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INSIDE

Gaia and the Colonization of Mars

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Dedicated to the memory of Heinz A. Lowenstam (1913–1993)

ABSTRACT

The Gaia hypothesis states that the atmosphere, hydrosphere, surface sediments, and life of Earth behave dynamically as a single integrated physiological system. What has been traditionally viewed as the *passive environment is a highly active, integral part of the gaian system.* Aspects of the surface temperature and chemistry are regulated by the sum of life, the biota. Formulated first by James E. Lovelock, in the late 1960s, the Gaia hypothesis has been in the scientific literature for more than 25 years. Because of its properties of exponential growth and propagation, life is a powerful geologic force. A useful aspect of the Gaia idea is that it requires integration of scientific disciplines for the study of Earth. The recently touted Earth system science is broadly parallel with the gaian concept of the physiochemical regulation of Earth's surface. We discuss here, in a gaian context, the colonization of Mars by Earth organisms. Although colonizing Mars may be impossible, its accomplishment would be exactly equivalent to "the reproduction of Gaia by budding."

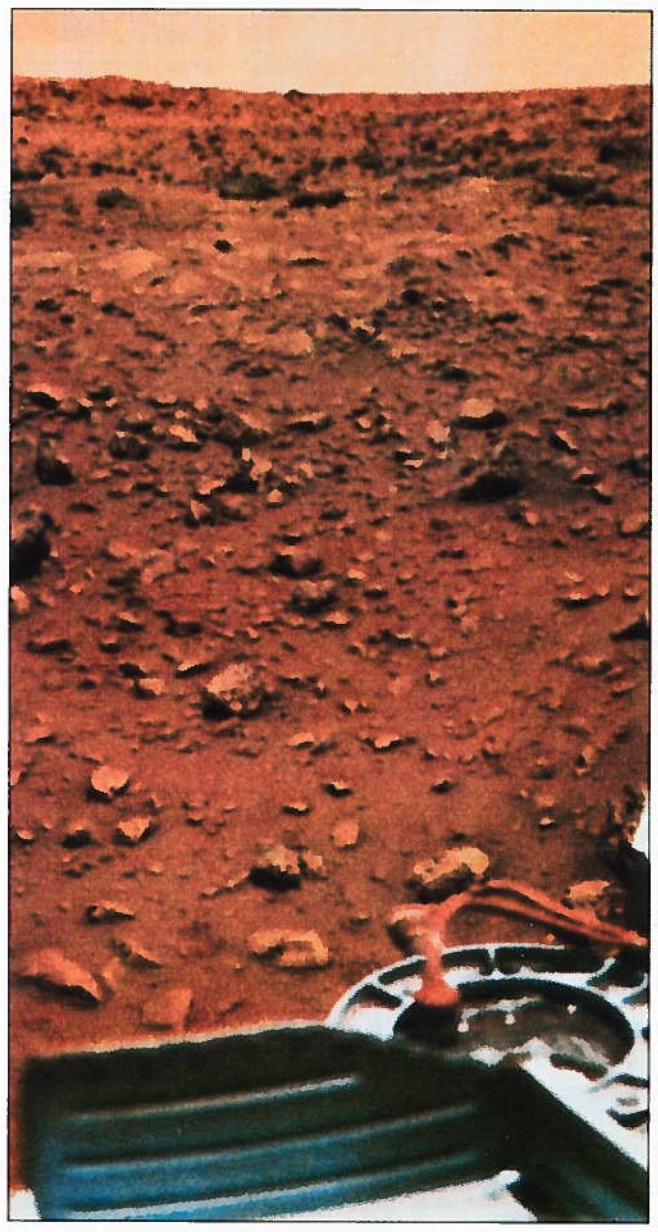

Figure 1. View of the Martian regolith from the Viking lander (in foreground). The surface is thought to be red from ferric iron.

INTRODUCTION

The Gaia hypothesis of James E. Lovelock holds that the surface temperature, chemistry of the reactive gases, redox state, and pH of Earth's atmosphere and surface sediments are homeorrhetically maintained by the metabolism, behavior, growth, and reproduction of living organisms. (Homeostasis is physiological regulation around a fixed set point, like control of adult mammalian body temperature around 37 °C, whereas homeorrhesis, a parallel concept, refers to regulation around a changing set point, like temperature regulation in a developing mammalian embryo.) The term "Gaia," the name of a daunting Greek goddess, is, in Lovelock's view, simply "a good four-letter word referring to the Earth." She is also "Ge" or "Gaea" (e.g., the Geos satellite, geology, geography, or in Pangea).

Gaian environmental regulation is achieved largely by the origin, exponential growth, and extinction of organisms, all related by ancestry and physically connected by proximity to the fluid phases (water and air) at Earth's surface. Organisms in communities form changing ecosystems that have persisted since the Archean. The interactions of organisms, driven by solar energy, produce and remove gases such that chemistry of non-noble gases, temperature, and alkalinity are actively maintained within limits tolerable to life.

Within this conceptual framework, biological as well as physical sciences become appropriate to the analysis of Earth's atmosphere and geologic history. Especially pertinent is the role of the microbiota (bacteria, protoctista, fungi) in Earth surface gaseous exchange that involves the recycling of those chemical elements (e.g., H, C, O, N, P, S) absolutely required by life.

TABLE 1. PLANETARY ATMOSPHERES

	Venus	Earth	Mars
Carbon dioxide (%)	98	0.03	95
Nitrogen (%)	1.7 (ve)	79	2.7 (vi)
Oxygen (%)	Tr (ve)	21	0.13 (vi)
Methane (%)	none	0.0000015	none
Water (m*)	0.003	3000	0.00001
Pressure (atm)	90	1	0.0064
Temperature (K)	750	290	220

* Depth of water in metres over the planet if all water vapor precipitated out of the atmosphere.

THE GAIA IDEA

Product of the lively imagination of a British atmospheric chemist and the international space program, the Gaia idea has come of age. The atmospheric composition of Earth signals unmistakably that the third planet is living: flanked by the dry, carbon dioxide–rich worlds of Mars and Venus, one invokes either physiological science or magic to explain Earth's wildly improbable, combustive, thoroughly drenched troposphere (Table 1). The Gaia hypothesis, in acknowledging this atmospheric disequilibrium (Margulis and Lovelock, 1974) has opted for physiology over metaphysics.

More than 25 years worth of scientific contribution is listed in Appendixes 1 and 2; many scientists are unaware of the extent of the serious literature and the potential contribution of the Gaia idea for integrating evolutionary, meteorological, sedimentological, and climatological data. Unfortunately, nonscientific Gaia literature (which tends to be anti-intellectual and hysterically toned "New-Age" commentary) has received so much press attention and contentious comment that much of the primary science remains unknown.

Despite the fact that an "Earth system science" approach is vigorously encouraged for the solid-earth sciences, mention of the G-word (Gaia) still causes apoplexy in some scientific circles. This is remarkable, considering the broad parallelism of these approaches to understanding Earth processes. The U.S. National Academy of Sciences (NAS) (1993) report on future directions of research in the solid-earth sciences advocates "A new approach to studying Earth processes, in which the Earth is viewed as an integrated, dynamic system, rather than a collection of isolated components" (statement by Frank Press in his introductory letter). This report calls for an understanding through integrated study of physical and biological processes and sees as desirable a process-oriented global approach to understanding Earth. Despite avoidance of the term, a gaian approach is advocated by the NAS.

The Gaia hypothesis, rejected by some as the fantasy of New Age crystal swingers, has been largely misunderstood by the scientific community. For example, George C. Williams (1992) perpetuates confusion by unconscionably maligning Gaia: "It [the idea that the universe is especially designed to be a suitable abode for life in general and for human life in particular] had to be abandoned in its earlier forms with the triumph of Copernican astronomy ... but some scholars still find it possible to argue that the Earth, at least, can be regarded as especially suited for human life.... [The] main modern manifestation [of this idea] is in the gaia concept of Lovelock and Margulis (1974)."

The Gaia hypothesis demonstrates how life sciences are essential to understanding Earth, while revealing the inadequacy of evolutionary theory developed in the absence of climatological and geological knowledge. The gaian viewpoint is not popular because so many scientists, wishing to continue business as usual, are loath to venture outside of their respective disciplines. At least a generation or so may be required before an understanding of the Gaia hypothesis leads to appropriate research.

VIKINGS OF '76

When the Viking mission to Mars returned its data, some members of the scientific community thought that "planetary biology" or "exobiology"

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were doomed because the absence of Martian life rendered them sciences with no object of study. Lovelock and his colleagues thought just the opposite: now that data from Mars were available, speculations comparing the planets could be replaced with knowledge. It became certain that the bleak Martian landscape is devoid of life (Fig. 1), whereas life is not only a planet-wide phenomenon but in today's Solar System living beings are limited to Earth's biosphere.

Gaia has been called "Goddess of the Earth," or the "Earth as a single living being." These are misleading phrases. Since much scientific work mentioning Gaia suffers from problems of misunderstood terminology, we offer this physiologically oriented statement of the Gaia hypothesis:

GAIA AS EARTH'S ECOSYSTEM PHYSIOLOGY

The Gaia hypothesis states that the chemical composition of the reactive gases and the temperature of Earth's atmosphere are biologically controlled. Certain features, e.g., the salinity and alkalinity of the hydrosphere, are moderated by the biota (flora, fauna, and microbiota) in that their range of variation is kept within tolerable limits. Over 30 million types of live beings, descendants from common ancestors and members of five kingdoms, produce and remove gases, ions, and organic compounds. Their collective activity results in regulation of Earth's temperature and aspects of its surface composition: pH, oxidation state, etc. The chemical reactions of a physiology (unlike those of a strictly physicochemical system) are moderated by metabolism and growth. Without life, surface properties of Mars, Earth, and Venus would be extremely similar: abundant in carbon-dioxide with a small proportion of gaseous nitrogen and very dry, reflecting their history, bulk composition, surface materials, proximity to the Sun, and interaction with solar radiation.

We reject the analogy that Gaia is a single organism, primarily because no single being feeds on its own waste nor, by itself, recycles its own food. Much more appropriate is the claim that Gaia is an interacting system the components of which are organisms. Nowhere is this more evident than in examples of biotic influence on important geological processes (Table 2; Westbroek, 1991).

The two landers and orbiters of the 1975–1976 Viking missions to Mars yielded data that complemented earlier Earth-based observations of that planet. Organic compounds were absent: the concentration of total organics if present must be less than one part per billion. The gas-chromatographic detection of oxygen was not due to life but to the release of O_2 from moistened peroxides, and the incorporation of radioactive CO_2 was due to cosmic radiation, including UV photochemistry, and not to photosynthesis. Once the reactants were spent, no new change was detected by these experiments. The conclusion is inescapable: no evidence exists for present life on Mars. The same is true of Venus.

As far as we know, the Gaia phenomenon is limited to Earth. Can it be extended by colonization of Mars? Comparison of Earth with Mars helps highlight both the nature of Gaia and implications of the idea for the study of Earth.

EXTRATERRESTRIAL GERMS

To prevent both lunar and Martian spacecraft from carrying microbes, "clean-room" techniques were applied. Even sterilization of the outside and much of the inside of the Viking spacecraft was undertaken. Ethylene oxide gas flooded the accessible components to assure microbial cleanliness; this increased the total cost of the Viking mission by about 10%. During the U.S. Apollo missions to the moon in the 1960s and 1970s, fears of possible "back-contamination" were rampant: extraterrestrial "germs" might "contaminate" Earth. This issue is sure to arise again if there is any future return of materials from Mars. Such fears seem silly, more a manifestation of pulp science fiction than a well-reasoned treatment of scientific probabilities.

Although investigators such as Rothschild (1990) have suggested that Martian life may still be found in oases, perhaps as permafrost bacteria or even as "endoevaporites" in isolated salt crystals, the chances of finding isolated life there are vanishingly small.

The Gaia hypothesis provided a framework for evaluation of Martian results. Life maintains its immediate environment and appears on Earth only as a planet-wide phenomenon. Life may have been sparse when it first appeared or may be sparse when it is dying out, as Lovelock emphasizes, but between these two end points life must be luxuriant. Why? Because of life's intrinsic tendency to grow, expand, and populate at exponential rates and its ability to travel. Therefore, a question of the 1990s is, Can life expand to

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TABLE 2. BIOLOGICALLY MEDIATED GEOLOGIC PHENOMENA

Example	Importance*	Lithospheric Reservoirs and Examples
1. Phosphorus cycle	Essential for all life: component of DNA and RNA nucleic acids and ATP and NADPH nucleotides; phospholipid membranes and the calcium phosphate of bones. Because phosphate is a major growth-limiting nutrient, the P cycle is completely biologically mediated. (Brock et al., 1982; Filipelli and Delaney, 1992)	Earth's crust (inaccessible to life) and deep-sea sediments; guano islands Atmospheric phosphine (PH_3) is negligible.
2. Calcium-carbonate deposition	Essential for formation of hard parts in shelled marine animals and many testate protoctists, e.g., foraminifera. Helps maintain pH balance in the oceans. As limestone, it is an important sink for CO_2.	Stromatolites Coral reefs Deep-sea carbonate ooze (foraminifera and coccoliths)
3. Organic matter deposition	Leads to development of anoxic conditions and CH_4 production, so that carbon is released to the atmosphere, thus preventing complete loss from the biosphere, leading to maintenance of elevated O_2 levels (Watson et al., 1978). Fossil fuels	Oil shale and other organic-rich shales Coal, peat, oil, tar sands
4. Methanogenesis	Atmospheric composition of Earth (e.g., presence of methane, ozone) is inexplicable in the absence of life. (Watson et al., 1978; Table 1)	Trapped natural gas, swamp and marsh gas Arthropod intestines Vertebrate rumen
5. Regolith consolidation	Unconsolidated sediments are bound by biotic communities, e.g., mucilage coating of bacterial mats. (Margulis and Stolz, 1983)	Mud Unlithified sediment
6. Erosion acceleration	Weathering rates increased by biologically mediated erosion, bacterial endoliths, fungal hyphae, plant roots, and lichens.	Lithosphere-atmosphere-hydrosphere interfaces
7. Microbially mediated mineral formation (biomineralization)	Genesis of important mineral deposits. Interpretation of modern and ancient environments.	Banded iron formation Witswatersrand gold deposits Bog iron Rock varnish Manganese nodules

*For references not in References Cited list, see Appendix 1 or 2.

Mars? This question, Can Mars be colonized?, is identical to that of, Can Gaia reproduce?

All organisms are connected through the atmosphere, and life as we know it on Earth is a global phenomenon, utterly dependent on sunshine. Hardy terrestrial forms such as halophiles or sulfur-loving acidophilic archaebacteria, ammonia-oxidizing chemolithotrophs or carbonate-precipitating stromatolite-forming cyanobacteria, are extremes connected to, and tolerated by, a ubiquitous planetary biota. There are no virtuoso individualists. Martian life, if present, would by analogy to Earth most likely be found in communities.

Although it is theoretically possible that subvisible life will be found in the nether reaches of Martian deserts, it remains far more likely that the Martian wasteland is as dead as it appears. If so, one scientific challenge is to enact in reverse the very process that was once so feared: to deliberately contaminate or, as is now said, to "seed" Mars with life from Earth.

ECOPOIESIS

The quest for life on Mars began (by telescope) long before the Viking missions, and it will not likely end with the deployment of rovers on the planet early in the next century. After acceptable confirmation that Mars is uninhabited, the next task might be to "seed" the red neighbor with propagules from Earth. (Many will justifiably argue that the resolution of more pressing Earth-based problems should be a far greater priority: curbing the human tendency to convert the surface of Earth to urban ecosystem or fostering and documenting the diversity of life.)

The first and perhaps most crucial task in making Mars habitable is to increase its surface temperature. Proposals for heating Mars have ranged from engineering dreams of melting the ice caps with giant orbiting mirrors or covering the surface with black lichens, to schemes of rocketing greenhouse chlorofluorocarbons (CFCs) into the atmosphere. Recent proposals tend to be more detailed and slightly more feasible, yet share with their forerunners a profound, simultaneous strength and weakness: although such schemes are ambitious enough to excite the imagination, making captivating layouts in popular science magazines, they are too grandiose and vague to be practical (Kluger, 1992).

