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INSIDE

The Basilica of Sant'Ubaldo, on the mountain overlooking Gubbio, Italy. A twelfth-century Bishop of Gubbio, Saint Ubaldo, led the citizens up the Bottaccione Gorge at night (past the K/T boundary) and circled around, surprising and driving off the combined armies of eleven nearby towns which were besieging Gubbio. *Photo by Walter Alvarez*

The Gentle Art of Scientific Trespassing

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ABSTRACT

Research on impacts and mass extinctions has been interdisciplinary in the extreme. As the field has developed, the scientists involved have learned a number of ways of bridging the barriers that normally separate specialties. The most difficult problems involve different training in the primary and secondary sciences, different cultures in different sciences, perceptions of a hierarchy or pecking order of sciences, judging the quality of scientific work, and the barrier of jargon and technical language. Doing interdisciplinary science involves learning the languages of different fields, and when this is done, most of the other barriers melt away. Perhaps the interdisciplinary style that is growing up in this field may eventually be as important as the things we are learning about impacts and mass extinctions.

Author's Note: In 1988, Frank Asaro was organizing a symposium at a meeting of the American Chemical Society and asked me to speak on the topic, "How geologists view chemists." Recognizing the potential for disaster inherent in that title, I convinced him to let me speak instead on "How scientists view each other across discipline boundaries" (a written version will appear in the Proceedings of the 1988 Snowbird II Conference [Alvarez, 1991]). At Eldridge Moores's suggestion, I have revised that article for *GSA Today*.

INTRODUCTION

There seems to be a close association between interdisciplinary science and revolutionary developments in geology, although it's not clear which (if either) is cause and which is effect. You might disagree, but I think I see four revolutions in 20th century geology. The first brought us radiometric dating. The interdisciplinary character of this development could be symbolized by the collaboration at Berkeley in the 1950s and 1960s between physicist John Reynolds, geologist Garniss Curtis, geophysicist Jack Evernden, and paleontologist Don Savage (Glen, 1982).

The second revolution, which brought us plate tectonics, had an aborted start with the meteorologist Alfred Wegener, then took off with geologist Harry Hess and geologists, geophysicists and paleontologists, physicists, and chemists too numerous to list.

Looming on the horizon is a coming revolution in understanding Earth as a system, which will surely involve people from biology, earth sciences, engineering, physics, chemistry, and mathematics.

Interdisciplinary work has also been characteristic of the currently active and controversial revolution over the role of impacts and other catastrophic events in Earth history. This development is forcing the rejection of classical uniformitarianism, as we realize that modern geologists must be able to think about both sudden and gradual changes in order to understand the history of Earth. Shortly before the discovery of the Italian Cretaceous-Tertiary iridium anomaly, we were already doing interdisciplinary research at Gubbio, in the Apennines, as a team ranging from paleomagnetist Bill Lowrie to micropaleontologist Isabella Premoli Silva correlated the biostratigraphic and magnetostratigraphic time scales (Alvarez et al., 1977). The iridium anomaly discovery paper (Alvarez et al., 1980) was written by a particle physicist, a geologist, and two nuclear chemists. Almost immediately, other interdisciplinary groups began to work on the problem. One early paper was written by an oceanographer, an atmospheric scientist, and a planetary geologist (Emiliani et al., 1981), and a more recent, extreme example was written by two astronomers, two geologists, and four paleontologists (Hut et al., 1987).

Many other questions in geology involve input from chemistry or biology or physics, but they do not often attract chemists and biologists and physicists to work on them; they stay strictly in the mainstream of geology. Why did this particular topic,

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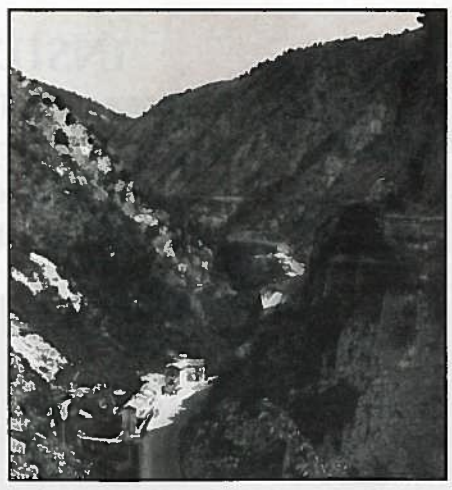

The Bottaccione Gorge at Gubbio. White pelagic limestones in the foreground are the Lower Cretaceous Majolica formation. In the distance are the pink pelagic limestones of the Upper Cretaceous-Eocene Scaglia rossa formation, with the K/T boundary about half way up the cliff. The near horizontal structure is a twelfthcentury aqueduct that brought water to Gubbio (this is the "Bottaccione," or "big water barrel").

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the mass extinction 65 m.y. ago, draw in so many people from so many other fields? I think it is because the impact of a 10 km extraterrestrial body on Earth is such an unusual and extreme event that it led to unexplored parts of other fields, not to their central, well-known bodies of information. Suppose one had gone to a chemist or physicist and asked for help in understanding some aspect of the K/T boundary. If that chemist or physicist had been able to say, "Well, why don't you just look in the index of any elementary textbook?," there would have been little incentive for that person to join in the research.

However, this extraordinary event has led to new kinds of thinking in every branch of science it has touched. In biology, it required thinking about non-Darwinian mechanisms of evolution. In geology, it forced a reevaluation of the central geological doctrine of "uniformitarianism" or "gradualism," which for 150 years had discouraged any thinking about catastrophic events. In chemistry, it focused on iridium, an almost comically obscure element, and created a demand for very fast analytical capabilities at the parts-per-trillion level. And new problems have been opened up in ecology, geophysics, astrophysics, and atmospheric science, as well.

Impact research has thus led to forefront work in a variety of different sciences. But progress in working out the implications for each science has depended on keeping in touch with what is happening in each of the other sciences. For example, think about astrophysicists, exploring the idea that a hypothetical companion star to the Sun (Davis et al., 1984; Whitmire and Jackson, 1984) might cause periodic impacts and mass extinctions on Earth by gravitationally disrupting the Oort comet cloud of the outer Solar System as it comes close to the Sun every 25 to 30 m.y. Calculations as to whether such a wide binary star system would be stable (Hut, 1984) depend on the latest information from geology and paleontology bearing on the timing of impacts and extinctions: are impacts periodic or aperiodic (Raup and Sepkoski, 1984, 1986; Grieve et al., 1985; Shoemaker and Wolfe, 1986; Baksi, 1990)? If they are periodic, what is the time interval between them?

The whole field of research on impact crises has been built on interdisciplinary research, and trespassing on other people's fields has become a privilege and a pleasure for those of us involved in it, as has welcoming visitors from other parts of science who get interested in our own disciplines. So let us consider the experience of crossing discipline boundaries in science.

BARRIERS TO CROSSING DISCIPLINE BOUNDARIES

It seems to me that there are several barriers to crossing discipline boundaries, some minor and others more difficult. In practice, however, it is quite possible to bridge these barriers, and doing so brings great rewards, both personal and scientific.

Academic Departmental Structure

First of all, interdisciplinary work is hindered by the departmental structure of the universities. In academia, at least, we live our lives surrounded by people in the same general field. Yet this is largely a matter of habit. At Berkeley, and I am sure elsewhere, there are many opportunities, both formal and informal, for moving out of the confines of one's department; this is no excuse!

Disciplinary Structure of Funding Agencies

A second obvious problem is that interdisciplinary research tends to fall into the cracks between programs at funding agencies like NSF. Perhaps there ought to be a special division at NSF, or a separate agency, aimed at funding maverick interdisciplinary proposals. Meanwhile, as we wait for this Utopian dream to come true, it is worth noting that interdisciplinary research topics are more likely to interest private donors and the generalists who run private foundations than are the narrowly focused projects that appeal to specialists.

Asymmetry in Training Between Primary and Secondary Sciences

Turning to the more subtle problems that raise barriers to interdisciplinary science, our third problem concerns the difference between what we might call primary and secondary sciences. As students we are all trained in the primary or basic sciences—mathematics, physics, and chemistry. However, the secondary sciences—geology, paleontology, biology—are studied almost exclusively by practitioners of those sciences. Almost all geologists have a basic understanding of chemistry, but few chemists know anything at all about geology. This puts a one-way valve in the communications system, and as you will see, good communications are the prime consideration and the prime difficulty in doing good interdisciplinary science. Because of the asymmetry in training, a somewhat harder burden falls on people from the basic sciences, but anyone wishing to cross disciplinary boundaries will have to learn—or will have the pleasure of learning—someone else's science.

Varying Cultures and Traditions in Different Sciences

The fourth problem concerns the different cultures and traditions of the different sciences. Because of our different subject matter, scientists in various disciplines must work in different ways. Chemists and physicists work in controlled laboratory settings, isolating the phenomenon they wish to study, and carrying out elegant and repeatable experiments. Geologists and paleontologists are restricted to studying what nature has preserved for us—or, sometimes, what the highway department has chosen to excavate, and has not chosen to pave over.

Our differing traditions go back centuries and are picked up and internalized by each of us as students. Chemists honor Marie Curie and Mendeleev; physicists honor Newton, Einstein, and Fermi; biologists honor Wallace and Darwin. As a geologist, I count G. K. Gilbert, Alfred Wegener, and Harry Hess among my heros. Although we are all scientists, we have had to develop quite different ways of doing science, and when people with these different backgrounds join together to work on a common problem there is inevitably misunderstanding at first, and friction. However, our experience is that these problems do not last long when people get together to work on an intriguing interdisciplinary problem.

The Spectrum or Hierarchy of Sciences

One of the misunderstandings emerges as we look at the fifth problem, which concerns the hierarchy, or pecking order, of the sciences. The scientific pecking order appears to reflect the prestige of the various disciplines. Why does this hierarchy exist? I'm leaning toward the view that the higher prestige disciplines are able to formulate general laws that require considerable mathematical sophistication to understand, whereas the lower prestige disciplines deal with subject matter of great complexity, which must be described and classified before it can be understood. In this view, the hierarchy of sciences has nothing to do with the relative merits of the different sciences, but is instead a function of the kind of subject matter with which they deal. If we drop the loaded terms like "hierarchy" and "pecking order" and simply arrange the sciences in a spectrum from mathematically sophisticated at one end to descriptively complex at the other, we would probably not differ too much in assigning a sequence something like the following: mathematics, physics, chemistry, astronomy, geology, paleontology, biology, psychology, sociology.

Let us trace one strand of impact-extinction research across the spectrum of sciences and watch the complexity increase. Nuclear chemists like Frank Asaro, Helen Michel, and Carl Orth use techniques from physics to do neutron activation analysis for elements like iridium. They measure the neutron flux that irradiates their sample, and as the radioactivity decays they measure the energy and release time of de-excitation gamma rays. They end up with a reliable value and uncertainty for the concentration of iridium in a sample, —say 37.9 ±2.3 (1 SD) × 10^{-12} g Ir/g whole rock.

Stratigraphers like Sandro Montanari and Jan Smit, studying an Ir profile across the K/T boundary, must consider less quantifiable uncertainties, including sedimentary reworking, burrowing by bottom-dwelling organisms, and chemical remobilization as they determine whether the Ir was deposited instantaneously.

Paleontologists like Gerta Keller, Hans Thierstein and Peter Ward, trying to decide whether the Ir input coincided in time with a mass extinction, must decide how to define a mass extinction—they have to choose the taxonomic level to use and whether to focus on taxa lost or on biomass destruction—and then they must consider whether hiatuses and fossil reworking

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are complicating the record, and whether an apparent diversity decline is real or just a sampling artifact.

If the evidence for impact seems to coincide with the extinction level, paleoecologists like David Milne and David Jablonski have to consider what the geographical extinction pattern was, what were the life styles of victims and survivors, and which of the suggested killing mechanisms—darkness, acid rain, greenhouse heating, fires, etc. (Gilmour et al., 1989)—might have affected each group.

Finally, if it is concluded that impact causes mass extinctions, evolutionists like Steven Gould and Digby McLaren must consider the extent to which this forces us to revise Darwin's concept of evolution by natural selection. From counting gamma rays to revising Darwin there is an unbroken chain of interdisciplinary science, but the levels of mathematical sophistication and descriptive complexity vary dramatically.

What is the effect of this spectrum of sciences on interactions across the disciplines? It causes real problems because the spectrum is often interpreted as a ranking in order of merit. But when a healthy interdisciplinary field grows up, most of the people in it simply see through the fallacy of this pecking order and recognize that each science has developed the techniques it needs for its kind of problem. My father once told me, after visiting me in the field, that he admired the work of geologists, but that he would stick to physics, thank you, because geology was just too complicated for him.

Judging the Validity of Scientific Results in Someone Else's Field

Continuing the list of barriers to interdisciplinary work, number six is this: How do you estimate the level of confidence you can have in data and interpretations from someone else's field? We are all accustomed to doing this every day in our own field, where

Trespassing *continued on p. 34*

Environmental Issues

Polyethylene, Recycled Paper, and GSA Publications

Jim Clark
Manager, GSA Publications Production and Marketing

One of the major challenges of the 1990s is conservation of our environment. Beginning this month, GSA is implementing changes that will make our publications program more environmentally responsible. These changes result from a two-year investigation that focused on two specific areas in our publications program:

1. Should we continue using polyethylene (poly) as a packaging medium for our publications; and, if any use is justified, which type (recyclable or degradable) best serves the environment?
2. Are the printing papers we use for our periodicals and books recyclable? Could we use recycled papers and continue meeting the standards for paper permanence, especially for library materials?

The Use of Poly

The first question was easy to answer. The use of poly has provided GSA with economic and marketing advantages. However, two indisputable facts now overshadow the advantages: (1) poly is made from hydrocarbons, a nonrenewable resource that we should use responsibly; and (2) pure poly is inherently recyclable, but for an unacceptably high percentage of people there is no *ready means* for recycling it, and far too much finds its way into landfills.

We can no longer avoid the conclusion that poly should be used only when the desired function cannot be performed adequately by an alternative that is better for the environment. Therefore, GSA is discontinuing or modifying its use of poly in the following areas.

Journal Subscribers

Poly is being discontinued as the packaging medium for our original fulfillment mailings of *GSA Bulletin*, *Geology*, and *Abstracts with Programs* to all domestic U.S. subscribers. These periodicals will be mailed without packaging, as is *GSA Today*. Copies damaged in the mail will be replaced free by GSA—just call or write the Membership Department.

Until we find a more suitable alternative, we will continue to use poly for mailing periodicals to our overseas subscribers. The U.S. Postal Service *requires* packaging for these, and because they move by ship we feel that poly offers the most protection against moisture and other hazards of ocean shipment.

Back-Label Journal Mailings

For the past two years we have used poly to mail back-label journal orders from our warehouse. These are copies of back issues that go to members when they pay their dues after the start of the subscription year. We will stop using poly for this purpose when our current supply is exhausted.

Catalogs and Flyers

We will no longer use poly in our publications marketing efforts. In the future, catalogs and flyers will be mailed in recyclable packaging or, when possible, without packaging.

GSA Books

GSA books have traditionally been shrink-wrapped with a special poly to protect them during shipment and mailing. We are working with our printers to phase out the use of poly for this purpose. We intend to substitute other environmentally safe packaging methods, or use no packaging at all.

Bookstore Shopping Bags

If you have visited the GSA Bookstore at any Section or Annual Meeting, AGU, or AAPG meeting, you are familiar with the blue and white poly book bag that thousands of customers use to carry their purchases. We will continue to offer these until our present supply is exhausted. By that time we hope to find an affordable, environmentally safe replacement for this give-away bag.

GSA now offers a new cotton-canvas shopping bag. These are similar in size and shape to bags offered for sale by many supermarkets. They are too expensive to give away; however, you can buy them at our cost ($3.50 net, less than supermarkets charge), or you can get one as a gift on any order to GSA Publication Sales that includes two or more items totaling $55 or more, net, before taxes.

Now to address the last part of the poly question: "If any use of poly is justified, which type (recyclable or degradable) best serves the environment?"

When we began using poly several years ago, GSA opted for 100% pure material. It still seems to be a better choice environmentally than "degradable" poly for two reasons: first, pure poly is the only kind that *can* be recycled. Poly materials labeled "degradable" contain additives such as starch that disintegrate—biologically or through photosynthesis—leaving behind unrecoverable poly fibers. These additives are detrimental to recyclers because even a small undiscovered amount of them in the recycling stream can ruin an entire batch of recycled poly.

Second, the label "degradable" encourages many people to feel more comfortable tossing the item into the trash headed for landfills where, current research indicates, it may never degrade.

In summary, although neither type of poly conserves our nonrenewable resource, pure poly is the better choice because it's recyclable.

Recycled and Recyclable Papers

The paper industry is regionally oriented, with many mills, each featuring its own line of papers and making its own decisions about producing recycled papers.

