-472-1988 or (303) 447-2020, ext. 133;
E-mail: meetings@geosociety.org

GSA Thanks the 1995 Annual Meeting Sponsors

For the New Orleans Annual Meeting, the following exhibitors have generously donated funds to support the meeting. GSA is most appreciative of this support and thanks these companies.

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1996 GeoVentures

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

Choose from two types of GSA GeoVentures

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Length . . . . . 5 days
Cost . . . . . Approximately $500
Site . . . . . College campuses or resort towns, North America
Time of Year . . . . . Summer
Traveling . . . . . Limited. Possible one or two off-site day field trips
Ground Transportation . . Provided by GSA
Physical Requirements . . . None
Education . . . . . Daily classroom programs and field excursions

GeoTrips

Length . . . . . 1 to 3 weeks
Cost . . . . . Over $1000
Site . . . . . Worldwide
Time of Year . . . . . Anytime
Traveling . . . . . Daily change of site
Ground Transportation . . Provided by participants
Physical Requirements . . . May be physically demanding
Education . . . . . Informal, outdoor field instruction

GeoHostels

The Geology of the Glacier National Park Region

JULY 20–25, The Big Mountain Resort, Whitefish, Montana
Leaders: *Robert Thomas and Sheila Roberts*
Western Montana College

The Geology of the Wine Country in Western Oregon

AUGUST 17–22, Portland State University, Portland, Oregon
Leader: *Scott Burns*
Portland State University

GeoTrips

Information will appear in a future issue of GSA Today.

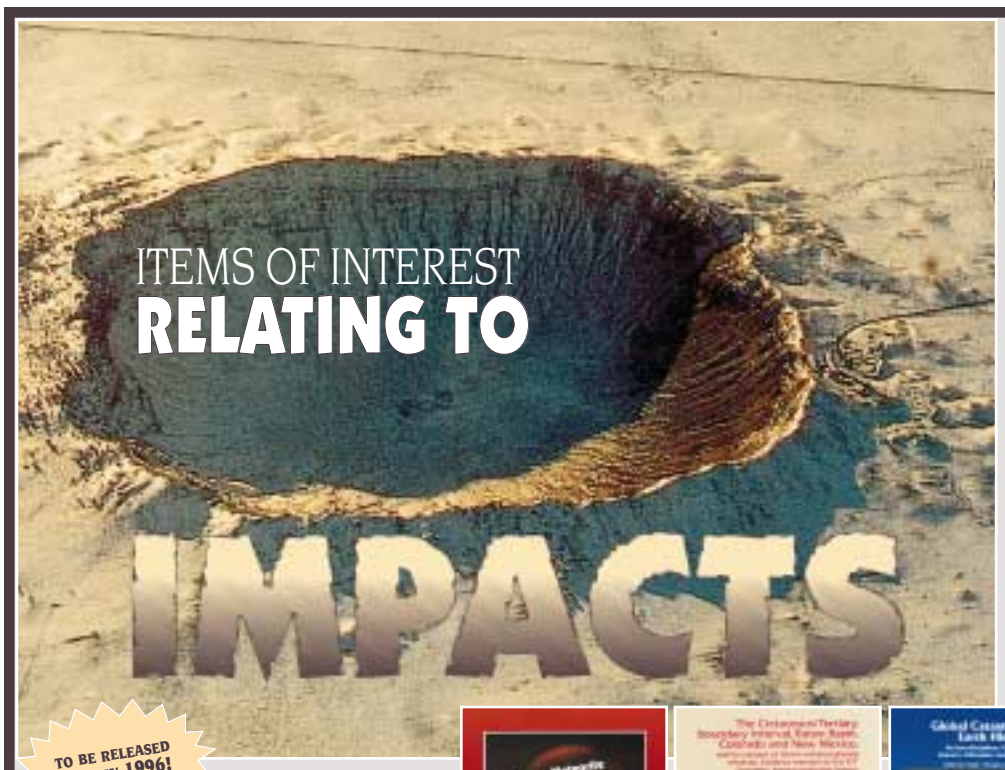
Full information in January *GSA Today*.

Registration begins January 1, 1996

Space will go quickly, so get in touch with us if you are interested. Detailed information on itineraries, registration fees, and travel arrangements will be sent on request. No obligation. Questions welcomed.

For details on the 1996 GeoVentures contact the GeoVentures Coordinator today:

1-800-472-1988 ext. 134 or
303-447-2020
E-mail: ecollis@geosociety.org
fax 303-447-0648

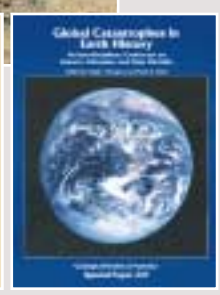


TO BE RELEASED EARLY IN 1996!

The Manson Impact Structure, Iowa: Anatomy of an Impact Crater
edited by C. Koeberl *and* R. R. Anderson, 1996
A comprehensive description of research on the 38-km-diameter Manson impact structure in north-central Iowa. This structure, one of about 20 confirmed impact structures in the U.S., was initially suspected as one factor in the K-T boundary drama. The possible association with the K-T boundary led to an increase in research on the Manson structure in the 1980s. Then, in 1991–1992 the Iowa Geological Survey Bureau and the U.S. Geological Survey conducted a Manson core-drilling program. The results of many of the investigations on samples of Manson cores and related studies are reported in this volume. The contents of the volume range from geophysical studies of the crater structure to detailed mineralogical, petrological, and geochemical investigations of rocks from the cores, and from the documentation of post-impact hydrothermal events to the study of possible distal impact deposits in South Dakota and Nebraska. These studies also have produced a more accurate age of Manson at about 74 Ma, discrediting theories that the Manson impact was associated with the K-T boundary events.
SPE302, 484 p., indexed, ISBN 0-8137-2302-7, $99.50.

Large Meteorite Impacts and Planetary Evolution:Proceedings of the Sudbury 1992 Conference on Large Meteorite Impacts and Planetary Evolution, August 31 to September 2, 1992
edited by B. O. Dressler, R. A. F. Grieve, *and* V. L. Sharpton, 1994
Twenty-eight papers, organized in five chapters, cover a wide range of topics of interest to the planetologist and other geoscientists. Topics include impact cratering phenomena and processes, shock metamorphism, the origin of tektites, terrestrial and planetary impact structures, and paleontological extinctions. Six papers present new data on the origin and evolution of the Sudbury Structure of northern Ontario. Information on nine other terrestrial impact structures also is presented, including the Popigai and Puchezh-Katunki structures of Russia, the Vredefort structure of South Africa, and the Beaverhead structure of Montana. The six papers in the first section on Planetary Constraints and Perspectives are of special interest to the planetologist dealing with the origin of lunar multiring basins, impact structures on Venus, and impact melt production on the planets. Includes an extensive glossary.
SPE293, 358 p., indexed, ISBN 0-8137-2293-4, $97.00






The Cretaceous/Tertiary Boundary Interval, Raton Basin, Colorado and New Mexico, and Its Content of Shock-Metamorphosed Minerals; Evidence Relevant to the K/T Boundary Impact-Extinction Theory
by G. A. Izett, 1990
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