For example, even if several millions of tons of new, UV-resistant CFCs could be produced annually in situ from the surface of Mars, leading to a release of carbon dioxide and to planetary temperatures of 22 °C, then what? Even if oceans appeared from ice trapped in the lower latitudes because a way had been found to return to the atmosphere the CO_2 now trapped in surface carbonates, what now? The density (and therefore livability) of a Martian atmosphere is probably intrinsically limited by the weakness of Mars's magnetic field. In the absence of magnetic deflection of solar wind a Martian atmosphere would quickly be ablated. Even if genetically engineered plants and microbes were created to produce oxygen and other gases at hitherto miraculous rates, it still could take, as Christopher McKay (NASA Ames Research Center) estimates, about a thousand years to build an atmosphere to stable levels of oxygen in carrier gases breathable by eukaryotic microbes, let alone humans.

Although the new science of geophysiology and the success of biotechnology with microorganisms may have incited us to fantasies of planetary design, colonizing Mars so that humans might walk in the open along its canyons remains a distant fantasy. One should distinguish here between ecopoiesis (Haynes, 1990, 1992; the inundation of a formerly uninhabited surface with viable living systems) and terraformation (McKay, 1987; the re-creation of Earth on another planetary surface). For the foreseeable future, ecopoiesis but not wholesale terraformation seems a possibility for Mars; the former is, however, a prerequisite for the latter (McKay et al., 1991). Ecopoiesis would not make Mars into an extraterrestrial paradise, so much as it would transform it into a global cesspool—colorful, perhaps, but rich in mephitic vapors. The early history of Earth, after all, and the present state of the gas giants in the outer Solar System are characterized by a chemistry that more resembles sewer gas than food. Though alien and inhospitable to mammals, these reduced sulfurous carbon-rich volatile compounds were crucial to the origin and early evolution of life.

The only dependable way to make a planetary surface livable may be to repeat the evolutionary colonization process that occurred on Earth, which began with hydrogen, methane, ammonia, formaldehyde, sulfides, nitriles, and simple sugars. Shortly after life appeared, noxious gas exchanges among anoxygenic phototrophic bacteria and their dependents ensued. Sped up on Mars, the outcome of a rushed and deliberate Martian colonization process is likely to be highly unpredictable—possibly even tragic.

Will we humans, Godlike, wave our wand? Do we really think, in our naivete, that strewing our scientific instrumentation over the red surface of Mars via robots in a geological wink of an eye will produce a New Blue Earth? Far more probably, Mars will be colonized slowly and gradually, and not by humanity but through humanity, facilitated by robots. For the foreseeable future it seems likely that the only human presence on Mars will be via the developing technology of telepresence. The landing of the two remote-sensing, remote-controlled, human-connected Viking landers in 1976 proves that the process of colonization has already begun. Unlike Neil Armstrong's epochal "one step for man, one giant leap for mankind," the ecopoiesis of Mars's surface has no instantly recognizable moment. The launch of human-built life detectors to Mars, the "telepresent" sensory cameras that radio their signals back to eager humans at mission control, space-crew first landings, early orbiting Mars stations, and the eventual habitation of the red surface by emigrants of a variety of species—all are part of a gradual process of ecopoiesis. All would be likely to occur haphazardly, with very little conscious planetary bioengineering.

The distinction between altering one's body to "adapt" to any inhospitable environment and altering the environment itself is largely specious from a gaian viewpoint. As organisms evolve, both their bodies and the environment change irreversibly. Such change occurs through technology, which is not a uniquely human phenomenon. Animate and inanimate nonhuman technologies abound, e.g., wasp nests, humidified and air-conditioned termite mounds, or the

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Cole Memorial Research Awards in Geomorphology and Micropaleontology

Through the generosity of W. Storrs Cole, two awards for support of research are offered through GSA. The Gladys W. Cole Memorial Research Award provides research support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. It is to be given to a GSA Member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology. Funds cannot be used for work already accomplished, but recipients of a previous award may reapply if additional support is needed to complete their work. The amount of this award in 1994 will be $7000.

The second award, the W. Storrs Cole Memorial Research Award, has been established to support research in invertebrate micropaleontology. This award will also carry a stipend of $7000 and will be given each year to a GSA Member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

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

All applications must be postmarked on or before February 15, 1994. Actions taken by the Committee on Research Grants will be reported to each applicant in early April.

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

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immense lithified limestone reefs fringing tropical islands.

GAIA'S PROPAGULES

Life packages its precious contents: production of heat-proof bacterial endospores, dinomastigote cysts, formation by trees of seeds and hardened fruits, rubbery eggs of snakes, or the tough eggcases of rays. Among the most remarkable of such propagules are the "tuns" of tardigrades or the salt-tolerant dust-like eggs of brine shrimp (Fig. 2).

To enable any Earthlings to dwell on the surface of Mars, bubblelike enclosures probably will be required that house a complexity of species in self-supporting recycling systems, in principle like the stated goals of the exorbitant Biosphere II project in Arizona's Sonoran desert. This incipient Earth-propagule (which "germinated" and released its contents in September 1993) contained eight "biospherians." The 17-acre facility allegedly was "materially closed" in the autumn of September 1991 to all but its enormous intake of external electrical power. It is clear that at present we are far from establishing any biospheres on Mars. The energy needed for the mere sustenance of any biospheres let alone their use as bases for any bio-industrial modification of the planet, will require on-site nuclear power. However, as soon as adequately closed artificial biospheres are established—e.g., to serve as base camps for CFC factories—global, terrestrial, biospheric Earth life will have de facto, if inconspicuously, colonized the surface of Mars.

Such an artificial biosphere, a radiation and desiccation-resistant form, is highly reminiscent of large-scale non-human evolutionary innovations far more continuous with the past than it seems at first glance. By packaging and miniaturizing the essentials for survival, life ventures out upon and ultimately makes a home for itself in formerly hostile terrain.

The ecopoiesis of Mars would likely be accomplished by interaction of many types of Earth organisms: bacteria, protoctists (mainly as algae), plants, and fungi will certainly play their roles. Indirectly, all life forms would be involved in planetary colonization, although at first multispecies bases will need to be constructed in an effort planned by exceedingly few, highly select, and passionately dedicated humans. Such bases are necessary to protect their inhabitants from an initially hostile external Martian world. Food plants must be grown and all wastes internally recycled.

That such enclosures of metal, glass, and plastic might be built by scientists, engineers, and other working people is hardly an argument for their absolute uniqueness: all previous technological advances in the evolution of life (e.g., silica fretwork of diatoms, calcium phosphate bone and teeth in vertebrates, lignification leading to great height in plants, and the chitinous exoskeletons of insects and crustaceans) involved more than a single type of life and were prerequisite to the adaptive radiation of their inventors into new and formerly hazardous realms.

Humans by no means have an "exclusive" on technology. Magnetite teeth in molluscs and wax synthesis by hymenopterans are technologies that preceded those of *Homo sapiens* by millions of years. Calcium phosphate teeth, barium sulfate gravitational sensors, and temperature- and humidity-controlled termite mounds were as much a prerequisite for cosmopolitan Cenozoic distribution of, say, rodents, charalean algae, and fungi-gardening termites as telephones and electric power are to human urban expansion. Silurian-Devonian emigration of life to the land, with its attendant problems of lack of support by water, depleted nutritional substrates, and its exposure to continuous solar UV radiation, demanded a dramatic repackaging of life's resources—an incorporation into bodies of what at one time could be found only "outside"—in the mineral environment (Sagan, 1992).

Such repackaging of living beings and their accoutrements might begin within recycling enclaves, "artificial biospheres." Above and beyond anything done later, the first of these bases on Martian terrain would already be colonization of Mars. Cosmic historians, in retrospect, might use establishment of such Martian base camps to date the reproduction of planetary life.

Such "artificial biospheres" might be recognizable not merely as a human technology but as an expansion and metamorphosis of Earth's original biosphere by members of all of the five kingdoms of life (Fig. 3). Gaia would have reproduced, challenging the objection of Doolittle (1981) that Gaia cannot be a life form because it is incapable of reproduction. Seen from afar, the settling of Mars would be akin to budding, a space-borne planting of a

Gaia *continued on p. 291*

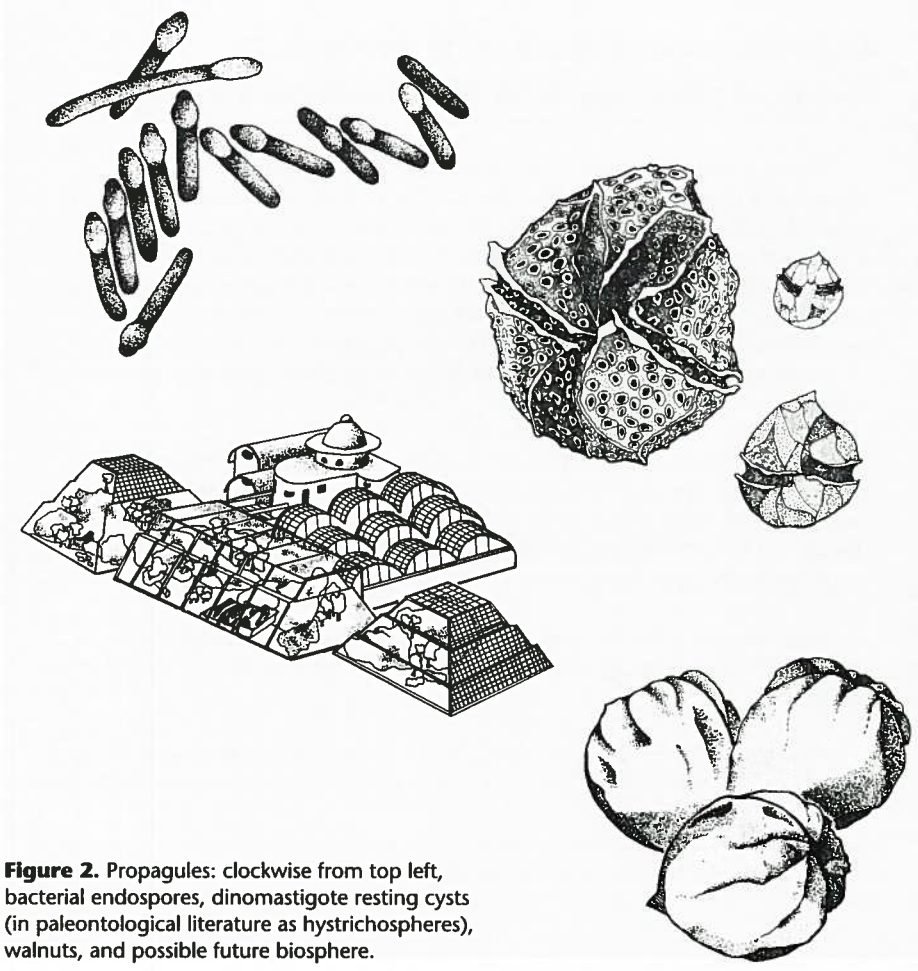

Figure 2. Propagules: clockwise from top left, bacterial endospores, dinomastigote resting cysts (in paleontological literature as hystrichospheres), walnuts, and possible future biosphere.

Figure 3. Five kingdom hand representing the major forms of life all connected through nearly four billion years of "Darwinian time" at Earth's surface ("Vernadskyian space"). In order of appearance (Ga—billion years ago) in the fossil record: Monera (Bacteria or prokaryotae, 3.9 Ga), Protoctista (algae, slime molds, ciliates and other microscopic eukaryotes and their larger descendants, 2 Ga), Animalia (egg-sperm embryo forming diploids, 0.75 Ga), Fungi (zygo-, asco-, basidiomycota, fungi imperfecti, and lichens that grow from fungal spores, 0.45 Ga), Plantae (bryophytic or tracheophytic haplodiploids that develop from maternally retained embryos, 0.45 Ga). This illustration is from the cover of *Five Kingdoms: An Illustrated Guide to the Phyla of Life* (second edition) by Margulis and Schwartz, 1988. (Available as a teaching unit from Ward's Natural History Establishment, Rochester, New York.)

WASHINGTON REPORT

Bruce F. Molnia

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

The National Performance Review: Reinventing Government. Will Federal Earth Sciences Be Reinvented Too?

"It is time to radically change the way the government operates—to shift from top-down bureaucracy to entrepreneurial government that empowers citizens and communities to change our country from the bottom up. We must reward the people and ideas that work and get rid of those that don't."

—Bill Clinton and Al Gore—Putting People First

This is the first of a pair of Washington Reports describing efforts by the Clinton Administration to reinvent government. Next month's Report will describe the new National Biological Survey.

Released on September 7, 1993, *From Red Tape to Results, Creating a Government that Works Better & Costs Less* is a 168-page report that summarizes the findings of the National Performance Review. The report presents about 500 recommendations, resulting from an intensive, 6-month-long study led by Vice-President Gore of the federal government that examined both agencies and crosscutting systems such as budgeting, procurement, and personnel. The report's title reflects the review's two goals: "moving from red tape to results and creating a government that works better and costs less." Unlike many past efforts that relied on nongovernmental consultants, hundreds of experienced federal employees were organized into teams to perform the review. Cabinet members were given the task of creating "Reinvention Teams" to lead transformations at their departments, and "Reinvention Laboratories" to begin experimenting with new ways of doing business.

How will the earth sciences fare in a reinvented government? A close look at the National Performance Review recommendations shows that few will have a direct impact on federal earth science, although a larger number could affect government science and research.

The review's vision of government is "one that works for people, cleared of useless bureaucracy and waste and freed from red tape and senseless rules." The report is organized into chapters, each corresponding to a principle necessary to make the vision succeed: (1) Cutting Red Tape, (2) Putting Customers First, (3) Empowering Employees to Get Results, and (4) Cutting Back to Basics: Producing Better Government for Less. The report states that it is the beginning of "what will be—what must be—an ongoing commitment to change." The review includes actions that can be taken now by directive of the President; actions that will be taken by the cabinet secretaries and agency heads; and recommendations for congressional action.

The National Performance Review recommendations and actions include 254 agency-specific recommendations (Appendix A), 130 recommendations affecting governmental systems (Appendix C), and more than 100 general recommendations and actions (presented in the body of the report). Governmental systems recommendations focus on creating quality leadership and management; streamlining management control; transforming organizational structures; improving customer services; mission-driven, result-oriented budgeting; improving financial management; reinventing human resource management; reinventing federal procurement; reinventing support services; reengineering through the use of information technology, rethinking program design; strengthening the partnership in intergovernmental service delivery; reinventing environmental management; and improving regulatory systems.

The focus of the review is "primarily on how government should work, not on what it should do." The report states, "Our job was to improve performance in areas where policymakers had already decided government should play a role." The review examined all 14 cabinet departments (Departments of Agriculture, Commerce [DOC], Defense, Education [ED], Energy [DOE], Health and Human Services, Housing and Urban Development, Interior [DOI], Justice, Labor [DOL], State, Transportation, Treasury, and Veterans Affairs) and ten agencies (Agency for International Development, Environmental Protection Agency [EPA], Executive Office of the President, Federal Emergency Management Agency, Intelligence Community, National Aeronautics and Space Administration [NASA], National Science Foundation [NSF], Office of Science and Technology Policy, Resolution Trust Corporation, and U.S. Information Agency).

A reading of the report reveals 20 performance review recommendations (presented in alphabetical order by agency name, no priority intended), which could affect the earth science community or science in general. These are: DOC05—Create Public/Private Competition for the National Oceanic and Atmospheric Administration (NOAA) Fleet; DOC12—Establish a Single Civilian Operational Environmental Polar Satellite Program under NOAA; ED05—Streamline and Improve the Department of Education's Grants Process; ED11—Build a Professional, Mission-driven Structure for Research; DOE05—Strengthen the Federal Energy Management Program; DOE06—Redirect Energy Laboratories to Post–Cold War Priorities; EPA10—Promote Quality Science for Quality Decisions; DOI01—Establish a Hard Rock Mine Reclamation Fund to Restore the Environment; DOI02—Redefine Federal Oversight of Coal Mine Regulation; DOI03—Establish a National Spatial Data Infrastructure; DOI05—Obtain a Fair Return for Federal Resources; DOI12—Create a New Mission for the Bureau of Reclamation; DOI14—Enhance Environmental Management by Remediating Hazardous Material Sites; DOL07—Redirect the Mine Safety and Health Administration's Role in Mine Equipment Regulation; DOL12—Partially Fund Mine Safety and Health Enforcement Through Service Fees; NASA02—Increase NASA Technology Transfer Efforts and Eliminate Barriers to Technology Development; NASA05—Clarify the Objectives of the Mission to Planet Earth Program; NSF01—Strengthen Coordination of Science Policy; NSF02—Use a Federal Demonstration Project to Increase Research Productivity; and NSF03—Continue Automation of NSF Research Support Functions.