Partly because of this, paper that is inherently recyclable may or may not be acceptable by recyclers in all areas. Recyclers have to live with the economic realities of "who, where, and when—who will buy it, how far must it be shipped, and when will it be needed?"

As more mills decide to produce recycled papers, recyclers will find it profitable to accept a wider variety of waste at local levels. But any improvement will occur only in relation to the demand by the public and major paper users, like GSA, for broader lines of new papers that are better for the environment.

For now, these papers are available in limited supply, with limited characteristics, in two categories: (1) recyc*lable* papers, commonly containing mostly virgin fiber, sometimes mixed with mill broke; and (2) recycl*ed* papers, mixes of up to 50% or more virgin fiber, 40% or so of preconsumer waste, manufacturing byproducts, and mill broke, rounded out by up to 10% or so of postconsumer fiber (waste paper you and I recycle).

A little skepticism is healthy in evaluating claims that paper is recycled. Many papers claiming to be "recycled" in fact contain no postconsumer fiber. For most of us, this is contrary to the basic meaning we attribute to that word.

GSA Has Long Used Recyclable Papers

Since 1984, the text papers used for GSA publications have been recyclable new paper. There is nothing inherent in them to prevent recycling. But in some areas where recycling is not yet well developed it is difficult to recycle them or other paper products. Only continued public demand will change that.

GSA Bulletin and *Geology* are printed on a coated, matte-finish, acid-free paper that is widely recyclable. This paper contains 26% recycled waste (preconsumer).

Our books, with rare exceptions, are printed on uncoated matte-finish, acid-free book papers which are commonly accepted by virtually all recyclers. Because books are rarely discarded, an insignificant number flow into the waste stream.

GSA Begins Using Recycled Paper

GSA News & Information and *Abstracts with Programs* have, for years, been printed on common 50 pound offset paper, a sheet which contains varying portions of preconsumer waste and is widely sought after by recyclers.

In January 1991, *GSA Today* replaced *GSA News & Information*. It is printed on a recyclable paper with a preconsumer waste content. We hope to find a paper with a postconsumer recycled content in 1991.

In the marketing area, we intend to print our future catalogs and updates on recycled and recyclable papers, starting with the October 1991 catalog.

The situation is more difficult for our journals and books. We are compelled to continue using papers that meet widely accepted standards for science publishing, a tradition from the earliest days of GSA. We want to use papers with a postconsumer recycled component, and we have examined many different sheets so far in that search. As yet, however, we have not located any that meet library standards for permanence, foldability, strength, etc., and also meet our requirements for appearance, availability, weight, and cost.

The cost factor is a major obstacle. The cost of paper containing 10% or more of postconsumer recycled waste, and otherwise meeting the EPA 1988 standard for recycled papers, generally run between 60% and 100% more than papers without postconsumer content. Because paper represents one of the major cost components in our journal prices, that kind of increase would make our journals prohibitively costly to many of our subscribers.

We will continue searching aggressively for affordable papers with postconsumer waste content. As soon as the right combinations become available, we intend to start using them. ■

Comments?

If you have comments or suggestions on these issues, please write to J. Clark, Production Manager, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140.

Presentation of the GSA Distinguished Service Award to William B. Heroy, Jr. (right) by GSA President Raymond A. Price (left) at the 1990 Annual Meeting in Dallas.

William B. Heroy, Jr. Receives GSA's Distinguished Service Award

"Bill Heroy has served the Geological Society of America in many different capacities, generously, unobtrusively, and with great distinction." With these words President Raymond A. Price presented the GSA Distinguished Service Award to William B. Heroy, Jr., at the 1990 Annual Meeting in Dallas. This award was established by Council as a means of acknowledging exceptional service to the Society. Price continued, "Bill Heroy's long record of distinguished service to GSA began more than 25 years ago as an Associate Editor of the *GSA Bulletin*. His first appointment to GSA Council was in 1968, while he was a senior executive with Teledyne Corporation. Over most of the next fifteen years he contributed his substantial business expertise and knowledge to the management of GSA financial affairs, as a member and chairman of the Budget Committee, and on the Committee on Investments. From 1977 to 1982 he served as Treasurer of the Society and as a member of the Executive Committee. Since 1989 he has been a Trustee of the GSA Foundation. The present financial strength of the Society is, in no small measure, a result of his unselfish service over a period of many years."

Thank you, Bill. ■

The Geological Society of America

Congressional Science Fellowship 1991–1992

The Geological Society of America invites applications for the 1991–1992 Congressional Science Fellowship. The Fellow selected will spend a year (September 1991–August 1992) in the office of an individual member of Congress or a congressional committee advising on a wide range of scientific issues as they pertain to public questions. Guided by the American Association for the Advancement of Science, the Fellow selects a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is aimed at highly qualified earth scientists in early or mid-career. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy problems.

Award

The GSA Congressional Science Fellowship carries with it a $35,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and the U.S. Geological Survey, which supports 47% of the program with a $21,000 grant. (Employees of the USGS are ineligible to apply for this fellowship.)

To Apply

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

Deadline for receipt of all application materials is February 15, 1991

GSA FORUM

Bruce F. Molnia

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

ISSUE: The Arctic National Wildlife Refuge (ANWR)—Energy Independence or Environmental Destruction

Days before the *Exxon Valdez* spill of March 24, 1989, the Senate Energy Committee voted to open the ANWR coastal plain to development. The Prince William Sound oil spill abruptly terminated debate about ANWR development. Now, almost two years later, the situation in the Persian Gulf has refocused attention on ANWR, resurrecting the fundamental question of fragile environment versus energy development.

PERSPECTIVE 1:

ANWR—An Alternative to Foreign Oil Imports

Carl Portman, Resource Development Council for Alaska, Inc., Anchorage, Alaska

With over one-third of the undiscovered oil and gas resources of the nation and half of its coal reserves, Alaska represents this nation's best chance to curb a growing dependence on Middle East production. If there is any single most important action the United States can make to plan for its energy future, it would be for Congress to allow leasing for petroleum production in the coastal plain of the Arctic National Wildlife Refuge. Leasing would probably result in bigger incremental increases in domestic oil production than could be obtained from any other action.

Conservation, alone, will not solve America's problems, and no magic carpet or other practical, benign energy alternative exists. It will take new oil and gas production, conservation, and a greater utilization of alternative energy sources for America to significantly reduce its dependence on foreign oil. Alone, none of these practices can solve America's mounting energy problem. Geologists believe the coastal plain may yield as much as 9 billion barrels of oil, representing the best chance for a major domestic oil discovery for a nation that imports more than half of its oil. Other strong prospects in Alaska include the Chukchi Sea, which may contain over 4.8 billion barrels of oil, and the Beaufort Sea, which may hold several billion more barrels of crude.

Despite this tremendous energy potential, the Federal Government has put little emphasis on new Alaska drilling, and environmentalists want the Federal Government to ban drilling off Alaska's coast and onshore ANWR. Such action would increase the nation's dependency on foreign oil and make it more vulnerable to petroleum price increases and supply disruptions. The inherent risks will only grow larger as domestic production falls and new petroleum prospects on federal lands are withdrawn from exploration and development.

As more and more land is closed to oil development, U.S. dependency on foreign oil has increased to record levels and so has the bill for OPEC crude. Oil imports accounted for 45% of the U.S. trade deficit in 1989 and climbed to an all-time high in the first six months of 1990, accounting for 50% of the nation's petroleum consumption. Meanwhile, domestic production fell to its lowest level in decades. Output from the giant Prudhoe Bay field held up national production levels and significantly slowed the rise in oil imports. But Alaska's North Slope output, which accounts for one-fifth of all domestic production, peaked in 1988 and is now declining. Daily production at Prudhoe Bay is expected to be cut in half within a decade. Declining production and the Middle East conflict emphasize the need for a comprehensive national energy policy of which oil development in ANWR is a major component. Although new production from the refuge would not bring immediate relief to any supply disruptions resulting from current global conflicts, every new domestic barrel of oil produced not only represents a decrease in the amount of oil this nation has to import, but also serves to reduce the risks of future conflicts.

Today the coastal plain of ANWR represents an alternative to petroleum imports from the troubled Middle East. A large discovery could reduce imports by nearly one-fourth. This would roughly equal the amount of oil the United States imported on a daily basis from Iraq during the first five months of 1990. Combined with other promising oil and gas prospects in Alaska's Chukchi and Beaufort Seas, ANWR has the potential to offset the amount of oil imported daily from Saudi Arabia, Iraq, and Kuwait.

Henry Schuler, Director of Energy Security Studies at the Center for Strategic and International Studies, recently said, "America must curb its growth in oil imports and reassess the costs and risks of domestic energy alternatives in light of the costs and risks associated with sending nearly half a million men and women to a region that has seen great strife and little peace for hundreds of years." Those alternatives, Schuler noted, must include efficiency improvements, natural gas substitution, clean coal technology, research and development in alternative energy sources, and continued domestic oil and gas production, especially on the Alaskan coastal plain where the potential is greatest. Schuler warned America not to overlook the enormous resource potential of ANWR as we search for ways to avoid sustained or repeated deployment of troops in the Middle East.

Yet environmental groups remain hotly opposed to any drilling in ANWR, contending that no amount of oil is worth entering the refuge. These

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WASHINGTON REPORT

Bruce F. Molnia

The Washington Report provides GSA membership with a monthly window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. In future issues, the 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.

Clean Air, Clean Water, Clean Coal, Hamburgers, and You

On November 15, President Bush signed The Clean Air Act, Amendments of 1990 (Public Law 101-549), calling it "the most significant air pollution legislation in our nation's history." In his 1988 campaign, Bush had promised to sponsor legislation to provide for a kinder and gentler America. The amendments, the first revisions since 1977 of the Clean Air Act of 1970, are very broad in scope, and their impact will be widely felt in and beyond the earth science community. Organized into eleven titles, the amendments impose: tighter controls on air quality, including tougher emissions standards for sulfur dioxide produced by coal combustion (Titles I and IV); lower limits on automobile emissions, requiring cleaner burning fuels (Title II); constraints on hazardous air pollutants aimed at eliminating urban smog (Titles I and III); controls on water-quality degradation from acid deposition (Title IV); stratospheric ozone protection, including limits on and abolishment of chlorofluorocarbons (CFCs) and other ozone-depleting chemical compounds (Title VI); information gathering on greenhouse gases contributing to global climate change (Title VIII); and clean-air research (Title IX).

Title VI (Stratospheric Ozone Protection) identifies the year 2000 as the target date for the end of production of all CFCs, halons, and carbon tetrachloride; 2002 for the elimination of methyl chloroform; and 2030 for the elimination of all CFC substitutes, including HCFCs. Recycling of CFCs from cooling, refrigeration, and air-conditioning equipment is required, beginning in 1992. Title VI also requires the Administrator of the Environmental Protection Agency (EPA), within two years, to prepare reports that: identify activities, substances, or processes that could result in a reduction of methane emissions; characterize methane emissions associated with the extraction, transportation, distribution, storage, and use of natural gas and coal; evaluate methane emissions from biogenic sources such as tropical, temperate, and subarctic forests, tundra, and freshwater and saltwater wetlands; and characterize changes in methane emissions from biogenic sources that may occur as the result of potential increases in temperature and atmospheric concentrations of carbon dioxide. The large number of reports required by the amendments may in themselves have a significant impact on U.S. air quality by substantially reducing the size of the U.S. tree population.

Days before the signing of the amendments, McDonald's Corporation, as a result of a joint task force study with the Environmental Defense Fund, announced that it would phase out its foam plastic hamburger boxes and switch to paper packaging materials. In the United States, CFCs and HCFCs are used to produce more than one billion pounds of foam packaging materials annually. Prior to their phase-out, McDonald's alone accounted for almost 10% of the U.S. total. On November 7, 1990, Burger King took out full-page advertisements in national newspapers applauding McDonald's for their "new environmental consciousness." The ads ask "what the planet would be like" if McDonald's had joined Burger King in using environmentally less destructive packaging in 1955.

Title IV (Acid Deposition Control) establishes limits on the maximum permissible sulfur dioxide emissions by utility companies. By the year 2000, emissions may not exceed 8.9 million tons a year, down 10 million tons a year from 1980 levels. In some areas, a January 1, 1995, deadline is identified for limiting sulfur dioxide emissions to 2.5 pounds per million BTUs. Appalachian coal, the most commonly burned coal in the United States, is typically high-sulfur, producing more than 5 pounds of sulfur dioxide per million BTUs. To meet the limits set forth in the amendments, utilities will either have to burn low-sulfur coal, mix high-sulfur coal with other energy sources, add expensive scrubbers to their plants, or shift to new technologies. In 1989, almost 60% of the electricity produced in the United States was produced by the combustion of coal. The amendments provide a method for coal-burning utilities to earn allowances and credits for reducing acid-rain-producing emissions below new levels and for reducing emissions before the stated deadlines. These credits can be sold to other utilities and may be one mechanism used by some utilities to help cut the cost of complying with the amendments. Title IV also reduces nitrogen dioxide levels by 2 million tons from 1980 levels.

Title IV also authorizes EPA, in consultation with a variety of other U.S. entities, to prepare and submit reports to Congress on January 1, 1994, 1999, and 2005, analyzing the current emission levels of sulfur dioxide and nitrogen oxides in each of the Canadian provinces participating in Canada's acid-rain control program, the amount of emission reductions of sulfur dioxide and nitrogen oxides achieved by each province, the methods utilized by each province in making reductions, the costs to each province, and the employment impacts in each province making and maintaining those reductions. Independent of—but on the heels of—the amendments, the Canadian Government announced, on December 11, a $3 billion program to clean and protect Canada's air, water, and land. The program will attempt to reduce air pollution by 40% during the 1990s.

Title IX (Clean Air Research) authorizes the continuation of the National Acid Precipitation Assessment Program and requires (jointly with Title IV) the creation, maintenance, and publication of a National Acid Lakes Registry. The registry, to be created by EPA within one year of the enactment of the amendments, shall list all lakes that are known to be acidified because of acid deposition. Lakes are to be added to the registry as they become acidic or as data become available to show that they are acidic. The amendments, optimistically, even provide for the removal of lakes from the registry "as they become nonacidic."

Future Washington Report columns will keep you apprised of the implementation of the amendments and other legislation that impacts the earth sciences during the next session of Congress. ■

GSA members' reactions to Forum topics are encouraged. Members are invited to respond to positions presented in Forum and to submit alternative views. Letters from the membership will be published in the Forum Feedback section. Responses up to 500 words (double-spaced) should be sent to the Forum editor. Upcoming Forum topics will be presented to *GSA Today* readers with sufficient lead time for all who wish to participate. March's Forum topic is Future Energy Needs and the Utilization of Fossil Fuel. Other future Forum topics may include:

- What should GSA do to enhance the role of minorities and women in the geosciences?
- Are the geological sciences properly represented in the U.S. Global change Research Program?
- Should all professional geologists be licensed?
- Are there alternatives to Yucca Mountain?
- Should GSA assume a more visible advocacy role?
- What is the role of GSA in precollege and informal science education?

ANWR *continued from p. 32*

preservationists view the issue as a choice between oil development and wildlife, indigenous people, and the landscape. But reality, not emotion, has shown that environmental impacts arising from energy development and production in Alaska are frequently exaggerated. Given major advances in arctic energy technology, petroleum operations today pose a far less serious threat to the environment than the critics claim. Their objections fly in the face of modern energy development on the North Slope, where the industry has learned a great deal from the early days of Prudhoe Bay development. Since oil production began in 1977, there have been no discernible adverse effects from energy operations on North Slope, caribou, waterfowl, and other wildlife.

The oil industry, the North Slope Borough, and the State of Alaska point out that with advancing Arctic petroleum-development technology only a mere sliver of ANWR would be developed, and then only if oil were discovered. Advances in oil-field technology and design will allow for a smaller and more compact "footprint" of energy operation in ANWR. Gravel pads containing twice as many wells and covering less than half of the acreage of those constructed in early development of the Prudhoe Bay field would be employed in ANWR.

According to the Congressional Office of Technology Assessment, if several major oil fields were discovered in ANWR, energy operation would affect fewer than 7000 acres, less than one-eighth of 1% of the 1.5-million-acre coastal plain. The coastal plain itself represents only 8% of the 19-million-acre refuge.

Some habitat would be changed by development, but by careful avoidance of critical habitat areas, federal agencies believe the coastal plain can be developed with little impact on the wildlife and environment. Contrary to claims made by environmental groups that development would tear up "Alaska's last Arctic wilderness," no development would occur inside ANWR's designated wilderness areas. On the other hand, extending a Wilderness designation to cover the entire ANWR coastal plain could deny the nation up to one-fourth of its future domestic oil production from an area less than one-eighth of 1% of the refuge. It would also deny the United States the opportunity to cut oil imports by tens of billions of dollars annually.