National Performance Review reinventions would result in a 252,000-job reduction in the size of the civilian, nonpostal workforce (12%) during the next 5 years. This reduction, concentrated in the "structures of over-control and micromanagement that now bind the federal government: supervisors, headquarters staffs, personnel specialists, budget analysts, procurement specialists, accountants, and auditors," will bring the federal workforce below two million employees for the first time since 1967.

Enactment of the review recommendations would produce a federal government savings of $108 billion over 5 years: $40.4 billion from reducing the workforce and streamlining the bureaucracy; $36.4 billion from specific changes in the agencies and departments; $22.5 billion from systematic reform of the procurement process; $5.4 billion from consolidation and modernization of the information infrastructure; and $3.3 billion from simplifying paperwork and reducing administrative costs related to state and local government grant programs.

Washington Report will keep you posted about implementation of the National Performance Review and its future impact on the earth sciences.■

Principles of the National Performance Review

We will invent a government that puts people first, by:

- Cutting unnecessary spending
- Serving its customers
- Empowering its employees
- Helping communities solve their own problems
- Fostering excellence

Here's how. We will:

- Create a clear sense of mission
- Steer more, row less
- Delegate authority and responsibility
- Replace regulations with incentives
- Develop budgets based on outcomes
- Expose federal operations to competition
- Search for market, not administrative, solutions
- Measure our success by customer satisfaction

Dibblee Foundation Nominations Invited

The Thomas Wilson Dibblee, Jr., Geological Foundation (Dibblee Geological Foundation) has established the Dibblee Medal in recognition of the unique contributions of Tom Dibblee to the science of geologic mapping of California. The medal is to be awarded at least biennially to a geologist whose published geologic mapping is exceptionally noteworthy.

The award will consist of a sterling silver medal bearing the likeness of Tom Dibblee; and on the obverse side, a sketch map of California, the geology of which has been Tom's domain for 60 years. A plaque suitable for wall hanging will accompany the medal.

Nominations of candidates to be considered for award of the Dibblee Medal are now being solicited. Nominations should include the name of the candidate, biographical data, a description of the geologic mapping, and the names of at least two geologists who support the nomination. Mail each nomination and supporting data by March 1, 1994 to:

Dibblee Geological Foundation
Post Office Box 60560
Santa Barbara, California 93160

The first Dibblee Medal will be awarded at the meeting of the Pacific Section of AAPG in May 1994, at Ventura, California.

The Dibblee Foundation is a nonprofit corporation chartered in California in 1983 for the purpose of publishing Tom Dibblee's geologic mapping. To date, the Foundation has published 47 maps covering sixty-five 7½-minute quadrangle; several hundred more await publication.

GSA Grants Support Research

June Forstrom, Research Grants Administrator

General Grants

The purpose of the general research grants program is to provide partial support of master's and doctoral thesis research for graduate students at universities in the United States, Canada, Mexico, and Central America. Applicants need not be GSA members. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program.

To apply for one of these grants, you must fill out an application form, which is available from GSA Campus Representatives at geology departments in the United States and Canada, or from GSA headquarters (Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140). Evaluations from two faculty members are required on GSA appraisal forms. The deadline for applications for the 1994 research grants program is *February 15, 1994*. Applications must be submitted on 1994 forms. The GSA Committee on Research Grants evaluates all applications and chooses those to be funded at its early spring meeting at GSA headquarters. Grants are awarded in April. In 1993, 575 proposals were received; 178 of them were funded. A total of $257,882 was awarded; the average amount awarded was $1449; the largest grant was $2200.

Specialized Grants

Recipients of special awards are selected by the Committee on Research Grants from applicants to the general research grants program; the same application forms are used, and they must also be postmarked by *February 15*. It is not necessary for applicants to indicate that they wish to be considered for a specialized grant. The committee considers all qualified applicants when selecting recipients for special awards.

The Gretchen L. Blechschmidt Award was established to support research by women interested in achieving a Ph.D. in the geological sciences and a career in academic research. Special consideration may be given to women whose proposals are (1) in the fields of biostratigraphy and/or paleoceanography and (2) who have an interest in sequence stratigraphy analysis, particularly in conjunction with research into deep-sea sedimentology.

The aim of the John T. Dillon Alaska Research Award is to support scientific research that addresses earth science problems particular to Alaska. Special consideration may be given to students whose proposals are (1) field-based studies dealing with the structural and tectonic development of Alaska, and (2) studies that include some aspect of geochronology (either paleontologic or radiometric) to provide new age control for significant rock units in Alaska. Candidates with other objectives in Alaskan earth science research will also be considered.

The Robert K. Fahnestock Memorial Award is made annually to the applicant with the best application in the field of sediment transport or related aspects of fluvial geomorphology.

The Harold T. Stearns Fellowship Award is awarded annually in support of research on one or more aspects of the geology of Pacific islands and of the circum-Pacific region.

Division Grants

Seven of the 12 GSA divisions award grants for outstanding student research within the respective division's field of interest. The Committee on Research Grants will select candidates from the general research grant applicants for awards by the Engineering Geology, Geophysics (Allan V. Cox Award), Hydrogeology, Sedimentary Geology, and Structural Geology and Tectonics divisions.

The Coal Geology Division awards the Antoinette Lierman Medlin Scholarship Award annually to the full-time graduate or undergraduate student who submits the best proposal of a research project in the field of coal geology. Detailed guidelines are available from the division secretary, Cortland F. Eble, Kentucky Geological Survey, 228 Mining & Minerals Resources Bldg., University of Kentucky, Lexington, KY 40506-0107. The recipient of the award is announced in the fall.

The Quaternary Geology and Geomorphology Division established its J. Hoover Mackin Research Grants in 1974 to support graduate student research on Quaternary geology or geomorphology. Applications for this grant are available from the secretary of the division, Deborah R. Harden, Dept. of Geology, San Jose State University, San Jose, CA 95192-0102. The deadline for applications for 1994 is *February 15, 1994*. Grant awardees are announced in April.

Five GSA divisions—Archaeological Geology, Geoscience Education, History of Geology, International, and Planetary Geology—do not currently award grants for student research.

Section Grants

Recipients for research grants from the South-Central Section are selected from applicants to the GSA general research grants program who are recommended by the Committee on Research Grants to the Management Board of the South-Central Section for final selection. Eligibility is restricted to graduate students attending a college or university within the geographic area of the South-Central Section.

The South-Central Section also awards grants to undergraduate students; applications for these awards are available from the section secretary, Rena M. Bonem, Department of Geology, Baylor University, P.O. Box 97354, Waco, TX 76798-7354. Undergraduate student recipients are selected by the Management Board of the South-Central Section. The deadline for undergraduate applications is *October 15;* the grants are awarded in late December.

The North-Central Section awards grants to undergraduate students within the geographic boundary of the section. For further information contact the section secretary, George R. Hallberg, Iowa Department of Natural Resources,109 Trowbridge Hall, University of Iowa, Iowa City, IA 52242.

The Southeastern Section awards grants for both undergraduate and graduate GSA Student Associates who are enrolled in an institution within the geographical boundaries of the section. The grants are competitive. Application forms can be obtained from the section secretary, Michael J. Neilson, Department of Geology, University of Alabama, Birmingham, AL 35294. The deadline for 1994 applications is *February 15, 1994*. The grants will be awarded in April.

The remaining three sections—Northeastern, Rocky Mountain, and Cordilleran—do not currently offer research grants. ■

About People

U.S. Geological Survey Meritorious Service Awardees in the Denver area this year include GSA Fellow **Fred Barker**, Fellow **Robert W. Fleming**, Fellow **Robert M. Kosanke**, and Member **Gary W. Winkler.** Member **Anthony B. Gibbons** and Fellow **Dwight L. Schmidt** received Superior Service Awards. All the awaredees are at the USGS in Denver, Colorado. Recipients of the award at the USGS in Reston are GSA Fellow **Charles G. Cunningham**, Fellow **Albert J. Froelich** (posthumous), Fellow **William A. Oliver, Jr.**, Fellow **James P. Owens**, and Fellow **Henry R. Spall.**

Maria Luisa Crawford, Bryn Mawr College, Bryn Mawr, Pennsylvania, has been awarded a $320,000 grant by the MacArthur Foundation's Fellows Program.

The University of Nanjing, Nanjing, China, has presented GSA Fellow **Michel T. Halbouty**, Houston, Texas, with an Honorary Professorship in Geology.

GSA Fellow **Haydn Murray**, Indiana University, was elected president of the Association Internationale pour l'etude des Argiles at the 10th International Clay Conference in Adelaide, Australia.

GSA member **Jill S. Schneiderman**, Pomona College, Claremont, California, has recived Pomona's 1993 Wig Distinguished Teaching Award.

James F. Quinlan Named 1994 Jahns Lecturer

James F. Quinlan has been selected as the Richard H. Jahns Distinguished Lecturer in Engineering Geology for 1994. Quinlan's lecture will be "Principles of Groundwater Monitoring in Carbonate Aquifers: How It Is Done and How It Should Be Done." He is president of Quinlan & Associates, a Nashville, Tennessee, consulting firm specializing in evaluating the hydrogeology of carbonate aquifers. He was research geologist for the National Park Service at Mammoth Cave, Kentucky, for 16 years. He earned a B.S. degree in geology at Virginia Polytechnic Institute (1959) and a Ph.D. degree in geology at the University of Texas at Austin (1978). His field and consulting experience includes six years in uranium exploration, development, and mining, and more than 35 years of research and observations in karst terranes in more than 25 countries and 25 states. He has run or directed more than 600 dye traces in the Mammoth Cave region and in various states. His field experience includes environmental applications of dye tracing, evaluation of waste-disposal sites in limestone terrains, design of ground-water monitoring networks, and analysis and remediation of sinkhole development. He has written or co-written more than 190 publications on karst-related topics and is often called to testify as an expert witness. For one of the papers concerning procedures for monitoring ground water in karst terranes, he and his co-author Ralph Ewers received the 1986 E.B. Burwell Award from the Engineering Geology Division of the Geological Society of America.

Those interested in inviting James Quinlan to present his lecture at their institutions are encouraged to contact him directly at the following address and phone number:

P.O. Box 110539
Nashville, TN 37222
(615) 833-4324

The travel funds provided for the Jahns Lecturer are extremely limited. Therefore, institutions able to supplement travel expenses are encouraged to do so.

The Jahns Award, established in 1988, is cosponsored by the Engineering Geology Division and the Association of Engineering Geologists to provide funding for a distinguished engineering geologist to present an annual series of lectures at academic institutions in order to increase student awareness about careers in engineering geology. Quinlan joins a group of distinguished engineering geologists who have receieved the Jahns Award: James E. Slosson (1989), Robert L. Schuster (1990), Ellis L. Krinitzsky (1991), Barry Voight (1992), and Roy J. Shlemon (1992). ■

Smithsonian Offers Research Fellowships

Smithsonian Institution research fellowships for 1993–1994 include the fields history of science and technology, anthropology, biological sciences, and earth sciences.

Smithsonian Fellowships are awarded to support independent research in residence at the Smithsonian in association with the research staff and using the institution's resources. Under this program, senior fellowships of three to twelve months, predoctoral and postdoctoral fellowships of three to twelve months, and graduate student fellowships of ten weeks are awarded.

Earth Sciences: meteoritics; mineralogy; paleobiology; petrology; planetary geology; sedimentology; and volcanology.

History of Science and Technology: history of agriculture; air and space; computers, communication, and society; electrical technology; engineering; industrial archaeology; mathematics; medicine and pharmacy; natural history; physical sciences; social dimensions of science and technology; and transportation.

Anthropology: archaeology; cultural anthropology; folklife; linguistics; and physical anthropology.

Biological Sciences: animal behavior and pathology; ecology; environmental studies; evolutionary biology; marine biology; natural history; paleobiology; systematics; and tropical biology.

Deadline for proposals is
January 15, 1994.

Postdoctoral Fellowships are offered to scholars who have held the degree or equivalent for less than seven years. *Senior Fellowships* are offered to scholars who have held the degree or equivalent for seven years or more. The term is 3 to 12 months. Both fellowships offer a stipend of $25,000 per year plus allowances. *Predoctoral Fellowships* are offered to doctoral candidates who have completed preliminary course work and examinations. The term is 3 to 12 months. The stipend is $14,000 per year plus allowances. Predoctoral, postdoctoral, and senior stipends are prorated for periods of less than twelve months. *Graduate Student Fellowships* are offered to students to conduct research in association with research staff members of the Smithsonian. Students must be formally enrolled in a graduate program of study, have completed at least one semester, and not yet have been advanced to candidacy if in a Ph.D. program. The term is 10 weeks; the stipend is $3000.

Awards are based on merit. Smithsonian fellowships are open to all qualified individuals without reference to race, color, religion, sex, national origin, age, or condition of handicap of any applicant.

For more information and application forms, write to Smithsonian Institution, Office of Fellowships and Grants, 955 L'Enfant Plaza, Suite 7000, Washington, DC 20560. Indicate the particular area in which you propose to conduct research and give the dates of degrees received or expected.

Smithsonian Minority Internship Program

Internships, offered through the Office of Fellowships and Grants, are available for students to participate in research and museum-related activities for periods of nine to twelve weeks during the summer, fall, and spring. U.S. minority undergraduate and graduate students are invited to apply. The appointment carries a stipend of $250 per week for undergraduate and $300 per week for graduate students, and may provide a travel allowance.

Deadlines: For Summer (to begin after June 1): February 15;
for Fall (to begin after September 1): June 15;
for Spring (to begin after January 1): October 15.

For applications and/or information, write to Smithsonian Institution, Office of Fellowships and Grants, 955 L'Enfant Plaza, Suite 7000, Washington, DC 20560.

Preliminary Announcement and Call for Papers

NORTH-CENTRAL SECTION, GSA 27th Annual Meeting

Kalamazoo, Michigan
April 28–29, 1994

The North-Central Section of the Geological Society of America will meet in the Fetzer Business Development Center and Rood Hall on the campus of Western Michigan University in Kalamazoo, Michigan. The meeting will be hosted by the Department of Geology, College of Arts and Sciences, WMU. Societies that will meet in conjunction with North-Central GSA include the East-Central Section of the National Association of Geology Teachers, the Great Lakes Section of the SEPM (Society for Sedimentary Geology), the Pander Society, and the North-Central Section of the Paleontological Society.

CALL FOR PAPERS

Technical sessions will include all topics listed on the GSA abstract form. Papers, poster sessions, theme sessions, and symposia on these and other subject areas (including all symposia listed below) are solicited. Special sessions focused on specific themes or subjects will also be arranged by the local program committee after review of the abstracts. The time allotted for the oral presentations will be 15 minutes followed by 5 minutes for discussion. In keeping with the intentions of GSA to broaden its focus and membership, sessions on environmental geology and hydrogeology will be showcased at the meeting. Submission of papers by professional hydrogeologists is encouraged. A special symposium is also planned for K–12 teachers to address the use of math in earth-science teaching.

REGISTRATION

Preregistration Deadline: April 5, 1994

Preregistration by mail will be handled by the Office of Conferences and Institutes, Western Michigan University, Kalamazoo, MI 49008. On-site registration will be held in the Fetzer Business Development Center on Wednesday, April 27, 4:00 p.m., on Thursday, April 28, 7:30 a.m.–5:00 p.m., and on Friday, April 29, 7:30–11:30 a.m.

Preregistration fees will be $45 for professional GSA members, or members of associated societies participating in this meeting, and $15 for student associates. For those not affiliated with GSA or the associated societies, preregistration will be $50 for professionals and $20 for students. On-site registration fees will be $10 more for professionals and students. Please take advantage of the lower registration fees and register by April 5.