Lost in the ANWR debate is the fact that Alaska already contains 56 million acres of designated wilderness, 62% of all federal wilderness in America. This immense wilderness block covers an area larger than the states of Pennsylvania, New Jersey, West Virginia, and Maryland combined. None of it is being considered for oil leasing.

Congress is likely to consider the ANWR issue over the next several months. It needs to filter out the emotional misinformation, weigh the facts, understand the options, and consider the implications for the future.

PERSPECTIVE 2:
Drilling the Arctic Refuge is No Answer to Our Energy Problems

George T. Frampton, Jr., The Wilderness Society, Washington, D.C.

Many people believe that if the oil industry were turned loose in the Arctic National Wildlife Refuge, we eventually would have another Prudhoe Bay–sized field on line. That is certainly what the oil companies and the Bush administration want us to believe. Yet the likelihood that a Prudhoe Bay lies below ANWR is just one in 100. That's not a Wilderness Society figure; it was produced by President Reagan's pro-development Interior Department in 1987. Of course, the prospects for finding a smaller field are greater. The Interior Department estimates that there is a 19% chance that the refuge is sitting on top of a commercially viable field. The oil industry likes to say that those

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Geology is more complicated than physics: When physicist Luis W. Alvarez visited the K/T boundary at Gubbio, it disturbed him that the beds were dipping at 45°. He leaned over and had this picture taken with the camera tilted, so that audiences of physicists would understand the originally horizontal bedding.

Trespassing *continued from p. 31*

we have the experience to evaluate the quality of a particular piece of research, or where we have worked on the same topic ourselves, or where we know the reputations of the people involved. Judging the quality of a piece of research in a completely different science is much more difficult, and the criteria may be quite different. At least at the beginning, one is probably dependent on the judgments of colleagues from that other science. It is of course even more difficult for the press and the public to make accurate judgments about the validity of particular scientific results.

Given this problem, it is important for workers in an interdisciplinary subject to go out of their way to make it possible for scientists from remote fields to judge published results. One needs to take more care in documentation than when writing for fellow specialists. This may mean (Editors, take note!) giving explanations or making citations that would be considered unnecessary or patronizing in most technical literature.

To facilitate judgments about the reliability of results, we can make use of a whole variety of techniques available to scientists. Familiar approaches include the determination of analytical confidence limits, estimating confidence levels for less quantitative observations, rigorous statistical testing of hypotheses, interlaboratory calibration of analytical standards, and the independent analysis of blind samples from critical locations. (Blind analysis of some critical, disputed levels across the Italian K/T boundary is currently being carried out under the supervision of Robert N. Ginsburg of the University of Miami.) One can often invent or modify special techniques suited to particular questions; Muller's (1988) description of the use of the "Game Program" to decide a confidence level in a proposed periodicity is an excellent example.

The key to judging research results across disciplines thus comes down to rigorous care and full explanation on the part of the producer, and the willingness of the reader to delve deeply into an unfamiliar literature. This last consideration brings us to the question of how well a scientist from one field can understand what a practitioner of a remote specialty is saying or writing.

Jargon and Technical Language as a Barrier to Communications

The final item in this list of problems in crossing disciplinary barriers is thus the matter of technical language and jargon. I have come to see this as a major barrier to communication, both in reading the literature and in conversation with scientists from other disciplines. Nevertheless, this barrier can be overcome, and overcoming it is in itself an interesting process.

What is the role of jargon and technical language in science? Why do they exist? Technical language is clearly a necessary part of science. We need new words to describe new phenomena that are not covered by the vocabulary of the common tongue. But jargon seems to play two additional roles in science, one detrimental and the other beneficial. In its detrimental role, jargon serves to exclude the untrained from a specific high priesthood—those who are initiated in a particular discipline or specialty. In its more beneficial role, jargon serves as a tool for calibrating the level of expertise of a new acquaintance, and helping you choose the level on which to communicate.

To me, jargon and technical language present the highest barrier to crossing discipline boundaries. The other major barriers, especially cultural differences and notions about a hierarchy of sciences, melt away once the language problem is surmounted.

AN APPROACH TO CROSSING DISCIPLINE BOUNDARIES

So how does one overcome the language barrier between disciplines? It seems to me that language fluency comes almost automatically, if we treat the boundaries between disciplines not as barriers, but as gateways leading to new things to explore. After all, as scientists we are driven by curiosity about nature. Why can't we be just as curious about the workings of somebody else's field of science? Each field has its own history, its own traditions and ways of thinking and working, its own folklore, and even its own language.

I have come to view language learning as the key to interdisciplinary work. There is no practical way to get different specialists to use the same tongue, so those wanting to cross barriers simply must learn other scientists' languages.

What does this language learning involve? First of all, we need to know what the words mean. The same word may carry very different meanings when used by two different people. We know about this in foreign languages; for example, *burro* means donkey in Spanish, but it means butter in Italian. Or to take an extreme case, *ne* means no in Yugoslavia, but across the border in Greece, it means yes. No wonder Balkan history has been so troubled. Different meanings for the same word arise through time in the same language. In order to understand Shakespeare's plays, we need to know that words like *compass* and *conceit* meant something quite different to the Elizabethans than they do to us. To a chemist, *radiation* means light, but to a paleontologist it means appearance of new species from a common ancestor. However, even this doesn't end the problem, for *species* has different meanings to a paleontologist and a chemist.

A second observation about language is that certain key phrases act as passwords for recognition among speakers of the same dialect. If we hear phrases like "right on" or "jolly good," we immediately know which side of the Atlantic the speaker comes from. The same thing holds true in scientific dialects. Trivial as it may seem, I found that my main breakthrough into the physics community came when I stopped saying that something "was a hundred times larger," as a geologist would, and began saying "two orders of magnitude greater."

At a more subtle level, one finds that cadence and style reflect the complexity, the traditions, and the folkways of a particular science and define recognizable dialects. For example, there is a dialect known as Physics Macho, in which any derivation that takes a sophisticated mathematician less than a week is referred to as "an exercise for the student." Another example is a dialect called Ecologic Jargon Overkill. Here is a sample from the literature, only slightly edited: "Dissimilatory anoxic oxidation is carried out in the sulfuretum by photolithotrophic bacteria like the Chlorobiaceae, which are obligate photolithoautotrophs and strict anaerobes, the Chromatiaceae, which are partly obligate, partly facultative photolithotrophs, and the Rhodospirillaceae, which are photoheterotrophs ... although many of them are able to grow photolithotrophically as well."

Geological dialect undoubtedly has its own sillinesses, too, which I would like to report to you if I could, but they are much harder for a native speaker like me to recognize. Perhaps an outside observer would find the dialect of geology to be colored by the description and classification of complex phenomena, which has been a major task of our science. Thus our dialect might be represented by a paper, published in the last century, with this title: "A Description of the Dessicated Human Remains in the California State Mining Bureau" (Anderson, 1888).

The difficulty of learning a language or a scientific dialect is clearly related to its complexity. Russian, with its ornate system of declensions, is harder for English speakers to learn than are Romance languages. Geology is a more complexly descriptive subject than physics (though not necessarily more difficult), and as a result, its dialect is harder for physicists to learn than vice versa. For the same reason, biologese has been very difficult for me to learn. I still can't speak Ecologic Jargon Overkill, but I'm working on it.

Serious understanding of another field does not immediately result from learning scientific dialects. But with the language mastered, you have the tools for discussing the subject matter and reading the literature in depth, and the practitioners of the field will take you seriously. Many people have done this in the general field of research on impacts and mass extinctions, and have found it to be scientifically and personally rewarding. I believe it is the key to successful interdisciplinary research.

CONCLUSION

As science penetrates deeper and deeper into the unknown, most fields become of necessity more and more separated and specialized. Yet some topics seem naturally to bridge the gaps between fields. The study of impacts and mass extinctions seems to be one of these bridging topics. Perhaps the scientific style that is growing up in this field may eventually be as important as the things we are learning about nature.

ACKNOWLEDGMENTS

This paper is based on things I have learned from and with many people interested in impacts and mass extinctions. Foremost among them are my original colleagues in the Berkeley group—Luis Alvarez, Frank Asaro, and Helen Michel. I especially thank Frank for organizing the American Chemical Society symposium that was the spur to think these matters through. The thoughtful books by David Raup (1986) and Rich Muller (1988) were a further stimulus to think not only about what science learns, but about how science is done. Despite the fact that our work was often difficult to pigeonhole in the structure of academic disciplines, my colleagues and I have received general financial support from DOE, NSF, NASA, and the California Space Institute, and more specialized support from the Murdoch Charitable Trust, the Hewlett-Packard Company Foundation, Dr. John Lawrence, Gordon Getty, and the U.C. Berkeley Foundation.

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Final Announcement

ROCKY MOUNTAIN (44TH) AND SOUTH-CENTRAL (25TH) SECTIONS, GSA, Annual Meeting

Albuquerque, New Mexico
April 21–24, 1991

The Rocky Mountain and South-Central Sections of the Geological Society of America and the Rocky Mountain Section of the Paleontological Society of America will meet jointly at the Albuquerque Hilton Hotel in Albuquerque, New Mexico. The meeting is sponsored by the University of New Mexico Department of Geology and Institute of Meteoritics, assisted by the New Mexico Bureau of Mines and Mineral Resources and the University of Texas at El Paso Department of Geological Sciences.

SETTING

With scenery that is a veritable textbook of geology, New Mexico has from early days attracted pioneer geologists. Pre-Columbian native Americans digging for turquoise and Spanish conquistadores seeking the gold of Cibola were forerunners of geologists who made New Mexico a leading producer of energy-related materials and base and precious metals. The Albuquerque area lies near the intersection of four major geologic provinces. The west and northwest are the Colorado Plateau/San Juan Basin region. Precambrian-cored foreland uplifts of the Nacimiento and southern Sangre de Cristo and Taos Ranges are exposed to the north. Features related to the Cenozoic Rio Grande Rift continue southward from south-central Colorado through New Mexico. East of the Sandia Mountains and behind Albuquerque is the high plains area of the Great Plains province.

The weather in north-central New Mexico in mid-April is splendid, with highs in the 60s and low 70s and cool evenings. Albuquerque is host to numerous excellent New Mexican–style restaurants suiting a range of budgets. The Old Town section of Albuquerque, a short distance from the meeting center, contains many shops and restaurants; nearby is the New Mexico Museum of Natural History and Albuquerque Art Museum.

REGISTRATION

Please preregister today! Preregistration deadline is *Friday, March 15, 1991.*

1. Note that there is a modest savings in registration fees if you register before the preregistration deadline. Advance registration is urged for many of the special activities. Please use the registration form provided in this announcement.
2. Badges must be worn for access to ALL activities.
3. Registration discounts are given to GSA or Associated Society members. Associated societies that qualify for this discount are indicated on the registration form. Please indicate your affiliation(s) and member number to register at member rates.
4. 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, as errors will delay your registration. Your confirmation letter from GSA will be your receipt. No other receipt will be sent.
5. Please register only one professional or student per form. Copy the form for your records.
6. Guest registration is required for guests attending guest activities. Guest registrants must be accompanied by a registered professional or registered student.
7. Current student ID is required to obtain student rates at both the on-site and preregistration counters. Students must display their current student ID when they pick up registration materials, or else they 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 *April 1, 1991.* GSA will refund advance registration fees for cancellations received in writing by April 1. NO REFUNDS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER THIS DATE. Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card \will be credited according to the card number on the preregistration form. NO refunds will be given for on-site registration and ticket sales.

HOUSING

Rooms will be available at the Albuquerque Hilton Hotel, the site of the meeting, as well as several nearby hotels and motels, including the Holiday Inn, Super Eight, Motel 6, Plaza Inn, LeBaron Inn, and Comfort Inn. The location of these facilities and their proximity to the Hilton Hotel are given on the Albuquerque area locator map. Reservations can be made by calling a hotel or motel directly and identifying yourself as a participant in the GSA Rocky Mountain–South-Central Meeting. Guest room rates are as follows; please note that a room tax of 10.75% will be added to these rates. (*See Room Rates chart.*)

WELCOMING PARTY

A welcoming party for all registrants will be held on Sunday evening, April 21, from 5 to 8 p.m. in the poolside area of the Hilton Hotel (see motel locator map). Hors d'oeuvres will be available with a partially hosted bar.

TECHNICAL PROGRAM

Scheduled symposia and their conveners are:

1. **Gold Deposits of the New Mexico Alkali Porphyry Belt.** Lee Woodward, University of New Mexico.
2. **Volcanic Centers as Targets for Mineral Exploration.** Wolf Elston, University of New Mexico; Geoffrey Plumlee, U.S. Geological Survey, Denver.
3. **Rocky Mountain Section, Paleontological Society—Geology and Paleontology of the Kinney Brick Quarry, Late Pennsylvanian, Central New Mexico.** Spencer Lucas, New Mexico Museum of Natural History; Robyn Burnham.
4. **Source Region of Magmas in the Rio Grande Rift: Evolution from Mid-Tertiary to Present.** Libby Anthony, University of Texas, El Paso; Nancy MacMillian, New Mexico State University.
5. **Early, Middle, and Late Proterozoic Tectonic Evolution of Southwestern North America.** Jeffrey Grambling, University of New Mexico.
6. **Genesis and Mineralogy of Pegmatites in the Central and Southern Rocky Mountains.** William Simmons, University of New Orleans; Gene Ford, U.S. Geological Survey, Denver.
7. **Basins of the Rio Grande Rift: Structure and Stratigraphy.** John Hawley, New Mexico Bureau of Mines and Mineral Resources.
8. **The Laramide Orogeny in Southwestern North America.** Betsy Julian, University of Texas, El Paso; Lee Woodward, University of New Mexico; Bill Seager, New Mexico State University.
9. **Hydrogeology and Geochemistry of Waste Disposal and Contaminant Migration in Arid Lands.** Michael Campana and Douglas Brookins, University of New Mexico; Carol Stein, Sandia National Laboratories.
10. **Paleozoic Magmatism in Southwestern North America.** Virginia McLemore, New Mexico Bureau of Mines and Mineral Resources.
11. **Time Framework and Geologic History of the Carboniferous.** Walter Manger, University of Arkansas.
12. **Geoscience Education in Public Schools.** Doug Brookins, University of New Mexico; Monte Wilson, University of Idaho.
13. **Plate Margin and Foreland Deformation: The Ouachita Orogeny and Ancestral Rocky Mountains.** Kent Nielsen and Kristian Soegaard. Send abstracts to Kent Nielsen, Programs in Geosciences, University of Texas at Dallas, Richardson, TX 75083-0688.

FIELD TRIPS

Both premeeting and postmeeting field trips are planned. For details, contact the respective field trip leaders. General field trip questions should be addressed to the field trip coordinator, Gary A. Smith, Department of Geology, University of New Mexico, Northrop Hall, Albuquerque, New Mexico 87131-1116, (505) 277-2348.

A dozen field excursions will provide participants with opportunities to examine a wide variety of spectacular geologic features in New Mexico and adjacent Colorado and Texas. Five of these trips will take symposium topics into the field for continued discussion on the outcrops. All trips begin and end in Albuquerque, from the Hilton Hotel, except for trips 1 and 12. The field guides will be published as a New Mexico Bureau of Mines and Mineral Resources Bulletin that will be included in the registration fee for all trips except trip 7.

Preregistration for all field trips is strongly encouraged because of participant limitations. All participants are accepted on a first-come, first-served basis through GSA headquarters. Trip costs include transportation for the trip, guidebook, and other services as noted by the following symbols: B—breakfast, L—lunch, D—dinner, and ON—overnight lodging.

The registration form and procedures are provided in this announcement. All field trip registrants must register for at least one day of the meeting. Registration after the preregistration deadline is possible if field trip logistics and space permit; please contact the GSA Registration

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ROOM RATES	Single	Double	Extra Person
Hilton Hotel 1901 University Blvd. NE (505) 884-2500, (800) 445-8667 (87107)	42.00 (Villa) 50.00 (Tower/Cabana)	42.00 (Villa) 58.00 (Tower/Cabana)	8.00 6.00
Holiday Inn 2020 Menaul Blvd. NE (505) 884-2511, (800) 545-0599 (87107)	39.00	39.00	7.00
Plaza Inn 900 Medical Arts, NE (505) 243-5693 (87102)	35.00	41.00	—
Le Baron Inn 2120 Menaul Blvd. NE (505) 884-0250, (800) 444-7378 (87107)	37.00	37.00	—
Comfort Inn 2015 Menaul Blvd. NE (505) 881-3210 (87107)	38.00	38.00	—
Super 8 2500 University Blvd. NE (505) 888-4884 (87107)	32.88	39.88	—
Motel 6 1701 University Blvd. NE (505) 843-9228 (87102)	21.95	27.95	—

Additional housing information may be obtained by contacting Jeffrey A. Grambling, Department of Geology, University of New Mexico, Albuquerque, NM 87131-1116; (505) 277-3867.