SYMPOSIA

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

1. **Devonian of Eastern North America.** William B. Harrison III, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5488; and James E. Day, Dept. of Geography-Geology, Illinois State University, Normal, IL 61761, (309) 438-7649.
2. **Modern and Recent Coastal Processes in the Great Lakes Region.** David A. Barnes, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5493.
3. **The Biological Basis of Taphonomic Patterns. Paleontological Society Symposium.** Danita Brandt, Dept. of Geological Sciences, Michigan State University, East Lansing, MI 48824, (517) 355-4626.
4. **Controls on the Development of Ground-Water Contaminant Plumes.** Duane Hampton, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5496.
5. **MEARTH (Math in Earth Sciences).** Marian Smith, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-3756.
6. **Aquifer Systems of the Great Lakes Region.** (Annual Symposium of the Great Lakes Section—SEPM). David B. Westjohn, U.S. Geological Survey, Water Resources Division, 6520 Mercantile Way, Suite 5, Lansing, MI 48911, (517) 377-1627.
7. **Integration of Geosciences, Engineering and Land Use Planning Principles to Maximize Environmental Capabilities.** *Sponsored by the Institute for Environmental Education.* William Davidson, BLDI, 2 Fountain Place NE, Suite 350, Grand Rapids, MI 49503, (616) 459-3737; and Ken Detlof, Wilkins and Wheaton Environmental Services, Inc., 169 Portage Road, Kalamazoo, MI 49008, (616) 345-1158.
8. **Geophysical and Tectonic Studies of the Eastern Arm of the Mid-Continent Rift.** William A. Smith, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5497, E-mail: smith@gw.wmich.edu, and Ernest C. Hauser, Institute for the Study of the Continents, Snee Hall, Cornell University, Ithaca, NY 14853-1504, (607) 265-4316, E-mail: hauser@geology.cornell.edu.
9. **Geology and Hydrogeology of Glacial Outwash Systems.** Gordon Fraser, Indiana Geological Survey, 611 N. Walnut Grove, Indiana University, Bloomington, IN 47405, and W. Thomas Straw, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5485.
10. **Aquifer Restoration and Remedial Action.** Paul Daniels, BLDI, 2 Fountain Place NE, Suite 350, Grand Rapids, MI 49503, (616) 459-3737.
11. **Geophysical Applications to Environmental Problems.** William A. Smith and Estella Atekwana, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5497, E-mail: smith@gw.wmich.edu.
12. **Geology and Tectonics of the Precambrian Lake Superior Region.** William J. Gregg, Dept. of Geological Engineering, Geology and Geophysics, Michigan Technological University, Houghton, MI 49931-1295, (906) 487-2795, and Stephen D. Stahl, Dept. of Geology, Central Michigan University, Mount Pleasant, MI 48859, (517) 774-3179.
13. **The National Park System and Informal Geology Education in the Great Lakes States.** Robert Corbett, Dept. of Geography-Geology, Illinois State University, Normal, IL 61761, (309) 438-7649; and Barbara Manner, Dept. of Physics and School of Education, Duquesne University, Pittsburgh, PA 15282.

SHORT COURSES

1. **Devonian Strata of the Michigan Basin: A Core Workshop.** William B. Harrison III, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5488.
2. **Environmental Geophysics.** William A. Sauck, William A. Smith, Estella Atekwana, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-4991.
3. **Hydrocarbon Monitoring and Recovery.** Duane Hampton, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5496.
4. **Building Ground-Water Flow Models.** Richard N. Passero, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5502.
5. **Environmental Hydrogeology.** Eric Eslinger, Alpha Earth, Inc., 20 Sussex Road, Glenmont, NY 12077, (518) 439-8447. Sponsored by SEPM and the Great Lakes Section of SEPM.

FIELD TRIPS

The Field Trip Coordinator is John Grace, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5494.

Premeeting

1. **Modern and Recent Coastal Processes of Lake Michigan.** David A. Barnes, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5493.
2. **Hydrogeology and Wetlands Hydrology of Southwest Michigan.** Richard N. Passero and W. Thomas Straw, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5485.
3. **Geology of the Kentland Structural Anomaly, Northwestern Indiana.** Shanaka L. de Silva, Dept. of Geology and Geography, Indiana State University, Terre Haute, IN 47809, (812) 237-2269.

Postmeeting

4. **Glacial Geology of the Grand Valley, Michigan.** Grahame J. Larson, Dept. of Geological Sciences, Michigan State University, East Lansing, MI 48824; Alan E. Kehew, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5495; and Norman Ten Brink, Dept. of Geology, Grand Valley State University, Allendale, MI 49401, (616) 895-3210.
5. **Classic Silurian Reefs of the Chicago Area.** Don Mikulic and Joanne Kluessendorf, Illinois State Geological Survey, 615 E. Peabody Dr., Champaign, IL 61820, (217) 244-2518.

POSTER SESSIONS

We strongly encourage student and professional members to take advantage of this highly effective means of communication. Please indicate Poster Session on the GSA Abstract form. Each poster booth will provide three 4' x 4' boards arranged at table height. Poster sessions will be located in the same vicinity as the exhibits and will be available for viewing for one-half day.

ABSTRACTS

Abstracts must be submitted camera-ready on official GSA abstract forms in accordance with instructions on the forms. Abstract forms are available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-8850, or from Ronald B. Chase, GSA North-Central Section Program Coordinator, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008. Forms are also available from GSA Campus Representatives at most colleges and universities.

ABSTRACTS DEADLINE: January 6, 1994.

Send one original and five copies to Ronald B. Chase, GSA Program Coordinator, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008. Abstracts submitted for inclusion in symposia should be sent directly to the symposium organizer.

All abstracts will be reviewed for informative content, proper format, and originality. Authors will be notified of acceptance well in advance of the meeting.

STUDENT PAPERS AND TRAVEL ASSISTANCE

The North-Central Section of GSA will award $75 for each of the eight best papers whose principal author and presenter is a graduate or undergraduate student. Abstracts submitted for these awards should be clearly indicated. In addition, awards for travel assistance will be made to students who are members of the GSA North-Central Section as of January 1994. To receive a travel grant, the student must present at the meeting a paper (oral or poster) of which he or she is the author or co-author. Applications for travel assistance awards may be obtained by writing the General Chair, Alan E. Kehew, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5495. Applications must be received by *February 15, 1994.*

PROJECTION EQUIPMENT

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

BUSINESS MEETING

The GSA North-Central Section Management Board will hold its business meeting with breakfast in the Fetzer Business Development Center on April 28, 1994, at 7:00 a.m.

EXHIBITS

Exhibits of educational and commercial organizations will be on display in the Fetzer Center in proximity to the symposia, technical, and poster sessions. Exhibit space must be reserved by January 7, 1994. For further information, contact William A. Smith, GSA Exhibits coordinator, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5497.

SOCIAL EVENTS

A welcoming reception will be held on the evening of Wednesday, April 27, 1994, in the Fetzer Business Develop-

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North-Central *continued from p. 284*

ment Center. On Thursday evening, April 28, the annual banquet will be held at the Fetzer Center, preceded be a social hour beginning at 6:00 p.m. The banquet address will be given by William S. Fyfe of the University of Western Ontario.

A variety of spouse and guest activities will be available for attendees of the meeting. Full details will be included in the final announcement.

The Great Lakes Section of SEPM and the North-Central Section of the Paleontological Society will hold a joint luncheon on Thursday, April 28, in Fetzer Center. On Friday, April 29, the National Association of Geology Teachers and the GSA North-Central Education Committee will have a joint luncheon. The North-Central GSA Campus Representatives will hold a breakfast on Friday, April 29, in the Fetzer Center at 7:00 a.m.

HOUSING

Rooms will be available at several local motels and hotels. Budget accommodations will also be available in dorm rooms on campus. A variety of restaurants are located within easy walking distance of the meeting both on and off campus.

TRAVEL ARRANGEMENTS

Western Michigan University is located near the junction of U.S. Route 131 and I-94. Kalamazoo is served by several commercial airlines, Amtrak, and bus lines. Shuttle service will be provided between participating motels and the campus.

DETAILED INFORMATION

All functions of the meeting will be held in the Fetzer Business Development Center and Rood Hall on the WMU campus. Information concerning registration, hotel accommodations, and other activities will appear in the February 1994 issue of *GSA Today* and in the North-Central Section *Abstracts With Programs* for 1994. Symposia and field trips listed for this meeting are in the planning stages, and further suggestions are welcome. Inquiries, additional information, requests, or suggestions should be directed to Alan E. Kehew, GSA General Chair, Dept. of Geology, Western Michigan University, Kalamazoo, MI 49008, (616) 387-5495, fax 616-387-5513. ■

Preliminary Announcement and Call for Papers

ROCKY MOUNTAIN SECTION, GSA Annual Meeting

Durango, Colorado
May 4–6, 1994

The Rocky Mountain Section of the Geological Society of America will hold its 1994 meeting, together with the Rocky Mountain Section of the Paleontological Society of America and the Southwest Section of the National Association of Geology Teachers, near Durango, Colorado. The meeting is being hosted by the Department of Geology, Fort Lewis College.

SETTING

The meeting will be held at the Tamarron Resort, 18 miles north of Durango, Colorado. Tamarron, one of Colorado's premier resorts, offers lodging and a wide range of facilities and services for the visitor as well as superb conference facilities for the meeting. The historic town of Durango, to the south, has a variety of restaurants and other attractions.

Tamarron is located at an elevation of 7500 feet in a beautiful mountain valley carved by the Animas River and Pleistocene Animas Valley glaciers. Several 14,000+-foot peaks of the Needle Mountains of the San Juans lie to the east, the Silverton caldera and historic Silverton are to the north, and the rampart of the Hermosa cliffs beyond which are the La Plata Mountains, lie to the west. To the south, the boundary between the Southern Rocky Mountains and the San Juan Basin of the Colorado Plateau is marked by prominent hogbacks developed on resistant sandstones deposited in the Late Cretaceous interior sea.

The weather in early May should be warm and springlike, with daily temperatures in the 60s and 70s (°F) and overnight lows in the 30s and 40s. Mountain weather is notoriously unpredictable, however, so the May visitor should come prepared for anything, including the last blizzard of the winter!

Tamarron can be easily reached by automobile via US Route 550. The Durango–La Plata County Airport is serviced by United Express, Continental Express, America West Express, and Mesa Airlines, with connections to Denver, Phoenix, and Albuquerque.

CALL FOR PAPERS

Papers are invited for presentation in oral technical sessions, symposia, and poster sessions. Papers dealing with all aspects of Rocky Mountain geology as well as those of general geologic interest will be considered for presentation and discussion. Technical sessions will allow 15 minutes for presentation and 5 minutes for discussion. Poster sessions will be set up for 4 hours; authors should be present to discuss their papers for a minimum of 2 hours. Conveners of symposia, together with the technical program chairman, are responsible for determining the format of their sessions. Abstracts not accepted for symposia will be considered for regular technical sessions.

REGISTRATION

Preregistration deadline: March 25, 1994

For lower registration fees and to assist the local committee in planning, please preregister.

Preregistration will be handled by GSA headquarters. Registration forms will appear in the February 1994 issue of *GSA Today.*

FIELD TRIPS

Both premeeting and postmeeting field trips are planned, and, in addition, a self-guided walking tour of the geology of the Tamarron area is being prepared. For details, contact the appropriate field trip leaders. General questions should be addressed to John A. Campbell, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7475. Preregistration forms will be available in the Final Announcement In the February 1994 issue of *GSA Today.*

Premeeting

1. **High-resolution Sequence Stratigraphy of the Mixed Carbonate–Siliciclastic–Evaporite Depositional System Containing the Giant Aneth Oil Field, Paradox Basin, Southeast Utah.** May 1–3. L. James Weber, J. F. (Rick) Sarg, Frank M. Wright, and A. Curtis Huffman, Jr. Contact A. Curtis Huffman, Branch of Sedimentary Processes, U.S. Geological Survey, M.S. 939, Box 25046, DFC, Denver, CO 80225.
2. **Permian-Triassic Depositional Systems, Paleogeography, Paleoclimate, and Hydrocarbon Resources in Canyonlands, Utah.** April 30–May 3. Russell F. Dubiel, John D. Stanesco, and Jaqueline E. Huntoon. Contact Russell F. Dubiel, Branch of Sedimentary Processes, U.S. Geological Survey, M.S. 939, Box 25046, DFC, Denver, CO 80225.

Postmeeting

3. **Proterozoic Geology of the Western and Southeastern Needle Mountains, Colorado.** May 7–8. David A. Gonzales, Clay M. Conway, and Jack A. Ellingson. Contact David A. Gonzales, Isotope Geochemical Laboratory, University of Kansas Center for Research, 2291 Irving Hill Drive, Campus West, Lawrence, KS 66045-2969.

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Reminders

CALL FOR NOMINATIONS

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

Officers and Councilors

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

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

Penrose and Day Medals, and Honorary Fellowship

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

Young Scientist Award (Donath Medal)

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

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

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

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

Distinguished Service Award

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

National Awards

The deadline is **April 30, 1994,** for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award

BOOK REVIEWS

Geology and Tectonics of the Karakoram Mountains. *M. P. Searle. John Wiley & Sons, Chichester, England, 1991.*

Until recently, it has been popular practice to refer to the Himalayan-Karakoram orogen of central Asia as a "simple" mountain belt. I am convinced that the proponents of this view have been fooled into their beliefs because most of the geological research in this part of the world has been concentrated in a handful of relatively accessible transects in widely separated areas. In comparing the results, we tend naturally to emphasize superficial similarities rather than important differences. The challenge for the future is to understand these differences, but it is often difficult to do so because a researcher in one part of the orogen may find it impossible to evaluate all the work done in another area; more often than not, this research will have been published in the "gray literature" in several languages, and the locations of critical features will be referred to in phrases like "two kilometers south of the bridge at Pandrikot" when the bridge in question was washed away in the spring floods five years ago. It is thus a welcome event when someone undertakes the daunting task of drawing together the collective knowledge about a well-studied part of the orogen. In his new book *Geology and Tectonics of the Karakoram Mountains,* Mike Searle has provided an important resource for those geologists interested in central Asia.

The first part of the book (three chapters, 52 pages) is devoted to placing the Karakoram Range into a regional context. This short section alone is reason enough to read the book; in my opinion, it is the best written introduction to the Himalayan-Karakoram orogen currently available. Part Two (seven chapters, 186 pages) is the "meat" of the book; it constitutes a detailed review of the bedrock geology of the Greater Karakoram. Surficial processes and neotectonic activity are the subjects of Part Three (two chapters, 50 pages). Finally, Part Four (two chapters, 57 pages) is aimed at combining currently available information into an internally consistent model of the tectonic evolution of the Karakoram Mountains.

The recent explosion of information about the Himalayan-Karakoram orogen makes any review of existing knowledge a difficult proposition, but Searle has done an admirable job in Part Two of this book. References to papers published as recently as 1991 indicate a special effort to make the text as up-to-date as possible. Some of the material in Part Two had not been published previously; this includes geochemical data from unpublished theses, as well as petrologic and geochronologic data obtained by Searle and co-workers. Searle seems torn between the need to present these data and the necessity of keeping the presentations short to avoid undue emphasis. The result is that the quality of writing in Part Two is more uneven than in other sections of the book. I have to applaud Searle for including these data, many of which may not have been published otherwise. However, I am disappointed that so little detail is provided in some instances; for example, tables of isotopic ages are of limited value if not accompanied by the actual data or, at the very least, a map showing sample localities! I hope that the appearance of this material in abbreviated form in this book will not discourage more thorough treatments in other forums.

These concerns aside, the book is a pleasure to read. Beyond his scholarly interests, Searle obviously loves the mountains of central Asia, and his writing is infused with enthusiasm. The large format used for this book permits the inclusion of many detailed maps and spectacular black-and-white photographs. A well-done, 1:250 000 color map of the central Karakoram (complete with topography) is included in the slipcase. Beautifully detailed and exceptionally well written, *Geology and Tectonics of the Karakoram Mountains* represents a landmark in our understanding of the Karakoram, and it deserves a wide readership.

Kip Hodges
Massachusetts Institute of Technology
Cambridge, MA

To Interpret the Earth: Ten Ways To Be Wrong. *Stanley A. Schumm. Cambridge University Press, Cambridge, UK, 1991, 133 p., $24.95.*

The words of H. L. Fairchild, published in the *Geological Society of America Bulletin,* are even more telling today than in 1904: "Geologists have been too generous in allowing other people to make their philosophy for them." Stanley A. Schumm, contribu-

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4. **Upheaval Meteorite Impact Crater and Roberts Rift Natural Hydraulic Fracture, Canyonlands, Utah.** May 6–8. Peter Huntoon and H. Jay Melosh. Contact Peter Huntoon, Dept. of Geology and Geophysics, University of Wyoming, Laramie, WY 82071.
5. **Late Paleogene Geology and Paleoenvironments of Central Colorado.** May 6–8. Emmett Evanoff, Kathryn Gregory, and Daniel Larsch. Contact Emmett Evanoff, University of Colorado Museum, Campus Box 315, University of Colorado, Boulder, CO 80309-0315.
6. **Overview of the Stratigraphy, Structure, and Ore Deposits of the Ouray (Uncompahgre) Mining District, Colorado.** May 7. Tom Westervelt and John Trujillo. Contact Tom Westervelt, Dept. of Geology, Fort Lewis College, Durango, CO 81301.
7. **Geology of the Animas Valley—Durango to Silverton.** *For secondary school teachers.* May 7. Robert W. Blair, Jr., Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7263.
8. **Geology of the Animas River—***Durango to Silverton via the Durango and Silverton Narrow Gauge Railroad.* May 7. John A. Campbell, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7475.

SYMPOSIA

The following symposia will include both invited papers and selected volunteered papers. Prospective authors are encouraged to contact the respective conveners. General questions should be addressed to Jack A. Ellingson, Dept. of Geology, Fort Lewis College, Durango CO 81301, (303) 247-7244.

1. **Volcanoes, Sequoias, and Tsetse Flies: Geology and Paleontology of the Florissant Area.** Emmett Evanoff and Kathryn Gregory, Hunter Building, Campus Box 315, University of Colorado, Boulder, CO 80309, (303) 492-8069.
2. **Use of Soils in Rocky Mountain Geology.** Peter Birkeland and Ralph Shroba, Dept. of Geological Sciences, Campus Box 250, University of Colorado, Boulder, CO 80309, (303) 492-8141.
3. **Geology of the Paradox Basin.** Curtis Huffman, Jr., U.S. Geological Survey, Box 25046, M.S. 939, DFC, Denver, CO 80225, (303) 236-1543.
4. **Boundaries and Provinces in the Proterozoic of the Southwestern United States.** Clay Conway, U.S. Geological Survey, 2255 N. Gemini Dr., M.S. 9320, Flagstaff, AZ 86001, (602) 556-7199.
5. **Geology of the Gunnison, Colorado Country.** Richard Mauger, Dept. of Geology, East Carolina University, Greenville, NC 27858, (919) 757-6016.
6. **Coal Bed Methane and the Cretaceous Geology of the Four Corners Area.** Dale Nations, Dept. of Geology, Box 4099, Northern Arizona University, Flagstaff, AZ 86011, (602) 523-7180.
7. **Hydrogeology of the San Luis Valley, Colorado.** Alan Mayo, Dept. of Geology, Brigham Young University, Provo, UT 84602, (801) 378-2338.
8. **Earth-Science Education in Primary and Secondary Schools.** Contact Jack A. Ellingson, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7244.
9. **Geology and Public Policy.** Contact Jack A. Ellingson, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7244.

ABSTRACTS

Abstracts must be submitted camera-ready on official 1994 GSA abstract forms, available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-8850, or from Jack A. Ellingson, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7244.

Abstracts Deadline: January 13, 1994

An original and 8 copies are required for each abstract. All abstracts should be sent to Jack A. Ellingson, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7244. Authors of symposium papers should send an additional copy directly to the appropriate convener. Abstracts will be reviewed for substantive content and format, appropriate geographic relevance, and originality. Only one volunteered paper may be presented by each individual, although a person may also be a co-author of papers presented by others and may present additional papers invited for symposia.

PROJECTION EQUIPMENT

All slides must be 2" x 2" and fit standard carousel trays. Two projectors and two screens will be available for all oral sessions. Please bring loaded carousel trays, if possible.

POSTER SESSIONS

Five half-days of poster sessions will be convened. Please indicate your preference for a poster session on the GSA abstract form if you wish to present your paper in this format.

EXHIBITS

Exhibit booths will be available for business, educational, and governmental institutions. The exhibit area will be open all day Wednesday and Thursday. For further information and space reservation, contact Robert W. Blair, Jr., Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7263.

STUDENT SUPPORT

The GSA Rocky Mountain Section has funds available for grants to support GSA Student Associates of the section who are presenting papers at the meeting. Students are strongly encouraged to apply for these grants; we anticipate that most students who qualify will be funded to some degree. Applications for grants should be sent to the Rocky Mountain Section Secretary Kenneth E. Kolm, Dept. of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, (303) 273-3932. Applications should certify that the student is presenting a paper and is a GSA Student Associate of the Rocky Mountain Section. *All letters must be received by April 1, 1994.*

SPECIAL EVENTS

After-hours events will include a no-host welcoming party for all registrants on Wednesday evening, May 4, on the Terrace at Tamarron. The annual luncheon of the Rocky Mountain Section of the Paleontological Society of America will be held Thursday at noon.

GUEST PROGRAM

Tours of several major archaeological sites, including Mesa Verde, Chimney Rock, and Aztec Ruins, will be offered if there is sufficient interest.

ACCOMMODATIONS

A block of rooms at Tamarron, the site of the meeting, has been reserved for attendees. A special rate of $75 for deluxe guest rooms and $115 for executive suites has been arranged. Specific information and reservation forms will be provided in the February 1994 issue of *GSA Today.*

DETAILED INFORMATION

More detailed information concerning registration, accommodations, field trips, and other activities will appear in the February 1994 issue of *GSA Today* and as part of the Rocky Mountain Section *Abstracts with Programs* for 1994. Symposia and field trips listed in this announcement are tentative. Questions or suggestions should be addressed to the meeting chairman: Douglas C. Brew, Dept. of Geology, Fort Lewis College, Durango, CO 81301, (303) 247-7254, fax 303-247-7660. ■

tor of many fundamental concepts to modern geomorphology, makes no claim to correcting this situation, and he humbly observes that modern philosophers of science will undoubtedly be irritated by his short book. Deservedly so. Modern philosophy of science, with its exaltation of theoretical and mathematical postulation coupled to controlled experimental verification-falsification, best serves those sciences and scientists suffering from a malady that might be termed "physics envy." Readers so afflicted will easily be able to dismiss this volume from their serious consideration by employing such labels as "epistemologically naive," "homespun philosophy," or "mere" common sense. Actually the last label (minus the "mere"), signifying a commodity in short supply for both science and philosophy, does imply something of the pragmatic flavor of this book.

Schumm, following in the tradition of physician-geologist James Hutton, begins his treatise with a medical analogy. However, whereas Hutton's geophysiology provided a model for Earth (reincarnated as James Lovelock's Gaia Hypothesis), Schumm's example of medical diagnosis provides a model for the ailing method of doing earth science. The ailment, I believe, can be attributed to the increasing alienation of much of modern science and philosophy from the reality that has heretofore inspired meaningful scientific discovery. I find it especially refreshing that this book spares its intended audience of neophyte earth-environmental scientists most of the cookbook course in doing science according to various stipulated ideologies, including positivism, relativism, decontructivism, empiricism, critical rationalism, and so-called "scientific" realism. Instead, Chamberlin's multiple working hypotheses and Gilbert's inculcation of scientific method by example underpin what Schumm prefers to call "an approach rather than a method of investigation."

Why do working earth scientists need to be concerned with such matters? Is not the study of planet Earth advancing in scientific "rigor" because of its unifying paradigm of plate tectonics, its infusions of "hard" science (physics, chemistry, mathematics), and its new instrumentation? Schumm suggests that fundamental difficulties remain, which he lists as ten ways to be wrong, and these naturally group into three classes of problem: (1) scale and place (time, space, and location), (2) cause and process (convergence, divergence, efficiency, and multiplicity), and (3) system response (singularity, sensitivity, and complexity). The problems and their discussion compose the core of the book, and their inclusion far outweighs various inadequacies of the methodological descriptions, which include fuzzy arguments about hypothesis origins and probabilities, the nature and role of induction, and overemphasis on the individual rather than the collective scientific mind. The ten problems are by no means confined to earth science. Moreover, Schumm's lucid analysis of each, through definition, statement, and example, gives the reader an insight to ten fascinating but separate trees, while, regrettably, the magnificent forest is never recognized. This is understandable because the nature of that forest is exactly what has also eluded much of the nominalistic neoscholasticism that passes as modern philosophy of science. The forest roots can be found, appropriately enough, in the etymology of words. By focusing on the concept of "geo-" there has been a failure to explore the profound meaning of "-logic," and especially the latter's basis in reality.

Logic, first formalized by Aristotle in his *Organon,* poses a continuing challenge, almost totally ignored by modern science. Aristotle showed that Logic begins with fundamental Categories under which all things intelligible must be subsumed. His famous list proposed ten categories: time, place, position, substance, state, quantity, quality, relation, passion, and action. That the parallels to Schumm's ten problems are partial and not exact is unsurprising, because the exact nature of the list consumed the efforts of the greatest philosophers. Kant produced a "short list" of 12, and Hegel listed a multiplicity. Bacon had a list, as did Whewell. An eventual convergence was achieved by the greatest of all American philosophers, who was also probably the first (perhaps only) person ever to devote an entire lifetime of scholarship to the singular study of logic: Charles Sanders Peirce. Peirce reduced the fundamental categories to three, which can simplistically be listed as existence (being or mind), necessity (formal logic or matter), and representation (involving chance). The correspondence to Schumm's trinity of scale-time, cause-process, and system response is remarkable, but to explain this convergence would require a book in itself. A century of scholarly analysis of Peirce's thought has yielded the most profound and perhaps the most important philosophical puzzle of our age. It will not be solved in the course of this review.

The issues raised in this book can be treated as trivial or immensely profound. The result will depend very much on the perspective brought by the reader. Those seeking detailed treatment of Schumm's seminal experimental fluvial research, explanations couched in sophisticated quantitative terms, or methodological justification of results need not consult this book. The peer-reviewed journal literature, now functioning less for communicating science than for grantsmanship, tenure and/or salary justification, and other accounting devices, provides a more than ample warehouse of such material. What nearly all today's so-called "scientific" literature fails to provide is what Grove Karl Gilbert so admired in the published works of Sir Archibald Geikie, "... each presenting some matter of personal observation or some contribution to geological philosophy." It is a delight to find at

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least one modern geologist, Stanley A. Schumm, who has not forgotten the spirit of Gilbert's words, written 110 years ago: "... whoever in publishing the result of a scientific inquiry sets forth at the same time the process by which it was attained, contributes doubly to the cause of science."

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Mechanics in Structural Geology. *Brian Bayly. Springer-Verlag, New York, 1992, 253 p.*

Brian Bayly has written an eclectic, eccentric, and innovative structural geology text that many will admire but probably equally many will dislike. The text goes to extraordinary lengths to relate mechanics to everyday experience. The intent, clearly, is to make the subject matter more approachable to average structural geology students for whom mechanics is a necessary evil. Bayly is, I believe, largely successful in this goal, although some caveats will become clear in this review.

The book includes one chapter on strain and displacements, two on forces and stresses, and one each on rheology, "parting" (i.e., failure), and concurrent fracture and flow. The entire book, like Ramsay and Huber volumes 1 and 2, is built around an extensive series of questions that are used both to motivate the expression of problems and to illustrate particular methods. Bayly's book cannot be used as a reference work; one must do the problems, usually in order, to gain the desired insight, because the intervening text is entirely too brief. This is not to say that the problems are not useful; in fact, many are very clever and thoughtful and all are answered at the end of each chapter. Anyone planning to curl up with this text had better have pencil and paper handy.

The treatment of the material varies from idiosyncratic to highly enlightening to conventional. Terminology is commonly used in nonstandard ways. For example, the body of the text nowhere contains the term "simple shear"; the term "laminar" behavior is used instead, even though "simple shear" is indexed. Some analogies to common materials are not always described clearly or completely enough to serve their purpose (e.g., we are told that a fistful of uncooked spaghetti readily simulates plane strain, without further elaboration). Unfortunately, virtually none of the figures—all simple line drawings—have captions. They are discussed, to varying degrees, in the text, but it is not always clear what exactly in the figure is being referred to in the text. The mathematical level is generally limited to algebra and simple calculus, but in one place the text jumps rather suddenly, and briefly, into partial differential equations, Einstein summation convention, and vector matrix form without sufficient introduction or background. The word "tensor" is studiously avoided.

I found the chapters on rheology and concurrent fracture and flow to be highly enlightening. The latter chapter, in particular, presents some of the most insightful concepts in the entire book. This topic is covered inadequately in almost all modern textbooks on structural geology. Bayly's book presents an exceptionally thought-provoking treatment of the subject. Unfortunately, these chapters are marred by his use of geological time units (gtu) and geological viscosity units (gvu). A gtu is equivalent to 10^{14} seconds and a gvu = 1 Mpa-gtu. I suspect that a value of 10^{14} s was chosen because "geological" strain rates are commonly considered to be 10^{-14} s^{-1} (although continental strain rates are probably one to two orders of magnitude slower). Bayly gives no explicit explanation for the choice of 10^{14} s, instead stating that the main purpose in using these units is to give a sense of scale for metamorphic rocks. These units will only be confusing to anyone already trained in conventional units; how 1 gtu can give a better sense of scale than its equivalent of about 3 m.y. is beyond me!

In the chapter "Parting," failure modes are introduced but again not with the precise terminology that a student is likely to see in other texts. Bayly's classification of low-angle normal faults as "slides" suggests a lack of familiarity with a vast amount of research on extensional tectonics during the past two decades. Beyond the introductory material, this chapter has two main emphases: wedge-shaped thrust sheets and the effect of pore fluids. This material, like all material in the book, is presented without references to any previous work. Bayly does pay homage to M. King Hubbert, but only in the appendix on books covering related material.

Mechanics in Structural Geology is quite definitely a teaching (or perhaps a learning) book, not a reference work. The book does not teach methods so much as a way of thinking about deformation. As such, it will give students an intuitive feel for problems, but it will not give them the mathematical tools to go much farther on their own, and the nonstandard terminology will make it more difficult for them to relate the material they have learned to more advanced texts. Those who work through all of the problems and decipher Bayly's terse prose will no doubt gain substantial insight into deformational processes. It does raise the question, though, For whom is this book intended? The scope of the text is not comprehensive enough to be the primary textbook for any introductory structural geology class, nor is it advanced enough to be the basis for an advanced course in continuum mechanics for structural geologists. I think that it will find its prime use as a supplemental text for either an introductory or an advanced course (depending on the level of students at any particular school). Instructors will no doubt find much stimulating teaching material in the many examples and questions that Bayly has posed.

Richard W. Allmendinger
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Handbook of Protoctista. *The Structure, Cultivation, Habitats and Life Histories of the Eukaryotic Microorganisms and Their Descendants Exclusive of Animals, Plants and Fungi. A Guide to the Algae, Ciliates, Foraminifera, Sporozoa, Water Molds, Slime Molds and the Other Protoctists. Lynn Margulis, John O. Corliss, Michael Melkonian, and David J. Chapman, editors. Jones and Bartlett Publishers, Boston, 1990, 914 p., $195.*

Protoctista? The title and subtitle tell it all. This book is about single-celled eukaryotes and their close multicellular relatives (kelps, in particular). As such, it includes those groups of interest in geological applications, such as foraminifera, radiolaria, diatoms, and others, but does not deal with animals or plants. The Protoctista have always gotten short shrift, having been considered "simple," "single-celled plants or animals," "primitive," etc. This book makes it clear that this is a major mistake—protoctists are fully evolved, complex organisms of immense importance to humans in our daily lives. They cause disease (over 350 million people worldwide suffer from malaria alone, millions more from other protoctistan illnesses), foul our lakes, streams, and nearshore waters ("algal blooms"), provide industrial products (diatomite used as polishes and beer and swimming pool filters, for example), make rocks (radiolarianites, diatomites, foraminiferal shales, fusulinid limestones), and aid in the search for petroleum (foraminifera and other shelled protoctists), which is a protoctistan product itself. Protoctists are complex, and it took 60 authors to deal with them in this book. It is a handbook, although a heavy one, and it does an admirable job of describing the essentials of each phylum. It is designed for biologists interested in the organisms themselves. The geologically important groups are dealt with concisely in short chapters (radiolaria, 12 p.; foraminifera, 24 p., diatoms, 22 p.). The handbook is a wonderful overview of a fascinating group of organisms, however, and, for those interested in biodiversity, it is certainly worth browsing.

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Precambrian Geology. *Alan M. Goodwin. Academic Press, San Diego, 1991, $199.*

A good book makes one think, and *Precambrian Geology* by Goodwin does just that. I thought a lot about the Precambrian in the several months that it took to read this book, but other things came to mind as well. Let's talk about geology first.

Precambrian Geology is an ambitious effort to compile, synthesize, and—to a lesser extent—interpret the geology of the rocks produced prior to the Phanerozoic. This book is different from other attempts to present the Precambrian. This is largely because Goodwin avoids interpreting the rock record in terms of a plate-tectonic framework, with the exception of a few cases where, in his opinion, arguments for tectonic setting are especially convincing. His perspective is presented clearly in the Preface, without being belabored: "Considering the application of modern plate tectonic processes ... to the Precambrian, the older the terrain, the less convincing the interpretation." And in the Concluding Statement (p. 607): "According to the preferred model, the operating tectonic processes changed greatly throughout geologic times...." Instead, Goodwin intends to find some way to approach the question of how to objectively define the processes responsible for Precambrian crust formation. It is unclear whether this is even possible, but Goodwin is right that the first thing that must be done is a detailed inventory of the Precambrian. This book is that inventory, and it is an excellent one. Goodwin's effort to treat the Precambrian comprehensively sets this book apart from any other volume of which I am aware.