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Coordinator or Gary Smith at the University of New Mexico. On-site registration for postmeeting trips may be possible during the meeting in the registration area.

If GSA must cancel a field trip due to logistics or registration requirements, a full refund will be issued after the meeting. Be aware of cancellation deadlines and possible penalties imposed by airlines. You may wish to cancel flight arrangements if a trip you have registered for is canceled.

Premeeting

1. **Modern Rifting and Ancient Anorogenic Magmatism** (3 days). Elizabeth Anthony, Department of Geological Sciences, University of Texas, El Paso, TX 79968-0555; Calvin Barnes, Texas Tech University; Jerry Hoffer, Randy Keller, Kathleen Marsaglia, Virginia McLemore, University of Texas at El Paso. Friday, April 19–Sunday, April 21. Cost: $175 (2 L, 2 ON, 1 D). Limit: 31.

   This three-day field trip compliments Symposia 4 and 5. Stops on the first day will provoke discussion of regional Proterozoic tectonics while examining the Proterozoic sedimentary section of the Franklin Mountains, the 1.1 Ga Red Bluff Granite that intrudes it, and the coeval Thunderbird Formation ignimbrites. The last two days will focus on features of the Cenozoic Rio Grande Rift, including the Potrillo Volcanic Field, and highlights of structural and general geologic features en route to Albuquerque. The trip begins at the La Quinta Motor Inn in El Paso, Texas, at 9 a.m. on April 19 and terminates in Albuquerque on the evening of April 21.
2. **Open-System Magmatic Evolution of the Summer Coon and Del Norte Volcanoes, Conejos Formation, San Juan Mountains, Colorado** (2 days). Don F. Parker, D. Anne Grau, Department of Geology, Baylor University, Waco, TX 79798-7354. Saturday, April 20–Sunday, April 21. Cost: $60 (1 ON, 1 B, 1 L). Limit: 18.

   This trip will emphasize new field, chemical, and mineralogical data for open-system magmatic evolution of two Oligocene volcanic centers. Participants will examine evidence for magma mixing, assimilation of upper crustal xenoliths, and the structure and growth of both volcanoes. Opportunities will be provided for sampling at analyzed localities. The trip will depart from the Albuquerque airport on the evening of April 20 and return late on April 21.
3. **Geomorphic and Tectonic Evolution Along the Margin of the Colorado Plateau and Rio Grande Rift, North-Central New Mexico** (2 days). Mark Gonzalez, Department of Geology, University of New Mexico, Albuquerque, NM 87131; David Dethier, Williams College. Saturday, April 20–Sunday, April 21. Cost: $110 (1 ON, 1 B, 2 L, 1 D). Limit: 25.

   This excursion will elucidate the evolution of part of the Rio Grande Rift and the processes that accompany rifting. The principal objectives are to (1) document long-term (10 m.y.) evolution of the Rio Chama–Rio Grande drainage system, which records multiple Pliocene-Pleistocene aggradation and incision cycles; and (2) inspect neotectonic features that chronicle the timing, magnitude, and kinematics of rift-margin structures. Exposure of Cenozoic deposits, preservation of landscape elements (geomorphic surfaces and paleocanyons), and fortuitous exposure of fault planes permit reconstruction of this dynamic region. The trip will leave Albuquerque at 8 a.m. on April 20 and return on the following evening after spending Saturday night at scenic Ghost Ranch.
4. **Stratigraphy and Correlation of Triassic Strata, Colorado Plateau to High Plains** (1 day). Spencer G. Lucas, New Mexico Museum of Natural History, P.O. Box 7010, Albuquerque, NM 87194. Sunday, April 21. Cost: $35 (1 L) Limit: 27.

   This trip will examine the long-ignored and overlooked Triassic strata of the Rio Grande valley that physically connect the Moenkopi and Chinle Formations of the Colorado Plateau with the Dockum Group on the southern High Plains. The trip will leave Albuquerque at 8 a.m. on Sunday.
5. **Tectonics, Intrusive Rocks, and Mineralization of the Ortiz Porphyry Belt** (2 days). Stephen P. Maynard, Lac Minerals, P.O. Box 21390, Reno, NV 89515; Lee A. Woodward, University of New Mexico; David Giles, Santa Fe. Saturday, April 20–Sunday, April 21. Cost: $75 (2 L). Limit: 25.

   An excursion to compliment Symposium 1 will examine features of the Tijeras-Canoncito fault zone, mineralization in the Cerillos Hills, and includes visits to gold mines and mineralization related to Oligocene alkaline magmatism in the Ortiz Mountains. The trip will depart at 7 a.m. on Saturday and Sunday.
6. **Proterozoic Tectonic History of the Manzano Mountains, Central New Mexico** (2 days). Amy Thompson, Jeffrey Grambling, Department of Geology, University of New Mexico, Albuquerque, NM 87131. Saturday, April 20–Sunday, April 21. Cost: $115 (1 ON, 1 B, 2 L, 1 D). Limit: 25.

   This trip, held in conjunction with Symposium 5, will examine two Proterozoic tectonometamorphic blocks separated by a major ductile shear zone. $^{40}Ar/^{39}Ar$ geochronology suggests that juxtaposition occurred near 1350 Ma. Strenuous hikes will take participants to view the well-exposed shear zone, placing amphibolite-facies rocks above those of greenschist facies, and to the margins of the Priest pluton where amphibolite-facies assemblages are overprinted by regional greenschist facies metamorphism. The trip will depart at 8 a.m. on Saturday; dinner that night will be at the historic Luna Mansion.
7. **General Geology of the Albuquerque Area** (1 day). Rachel Cowan, Douglas Brookins, Department of Geology, University of New Mexico, Albuquerque, NM 87131. Sunday, April 21. Cost: $25 (1 L). Limit: 40.

   This trip is sponsored by the Albuquerque Geological Society and will provide teachers with hands-on experience with the rocks, field geology, hydrology, and engineering geology aspects of the Albuquerque area. The leaders hope that the participating teachers will subsequently impart a similar out-of-doors experience to their students. Open to school teachers, grades K–12, only. Departs at 8 a.m. on Sunday.

During Meeting.

8. **Pennsylvanian Paleoecology of the Kinney Brick Quarry, Manzanita Mountains, Central New Mexico** (half day). Spencer G. Lucas, New Mexico Museum of Natural History, P.O. Box 7010, Albuquerque, NM 87194; John Lorenz, Sandia National Laboratory. Monday, April 22. Cost: $30 (refreshments). Limit: 27.

   The Rocky Mountain Section of the Paleontological Society sponsors this afternoon field outing immediately after Symposium 3 on April 22. Paleoecological interpretations presented during the symposium will be examined in the context of the exposures of Upper Pennsylvanian strata at this world-class fossil locality.

Postmeeting

9. **A Tale of Two Volcaniclastic Aprons: Sedimentology and Physical Volcanology of the Espinaso Formation (Oligocene) and Peralta Tuff (Miocene), North-Central New Mexico** (2 days). Gary A. Smith, Daniel Larson, Department of Geology, University of New Mexico, Albuquerque. NM 87131. Thursday, April 25–Friday, April 26. Cost: $120 (1 ON, 2 L). Limit: 30.

   This two-day excursion will compare and contrast primary and reworked volcaniclastic facies associated with volcanic centers of different composition, eruptive style, and tectonic setting. The results of sedimentological, volcanological, petrological, and paleomagnetic investigations will be integrated to illustrate the influence of volcanism on sedimentation and the use of the sedimentary record to reconstruct eruptive styles and the composition of erupted magmas. The trip will depart at 7:30 a.m. on Thursday, April 25.
10. **Quaternary and Neogene Landscape Evolution: A Transect Across the Southeastern Colorado Plateau and Basin and Range Provinces** (3 days). Stephen G. Wells, Department of Geology, University of New Mexico, Albuquerque, NM 87131; John Hawley, Dave Love, New Mexico Bureau of Mines and Mineral Resources; Bruce Allen, University of New Mexico. Wednesday, April 24–Saturday, April 27. Cost: $215 (3 ON, 3 B, 3 L). Limit: 30.

    This three-day field trip examines a variety of Late Cenozoic geomorphic, stratigraphic, and volcanic features in a transect across central New Mexico. Day one highlights include Quaternary basalt fields and Holocene alluvial chronology of the Zuni Mountain region of the southeastern Colorado Plateau. The second day stresses (1) Rio Puerco drainage basin evolution between the Mount Taylor volcanic center and the central Rio Grande Rift, and (2) late Quaternary climatic fluctuations recorded by the geomorphology and lacustrine stratigraphy of the Estancia Valley. Rift-basin and valley fills along with Pliocene-Pleistocene volcanics of the northern Albuquerque Basin will be emphasized on day three. The trip will depart Albuquerque at the conclusion of the meeting on April 24 and will return on the evening of April 27.
11. **Cenozoic Magmatism and Tectonics of the Southeastern Colorado Plateau, New Mexico** (3 days). W. Scott Baldridge, ESS-1, MS D462, Los Alamos National Laboratory, Los Alamos, NM 87545; Frank V. Perry, Los Alamos National Laboratory and University of New Mexico; A. William McLaughlin, Ken Wohletz, Los Alamos National Laboratory. Thursday, April 25–Saturday, April 27. Cost: $215 (2 ON, 2 B, 3 L, 1 D; also reception and tour of the Grants Mining Museum). Limit: 25.

    Participants on this three-day trip will examine Miocene to Holocene basaltic rocks (flows, pyroclastics, dikes) of the Lucero and Zuni-Bandera volcanic fields (day one), the Mount Taylor central volcano (day two), and the Zuni Salt Lake maar (day three). Features emphasized include (1) the compositional range of basaltic rocks and their temporal and spatial variations; (2) compositions, origin, and evolution of intermediate and silicic rocks of Mount Taylor; (3) the structural setting of magmatic rocks, including the relation of the Rio Grande rift to the Colorado Plateau; and (4) morphology of volcanic rocks, eruptive mechanisms, surface and near-surface phenomena. The trip will depart Albuquerque at 7:30 a.m. on Thursday, April 25.
12. **Morrowan-Atokan Relations, Type Derryan Region, Southern New Mexico and Western Texas** (1-1/2 days). Walt Manger, Department of Geology, University of Arkansas, Fayetteville, AR 72701; W. W. Clopine, David Kaiser, and Patrick K. Sutherland, University of Oklahoma. Wednesday, April 24–Friday, April 26. Cost: $125 (2 ON, 1 L). Limit: 30.

    This trip, sponsored by the South-Central Section of the Paleontological Society, compliments Symposium 11. Participants will examine the type Derryan (Lower Pennsylvanian) section and Bishop's Cap, in southern New Mexico, and Vinton Canyon in the Franklin Mountains, Texas, to demonstrate wedging-out of Morrowan rocks from the Orogrande Basin onto the Robledo Shelf. The leaders will document the occurrence of Morrowan strata at the type Derryan section and the fusilinid succession through Atokan in the Magdalena Group. The trip will depart Albuquerque for Las Cruces at the end of the meeting on April 24 and will end at the airport in El Paso in the early afternoon of April 26.

FIELD TRIP GUIDEBOOK

Each field trip registrant will receive a single copy of the guidebook, which will contain information on all trips. The guidebook will be published by the New Mexico Bureau of Mines and Mineral Resources. The book will also be on sale at the Bureau exhibit during the meeting.

PROJECTION EQUIPMENT

All slides must be 2" × 2" and fit into a standard carousel tray. Two slide projectors, one overhead projector, and two screens will be provided in each technical session. Please bring your own loaded carousel trays, if at all possible. A speaker ready room equipped with projectors will be available for review and practice.

POSTER SESSIONS

Poster sessions will be located adjacent to the exhibit area. If you wish to take advantage of this effective means of communication, please indicate your preference for a poster session on the GSA abstracts form. Each poster presenter will be provided with at least one eye-height board, approximately 4' × 8', and one board 4' × 4'.

EXHIBITS

Exhibits will be located in the Southwest Room of the Hilton Hotel, where a refreshment area will also be maintained. The cost of standard booths is $250 for commercial exhibitors and $150 for educational or nonprofit institutions. For further information, please contact Crayton J. Yapp, Exhibits Coordinator, Department of Geology, University of New Mexico, Albuquerque, NM 87131-1116, (505) 277-2000.

STUDENT AWARDS

Three cash awards ($200, $100, and $50) will be presented for the best student papers for each section. Outstanding paper awards will be based on quality of research and effectiveness of presentation. To be eligible, the abstract form may list only students as authors, and must identify the abstract as a student paper.

SPOUSE/GUEST ACTIVITIES

A number of spouse/guest activities are planned to take advantage of the diversity of cultures and scenery in the Albuquerque area. On Monday, an approximately two-hour-long historical tour of Albuquerque is planned for the early afternoon. Also on Monday at least one bus will run to Santa Fe for a tour of the historic city, shopping, etc. On Tuesday morning through mid-afternoon, a trip to the Acoma Pueblo, about 100 km west of Albuquerque, is planned. On both Monday and Tuesday, a tour of the Sandia Mountains due east of Albuquerque is planned via the world's longest tramway. Monday's Sandia Peak tram tour will take place in the late afternoon, after the technical sessions, to allow for a spectacular twilight setting. The tram tour on Tuesday will be over lunch time. Each tour includes tram ticket and cost of dinner or lunch.

In addition, a trolley servicing the Old Town, downtown, and major shopping mall areas of Albuquerque stops at the Hilton Hotel every half hour.

TRAVEL

Albuquerque is served by a modern international airport with direct routes to numerous cities in the Rocky Mountain and South-Central regions. Car rentals may be arranged at the Albuquerque Airport. Several hotels, including the Albuquerque Hilton Hotel, the Holiday Inn, and the Le Baron Inn, have courtesy shuttles to and from the airport for their guests. All hotels and motels listed in the Housing section are located within 1 km of the intersection of Interstate Highways I-25 and I-40 and less than 2 km from the University of New Mexico.

SPECIAL EVENTS

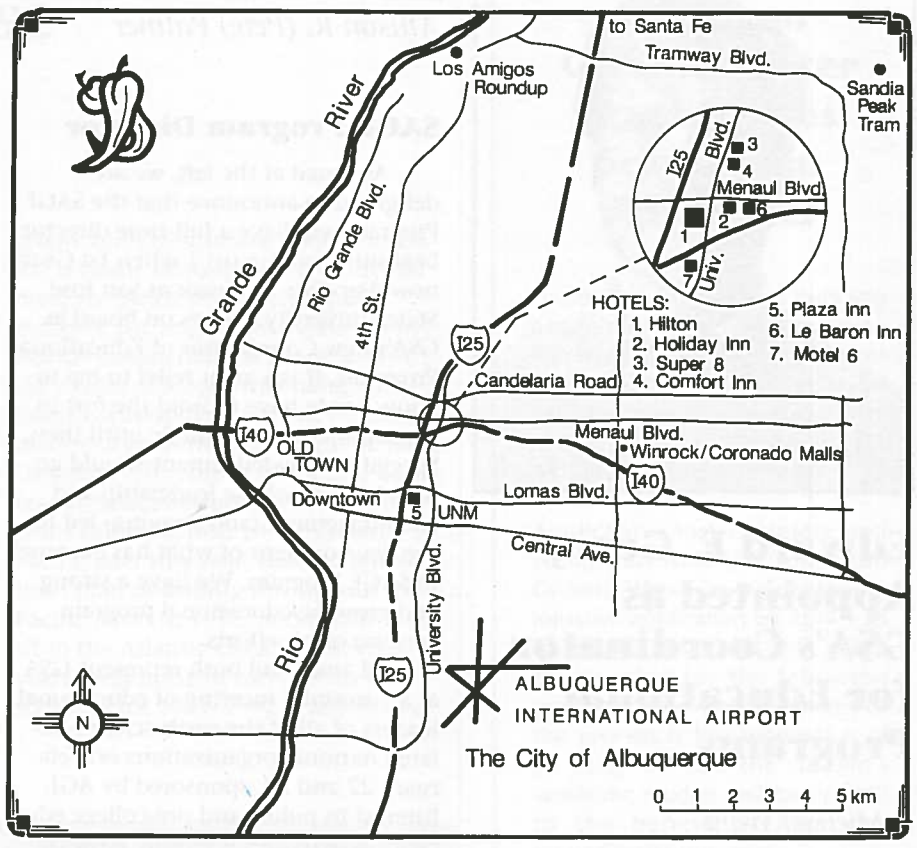
On Monday, April 22, at 6:30 a.m. the New Mexico Section of the American Institute of Professional Geologists will host a **breakfast for AIPG members** from other Sections and anyone interested in AIPG. There will be a speaker and discussion, dealing with pending federal legislation of interest to geologists. Cost is $9.75.

The Rocky Mountain Section of the Paleontological Society and the New Mexico Museum of Natural History will sponsor a free **party for paleontologists** on Monday, April 22, from 7 to 10 p.m. at the Museum of Natural History.

On Tuesday evening, April 23, we are planning a **New Mexico–style western party**. Your enjoyment is guaranteed. Los Amigos Roundup has put together an evening of fun, food, drink, and entertainment that cannot be matched anywhere else in town, at any price. With spectacular views of the Sandia Mountains, the Los Amigos spread is located on the southern edge of the Sandia Pueblo Indian Reservation in the Rio Grande Valley. Within their large all-weather barn, Los Amigos will provide all the food you can eat (including some great mesquite-grilled prime rib!), drinks (beer, wine, lemonade, coffee, tea), an old-time band,

RM/SC Sections *continued on p. 48*

Albuquerque, New Mexico



REGISTRATION FORM

Rocky Mountain and South-Central Sections, GSA, April 22–24, 1991

IMPORTANT!

1. Full Payment must accompany registration. Make personal checks or money orders payable in U.S. funds to: 1991 RM-SC GSA.
2. Use separate form for each registrant: professional or student.
3. **PREREGISTRATION MUST BE RECEIVED NO LATER THAN FRIDAY, MARCH 15, 1991**. Preregistration for field trips is required; cancellation deadline for a full refund is April 1, 1991. No refunds after April 1 unless event is canceled.
4. For registration information, please call the GSA registration coordinator at (303) 447-2020.

Mail to: 1991 Rocky Mountain–South-Central Meeting, P.O. Box 9140, Boulder, CO 80301

PLEASE PRINT OR TYPE, KEEPING A COPY FOR YOUR RECORDS

Name (Last, First, Middle) _____

Name for Badge _____

Institution/Employer _____

Address _____ City _____ State _____ ZIP _____

Work Phone ( ) _____ Home Phone ( ) _____

Membership Affiliation A ☐ GSA B ☐ NAGT C ☐ I's D ☐ AWG E ☐ GSA Student Associate

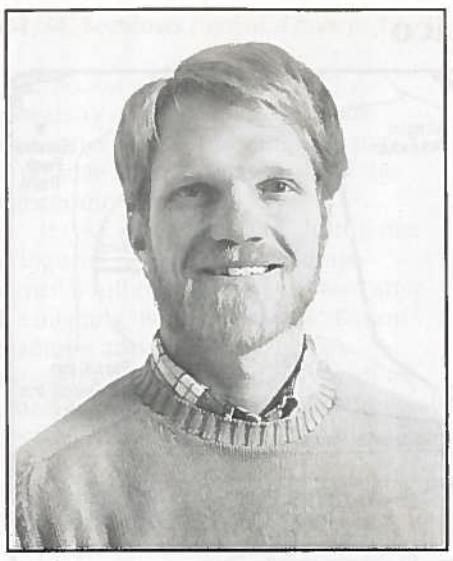
PLEASE SPECIFY THE GSA SECTION YOU LIVE IN F ☐ Rocky Mountain G ☐ South-Central H ☐ Other Section

PREREGISTRATION (postmarked on or before March 15, 1991)		
Professional, member of GSA or affiliated society	(001)	$45.00
Professional, nonmember	(003)	$60.00
Student Associate member of GSA	(005)	$25.00
$25.00		
Student, nonmember	(007)	$30.00
One day only (all categories)		
Day ☐ Mon ☐ Tues ☐ Wed	(008)	$30.00
Guest (Name for badge) _____	(009)	$20.00
REGISTRATION (after March 15, 1991)		
Professional, member of GSA or affiliated society		$60.00
Professional, nonmember		$75.00
Student Associate member of GSA		$30.00
Student, nonmember		$35.00
One day only (all categories)		
Day ☐ Mon ☐ Tues ☐ Wed		$35.00
Guest (Name for badge) _____		$25.00
ABSTRACTS WITH PROGRAMS (reserved for on-site pick up)	(301)	$12.00
FIELD TRIPS (registration required)		
1. Modern Rifting and Ancient Anorogenic Magmatism, April 19–21	(100)	$175.00
2. Open-System Magmatic Evolution, Summer Coon and Del Norte Volcanoes, April 20–21	(101)	$60.00
3. Geomorphic and Tectonic Evolution Along the Margin of the Colorado Plateau and Rio Grande Rift, April 20–21	(102)	$110.00
4. Stratigraphy and Correlation, Triassic Strata, April 21	(103)	$35.00
5. Tectonics, Intrusive Rocks, and Mineralization, Ortiz Porphyry Belt, April 20–21	(104)	$75.00
6. Proterozoic Tectonic History of the Manzano Mountains, April 20–21	(105)	$115.00
7. General Geology of the Albuquerque Area, April 21	(106)	$25.00
8. Pennsylvanian Paleoecology of the Kinney Brick Quarry, April 22	(107)	$30.00
9. A Tale of Two Volcaniclastic Aprons, April 25–26	(108)	$120.00
10. Quaternary and Neogene Landscape Evolution, Transect, April 24–27	(109)	$215.00
11. Cenozoic Magmatism and Tectonics, Southeastern Colorado Plateau, April 25–27	(110)	$215.00
12. Morrowan-Atokan Relations, Derryan Region, April 24–26	(111)	$125.00
SPECIAL EVENTS		
1. Tuesday Evening Roundup, April 23 (children, 5–11 years, $6.00; 12–18, $16.00)	(040)	$25.00
2. GSA Rocky Mountain Section Business Luncheon	(041)	$15.00
3. GSA Rocky Mountain Section Management Board Meeting	(042)	$9.75
4. GSA South-Central Section Business Luncheon	(043)	$15.00
5. GSA South-Central Section Management Board Meeting	(044)	$9.75
6. AIPG Breakfast	(045)	$9.75
GUEST EVENTS		
1. Duke City Historical Tour, Monday, April 22	(020)	$11.00
2. Santa Fe Tour, Monday, April 22	(021)	$28.00
3. Sandia Peak Tram Tour, Monday, April 22	(022)	$33.00
4. Sandia Peak Tram Tour, Tuesday, April 23	(023)	$33.00
5. Acoma "City in the Sky" Tour, Tuesday, April 23	(024)	$27.00
TOTAL PAYMENT ENCLOSED (Remit in U.S. funds)		$ ____

Make checks payable to 1991 GSA Rocky Mountain–South-Central Meeting

☐ American Express ☐ VISA ☐ MasterCard ☐ Diners Club Card No. _____ Exp. _____

Card Holder's Signature _____



Edward E. Geary Appointed as GSA's Coordinator for Educational Programs

F. Michael Wahl

Edward E. Geary, Associate Professor of Geology at San Jose State University, has accepted the challenge to lead GSA's SAGE Program (Science Awareness through Geoscience Education), and will become our full-time Coordinator for Educational Programs on August 1, 1991. Geary received his B.S. degree from Stanford, and the M.S. and Ph.D. degrees from Cornell. He is assuming the GSA coordinator position after several years of high-quality teaching, research, and administrative experience. He is also Director of the Bay Area Earth Science Institute, a teacher enhancement program for middle and senior high school science teachers in the San Francisco Bay area, and has firsthand knowledge of the problems and limitations faced by teachers in the classroom. He brings a great deal of highly focused energy and dedication to what will be one of GSA's premier activities in the 1990s.

Prior to his move to Boulder this summer, Geary will be working closely with Pete Palmer in coordinating efforts to develop the SAGE network through the GSA Section education committees, and to build a high-quality set of materials for the Partners for Excellence Projects. ■

SAGE REMARKS

Science Awareness through Geoscience Education

Allison R. (Pete) Palmer

SAGE Program Director

As noted at the left, we are delighted to announce that the SAGE Program will have a full-time director beginning on August 1 when Ed Geary, now Associate Professor at San Jose State University, comes on board as GSA's new Coordinator of Educational Programs. It is a great relief to me to know I only have to hold the fort in my semi-retirement mode until then. Special acknowledgement should go to E-An Zen, whose leadership and encouragement (and nagging) led to the development of what has become to SAGE Program. We have a strong and growing educational program because of his efforts.

Ed and I will both represent GSA at a "summit" meeting of educational leaders of all of the earth-science–related national organizations on February 22 and 23, sponsored by AGI. Interest in public and pre-college educational activities is rapidly growing across the board among the professional science societies. AGI will serve the vital role of enhancing intercommunication in the area of earth sciences so that duplication of activities is minimized, and each society can focus its special skills on the multi-faceted and multi-tiered problems of public geoscience understanding and education.

Food for Thought

This past month, two complementary publications have serendipitously been juxtaposed in my reading pile. Walter Younquist has recently written a small but powerful book *Mineral Resources and the Destinies of Nations* that was brought to my attention by Mason Hill. This book brings together the data on resource utilization and distribution, the problems of geopolitics, and the overriding problem of global population growth that should be understood by political leaders throughout the world. A somewhat more optimistic presentation of the resource problem is in a series of articles in a special fall issue of *Scientific American*. Together, these publications develop significant issues of major concern to us and they should be among those that "my neighbor" should know. Walter's book can be purchased from National Book Company, P.O. Box 8795, Portland OR 97207-8795. List price is $17.95. The issues can and should be addressed at various levels from high school to graduate seminars with these two publications as guides.

Other Ways To Partner

The Scouting movement has recently opened the way for special Explorer groups that are topically oriented and coeducational. An example that some of you may want to follow has been set in motion in Vancouver, Washington. Using the USGS David A. Johnston Cascades Volcano Observatory as a base, five geologists from the USGS, industry, and the local school system created Northwest Earth Science Explorers in early 1989. This group now includes 20 young men and women between 14 and 19 years old. If you want more information about this program, call William Connelly, NERCO Oil and Gas Co., at (206) 253-3244.

Another creative development is based at the Colorado School of Mines, where Christine Arthur, former president of the Association of Geoscience Students (AGS), has developed a program of "geological ambassadors." With the support of Sam Adams, head of the Department of Geology and Geological Engineering, she and five fellow AGS members visit local classrooms to make presentations about how geology and geological engineering apply to real-world problems and to discuss opportunities for careers in the geosciences. Their efforts have been focused on schools with significant ethnic minority populations. For more information about this activity, contact Leigh-Ann Willar, (303) 273-3100. ■

GSAF UPDATE

Robert L. Fuchs

The GSA Institute For Environmental Education

The importance geoscientists place on the environment is evidenced by the initial, early-stage development of GSA's Institute for Environmental Education. The concept of a GSA program that would focus on this very timely subject was first suggested by the Foundation's Trustees at the 1988 Centennial meeting in Denver. Subsequently, general concepts of the program have been formulated by the GSA and Foundation staffs. In April of this year a gift of $5000, the first direct financial support for the Institute, was received from Leighton & Associates of Irvine, California.

At their meeting in June, the Foundation Trustees acknowledged the potential for additional funding for this new program initiative from industry sources, as well as individual contributions, and indicated their further support of a definitive program that would be developed by GSA.

The logical next step in the process has been to appoint a program manager who will put more flesh on the skeletal concepts already developed. The approval to retain a part-time executive director was given by Council at its November meeting. Subsequently, Fred A. Donath, a leading environmental geoscientist and GSA Foundation Trustee, has agreed to accept the position of Executive Director of the Institute for Environmental Education on a part-time basis. Donath is charged with developing the IEE's mission, educational objectives, scientific objectives, and general plan of action, including funding activities. In carrying out this task, he will be working closely with both the Engineering and Hydrogeology Divisions of GSA, whose members are intimately involved with environmental activities.

President Doris Curtis commented, "The Institute for Environmental Education is a logical evolutionary development in GSA programs. The demographics of the Society in recent years have shifted strongly in the direction of environmental geology. There is now a clear emphasis on this field within the membership, and the Society must be responsive to and provide support for its members in their areas of specialization."

Fred Donath said that he will concentrate on defining a broad and flexible set of programs that will serve as a framework for the Institute. Initially, IEE plans to focus on a few select activities that will have a high likelihood of becoming well established and financially self-supporting. In this latter regard, Donath and the Foundation will be undertaking a fund-raising effort over the next few years to provide the financial base for IEE. In addition to Leighton & Associates, other companies in the burgeoning environmental and geotechnical fields have indicated their willingness to support this new GSA program.

Environmental Geology Award

The first award for the best paper on environmental geology published by either GSA or one of the state geological surveys was presented at the Dallas GSA meeting. The winner was chosen by a committee of state geologists consisting of Earl Bennett of Idaho, John Kempton of Illinois, and Frank Kottlowski of New Mexico. By a narrow margin, the first-place choice was Circular 85 of the Washington Division of Geology and Earth Resources, entitled "Washington State Earthquake Hazards," co-written by Linda Lawrence Noson, Anthony Qmar, and Gerald W. Thorsen. The presentation was made at the AASG breakfast during the Dallas meeting.

Funding for the Environmental Geology Award is provided by the Foundation's John C. Frye Memorial Fund. Since the establishment of this award, the Foundation has received numerous contributions to this fund, which has doubled in size over the past year to a current balance of more than $13,000. This is another clear indication of the interest among GSA members in environmental matters.

GSAF *continued on p. 40*

View of *Joides Resolution* (registered as *SEDCO/BP 471*), the drilling ship of the Ocean Drilling Project. The ship dimensions are 143 m length, 21 m beam, 18,000 T displacement. The derrick is 62 m high; the ship carries 9150 m of drill string. The ship has 1115 sq m of laboratory space and accommodations for 68 crew and 51 scientific and technical party. The cruising speed is 11 knots, and the cruising range is 120 days.

The Ocean Drilling Program Schedule 1991–1992

Eldridge Moores

The Ocean Drilling Program (ODP) is one of the most extensive and ambitious research programs in the earth sciences. It is funded by the U.S. National Science Foundation, the Australia-Canada Consortium, the European Science Foundation Consortium (including Belgium, Denmark, Finland, Greece, Iceland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey), France, Germany, Japan, and the U.K. Since its inception in 1985 as a successor to the Deep Sea Drilling Program (DSDP) and the International Program of Ocean Drilling (IPOD), ODP has drilled, with the *JOIDES Resolution*, in all the world's oceans to pursue questions about the origin and evolution of oceanic crust, the tectonic evolution of continental margins, processes in active plate margins, the origin and evolution of marine sedimentary sequences, and the causes of long-term changes in Earth's atmosphere, oceans, ice cover, marine organisms, and magnetic field. Currently, the ship is in the Lau Basin region, southwestern Pacific. Current plans call for transit to the eastern Pacific later this year, then an ambitious plan of drilling throughout the Pacific Basin in 1992, and finally transit to the Atlantic Ocean for several years, beginning in early 1993. The schedule for 1991–1992 is as follows:

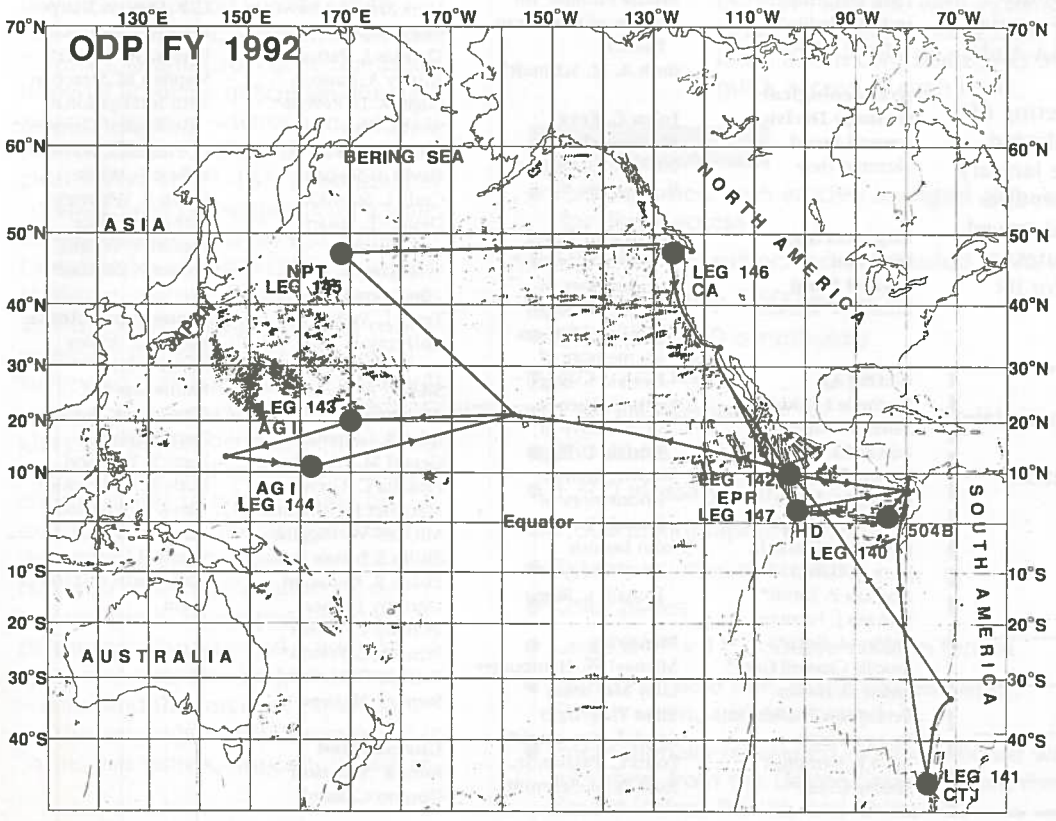
1991 Schedule

Leg No.	Dates	Objectives
136	3/3–3/20	Drill pilot hole in Hawaiian arch for ocean seismic network.
137	Mar.–May	Clean out and perform down-hole measurements in Hole 504B in Costa Rica Rift, previously drilled to top of sheeted dike complex.
138	May–July	Study late Cenozoic paleoceanography of eastern equatorial Pacific Ocean.
139	July–Sept.	Explore Middle Valley of Juan de Fuca Rift to study hydrothermal processes in sediments over an active rift.
140	Sept.–Nov.	Deepen hole 504B or drill exposure of lower oceanic crust in Hess Deep, Galapagos triple junction, hoping to reach suboceanic Moho.