The book is organized like a 666-page sandwich. One slice of bread contains the prefatory remarks, acknowledgments, and an introductory chapter. This chapter presents the global distribution of Precambrian rocks, briefly summarizes geochronologic techniques, discusses orogenic cycles, presents several subdivisions of Precambrian time, and then turns to an overview of each platform. The other piece of bread is a chapter entitled "Evolution of the Continental Crust," 50 pages that summarize some of the most important conclusions to be drawn from the Precambrian. In between is the meat: four chapters and almost 500 pages presenting the Precambrian. Subdivisions are made on a basis of time and space. The chapters are by time, and within each chapter the various geographic locations are taken in order, starting in China and ending with Antarctica. The descriptions of the successions of each platform are presented in a chronostratigraphic framework, and Goodwin's effort is to get the names and ages right. The book is full of high-quality line drawings and summary tables—essential to help the reader plough through a text that is necessarily full of often unfamiliar stratigraphic names. Good figures are challenging to produce but delightful to behold, and this book is full of them. A few more stratigraphic columns and structural cross-sections would have helped the discussion. A few minor problems are to be expected in an undertaking of this magnitude. For example, the late Precambrian-Paleozoic granulites of southern India and Sri Lanka are overlooked. A few annoyances: discussion of the "expanding Earth theory" seems quaint, and a discussion of the role of impacts during the Precambrian is conspicuous in its absence. Excepting these and a few other minor distractions, I found the book to be an encyclopedia of the Precambrian, one that is most useful as a reference book. A good way to digest the information in this book would be in tandem with two other books: Windley's *The Evolving Continents* and Cloud's *Oasis in Space*. The latter two books are full of interpretation and thus are more readable, but can leave the interested student hungering for more detail. This can be found in *Precambrian Geology*, and if it isn't in the book itself, you can probably find it in one of the 1800 or so references. This is a fine book, and I, for one, would like to encourage Goodwin to think about updating and revising it in a few years, or perhaps even mutating it into an Encyclopedia of the Precambrian.

Is it worth $199? Certainly this volume cannot be used as a textbook, even if it were cheaper. Concepts and models are sacrificed (in my opinion, appropriately) to allow an objective inventory of the Precambrian. But the volume is still invaluable to the student and the professor of the Precambrian. Certainly every serious library should have a copy, and those serious about understanding the Precambrian should take a look and decide for themselves whether or not they should invest in their own copy.

Reading *Precambrian Geology* also made me think about the problem of good geology books—there aren't enough of them. We are living in a time when there are more earth scientists alive (by how many orders of magnitude?) than at any time in the past. We are living in a time when more articles in journals and edited volumes are being published than ever before, in a time when it is becoming increasingly difficult to keep up with important developments in the earth sciences.

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Never before have so many resources been applied to the understanding of Earth, achieving tremendous advancements. In spite of this—or because of it—we scientists are unaware of many fundamental understandings of discoveries outside of our narrow disciplines but still in the field of geology. This makes teaching and research more difficult and less fruitful than these endeavors might otherwise be. Why does it seem that there are so few good books concerning the major fields of earth science being written? Books by experts are the heart of education—books by Holmes, Bowen, and Cloud come to mind. How can we encourage more experts like Goodwin to take the time and effort to write more books like *Precambrian Geology*? We scientists and our students would benefit if we were to increase the ratio of publication of books by experts to journal articles.

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Geology of Japan. *T. Kimura, I. Hayami, and S. Yoshida. University of Tokyo Press, Tokyo, 1991, 287 p., ¥10,000 (approx. US$80).*

In the 30 years since the previous *Geology of Japan* was published, a significant amount of research has been done on the stratigraphy of the Japanese islands. This well-produced and well-edited book is a remarkable synthesis of the present status of stratigraphic research that would better be called *The Stratigraphy of Japan*. The first chapter is a brief summary of the geological history of Japan, including the authors' structural subdivision of the islands. Chapter 2 concentrates on a chronologic summary of the stratigraphy of Japan. Each section details the stratigraphic framework of a geologic period region by region, then briefly summarizes the igneous activity and paleogeography of that time period. A considerable number of new paleontological and radiometric dates produced over the past three decades is included. Each section has an extensive reference list. The third chapter too briefly summarizes the formation and geologic structure of Japan. An illustration of the lack of balance is evident from the reference list: 32 pages of references are devoted to the stratigraphic chapter, whereas chapter 3 has only two pages of references. The reference list has another shortcoming. There are few references to papers by non-Japanese workers, even though hundreds of papers on the geology of Japan have been written by North American and European geologists over the past 30 years. By excluding much of the recent structural-tectonic work, the authors contradict prevailing theories by proposing that collision tectonics have never been important in the development of the arc system of Japan; many "tectonicists" would strongly disagree.

This book contains a wealth of new information on the stratigraphy of Japan, but it lacks information on other aspects of the geologic development of the islands. If you are planning to conduct stratigraphic research on the Japanese islands, this book is a "must buy." If, however, you are expecting to get a broad view of the geology of Japan, this volume may disappoint you.

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Extinction—Bad Genes or Bad Luck? *David Raup. Norton, New York, 1991, $19.95, 210 p.*

In a paper for *Science* co-authored with my colleagues on *Glomar Challenger,* on terminal Cretaceous mass killing, I introduced the slogan "survival of the luckiest." Unbeknownst to me, Dave Raup wrote at the same time for *Acta Geologica Hispanica* an article titled "Extinction: Bad genes or bad luck?" We both wrote a book to express the same sentiment, but our styles are completely different. My book *The Great Dying* was a detective story. There was a case of mass murder, and the story was a one-sided account by a successful prosecuting attorney. My style was described as "profound and passionate," and the book garnered harsh critiques from reviewers who are equally "profound and passionate" in adopting a contrary viewpoint. I can never speak or write in the calm style of Dave Raup, who has earned special affection from many of his colleagues, including acidic personalities like myself or Steve Gould, who wrote the introduction of this opus. "David Raup is the best of the best," writes Gould, "in applying quantitative approaches to the fossil record."

In analyzing the problem of extinction, Raup pointed out three alternatives (p. 188): (1) Field of Bullets: random extinction without regard to differences in fitness; (2) Fair Game: selective extinction in a Darwinian sense, leading to the survival of the most fit or best adapted species; (3) Wanton Extinction: selective extinction, where some kinds of organisms survive preferentially, but not because they are better adapted to their normal environment. Raup presents wonderful arguments and case histories to show that "the third, wanton extinction, has been the essential ingredient in producing the history of life that we see in the fossil record" (p. 189). So there is luck involved.

Luck was exemplified by "random walks." Many of us thought we understood what constitutes random walks, and I thought so too, until I read the excellent exposition in this slim volume. The statistics of random walks tell us that death is a certainty, and that the improbable is inevitable, given enough time. Instead of a passionate pleading for a fractal geometry of fate, as I did in *The Great Dying,* Raup shows, in diagram after diagram, that the counterintuitive "skewed (asymmetrical) shape of variation is typical of important biological properties germane to the extinction question" (p. 54). The extinction pattern is not what mathematicians call "white noise"; it is a "1/f noise" typical of phenomena with fractal geometry. Fractal geometry is not chaos. There is the "waiting time" (p. 115), but there is also the inevitability. In gambling, there are winning and losing streaks. If the house has a financial resource much greater than yours, you are bound to lose your shirt if you play the game long enough, although you can gamble longer if you start with more capital. Darwin thought that he was inspired by Malthus´s work, but he ignored the pattern of random walks as presented in Raup's book. Malthus noted that 3/4 of noble families in Bern died out over a 200-year period; extinction is inevitable, sooner or later. A game of random walks makes the rich (the house) richer and the poorer extinct. Raup discusses the fate of the trilobites which constituted 3/4 of the Cambrian species. They were the "rich," but they were all gone before the end of the Paleozoic. Luck alone cannot do the trick; there were bad genes.

While admitting that extinction is a combination of bad genes and bad luck, Raup nevertheless concludes that *most* species die "because they are subjected to biological or physical stresses not anticipated in their prior evolution and because time is not available for Darwinian natural selection to help them adapt" (p. 191). Having, in my opinion, demolished completely the dogma of "survival of the fittest," Raup seems to feel obliged to pay lip service to the Church of Neo-Darwinism. He has to add that extinction through bad luck is not a challenge to Darwin´s natural selection, because "natural selection remains the only viable, naturalistic explanation we have for sophisticated adaptations like eyes and wings" (p. 192). Dave is treading on thin ice there, because many others argued that the naturalistic explanation is not viable, and that the only viable explanation for the origin of eyes and wings is provided by scientific creationism.

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GSAF UPDATE

Robert L. Fuchs

Good News in New Tax Law

While the title above may appear to be an oxymoron, the legislation recently signed into law that increased taxes for Americans did in fact have some good news that is also good for charitable institutions such as the GSA Foundation.

The congressional munificence bestowed upon the country's philanthropists comes in the form of an exemption for gifts of appreciated securities and other property from the alternative minimum tax (AMT). The AMT was created several years ago to ensure that upper-income taxpayers pay at least some tax to the government. Through a complex and somewhat arcane calculation best left to accountants and tax preparers, an individual could end up the year owing more tax as a result of the elimination of certain deductions in the AMT calculation. AMT no longer applies to gifts of appreciated securities, and this change retroactive to mid-1992 is expected to have a positive effect in the world of philanthropy.

In the April issue of *GSA Today*, I wrote about gifts of appreciated securities. To recap, a gift of appreciated securities is a contribution of stocks, bonds, etc., in which the donor has a cost basis less than the current market value. The gift is valued at the market price at the time of the gift, and such a gift therefore avoids the capital gains tax on the increase of market value over cost. In essence, the government has become a partner in a gift to the GSA Foundation, for example, by allowing the Foundation to keep the amount of the capital gains tax.

I recently met with two development officers from one of the country's largest universities, and they said that their institution is now receiving more gifts of appreciated securities. In part, this is due to the higher and higher value being seen in the stock and bond markets. Also, to some extent the increase in this type of gift can be attributed to the change in the tax law.

The Foundation's Special Funds—III

Engineering Geology Division Award—$11,000

This fund has evolved from the Engineering Geology Division's 40th Anniversary Fund. In January 1990 the GSA Foundation challenged the division to raise additional money for this fund, agreeing to contribute 50 cents from Foundation unrestricted funds for every dollar brought into the fund by the division. The result was a success—the Division Award Fund has grown to more than double the amount at the start of the challenge.

Income from the EGD Award Fund is the basis for the Engineering Geology Division's Student Research Awards, for exemplary work in the field of engineering geology. The 1992 award was given to Lauren Hammack of Colorado State University for her project titled "Hydraulics of Debris Flows and Floods at Warm Springs Rapids on the Yampa River, Colorado."

Gretchen Louise Blechschmidt Fund—$16,000

Gretchen Blechschmidt died in August 1990 after a brief illness. Her family and friends created the Gretchen Louise Blechschmidt Fund, the income from which supports an annual award to women in the geological sciences. Guidelines under which the award recipients are chosen include the objective of a Ph.D. in biostratigraphy and/or paleoceanography, an interest in sequence stratigraphy in conjunction with deep-sea sedimentology, and the desire to pursue a career in academic research. The 1993 recipient of an award in the amount of $1200 was Aradhna Srivastav of the University of Nebraska.

Three years prior to her death, Gretchen Blechschmidt contacted the Foundation for information about estate planning and establishing a scholarship fund to support women students in geoscience. That fund is now benefiting her geological successors.

History of Geology Award—$9000

In response to the 50 cents for each dollar challenge from the Foundation, the History of Geology Division has managed to increase the size of its award fund more than sevenfold in the space of 2½ years. This result is attributable directly to the hard work and perseverance of the members of this division, who recognized a good deal when they saw it and exploited it to the fullest extent.

An award committee of the History of Geology Division selects recipients for this honor. Achievements deserving of the award include publication of papers or books that contribute new and profound insights into the history of geology; discovery of and making available rare source materials; comprehensive bibliography surveys; editing a thematically integrated collection of articles; organizing meetings and symposia in the history of geology; research into original sources; general interpretations of data; translations of key materials; and exceptional service to the division. The 1992 award was presented to Michelle L. Aldrich.

Hydrogeology Division Award—$11,000

The Hydrogeology Division also took advantage of the Foundation's challenge and raised the balance in its award fund from $2700 at the end of 1990 to the present $11,000. In addition to designated contributions from division members, growth in the fund balance has been helped by specific efforts such as the Lohman Memorial, spearheaded by Phil LaMoreaux.

This fund serves the Hydrogeology Division in a variety of ways. Money from the fund is used in the GSA Student Research Grants Program for Outstanding Student Awards, which may take the form of financial support for annual dues or annual meeting registration. Seed funding has supported the division's "Historical Mug Series" endeavor. Also, money has been given to students as special incentives, such as discounted short course tuition. ■

In Memoriam

Charles N. Beard
Fresno, California
March 3, 1993

Newton E. Chute
Los Angeles, California
May 29, 1987

Richard C. Emmons
Madison, Wisconsin
September 4, 1993

David LeCount Evans
Faber, Virginia
April 20, 1993

William R. Gealey
Mill Valley, California
June 20, 1993

Robert L. Heller
Duluth, Minnesota
July 11, 1993

John W. Vanderwilt
Sun City, California
November 15, 1992

Horace Winchell
Hamden, Connecticut
July 20, 1993

Donors to the Foundation, August 1993

History of Geology Award Fund
Michael B. E. Bograd
Sherman Wengerd

Hydrogeology Division Award
Robert N. Farvolden
John M. Sharp, Jr.*

GEOSTAR

Doris M. Curtis Memorial
Michael F. Infanger

John T. Dillon Alaska Scholarship
ARCO Foundation*
James P. Dixon

GEOSTAR
James W. Head, III*

J. Hoover Mackin Award
Bruce H. Bryant*
Dwight L. Schmidt

Research
Desh B. Ahuja

SAGE
Richard H. Mahard*
Ian Williams

Second Century Fund
Geneviene Atwood*
Robert H. Dott, Jr.*
Sharon Mosher*

Unrestricted
Desh B. Ahuja
Yehuda Eyal
Vin' I. Maeda
Garry Maurath
Marshall Schalk
Stuart L. Schoff
C. Michael Seidensticker

Women In Science
Mary N. Gilzean

*Century Plus Roster (gifts of $150 or more).

Gaia *continued from p. 280*

"sporulated" form of biospheric life—Gaia transporting propagules of itself to the surface of a new world.

CONCLUSIONS

A gaian scientific world view is especially relevant in light of extensive human-wrought modification of the global environment and the talk about further missions to Mars. Although the fundamentals of Lovelock's Gaia hypothesis have not changed in 25 years, researchers still don't yet understand them. The gaian approach critically enables research on Earth systems precluded by the patchiness of the "academic apartheid" from which Lovelock, as a young man, fled.

The gaian concept of physiological surface regulation is unpalatable, especially to those who hold dogmatic ideas on Earth processes. Lovelock remarked (in the BBC program "Goddess of the Earth") that the Gaia hypothesis hasn't been controversial; it has just been ignored. But the scientific details, contained in the literature listed here (Appendix 1), are becoming better known. We are hopeful that the full importance of the Gaia idea will continue to be more extensively understood by scientists and students, especially by geologists upon whom rest the future of gaia-oriented scientific research.

ACKNOWLEDGMENTS

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MEETINGS

GSA Penrose Conferences

March 1994

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

April 1994

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

June 1994

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

1993 Meetings

November

International Circum-Pacific and Circum-Atlantic Terrane Conference VI, November 5–21, 1993, Guanajuato, Mexico. Information: Fernando Ortega-Gutiérrez, fax 52-5-550-6644 or -8432; or David G. Howell, fax 415-353-3224.

24th Annual Underwater Mining Institute, November 7–9, 1993, Estes Park, Colorado. Information: Karynne Chong Morgan, UMI Conference Coordinator, 811 Olomehani Street, Honolulu, HI 96813-5513, (808) 522-5611, fax 808-522-5618, Internet: morgan@uhunix.uhcc.hawaii.edu, Compuserve: MMTC, 70673,534.