1992 Schedule (dates not yet finalized)

141	---	Ridge-trench collision off South Chile.
142	---	East Pacific Rise crest: engineering test of diamond coring system, an innovative application of high-speed diamond drilling technology to ocean drilling in hopes of enhanced recovery of fractured or porous rocks such as reefs and volcanic breccia.
143	---	Atolls and guyots of central Pacific to investigate questions of sea-level change, vertical motion in western Pacific Superswell, and horizontal motion of hot spots.
144	---	Same.
145	---	Transect of North Pacific to investigate Neogene paleoceanography and age and geometry of Late Cretaceous "superchron" (lithosphere formed during long magnetic normal-polarity period).
146	---	Hydrogeology of Cascadia subduction zone off Vancouver and Oregon.
147		Hess Deep Moho, or East Pacific Rise crest (continued testing of diamond coring system).

Legs 140–147 are not yet staffed. Anyone interested in further information about possible participation is encouraged to contact: Manager of Science Operations, Ocean Drilling Program, Texas A&M University Research Park, 1000 Discovery Drive, College Station, TX 77845-547; (409) 845-2673; fax 409-845-0876. ■



Map of Pacific Ocean showing approximate ship track and locations of Ocean Drilling Project legs for fiscal year 1992. Symbols: AG = atolls and guyots, CA = Cascadia, CTJ = Chile Triple Junction, EPR = East Pacific Rise, HD = Hess Deep, NPT = North Pacific Transect, 504B = Hole 504B.

American Ground Water Trust Invites Scholarship Applicants

Undergraduate students pursuing academic studies beneficial to America's ground water resources are invited to apply for scholarship support from the American Ground Water Trust's AMTROL Scholarship Fund.

Applicants must complete and submit an AMTROL/American Ground Water Trust Scholarship Initiative application by April 1 to be eligible for funds that could be awarded for the following academic year. A requirement of the process is the submission of an essay on how the student's academic studies will be applied to the benefit of America's ground water resources.

Successful candidates must maintain at least a 2.0 cumulative grade point average (GPA) during their first full academic year, and at least a 2.5 GPA for the second and any following years.

For an application and more information about the American Ground Water Trust, write: 6375 Riverside Dr., Dublin, OH 43017.

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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by William C. Overstreet and Paul K. Theobald

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In Memoriam

Arthur H. Lang
Ontario, Canada
July 19, 1990

Charles Milton
Reston, Virginia
October 4, 1990

Robert H. Nesbitt
Harrisonburg, Virginia
October 15, 1990

Claude M. Roberts
Hackettstown, New Jersey
October 21, 1990

George W. H. Norman
British Columbia, Canada

BOOK REVIEWS

The Solid Earth: An Introduction to Global Geophysics. By *C.M.R. Fowler. Cambridge University Press, New York, 1990, 472 p., paper: $37.50, cloth: $59.95.*

Fowler aims to introduce geophysics to senior undergraduates and graduate students specializing in either geology or physics, and emphasizes many tectonic settings and models to achieve these goals. This book holds much promise of success for students with these greatly different backgrounds. Moreover, the book serves as an up-to-date refresher for those who feel a need to catch up on some major developments in tectonics and geophysics of this, the computer and space age.

The introductory chapter is a concise and informative review of plate tectonics. It is followed by a paleogeographic perspective on the history of seafloor spreading for each of the major ocean basins, excepting the Arctic, and a synopsis of Phanerozoic continental paleogeography. Principles of paleomagnetism and magnetic anomalies are woven into these perspectives—all too briefly, in my view. A long and detailed treatment of seismology is followed by briefer treatments of gravity and the geoid and of geochronology. In the latter area, the surveys of Ar-Ar, Nd-Sm, and fission track methods will be appreciated by nonspecialists. The chapter called simply "Heat" is a wide-ranging gem; it leads into mantle convection and, better late than never, geomagnetism and core-dynamo theory.

The final chapters cover the essentials of lithospheric and plate-boundary structures and processes, with separate emphases on the oceanic and the continental crustal environments. The Archean setting gets a deserved special mention.

The book has abundant illustrations and generous (8 cm) margins. The glossary helps physicists with the plethora of geologic terminology, especially with igneous and metamorphic rock names and stratigraphic and structural terms. The appendices assist the geologists who struggle with vectors, differential operators, elastic wave theory, ray paths, least-squares procedures, and the like. The final appendices on units, symbols, and numerical data are a useful reference for all.

Among the usual shortcomings of new publications, the most serious is a printer's error that repeats p. 54 into p. 56 and omits the right half of a major figure (Fig. 3.20, p. 55) on the structure of the Indian Ocean. Shading and fine lines fade in some diagrams. As for the choice of topics, a passing nod at the increasing potential of GPS (global positioning system) methods might have been made. But these slight imperfections in no way spoil the book's impact. Every chapter has novel and thought-provoking problems.

Reading between the lines, the influence of the Cambridge University geophysical community shines strongly through, with major benefit to the reader and to author Fowler at the University of Saskatchewan.

William D. MacDonald
State University of New York at Binghamton
Binghamton, NY 13901

Scientist of Empire. *By Robert A. Stafford, Cambridge Universtiy Press, Cambridge and New York, 1989, 293 p., $49.50.*

Every revolution has been preceded by a tyrant. There was Ptolemy before Copernicus, and the author of Genesis before Darwin. I have often wondered who had the *après nous le déluge* mentality that eventually unleashed the earth-science revolution of the 1960s. Certainly it was not James Hutton, nor Lyell; the young rebels were radical uniformitarians. The book by Stafford suggests to me

GSAF *continued from p. 38*

Fall Meeting, Board of Trustees

The GSA Foundation Trustees met at the GSA Annual Meeting in Dallas. The Trustees received reports from the Foundation President and staff on fund-raising activities and the general financial status of the Foundation. Considerable progress has been made during the year in increasing the Foundation's asset base. Particular success has been achieved in the area of special funds such as the John C. Frye Memorial Fund; two new funds, the Donald L. Biggs Fund and the Gretchen Louise Blechschmidt Fund; and most recently the International Geological Congress Fund.

Considerable time was devoted to the financial situation of DNAG, and ways of increasing the amount of funds available to support this major project were discussed. Short of added funding from the outside, GSA will cover the necessary costs of producing the remaining volumes, with that money to be recovered from future sales of the series. The original contributors to DNAG have been contacted, and some have expressed support for the project in the form of added funding. Pennzoil made an additional contribution of $10,000, and other companies suggested they might respond favorably to additional funding for this or other GSA programs such as SAGE.

Special presentations were made to the Trustees on several new projects. Charles Drake and Bruce Hanshaw announced that the surplus from the 28th International Geological Congress would be gifted to the Foundation to establish the 28th IGC Fund, which will support participation by young scientists in future IGCs and also serve as the seed money for the next congress in the United States.

Steve Stow and Dave Stephenson made a presentation on the SAGE program and its future requirement for funds. SAGE will be a major financial undertaking for the Society, and the Foundation will have extensive fund raising ahead if this program is to be supported at the levels envisioned. The Trustees emphasized that the SAGE program must be sharply defined, at least at the outset, in order to avoid undertaking more than could be effectively handled by GSA.

Other reports to the Trustees included F. M. Wahl's review of the permitting process required prior to any consideration of an expansion of the Boulder headquarters building. The GSA Investment Committee advised the Trustees with respect to the financial portfolio managed by Warburg, Pincus Counsellors and Delaware Investment Advisors, suggesting that some 20% of the corpus could be invested in equities for future growth. The Trustees approved the appointment of Peter T. Flawn as the Foundation's representative on the GSA Audit Committee.

This being the annual meeting of the Foundation, the Trustees elected new officers, as reported in the January issue of *GSA Today*. The Trustees also selected Honorary Trustees and agreed upon a slate of Trustee candidates to be submitted to GSA Council for its approval. ■

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that the culprit was Sir Roderick Impey Murchison, Bart., K.C.B., 1792–1871.

I would think this volume, published by Cambridge University Press, a Sedgewick's revenge if I had not had a brief encounter with the biographee. I wrote a history on flysch research in 1971, and was impressed by Sir Roderick and his 1848 monograph, *The geological structure of the Alps, Apennines, and Carpathians, more especially to prove a transition from Secondary to Tertiary rocks, and the development of Eocene deposits in Southern Europe*, written after a summer "invasion" of central Europe. The title page was not big enough to record in full all the honors received by this great man. It was no wonder that Bernhard Studer should have discarded his correct interpretation of flysch as a recurrent facies and accepted Murchison's authoritative designation of flysch as an Eocene formation. This mistake hindered the progress of flysch research for almost a century. Stafford's biography reinforced my impression: not only was Murchison vain and authoritative, but he was more a self-serving soldier-politician than a scientist.

Of the eight chapters of Stafford's opus, the first—King of Siluria—and the last—The architect of imperial science—give a portrait of the man; the other six describe his imperialistic designs on the Americas, the Middle East, the Indian empire and Central Asia, the Far East, and Africa. The man is such a stereotype that Stafford's monochromatic brush, like a Sung painting, is quite sufficient to give a vivid portrait. I shall use the technique of Chinese poetry and string words and phrases used by Stafford to convey an impression of the great man's life: imperial heritage; performing poorly in the classroom; deficiency in mathematics; military career; riding, hunting, drinking bouts; debt; gay life; shooting partridges with Sir Humphry Davy (1823); study of science (for) the rising bourgeoisie; admission as a Fellow of the Geological Society (secured by Davy, 1825); began independent field work; election as a Fellow of the Royal Society (secured by Davy, 1826); reliance on paleontological dating and interest in economic geology; striding at such a relentless pace that he walked the legs off the younger Lyell; frontier skirmish; campaign of pacification and annexation for the "invasion of Graywacke"; bitterest controversies; inductive accumulation of data; against theory; President of the Geological Society (1842, 1869); Vice President of the Royal Society (1849); President of the Royal Geographical Society (1843, 1851, 1862–1871); Silurian; Devonian; Permian; Grand Cross of St. Stanislaus; Imperial academy of Science (Russia); alliance between science and national interest; Director-General of the Geological Survey (1855–1871); founding of colonial surveys; conquests on a scale commensurate with his ego; Knight Commander of Bath (1863); baronet (1866); mapping; discovery of exploitable minerals; arch-patriot and consummate promoter; [the Geological Survey as] a global arena for self-fulfillment; general in science like Napoleon; glory in the number and power of his clan; make or mar careers; authority to enforce conformity; exercising his omnipotence; utilitarian quackery of the age; "far wider reputations than the real men of science"; influence on honors, publications privileges, etc.; patronage of survey and academic appointments, etc.; bargain between science and the forces of expansion [of the empire]; his mind compared to "a Silurian matrix, impervious and resistant"; British natural science as a gigantic looting operation that helped maintain British ascendancy; desire for new data, careers, classificatory conquests, and power in administrative affairs.

I could go on and on, but you should read the book itself. If William Smith is my hero in geology, then Sir Roderick would be the antipode; he is everything that William Smith is not.

Stafford did laborious research to assemble data for the chapters describing Murchison's imperial exploits. Being somewhat familiar with the situation of China, I can vouch for the adequacy of his narratives. One need only mention a few of Murchison's friends to appreciate his contribution to Chinese geology: James Matheson ("prince of opium traders"), Sir John Barrow (urged the annexation of Hong Kong), Sir John Davis (advocated the occupation of Hong Kong and Canton), Laurence Oliphant (urged the acquisition of Hankow settlement), Earl of Elgin (burned the Imperial Summer Palace to teach the heathens a lesson), etc. Murchison's greatest interest in China was to send spies to find out where Chinese coal mines were so that the British gunboats would not run out of steam. Only his favoritism for the Czar of Russia prevented him from advising a British-Russian competition for the Siberian gold that was China's.

Of particular interest is Stafford's analysis of Murchison's fatal influence on the development of geology. "Instead of promoting the development of the new increasingly 'scientific' facets of geology which he found so bewildering, ... Murchison masterminded a programme ... based upon the simple principles of survey and mapping" (p. 206). He did much to insure that the geology in the century after him, "like the geology of the era in which he had learned the science, would require no formal training." I know this because I grew up in that era, when the best geologists were those who could walk the legs off their younger assistants, when data gathering was considered facts and formulation of falsifiable theories speculations. "Facts" may or may not be facts, but implications of facts are often lies. One example given by Stafford is Murchison's preoccupation with Carboniferous coal and Silurian gold. Coal does occur in Carboniferous strata and gold in Silurian, but the apparent implication is a lie. The Murchisonian inductive geology and his abhorrence "of theories from which derivative phenomena might be deduced" (p. 9) is a stereotype of bad science singled out by Karl Popper, Imre Lakatos, and other philosophers.

Of course, field mapping is important, but Murchison's type of field mapping was to outlive much of its usefulness. It is not enough to map only Silurian or Devonian or to place a boundary between Permian and Carboniferous; we need to map other attributes of rocks. The work that led to the seafloor-spreading theory was field mapping too, but the map was one of magnetic lineations, not of biostratigraphy. These "scientific facets" that Murchison found bewildering are

Book reviews *continued on p. 43*

GEOVENTURES 1991

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GeoVentures are a special benefit created for members, but are open also to guests and friends. GeoVentures is the overall name for adult educational and adventure experiences of two kinds: GeoTrips or 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. After that, the venues are quite different.

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HURRY! Don't be left out. Spaces on these events will go fast.
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GT912

Great Britain's Classic Geologic Sites

Co-sponsored by NAGT

21 days: Saturday, June 15–Saturday, July 6

Scientifc Leaders:
Donald McIntyre, Pomona College
Ron Roberts, Geological Museum of London
D. H. Tarling, Plymouth Polytechnic Southwest

This adventure is being coordinated by NAGT President, Dorothy (Dottie) Stout, Cypress College, California, who has had abundant experience with geologic trips to our sites in Great Britain, Wales, and Scotland. The itinerary includes visits to the following geologically and historically colorful places: London, Chalk Cliffs, Lyme Regis, Sidmouth, Cornwall, Stonehenge, Bath, Isle of Arran, Parallel Roads of Glenroy, Hadrian's Wall, Glasgow, Great Glen Fault, Torridonians, Moine Thrust, Siccar Point, Edinburgh, and Newcastle-upon-Tyne.

Registration

Fee includes double occupancy lodging, ground transportation, all breakfasts plus 15 dinners and a farewell fete, entry fees, and theater tickets. Airfare not included.

Open to all geologists and their friends, but GSA and NAGT members will enjoy a $100 special discount. Minimum age: 21 years. Trip limit: 30 persons.

Fees and Deposit

Cost: $3090 (based on 25 person minimum)
Special for GSA and NAGT Members: $2990
Register before February 28 and SAVE $100!

A $250 deposit is due with your reservation.
It is totally refundable up to February 28.

GT913

Grand Canyon Adventure

An educational adventure: rafting, hiking, and camping
9 days, 8 nights on the river—Lee's Ferry to Pearce Ferry—250 miles of river ride

Sunday, July 14–Monday, July 22

Scientific Leaders:
George H. Billingsley, USGS, Flagstaff
William K. (Ken) Hamblin, Brigham Young University

Registration

Fee includes meals, tent and sleeping bag package, geologic materials, bus travel to and from Grand Canyon and Las Vegas.
Minimum age: 16 years. Trip limit: 35 persons.

Fees and Deposit

Cost: $1440
$100 less for GSA Members
Register Before February 10 and SAVE $50!
GSA Members $1290
Guests and Nonmembers $1390

$150 deposit will hold your place.
The deposit is completely refundable up to April 9.

GH91

Colorado GeoHostel Program

Morning classes, a field trip (or two), and plenty of free time to enjoy the spectacular Rocky Mountain summer

5 days: Sunday, June 23–Thursday, June 27

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

Programs

GH91A **Evolution of Geologic Landscapes in the Colorado Rockies**, 8:00–9:30 a.m.
GH91B **Environmental and Engineering Issues in Colorado**, 9:30–11:00 a.m.
GH92B **Old Mining Towns of the Rockies**, 9:30–11:00 a.m.

Registration

Fee includes classroom programs, field excursions, lodging (double occupancy), breakfasts, welcoming and farewell events.
Minimum age: 21 years. Class limit: 40 persons.

Fees and Deposit

Cost: $350
$25 less for GSA Members
$50 deposit is due with your reservation.
It is totally refundable up to April 1.

DNAG NEWS

Allison R. (Pete) Palmer

State of the Union

I keep hoping that this column can be terminated and I can report that the DNAG Project is finished. Our twentieth book, *The Caribbean Region*, was published and available by late December, and two more books, *The Heritage of Engineering Geology*, and *Economic Geology of Mexico* will be at the printer by the time you read this and available in April or May. As of this writing (early December), the end is in sight for six additional books (only two chapters needed for each), two continent-scale maps, and two transects, leaving two books (Alaska and the Transects volume), three east-coast transects, and the Geologic Map of North America dragging significantly on into early 1991. Maybe next month I can acknowledge some long-suffering contributors to several of the volumes—perhaps by then the long-awaited final chapters will be on my desk. ■

Book Reviews *continued from p. 41*

exactly those that are required to make geology advance.

It would be extreme not to see some redeeming values of Sir Roderick Murchison. Aside from the help of influential friends, two characteristics—reliance on paleontological dating and interest in economic geology—were the key to his success. We should recognize that the last revolution in geology was William Smith's discovery of biostratigraphy. Murchison was perceptive enough to mop up with the new paradigm, but the same mopping up could have been done by someone else, perhaps better. We are now in the aftermath of the revolution of the 1960s; we are mopping up. Stafford's book flashes a red light to warn us of the danger of modern Murchisonism: searching for terrains in the mountains while rejecting "subjective interpretations" reminds me very much of the raids, campaigns, invasions, and conquests by the King of Siluria.

Kenneth J. Hsü
ETH
Zurich, Switzerland ■

ANWR *continued from p. 33*

are good odds, but the mathematical reality is that there is an 81% chance that if the oil exploration crews sink the projected 100 wells, they will find that it does not make economic sense to proceed to full-scale development.

Suppose they beat the odds. The Interior Department predicts they would be able to extract 3.2 billion barrels of oil over the life of the field. That's a very big field. But that output would satisfy just 2% of U.S. oil demand. In exchange for the drop in our oil bucket, we would be sacrificing what is called "America's Serengeti." The Arctic Refuge's coastal plain, where any drilling would occur, runs along the Arctic Ocean for about 100 miles. This swath, roughly 25 miles wide, is bordered on the south by the spectacular Brooks Range. It features fresh streams running down from the mountains and, in season, a kaleidoscope of wildflowers. At least as impressive to a visitor are the vastness, the peacefulness, and the freshness. It is a wilderness without equal. Polar bears, grizzlies, and Dall sheep depend on the coastal plain. So do muskoxen, the distinctive survivors of the Ice Age that were almost wiped out by hunters but are now making a comeback. Literally millions of swans, geese, and other migratory birds congregate on the coastal plain in the warm months, coming from as far away as the Chesapeake Bay and South America. Best known of all are the 180,000 caribou in the herd that migrates every year across Canada's Porcupine River to bear their young on the coastal plain. This migration is one of the most stunning wildlife sights in the world.

Only in the Arctic National Wildlife Refuge is the complete range of arctic and subarctic ecosystems preserved intact. Humankind has moved in everywhere else. In Alaska, for example, 90% of the Arctic Ocean coastline has been made available to the oil industry. Only the 10% represented by the Arctic Refuge remains off limits. The oil companies insist that they can develop the coastal plain without damaging the environment. But how credible is that? If Congress decided to give the industry a green light, the Arctic Refuge soon would feature hundreds of wells, 100 miles of main pipeline, 380 miles of roads, collector lines, 11 production facilities, four air strips, two ports with salt-water treatment facilities, and the housing and other infrastructure needed to support thousands of people. Forty to 50 million cubic yards of gravel—enough to cover 28,000 football fields to a depth of one foot—would have to be mined from streambeds and elsewhere for roads and well pads. Vehicles and production facilities would create pollution. Enormous amounts of solid waste would be generated. It is hard to understand how all that could be brought to the coastal plain and do no damage to the environment.

In defense, the oil companies rush out their pictures of caribou at Prudhoe Bay. The herd has increased since development began more than a decade ago. What the oil industry does not mention is the virtual elimination of the caribou's predators. Moreover, because of warm weather and other factors, caribou populations are at cyclical highs throughout Alaska and Canada. Finally, there is an important difference between the central caribou herd at Prudhoe Bay and the Porcupine caribou herd: the latter are migratory and therefore would find their routes cut off by roads, pipelines, and other development. The oil industry also likes to nurture the notion that what has been going on at Prudhoe Bay has been done without cost to air, land, and water. But the records kept by the Alaska Department of Environmental Conservation reveal that spills there have averaged 500 a year. Emissions of nitrogen oxides nearly equal those of Chicago.

Why expose the unique coastal plain to this grimy industrial reality when there are much more promising ways to solve our energy problems? By increasing the fuel efficiency of new cars by just two miles per gallon, we could save the 3.2 billion barrels of oil that drilling advocates hope is below the refuge. And it's not a one-in-five shot; it's a one-in-one shot. By increasing the standard from the current 27.5 mpg to 40 mpg, as proposed by Senator Richard Bryan's (D—Nevada) bill, we could save ten times that much. Improvement in gas mileage would save motorists money at the pump, reduce emissions, lessen the threat of oil spills and global warming, and make U.S. cars more competitive in the global marketplace.

Thanks to the fuel-efficiency improvements mandated by Congress in 1975, we are saving at least 2 million barrels of oil per day—more than we were importing from Iraq and Kuwait. The potential for much more efficiency exists. Yet over the past two years new U.S. cars have become 4% less efficient. Last fall, when the Environmental Protection Agency listed the 10 most efficient cars, not a single one was made in the United States.

Compounding our energy problems is the halfhearted effort to develop renewable sources. The oil shocks of the 1970s spurred a long-overdue campaign to speed up the inevitable transition to renewable sources. Yet over the past decade, federal funding of research and development has been slashed 80%. In Fiscal Year 1990, the Department of Energy invested just $86 million in renewable energy R&D; nuclear energy received $455 million. Japan has taken the solar photovoltaic technology that spun off of our space program and moved past us in the global market. This is an industry with enormous future potential.

Unfortunately, the United States remains addicted to oil. We continue to use 25% of world output, while sitting atop barely 4% of world reserves. The Middle East harbors 65% of those reserves, so until we end our addiction, OPEC will remain our dealer. The consequences of that dependence were manifested in yet another way when Saddam Hussein rolled into Kuwait last summer. The fear of war sent our oil bill skyrocketing. Factoring in military costs associated with Operation Desert Shield, we were paying $100 for each barrel of oil, according to energy experts Hunter and Amory Lovins—to say nothing of the potential cost of lost lives.

Despite all the evidence that our 1950s-style energy policy is hurting our economy, our environment, and our security, the Bush administration is poised to unveil a national energy policy that is but an echo of that outdated approach. No doubt there will be some provisions that involve efficiency improvements, but there will be no commitment to ending our oil addiction. In fact, there is sure to be a call for letting the oil industry into the Arctic Refuge in hopes that it can squeeze a bit more oil out of our exhausted continent. For the sake of future generations, we need to do better than that. ■

MEETINGS

■ Indicates new or changed information

1991

February

American Geophysical Union 1991 Front Range Meeting: Our Changing Environment, February 11–12, 1991, Boulder, Colorado. Information: Rush Services, 5106 Forsyth Place, Boulder, CO 80303; (303) 443-8489; fax 303-449-4394.

Seventh Annual V.E. McKelvey Forum on Mineral and Energy Resources, February 11–14, 1991, Reno, Nevada. Information: Buhler and Abraham, Inc., 8700 First Avenue, Silver Spring, MD 20910; (301) 588-4177.

American Association for the Advancement of Science Annual Meeting, February 14–19, 1991, Washington, D.C. Information: AAAS Meetings Office, 1333 H Street, N.W., Washington, DC 20005; (202) 326-6448.

Mineral Resources and the Changing International Economy of the 90s, February 14–19, 1991, Washington, D.C. Information: Carroll Ann Hodges, U.S. Geological Survey, MS 984, 345 Middlefield Rd., Menlo Park, CA 94025; (415) 329-5357.

United Nations Development Programme 5th International Conference on Heavy Crude and Tar Sands, February 17–22, 1991, Caracas, Venezuela. Information: Sigfrid Steinhold S., 5th UNITAR/UNDP Conference, 801 U.N. Plaza, 5th Floor, New York, NY 10017; (212) 370-1122; fax 212-986-5779.

10th Annual Symposium on Caribbean Geology: Tectonics and Mineral Deposits of the Caribbean, February 20–24, 1991, Mayagüez, Puerto Rico. Information: J. H. Schellekens, Dept. of Geology, University of Puerto Rico, P.O. Box 5000, Mayagüez, Puerto Rico 00709-5000; (809) 265-3845.

Society for Mining, Metallurgy, and Exploration Annual Meeting, February 25–28, 1991, Denver, Colorado. Information: Meetings Department, Society for Mining, Metallurgy, and Exploration, P.O. Box 625002, Littleton, CO 80162; (303) 973-9550; fax 303-979-3461.

TER-QUA Symposia on Early Man, Eolian Activity, and Climate Change on the Great Plains, February 28–March 2, 1991, Lawrence, Kansas. Information: Wakefield Dort, Jr., Dept. of Geology, University of Kansas, Lawrence, KS 66045; (913) 864-4974.

March

AAPG/SEPM/SEG/SPWLA Pacific Sections 66th Annual Meeting, March 5–10, 1991, Bakersfield, California. Information: Robert Horton, 1991 Annual Pacific Sections Convention, 4909 Stockdale Highway, Suite 251, Bakersfield, CA 93309.

Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics (including special session on the Loma Prieta [California] Earthquake of October 17, 1989), March 11–15, 1991, St. Louis, Missouri. Information: Shamsher Prakash, Dept. of Civil Engineering, 308 Butler Carlton Hall, University of Missouri, Rolla, MO 65401-0249; (314) 341-4489; fax 314-341-4729.

GSA Northeastern and Southeastern Sections, March 14–16, 1991, Baltimore, Maryland. Information: Emery Cleaves, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218; (301) 554-5504; Juergen Reinhardt, U.S. Geological Survey, 926 National Center, Reston, VA 22092; (703) 648-6789.

Appalachian Karst Symposium, March 23–26, 1991, Radford, Virginia. Information: Ernst H. Kastning, Department of Geology, Radford University, Radford, VA 24142; (703) 831-5336 or 5652; fax 703-831-5970.

Sixth Biennial Meeting of the European Union of Geosciences, March 24–28, 1991, Strasbourg, France. Information: Organizing Committee of E.U.G. VI, University of Trieste, Institute of Mineralogy, Piazzale Europa, 1-34100 Trieste, Italy.

GSA Cordilleran Section, March 25–27, 1991, San Francisco, California. Information: Raymond Sullivan, Dept. of Geosciences, San Francisco State University, San Francisco, CA 94132; (415) 338-7730.

Fifth SIAM Conference on Parallel Processing for Scientific Computing, March 25–27, 1991, Houston, Texas. Information: SIAM Conference Coordinator, Dept. CC0990, 3600 University City Science Center, Philadelphia, PA 19104-2688; (215) 382-9800; fax 215-386-7999; E-mail siamconfs@wharton.upenn.edu.

Petroleum-Reservoir Geology in the Southern Midcontinent, March 26–27, 1991, Norman, Oklahoma. Information: Kenneth S. Johnson or Jock A. Campbell, Oklahoma Geological Survey, University of Oklahoma, 100 E. Boyd, Rm. N-131, Norman, OK 73019; (405) 325-3031.

April

■ **American Association of Petroleum Geologists Annual Meeting**, April 7–10, 1991, Dallas, Texas. Information: Charles F. Dodge, General Chairman, 607 Meadows Building, 5646 Milton, Dallas, TX 75206; (214) 363-2937; or AAPG Convention Department, P.O. Box 979, Tulsa, OK 74101; (918) 584-2555.

Engineering Geology and Geotechnical Engineering, 27th Symposium, April 9–13, 1991, Logan, Utah. Information: James McCalpin, Dept. of Geology, Utah State University, Logan, UT 84322-4505; (801) 750-1220.

Permian Basin Section—SEPM Annual Field Seminar: Sequence Stratigraphy, Facies, and Reservoir Geometries of the San Andres/Grayburg/Queen Formations, Guadalupe Mountains, New Mexico and Texas, April 11–13, 1991, Permian Basin, Texas. Information: Sally Meador-Roberts, PBS-SEPM 1991 Annual Field Seminar, P.O. Box 1595, Midland, TX 79702; (915) 684-7122.

Association of American Geographers Annual Meeting, April 13–17, 1991, Miami, Florida. Information: AAG, 1710 16th Street NW, Washington, D.C. 20009-3198; (202) 234-1450.

International Conference on Environmental Pollution, April 15–19, 1991, Lisbon, Portugal. Information: ICEP Conference Office, ICTR Secretariat, 11–12 Pall Mall, London SW1Y 5LU, England; phone 01-930-6825; telex 925312 REICO G; fax 01-976-1587.

GSA North-Central Section, April 18–19, 1991, Toledo, Ohio. Information: Lon Ruedisili or Mark Camp, Dept. of Geology, University of Toledo, Toledo, OH 43606.

International Symposium on Geophysical Hazards in Developing Countries and Their Environmental Impacts, April 21–27, 1991, Cairo, Egypt. Information: T. S. Murty, Hazards-91, c/o Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C. V8L 4B2, Canada; (604) 356-6311; telex 04-97281; fax 604-356-6390; Mohammed I. El-Sabh, Hazards-91, Dept. Océanographie, Université du Québec, 300, Allée des Ursulines, Rimouski, Québec G5L 3A1, Canada; (418) 724-1707; telex 051-31623; fax 418-723-7234.

GSA Rocky Mountain and South-Central Sections, April 22–24, 1991, Albuquerque, New Mexico. Information: G. Randy Keller, Dept. of Geological Sciences, University of Texas, El Paso, TX 79968-0555; (915) 747-5501; John Geissman or Wolfgang Elston, Dept. of Geology, University of Albuquerque, Albuquerque, NM 87131; (505) 277-4204.

European Geophysical Society XVI General Assembly, April 22–26, 1991, Wiesbaden, Federal Republic of Germany. Information: EGS Office, Postfach 49, 3411 Katlenburg-Lindau, Germany; phone 49-5556-1440; fax 49-5556-4709; telex 965564 zil d.

Association of Exploration Geochemists 15th International Geochemical Exploration Symposium, April 29–May 1, 1991, Reno, Nevada. Information: Harold Bonham, 15th IGES, P.O. Box 9126, Reno, NV, 89507; (702) 784-6691; fax 702-784-1709.

Eighth Thematic Conference on Remote Sensing for Exploration Geology, April 29–May 2, 1991, Denver, Colorado. Information: Robert H. Rogers, ERIM Thematic Conferences, P.O. Box 8618, Ann Arbor, MI 48107-8618; (313) 994-1200.

May

Society for the Preservation of Natural History Collections, 6th Annual Meeting, May 6–11, 1991, Ottawa, Ontario. Information: G. R. Fitzgerald, Canadian Museum of Nature, Earth Sciences (Paleobiology), P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada.

14th Annual Spring Systematics Symposium: Origin of Anatomically Modern Humans, May 11, 1991, Chicago, Illinois. Information: Sophia L. Brown, Symposium Coordinator, Department of Geology, Field Museum of Natural History, Roosevelt Road and Lake Shore Drive, Chicago, IL 60605-2496; (312) 922-9410, x298.

Third International Seminar on Coastal Parks and Protected Areas, May 11–June 5, 1991, Florida and Costa Rica. Information: John R. Clark, University of Miami-RSMAS, 4600 Rickenbacker Causeway, Miami, FL33149-1098; (305) 361-4620; telex 317454; fax 305-361-9306; Easylink mailbox 62845425.

International Symposium on Land Subsidence, May 12–18, 1991, Houston, Texas. Information: Ivan Johnson, A. Ivan Johnson, Inc., 7474 Upham Ct., Arvada, CO 80003; (303) 425-5610.

Fifth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring, and Geophysical Methods, May 13–16, 1991, Las Vegas, Nevada. Information: Fifth National Outdoor Action Conf., National Water Well Association, P.O. Box 182039, Dept. #017, Columbus, OH 43218; (614) 761-1711.