Third International Congress of the Brazilian Geophysical Society, November 7–11, 1993, Rio de Janeiro, Brazil. Information: SBGf-Divisão Centro-Sul, Secretaria do 3º CISBGf, Av. Rio Branco 156, sala 2510, 20043-900 Rio de Janeiro, RJ, Brasil, phone 55-21-533-0064, fax 55-21-533-0064.

Mineral Resources of Russia, International Symposium and Exhibition, November 9–13, 1993, St. Petersburg, Russia. Information in the USA: (505) 291-9812. Information in Russia: Organizing Committee, P.O. Box 215, 199004, St. Petersburg, Russia, E-mail: vsg@sovamsu.sovusa.com., phone 7-812-218-9224, fax 7-812-355-7952.

15th New Zealand Geothermal Workshop, Long-term Use of Geothermal Resources: Problems and Solutions, November 10–12, 1993, Auckland, New Zealand. Information: K. C. Lee, M. G. Dunstall, or S. F. Simmons, Geothermal Institute, University of Auckland, Private Bag 92019, Auckland, (649) 373-7599, ext. 8401, fax 649-373-7436.

Basement and Basins of Eastern North America, AAPG Hedberg Research Conference, November 10–13, 1993, Ann Arbor, Michigan. Information: AAPG Continuing Education Department, P.O. Box 979, Tulsa, OK 74101, (918) 584-2555, fax 918-584-0469.

Developing a Science and Drilling Program for the Chicxulub Impact Crater, November 13–14, 1993, Puerto Vallarta, Mexico. Information: Virgil L. Sharpton, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058, (713) 486-2111, fax 713-486-2162, E-mail (Internet): sharpton@lpi.jsc.nasa.gov.

Eastern Oil Shale Symposium, November 17–19, 1993, Lexington, Kentucky. Information: Geaunita H. Caylor, University of Kentucky/OISTL, 643 Maxwelton Court, Lexington, KY 40506-0350, (606) 257-2820, fax 606-258-1049.

December

American Geophysical Union Fall Meeting, December 6–10, 1993, San Francisco, California. Information: AGU—Meetings Dept., 2000 Florida Avenue, N.W., Washington, DC 20009, (202) 462-6900, fax 202-328-0566, E-mail: dsolomon@kosmos.agu.org.

World Organization of Volcano Observatories—IAVCEI Commission, December 13–17, 1993, Guadeloupe Island, West Indies. Information: Catherine Netter, Observatoires Volcanologiques, IPGP, phone 33-1-44-27-24-00, fax 33-1-44-27-24-01.

1994 Meetings

January

Remote Sensing and GIS International Symposium, January 27–28, 1994, location to be determined. Information: Vern Singhroy, Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, Ontario K1A 0Y7, Canada, (613) 947-1215, fax 613-947-1385; or Ivan Johnson, 7474 Upham Court, Arvada, CO 80003, (303) 425-5610; and Doug Nebert, Water Resources Division, USGS National Centre, MS 445, Reston, VA 22092, (703) 648-5691, fax 703-959-5691.

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

February

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

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

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

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

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

March

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

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

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

GSA South-Central Section Meeting, March 21–22, 1994, Little Rock, Arkansas. Information: Philip L. Kehler, Dept. of Earth Sciences, University of Arkansas, 2801 S. University Ave., Little Rock, AR 72204, (501) 569-3546, fax 501-569-8020. *(Abstract deadline: November 30, 1993.)*

GSA Cordilleran Section Meeting, March 21–23, 1994, San Bernardino, California. Information: Joan Fryxell, Dept. of Geological Sciences, California State University, 5500 University Parkway, San Bernardino, CA 92407-2397, (909) 880-5311, fax 909-880-7005. *(Abstract deadline: November 29, 1993.)*

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

GSA Northeastern Section Meeting, March 28–30, 1994, Binghamton, New York. Information: H. Richard Naslund, Dept. of Geological Sciences, SUNY, Binghamton, NY 13902-6000, (607) 777-4313, fax 607-777-2288. *(Abstract deadline: December 2, 1993.)*

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

April

GSA Southeastern Section Meeting, April 7–8, 1994, Blacksburg, Virginia. Information: Lynn Glover, III, and Robert J. Tracy, Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061-0420, Glover's direct (703) 231-6213, fax 703-231-3886, Tracy's direct (703) 231-5980. *(Abstract deadline: December 1, 1993.)*

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

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

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

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

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

European Association of Science Editors 5th General Assembly and Conference, April 24–28, 1994, Budapest, Hungary. Information: EASE Secretariat, 49 Rossendale Way, London, NW1 0XB, UK, phone 44-71-388 9668, fax 44-71-383 3092.

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

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

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

May

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

Geologic Remote Sensing Tenth Thematic Conference, May 9–12, 1994, San Antonio, Texas. Information: ERIM/Thematic Conferences, P.O. Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123, Internet: wallman@vaxb.erim.org.

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

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

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

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

June

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

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

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

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

July

FORAMS '94: International Symposium on Foraminifera, July 5–9, 1994, Berkeley, California. Information: FORAMS '94, Museum of Paleontology, University of California, Berkeley, CA 94720, (510) 642-1821, fax 510-642-1822.

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

Basement Tectonics 11th International Conference, July 25–29, 1994, Potsdam, Germany. Information: Onno Oncken, Conference Chairman, Geo-Forschungs Zentrum, Telegrafenberg, D-0-1561 Potsdam, Germany, phone 49-331-310601, fax 49-331-310306. *(Abstract deadline: March 1, 1994.)*

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

August

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

■ **The South Atlantic: Present and Past Circulation,** August 15–18, 1994, Bremen, Germany. Information: South Atlantic Symposium, Barbara Donner,

Meetings *continued on p. 294*

Meetings *continued from p. 293*

Fachbereich Geowissenschaften der Universität, Postfach 33 04 40, D-28334 Bremen, Germany.

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

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

■ **Proterozoic Crustal and Metallogenic Evolution,** August 29–September 1, 1994, Windhoek, Namibia. Information: G.I.C. Schneider, Geological Society of Namibia, P.O. Box 699, Windhoek, Namibia, phone 264-61-37240, fax 264-61-228324.

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

September

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

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

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

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

■ **Eco Rio '94, International Symposium on Resource and Environmental Monitoring,** September 26–30, 1994, Rio de Janeiro. Information: National Institute of Space Research—INPE c/o Mônica Oliveira, CRI, P.O. Box 515, Av. dos Astronautas, 1758-CEP 12227-010, San José dos Campos, SP-Brazil, phone 55-123-22-9816 or 41-8977 x250, fax 55-123-21-8543 or 22-9325.

October

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

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

November

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

December

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

1995 Meetings

April

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

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

May

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

■ **17th International Geochemical Exploration Symposium,** Exploring the Tropics, May 15–19, 1995, Townsville, Queensland, Australia. Information: Russell Myers, 171GES, National Key Centre in Economic Geology, James Cook University, Townsville, Q4814, Australia, phone 61-77-814486, fax 61-77-815522.

■ **Geological Association of Canada–Mineralogical Association of Canada Joint Annual Meeting,** May 17–19, 1995, Victoria, British Columbia, Canada. Information: Chris Barnes, General Chair, SEOS, University of Victoria, P.O. Box 1700, Victoria, B.C. V8W 2Y2, Canada, fax 604-721-6200.

■ **1995 World Geothermal Congress,** May 18–31, Florence, Italy. Information: George Frye, Executive Director, International Geothermal Association, LBL 50C, Rms. 106–108, One Cyclotron Road, Berkeley, CA 94720, (510) 486-4584, fax 510-486-4889.

August

■ **Third Hutton Symposium: The Origin of Granites,** August 28–September 2, 1995, College Park, Maryland. Information: Michael Brown, Dept. of Geology, University of Maryland, College Park, MD 20742, (301) 405-4082, fax 301-314-9661.

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

BOSTON

GSA Thanks the 1993 Annual Meeting Contributors and Sponsors

For the Boston Annual Meeting, GSA received generous contributions to both the general meeting fund and to specific events. GSA is most appreciative of this support and thanks the following companies. Companies with bold listing have contributed $500 or more to the meeting. Those in uppercase have contributed $1000 or more.

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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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GSA Division News

Divisions recognized the following individuals at the 1993 Annual Meeting in Boston for their service to the Division and/or contributions to the geological sciences. (For a listing of other award recipients honored at the Boston meeting, see page 266 of the October 1993 issue of *GSA Today*.)

Engineering Geology Division
James F. Quinlan, Richard H. Jahns Distinguished Lecturer

Structural Geology and Tectonics Division
Dan M. Worrall, Best Paper Award
Sigmund Snelson, Best Paper Award

Correction to p. 175, July *GSA Today*
The correct affiliation for the 1993 George P. Woolard Award recipient Ron M. Clowes is *Lithoprobe and Department of Geophysics & Astronomy, University of British Columbia.*

November *BULLETIN* and *GEOLOGY* Contents

Are you missing out? If you're not a *Bulletin* or *Geology* subscriber, you may miss the articles listed below. Subscribe today and receive all 1993 issues, even if you've already paid your 1993 dues. Call Membership Services today at 1-800-472-1988.

The Geological Society of America

BULLETIN

Volume 105, Number 11, November 1993

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GEOLOGY

VOLUME 21
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NOVEMBER 1993

Call for Papers—Planetary Geoscience Student Paper Award

The Award

Planetary geologist Stephen E. Dwornik established the award, in 1991, to provide encouragement, motivation, and recognition to outstanding future scientists. Two awards are given annually, each winner receiving a citation and $500. The program is administered through the Planetary Geology Division of the Geological Society of America. The GSA Foundation manages the award fund. Arrangements for travel by the recipients to the awards ceremony at NASA headquarters in Washington, D.C., are handled by the Planetary Geology and Geophysics Program, NASA.

Criteria

Students who are U.S. citizens and are enrolled in a college or university at any level of their education in the field of planetary geosciences may submit abstracts for the Student Paper Award. Student applicants must be the senior author of the abstract, and the paper may be presented orally or in a poster session. Papers will be judged on the quality of the scientific contribution, including methods and results; clarity of material presented; and methods of delivery, oral or display. Two awards are given: one for the best oral presentation, the other for the best poster presentation.

To Apply

The application form and instructions may be found in the Call for Papers for the 1994 Lunar and Planetary Science Conference, March 14–18, to be held in Houston, Texas. Only one abstract per student will be considered.
Deadline for application is January 7, 1994.

Initially published in Summer 1993 issue of AEG News. ■

GSA ANNUAL MEETINGS

■ 1994

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

General Chairman: ***Darrel S. Cowan***

Technical Program Chairmen: ***Mark S. Ghiorso, Thomas Dunne***
Symposia and theme proposals due: January 3, 1994.

Field Trip Chairman: ***Donald A. Swanson***
Field trip proposal deadline was May 15, 1993; however, a few trips may still be accepted. Call today if you are interested in leading a trip. First draft of guidebook copy will be due January 1, 1994.

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

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

1994 Technical Program Theme

Geology *At the Leading Edge* will be the scientific theme of the 1994 GSA Annual Meeting in Seattle. The theme will draw emphasis both to the geographical position of Seattle, situated on the leading edge of a convergent plate margin, and to the application of "leading edge" theoretical approaches to and technological advances in the elucidation of geological problems. Theme sessions and symposium proposals are sought in all aspects of Pacific Rim and convergent margin geology, with particular emphasis on the utilization of new technology. The Seattle Program Committee will sponsor a GSA symposium titled "The Birth and Death of a Plate," which will include invited talks on topics such as arc volcanism, kinematics of plate motion, accretionary wedges, and evolution of ocean-ridge spreading centers. Speakers will illuminate these issues with results from remote sensing, geodesy, seismic imaging, experimental studies of geologic materials, and computational advances in modeling geologic systems.

Theme sessions will have the option of being organized with more flexibility. One proposal is to lead off a theme session with an invited speaker who will review the subject of the theme and set the tone and organization of the abstracts in the remainder of the session.

The Seattle Program Committee also proposes to have several less formal evening sessions aimed at bringing attendees up to date on new techniques such as GIS (Geographical Information Systems), GPS (Global Positioning System), and major nationally funded research projects such as the RIDGE initiative and the Continental Drilling Program. The 1994 GSA Annual Meeting in Seattle promises an exciting opportunity to discuss important geological questions in a nontraditional way. Plan to join us *At the Leading Edge*.

■ 1995

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

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

Technical Program Chairman: ***Laura Serpa, University of New Orleans***

Call for Field Trip Proposals: *Please contact the Field Trip Chairmen listed below.*

Whitney Autin
Louisiana Geological Survey
P.O. Box G, University Station
Baton Rouge, LA 70893-4107
(504) 388-5320

Duncan Goldthwaite
4608 James Drive
Metairie, LA 70003
(504) 887-4377

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

■ FUTURE

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

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

1994 Abstract Form Request

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

Please send _____ copies of the 1994 GSA Abstract form. I understand that the same form may be used for all 1994 GSA meetings—the six Section Meetings and the GSA Annual Meeting in Seattle.

Name _____

Address _____

_____

City _____ State _____ ZIP _____

GSA SECTION MEETINGS

South-Central Section

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

Cordilleran Section

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

Northeastern Section

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

Southeastern Section

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

North-Central Section

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

Rocky Mountain Section

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

Student Travel Grants

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

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

BOSTON

1993 GSA CONTINUING EDUCATION COURSE NOTES FOR SALE

A limited number of short course notes are available from some of the courses presented at the Boston Annual Meeting. Prices range from approximately $10 to $25 per copy. Credit card orders are gladly accepted.

A list of available titles and prices will appear in the December issue of *GSA Today*, but if you would like this information now, please call:

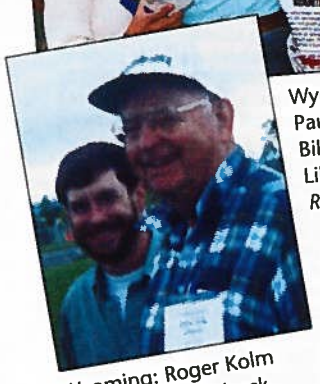
Edna A. Collis
Meetings Department
1-800-472-1988, Ext. 134

1993 GeoVentures

Wyoming: Happy Trails. *Edna Collis.*

Wyoming: Paula Venuto, Bill Elliott, and Lillian Pollock. *Roger Kolm.*

Wyoming: Karen and Daryl Streiff. *Martyne Kolm.*



Wyoming: Roger Kolm and Michael Starbuck. *Edna Collis.*

Santa Fe: Rio Grande Gorge, New Mexico. *Don Wolberg.*

Santa Fe: Plaza Resolana en Santa Fe, home to the New Mexico GeoHostel. *Edna Collis.*

GSA GeoVentures once again offered a variety of field-based programs unrelated to the annual or section meetings. The total of 78 participants, ranging in age from 30 to 85, represented a range of interests and backgrounds.

This educational program serves professionals who enjoy their geology and the company of other geologists in a field setting. GeoVentures are a special benefit created for members, but are open to guests and friends also.

GeoVentures is the overall name for adult educational and adventure experiences of two kinds: GeoHostels and GeoTrips. Both are known for superior scientific leadership. Fees for both are low to moderate (relative to the destination, length, time of year, and number of participants). GeoHostels are usually five-day, campus-based programs. GeoTrips are anywhere from one to three weeks in length, and the itinerary covers a variety of destinations.

GeoHostels

Geology, Paleontology, and Cultural History of North-Central and Northwestern New Mexico. 17 participants, May 29–June 3, 1993.
Leaders: Donald Wolberg, New Mexico Bureau of Mines, and Patsy Reinard Wolberg.

"The trip was wonderful and most enjoyable. It was well balanced as to content. The leaders are to be especially commended," T. Mylan and Eunice Stout (Lincoln, Nebraska) said of this program.

Scenic Geology and Natural History of East Yellowstone, Beartooth, and Absaroka Country, Wyoming. 32 participants, July 17–22, 1993.
Leaders: Kenneth Kolm and Gregory Holden, Colorado School of Mines.

"Our trip went like clockwork—it was most worthwhile. The leaders were cheerful, mature, and knowledgable," according to Kitty White of Claremont, California.

"I really enjoyed this year's GeoHostel. Ken and Greg are a dynamic duo. Keep up the good work," wrote Robert Church, of Los Gatos, California.