Brazil Gold '91, May 13–17, 1991, Belo Horizonte, Brazil. Information: Organizing Committee, Av. Afonso Pena, 3880-3/5 andares, 30130 Belo Horizonte MG, Brazil; or Charles Thorman, U.S. Geological Survey, Box 25046, MS 905, Denver Federal Center, Denver, CO 80225; (303) 236-5601; fax 303-236-5603.

14th International Radiocarbon Conference, May 20–24, 1991, Tucson, Arizona. Information: Austin Long, Dept. of Geosciences, University of Arizona, Tucson, AZ 85721; (602) 621-8888; fax 602-621-2672; telex 650-3839821.

Geological Association of Canada–Mineralogical Association of Canada Annual Meeting held jointly with the Society of Economic Geologists, May 27–29, 1991, Toronto, Ontario. Information: J. J. Fawcett, Dept. of Geology, Earth Sciences Center, University of Toronto, 22 Russell St., Toronto, Ontario M5S 3B1, Canada; (416) 978-3027; fax 416-978-3938.

July

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

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

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

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

August

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

Sedimentary and Paleolimnological Records of Saline Lakes, August 13–16, 1991, Saskatoon, Saskatchewan. Information: Robin W. Renaut, Dept. of Geological Sciences, University of Saskat-

chewan, Saskatoon, Saskatchewan S7N 0W0, Canada; fax 306-966-8593; W. M. Last, Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada; fax 204-261-7581.

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

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

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

September

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

Geometry of Naturally Deformed Rocks (John Ramsay Meeting), September 9–11, 1991, Zürich, Switzerland. Information: E. Pour, Geologisches Institut, ETH-Zentrum, CH-8092, Zürich, Switzerland; phone 256 36 80; fax 252-70-08. (*Abstracts deadline: June 1, 1991.*)

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

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

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

2nd International Symposium on Environmental Geochemistry, September 16–19, 1991, Uppsala, Sweden. Information: Mats Olsson, Dept. of Forest Soils, Swedish University of Agricultural Sciences, Box 7001, S-750 07 Uppsala, Sweden; phone 46-18-672212; fax 46-18-300831. (*Abstracts deadline: March 28, 1991.*)

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

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

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

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

October

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

International Symposium on Debris Flow and Flood Disaster Protection, October 14–20, 1991, Emeishan City, Sichuan Province, China. Information: Tong Yuling, International Research and Training Centre on Erosion and Sedimentation (IRTCES), P.O. Box 366, Beijing, China 100044; phone 8413372; telex 22786 ITCES CN; fax 8412539.

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

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

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

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

Brazilian Geophysical Society Second International Congress, October 28–November 1, 1991, Salvador City, Bahia, Brazil. Information: Brazilian Geophysical Society—SBGf, Alberto Brum Novaes, Universidade Federal da Bahia/UFBa-PPPG, Rua Caetano Moura 123, Federacão 40.210, Salvador BA, Brasil; phone 55-071-2370408. (*Abstracts deadline: May 31, 1991.*)

November

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

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

December

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

1991 Penrose Conferences

February

Flow and Associated Transport in Basins: Driving Forces, Coupling and Geologic Controls, February 25–March 1, 1991, Napa Valley, California. Information: Stuart Rojstaczer, Dept. of Geology/Old Chemistry Bldg., Duke University, Durham, NC 27706; (919) 648-5847; Patrick A. Domenico, Dept. of Geology, Texas A&M University, College Station, TX 77843; (409) 845-2451 (dept.), (409) 845-0636 (dir.).

October

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

1992

February

■ **First South Asia Geological Congress—GEOSAS-I**, February 23–27, 1992, Islamabad, Pakistan. Information: Hilal A. Raza, GEOSAS-I Secretary General, Hydrocarbon Development Institute of Pakistan, 230-Nazimuddin Road, F-7/4, P.O. Box 1308, Islamabad, Pakistan; phone 9251-823690 or 821417; telex 5516 HDIP PK; fax 9251-828773.

March

■ **Hydrocarbon Contaminated Soils and Groundwater Second Annual West Coast Conference**, March 4–7, 1991, Newport Beach, California. Information: EPACH Corporation, 150 Fearing St., Suite 17, Amherst, MA 01002; (413) 549-5561; fax 413-549-0579.

April

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

June

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

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

August

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

September

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

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

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

October

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

■ **Arbuckle Group Core Workshop and Field Trip**, October 27–29, 1991, Norman, Oklahoma. Information: Kenneth S. Johnson, Oklahoma Geological Survey, University of Oklahoma, 100 East Boyd, Rm. N-131, Norman, OK 73019; (405) 325-3031.

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

GSA ANNUAL MEETINGS

■ 1991

GSA Annual Meeting, San Diego, California
October 21–24
General Chair:
R. Gordon Gastil, Dept. of Geological Sciences,
San Diego State University, San Diego, CA 92182

■ 1992

GSA Annual Meeting, Cincinnati, Ohio
October 26–29
Call for field trip proposals:
Send proposals to Thomas M. Berg, State Geologist and Chief, Division of Geological Survey, Ohio Dept. of Natural Resources, Fountain Square, Columbus, OH 43224; (614) 265-6605

■ FUTURE

San Diego	October 21–24	1991
Cincinnati	October 26–29	1992
Boston	October 25–28	1993
Seattle	October 24–27	1994
New Orleans	November 6–9	1995

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

GSA SECTION MEETINGS

■ 1991

Northeastern-Southeastern
Omni Inner Harbor Hotel, Baltimore, Maryland, March 14–16

Emery Cleaves, Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218; (301) 554-5504
or Juergen Reinhardt, U.S. Geological Survey, 926 National Center, Reston, VA 22092; (703) 648-6789

Cordilleran
Cathedral Hill Hotel, San Francisco, California, March 25–27

Raymond Sullivan, Dept. of Geosciences, San Francisco State University, San Francisco, CA 94132; (415) 338-7730

North-Central
University of Toledo, Toledo, Ohio, April 18–19

Lon Ruedisili or Mark Camp, Dept. of Geology, University of Toledo, Toledo, OH 43606; (419) 537-2009

Rocky Mountain–South-Central
University of New Mexico, Albuquerque, New Mexico, April 22–24

G. Randy Keller, Dept. of Geological Sciences, University of Texas at El Paso, El Paso, TX 79968-0555; (915) 747-5501
or John Geissman or Wolfgang Elston, Dept. of Geology, University of New Mexico, Albuquerque, NM 87131; (505) 277-4204

FOUNDATION TO FUND MATCHING STUDENT-TRAVEL GRANTS

The GSA Foundation will award matching grants up to a total of $3000 each to the six GSA Sections. The money, when combined with equal funds from the Sections, will be used to assist students traveling to the 1991 Section Meetings and the GSA Annual Meeting in San Diego.

Travel grants will be awarded and administered by the Sections, whose officers should be contacted for further information.

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The Geological Society of America
BULLETIN
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FEBRUARY 1991

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Positions Open

FACULTY POSITION — GEOLOGY

The School of Science, Southwest Texas State University, invites applications for a tenure-track appointment at the assistant professor level in the field of Geology. The applicant will be expected to have a strong commitment to excellence in teaching and to develop an active, externally-funded research program. Preference will be given to individuals whose background complements the ongoing groundwater research programs at the Edwards Aquifer Research and Data Center. Teaching commitments will include introductory courses in physical and historical geology as well as supervision of the associated laboratories. The successful applicant will be expected to develop additional geology curriculum sufficient to lead to a minor in geology within three years. The Ph.D. must be completed by the time of the appointment. The deadline for receipt of applications is April 1, 1991. A curriculum vitae, copies of relevant publications, official graduate and undergraduate transcripts, and at least three letters of recommendation should be sent to: Dr. James R. Crawford, Chairman, Geology Search Committee, Department of Physics, Southwest Texas State University, San Marcos, Texas 78666. Southwest Texas State University is an Affirmative Action/Equal Employment Opportunity employer and encourages applications from qualified minority and women candidates.

THE UNIVERSITY OF SAN DIEGO

Marine and Environmental Studies Program invites applicants for a tenure-track position in GEOLOGY or GEOCHEMISTRY at the Assistant Professor level beginning in September 1991. Teaching responsibilities include Geological Oceanography, an upper division course to be developed by the candidate and participation in the introductory curriculum. Marine and Environmental Studies is a broadly interdisciplinary program in the college of Arts and Sciences and maintains close ties with the Hubbs/Sea World Research Institute in San Diego. The program offers degrees at the baccalaureate and masters' levels. USD is a Catholic university whose primary aim is teaching excellence. Active scholarship by the faculty is considered essential to this aim. The candidate is expected to maintain an active research program that has the potential for the involvement of both undergraduate and graduate students. Teaching experience is desirable. *Women and members of minority groups are encouraged to apply.* Send curriculum vitae, a brief description of teaching philosophy and research interests, and three letters of reference by 13 February 1991 to: Director, Marine & Environmental Studies Program, University of San Diego, Alcalá Park, San Diego, CA 92110.

SCIENTIFIC EDITOR

The Earth Sciences and Resources Institute (University of South Carolina) invites applications for a scientific editor to assist a small team in the preparation of reports and Institute publications. The ideal candidate should have a strong geological background with experience in petroleum geology and geophysics and/or regional geology, in addition to a facility in writing reports. As part of the work responsibility lies in assisting non-native English speaking scientists, familiarity with one or more foreign languages would be advantageous. Possibilities exist for participation in the Institute's research programs. Interested candidates should submit a current CV and an outline of relevant experience, along with letters of recommendation, to Prof. A. Nairn, ESRI-USC, Columbia, SC 29208. Salary and professional rank are negotiable and commensurate with experience. The University of South Carolina is an equal opportunity/affirmative action employer.

UNIVERSITY OF NEVADA, LAS VEGAS
STRUCTURAL GEOLOGIST

The University of Nevada, Las Vegas announces a new tenure-track position in structural geology beginning August 19, 1991. The successful candidate will be a structural geologist who has expertise with one or more of the following quantitative tools: geophysics, isotope geochemistry/geochronology, or lithospheric modeling. The applicant will be expected to develop a strong externally funded research program. Research interests in the Great Basin and/or Colorado Plateau are desirable but not required.

The candidate will teach, on a rotating basis, structural geology, introductory geology, field geology, and graduate/undergraduate-level courses in his/her area of specialization. The applicant will be expected to supervise graduate students (M.S. level) and participate enthusiastically in the development of a Ph.D. program (anticipated by Fall 1992).

The department is equipped with modern analytical equipment including XRF, XRD, AA, SEM, fluid inclusion facilities, and a mineral separation laboratory. A microprobe is available through an instrumental consortium.

Candidates are required to have a Ph.D. in geology by August 1991. Appointment will be at the assistant professor level.

Please send a statement of research and teaching interests, curriculum vitae, academic transcripts, and 4 letters of recommendation to Eugene I. Smith, Chair of the Search Committee, Department of Geoscience, University of Nevada, Las Vegas, NV 89154. The closing date for applications is February 15, 1991.

The University of Nevada, Las Vegas is an equal opportunity/affirmative action employer.

MOUNT HOLYOKE COLLEGE
GEOLOGY DEPARTMENT TECHNICIAN

The Department of Geology invites applications for a half-time technician position (9-month salary $11,169.50). Candidates should have technical experience in a laboratory of geology or other physical science and have knowledge and skills in setting up, operating and maintaining scientific equipment. Some experience with scanning electron microscopy and thin-sectioning required; knowledge of energy-dispersive spectrometry, x-ray diffraction, and darkroom techniques desirable. Applicants should submit a summary of background and relevant work experience, and names and addresses of three persons as references by June 1, 1991 to: Mark McMenamin, Mount Holyoke College, Department of Geology, Clapp 419, South Hadley, MA 01075-1484. Mount Holyoke College is an equal opportunity/affirmative action employer.

Services & Supplies

FOR SALE: *GSA Bulletin*, 1920 thru 1990. Best offer. Reply GSA Code #1051.

LEATHER FIELD CASES. Free brochure, SHERER CUSTOM SADDLES, INC., P.O. Box 385, Dept. GN, Franktown, CO 80116. X12/90

Opportunities for Students

RESEARCH GRANTS AVAILABLE. The Colorado Scientific Society invites graduate students to apply for research monetary grants to be awarded by the Society in early May 1991. Applicants must be currently enrolled in a Masters or Ph.D. program at a private or state college or university. Four to six grants ranging from $800 to $1300 each will be awarded for field-oriented earth-science thesis projects in Colorado and the Rocky Mountain region. Also, a grant of about $950 will be awarded for an engineering geology thesis project (with no areal restriction). Interested students can obtain research grant applications from the Chairman of the Memorial Funds Committee, F.G. Poole, Colorado Scientific Society, P.O. Box 150495, Lakewood, CO 80215. Deadline for applications is April 10, 1991.

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

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RM/SC Sections *continued from p. 37*

Indian dancers. Total cost for the evening is $25, with a reduced price for children. In addition to New Mexican ambiance, Los Amigos also provides volleyball, ping-pong, and horseshoes for loosening up stiff muscles. The ticket price includes all you can eat and drink, entertainment, a special souvenir, and bus transportation to and from the Hilton Hotel. Wear your casual clothes (western attire encouraged) and come prepared for a great time.

BUSINESS MEETINGS

The **GSA Rocky Mountain Section Management Board Meeting** will be held Tuesday morning, beginning at 6:30 a.m., in the Hilton Hotel.

The **GSA Rocky Mountain Section Business Meeting** will be at noon Tuesday, in the Hilton Hotel.

The **GSA South-Central Section Management Board Meeting** will be held Tuesday morning, at 6:30 a.m., in the Hilton Hotel.

The **GSA South-Central Section Business Meeting** will be at noon Tuesday, in the Hilton Hotel.

STUDENT SUPPORT

Both the Rocky Mountain and South-Central Sections of GSA have funds available for grants to support GSA Student Associates of the Rocky Mountain and South-Central Sections who are presenting papers at the meeting. Students are encouraged to apply for these grants, and we hope to give some degree of support to most students who qualify. Application letters must be received by *February 28, 1991*, by the appropriate Section Secretary: Rocky Mountain—Kenneth E. Kolm, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, (303) 273-3651; South-Central—Rena M. Bonem, Department of Geology, Baylor University, Waco, Texas 76798 (817) 755-2361. Applications should include certification that the student is a GSA Student Associate of the appropriate section.

DETAILED INFORMATION

For other information concerning technical sessions, field trips, registration, accommodations, and activities, please contact Co-Chairpersons John Geissman and Wolfgang Elston, Department of Geology, University of New Mexico, Albuquerque, NM 87131-1116, (505) 277-3433 (Geissman), (505) 277-5339 (Elston), fax 505-277-8843; or G. Randy Keller, Department of Geological Sciences, University of Texas, El Paso, TX 79968, (915) 747-5501, fax 915-747-5111. ■

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THE SECOND ANNUAL INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT CONFERENCE & EXPO

APRIL 28-MAY 3, 1991 CAESARS PALACE, LAS VEGAS

FACING THE PROBLEM

Where to put our nuclear waste, and how to get it there safely is one of the most pressing issues of our times. This topic will be the focus of The Second Annual International High-Level Radioactive Waste Management Conference and Exposition, hosted by Howard R. Hughes College of Engineering, University of Nevada, Las Vegas in April, 1991.

DEVELOPING SOLUTIONS

Inventing and generating systems that provide absolute assurance to the safety of future generations is the goal of this conference, and it's at this meeting that sharing knowledge and experience will open new avenues of thought and development.

If you are a manufacturer, distributor or vendor of products or services related to high-level radioactive waste management, you are invited to participate in the Exposition at Caesars Palace.

THE BEST AND THE BRIGHTEST

Attendees are scientists and nuclear and non-nuclear engineers concerned with identifying, measuring and dealing with high-level radioactive waste. Here you'll find the country's top minds gathered to grapple with questions of geology, hydrology, transportation, handling radioactive materials, and public health and safety issues.

Topics to be addressed at this Conference include:

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- Physical Geology and Resources
- Saturated and Unsaturated Zone Flow
- Geochemistry and Transport Processes
- Climatology Issues and Assessments
- Environmental Issues and Assessments
- In Situ and Laboratory Testing

INTEGRATED SYSTEMS
- Transportation Systems
- System Modeling and Performance
- System Data Development and Assessment
- System Technology Development and Assessment
- System Storage
- International Cooperation

ENGINEERED SYSTEMS
- Spent Fuel and Vitrified Waste Characteristics
- Interim Storage Facilities
- Transportation Casks and Handling Systems
- Waste Package and Underground Emplacement Facilities
- Engineered Systems Testing and Techniques

SOCIAL SYSTEMS
- Socioeconomic Impact and Assessment
- Institutional Impacts
- Public Involvement in Technical Issues
- Regulations and Regulatory Process
- Health Effects Assessment

Conference Host: Howard R. Hughes College of Engineering, Univ. of Nevada, Las Vegas
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