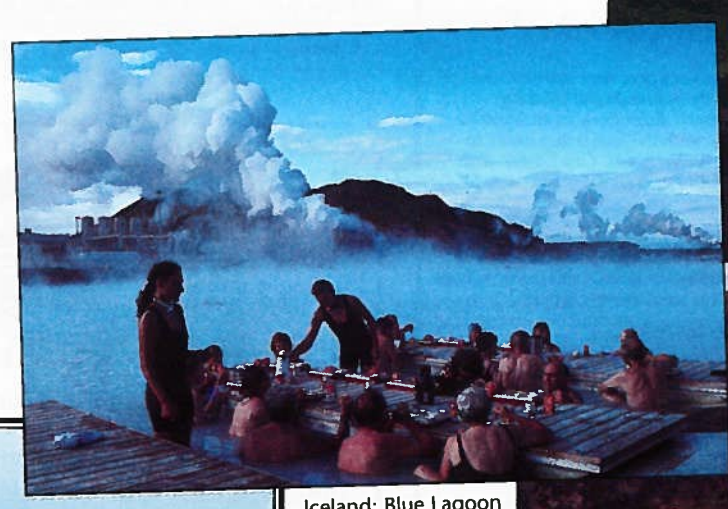
GeoTrip

Iceland for Geologists. 29 participants, July 31–August 15, 1993.
Leaders: Haraldur Sigurdsson, University of Rhode Island, and Haukur Johannesson, Iceland Geological Survey.

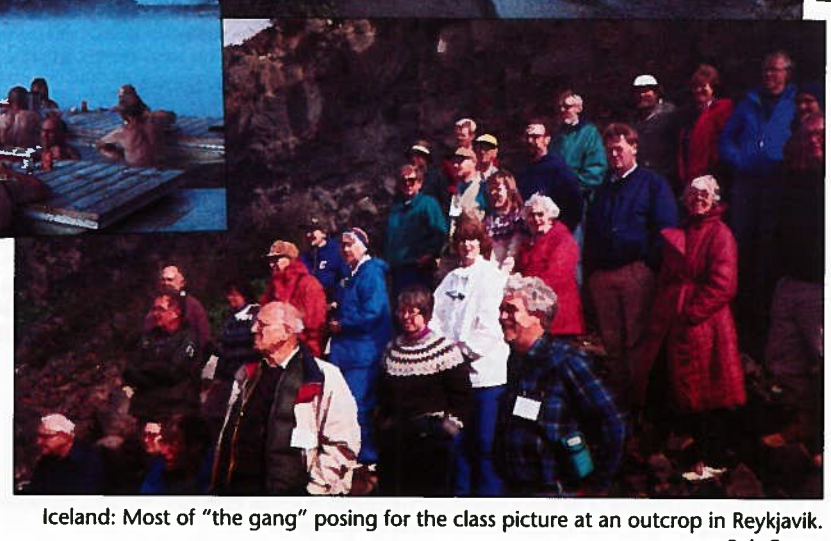
"I enjoyed this trip immensely and appreciate the time and effort of the leaders."
"I hope the trip can be repeated for all those who wanted to go and couldn't get on," Jeanie Barnett (Bakersfield, California) said.

"Both leaders are among the very best I have ever experienced," wrote Nels Vollo of Kamloops, British Columbia. "On a scale of one to five, I rated this trip a five. Great people and interesting geology," said Ruth Schmidt of Anchorage, Alaska.

Iceland: Pjofafoss Waterfall. *Bob Grant.*



Iceland: Blue Lagoon at Suarsengi Geothermal Plant. *Bob Grant.*



Iceland: Most of "the gang" posing for the class picture at an outcrop in Reykjavik. *Bob Grant.*

Coming in December GSA Today...

GeoVentures 1994

Registration begins January 1.

CLASSIFIED ADVERTISING

Published on the 1st of the month of issue. Ads (or cancellations) must reach the GSA Advertising office one month prior. Contact Advertising Department (303) 447-2020, 1-800-472-1988, fax 303-447-0648.

Classification	Per line for 1st month	Per line for each addt'l month (same ad)
Situations Wanted	$1.75	$1.40
Positions Open	$4.50	$3.80
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Services & Supplies	$4.50	$3.80
Opportunities for Students		
first 25 lines	$0.00	$1.35
additional lines	$1.35	$1.35

Code number: $2.75 extra

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

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

Positions Open

THE WATER RESOURCES CENTER OF THE DESERT RESEARCH INSTITUTE is accepting applications for two research faculty positions to be filled at the Assistant or Associate Research Professor level. Incumbents will plan, initiate, and carry out research in areas shown. Positions require doctorates in disciplines shown. Candidates must have experience to perform described duties; demonstrated ability to publish research studies in peer-reviewed publications, ability to generate grant and contract funds, and capacity to work harmiously with colleagues. Opportunity to participate in teaching and graduate student advising.

Hydrogeochemist. Research relating to processes of contaminant transport and interactions between chemical compounds and soil/rock-water media; modeling of contaminant transort processes at either microscopic or macroscopic scales including microbiological and geochemical interactions; and integrating concepts of hydrogeology, chemistry, geology, microbiology, and engineering into contaminant geochemistry problems. Requires Ph.D. in geochemistry, hydrology, hydrogeology, or related discipline and experience or willingness to acquire experience, in evaluating field programs. Ability to conduct laboratory experiments. Application review begins January 1, 1994.

Geochemist. Research relating to interaction of radionuclides and heavy metals with soil-matrix. Position involves development and evaluation of biological, chemical, and microbiological methods to remove radionuclides and heavy metals from soil. Laboratory experiments will be conducted. Requires Ph.D. in geochemistry, mineralogy, or related background and experience in soil/rock-water interactions, mineral processing and aqueous systems; and ability to qualify for security clearance. Application review begins November 1, 1993. This position is in Las Vegas.

Applications will be accepted until position is filled. Starting salary will be commensurate with qualifications.

Three letters of recommendation and any technical questions to: Dr. Roko Andricevic, search committee chairman, Desert Research Institute, Water Resources Center, P.O. Box 19040, Las Vegas, NV 89132-0040, tel. (702) 895-0475, FAX 702-895-0427, E-mail: roko@snsc.unr.edu.

The application package should include a resume, a narrative statement of research interest, transcripts and reprints or preprints of three most relevant papers published or submitted for publication. Please send your applications to: Recruitment Office, Desert Research Institute, Southern Nevada Science Center, University and Community College System of Nevada, P.O. Box 19040, Las Vegas, NV 89132-0040.

DRI employs only U.S. citizens and persons authorized to work in the U.S. Affirmative Action/Equal Opportunity Employer.

ARIZONA STATE UNIVERSITY
TENURE TRACK POSITION
ENVIRONMENTAL GEOLOGY

The Department of Geology at Arizona State University invites applications for an anticipated tenure-track faculty position at the rank of Assistant Professor from individuals with research interests in the broadly defined field of environmental geology. Applicants with backgrounds in hydrogeology, Quaternary geology, geomorphology, engineering geology, geologic hazards, geochemistry, geophysics, or other disciplines whose research focuses on environmental problems are encouraged to apply.

The successful candidate will be expected to develop a vigorous research program and to be strongly committed to quality teaching. Ph.D. in geology or related science required. Starting date August 16, 1994. This position is contingent upon final budgetary approval.

Send letter of application describing current and near-term research and teaching interests, curriculum vitae, and names and addresses of three potential references to: Dr. Simon Peacock, Search Committee Chair, Department of Geology, Arizona State University, Box 871404, Tempe, Arizona 85287-1404. Phone (602) 965-1733, Fax 602-965-8102. The closing date for applications is December 1, 1993 and the first day of each month until the position is filled. Arizona State University is an Equal Opportunity/Affirmative Action employer.

UNIVERSITY OF FLORIDA
LOW TEMPERATURE GEOCHEMISTS

The Department of Geology invites applications for two tenure track assistant professorships to begin in the fall of 1994. Applicants should have: 1) a Ph.D. or equivalent; 2) interest and expertise within the broadly defined area of low temperature geochemistry (e.g., environmental, isotope, hydro-, sedimentary, marine, global change, etc.); and 3) the capability of establishing a high quality research and instructional program in their specialty. Applications must be received before January 15, 1994, and should be addressed to Prof. Paul A. Mueller, Department of Geology, University of Florida, Gainesville, FL 32611. Hiring will be done in compliance with all applicable EOE, ADA, and Affirmative Action guidelines.

DEPARTMENT CHAIRPERSON / GEOSCIENTIST
OREGON STATE UNIVERSITY

Position as Professor and Chairperson available September 1994 in Geosciences Department with strengths in petrology, structure, sedimentology/paleontology, surficial processes, physical and resource geography, and spatial analysis. The department has 19 tenured faculty, 90 graduate students, and 135 undergraduate majors. Long-term department goals are in earth and environmental geosciences. Geosciences, housed with other basic sciences in the College of Science, has strong collaborative ties with the Colleges of Forestry, Agricultural Sciences, and Oceanic and Atmospheric Sciences; the Center for Analysis of Environmental Change; the U.S. Forest Service Research Lab; the U.S. Geological Survey; and the U.S. EPA Environmental Research Laboratory located on or near the OSU campus. Oregon State University is a Land Grant, Sea Grant, Space Grant, and Carnegie Class I Research University.

Candidates must have a Ph.D. or equivalent in the physical geosciences and a distinguished record of academic achievement commensurate with full-professorial appointment.

Send resume, including evidence of administrative, research, and teaching experience; publications; external recognition awards; and names of three references to Professor A. Jon Kimerling, Chairman, Geosciences Search Committee, Department of Geosciences, Oregon State University, Corvallis, OR 97331-5506. Candidates should also submit a statement on their views of the future of geosciences teaching and research. Candidates will be notified before letters of reference are requested. Applications will be reviewed starting January 1, 1994, until the position is filled.

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

FACULTY POSITION
GROUND WATER HYDROGEOLOGY
STATE UNIVERSITY OF NEW YORK
AT BUFFALO

The Department of Geology invites applications for a tenure-track faculty position in hydrogeology at the Assistant Professor level starting September 1994. The successful candidate will demonstrate a potential for research which will complement our existing, rapidly growing programs in environmental geology. Teaching duties will involve hydrogelogy courses at the undergraduate and graduate levels. The salary and initial University contribution to the candidate's research will be very attractive. The successful candidate is expected to have the Ph.D. degree as of the date of appointment. Apply with a statement of teaching and research goals and a curriculum vitae, including published research, grant support, and names of at least three references to: Dr. John C. Fountain, Chair, Search Committee, Department of Geology, State University of New York, 415 Fronczak Hall, Buffalo, NY 14260. Review of applications will begin January 1, 1994.

The State University of New York is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

FACULTY POSITION IN
GEOPHYSICS-TECTONOPHYSICS-HYDROLOGY,
BOSTON COLLEGE

Department of Geology and Geophysics invites applications for a tenure-track faculty position in geophysics-tectonophysics-hydrology at the Assistant Professor rank for September 1994. We seek a person capable of conducting an active and funded research program as well as teaching courses at the undergraduate and graduate levels. A Ph.D. is required; post-doctoral research experience is desirable. We are particularly interested in candidates who can apply geophysical and engineering methods to hydrologic and other environmental problems and whose background complements our present research efforts in one or more of the following areas: seismology, gravity-magnetism, structural geology and rock physics, regional bedrock geology and geochemistry, and sedimentation-Earth surface processes. Send resume and the names and addresses of professional references by December 17, 1993 to: George D. Brown, Jr., Acting Chairman, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA 02167. Boston College is an equal opportunity/affirmative action employer.

IDAHO STATE UNIVERSITY

Applications are invited for a temporary position as assistant professor/instructor. A Ph.D. or A.B.D. is required. Position is for one semester, beginning January 1994, but may be extended to spring 1995 pending a sabbatical leave. Teaching responsibilities include introductory geology and hand-specimen petrography in spring 1994, plus historical and structural geology the following year. Preference will be given to those familiar with Idaho geology. Send resume, statement of teaching interests and philosophy, transcripts, and names of 3 referees by November 15 to Search Committee, Department of Geology, Idaho State University, Pocatello, ID 83209-8072. Idaho State University is an Equal Opportunity/Affirmative Action Employer.

STABLE ISOTOPES - UNIVERSITY OF WYOMING

The Department of Geology & Geophysics is looking for a stable isotope geochemist at the assistant professor level. We seek a creative researcher whose main interest is movement of fluids in the subsurface. We hope particularly to strengthen existing interdisciplinary programs in aqueous geochemistry, hydrology, and diagenesis. The successful candidate should be open to collaborative projects with faculty members in various fields, including petrology and sedimentology. Candidates should anticipate undergraduate teaching as well as graduate teaching in the area of specialization. Ph.D. required at time of appointment.

Applicants should send a curriculum vitae, a statement of teaching and research interests, and the names of at least three referees to Dr. James R. Steidtmann, Department of Geology and Geophysics, University of Wyoming, P.O. Box 3006, Laramie, WY 82071, by November 15, 1993. The University of Wyoming is an equal opportunity/affirmative action employer.

EARTH SURFACE PROCESSES
NORTH CAROLINA STATE UNIVERSITY
TENURE TRACK POSITION, DEPARTMENT OF
MARINE, EARTH & ATMOSPHERIC SCIENCES

We seek an outstanding earth scientist with research interests in the physical processes that take place in surface or near-surface terrestrial environments. We will favor scientists oriented toward physical measurement and/or mathematical modeling over those with a dominantly descriptive approach. We are particularly interested in scientists who integrate hydrology and geomorphology. Our department offers excellent opportunities for cross-disciplinary research. The department consists of 37 faculty with research interests in geology, geophysics, meteorology, climatology, and oceanography. The department is housed in a new building and incorporates a wide range of analytical and computational facilities.

The position will be filled at the Assistant or Associate Professor level. The successful candidate will have a commitment to excellence in both research and teaching at the undergraduate and graduate levels. Applicants should send a complete curriculum vitae, description of research and teaching interests, publications list, and the names of at least three references by December 20 to: Dr. David Evans, Chair of Search Committee, Department of Marine, Earth & Atmospheric Sciences, North Carolina State University, Box 8208, Raleigh, NC 27695-8208. In its commitment to diversity and equity, North Carolina State University seeks applications from women, minorities, and the disabled.

ENVIRONEMNTAL GEOLOGIST

Syracuse University invites applications for a tenure-track appointment at the Assistant Professor level in the area of environmental geology, to begin in August 1994. We seek an individual with a broadly based, multidisciplinary approach to research in environmental earth sciences. The successful candidate must also be committed to excellence in teaching at all levels, from large introductory undergraduate to smaller graduate courses. Preference will be given to candidates whose breadth of experience allows them to teach undergraduate courses in one of the following additional areas: surficial processes, geomorphology, or geochemistry/petrology. It is expected that the successful candidate will develop an externally funded research program involving students. Candidates must have completed the Ph.D. by the time of appointment. Screening of applications will begin November 15 and will continue until the position is filled.

Syracuse University is an equal opportunity/affirmative action employer. Women and members of under-represented ethnic groups are encouraged to appy.

Applicants should send a curriculum vitae and names of three references to: Chair, Search Committee, Department of Geology, Heroy Geology Laboratory, Syracuse University, Syracuse, New York 13244-1070; (315) 443-2672 or 3710.

SAINT LOUIS UNIVERSITY

Department Chairperson: Earth & Atmospheric Sciences

The Department of Earth and Atmospheric Sciences of Saint Louis University invites applications for chairperson. We seek an individual with broad interests to coordinate the research and teaching activities of a diverse department (Geology, Geophysics, and Atmospheric Sciences). In addition to proven ability as a teacher and researcher, we are looking for someone with the leadership skills to develop our research and teaching programs to meet both current and future needs. Candidates with expertise in any field of Earth or Atmospheric Sciences are encouraged to apply. Administrative experience is desirable but not essential.

The Department presently has 13 full-time faculty and 25 graduate students. We offer undergraduate degrees in all three disciplines and MS/PhD programs in Geophysics and Atmospheric Science. We have plans to institute a Masters program in Geology. Our research strengths include seismology, fault mechanics, marine geology, paleomagnetism, structural geology, severe local storms, tropical meteorology, radiative transfer, and climate studies. We are currently trying to expand our course offerings and research activity in environmentally oriented areas.

The chairperson reports to the Dean of the College of Arts and Sciences. He or she is responsible for administration and budget development and is expected to provide direction for instruction, and research programs. The chairperson is also expected to contribute to the research and teaching activities of the department. Qualifications include: an earned doctorate in the Earth or Atmospheric Sciences, a record of scholarship commensurate with the rank of associate or full professor, the ability to develop and administer education and research programs, and effective communication and interpersonal skills.

Applicants should submit a curriculum vitae, the names and addresses of at least four references, a statement of goals as chairperson, and statements of research and teaching interests. Applications should be received by December 15, 1993, but will be accepted until the position is filled. Application materials should be directed to:

Search Committee Chair
Department of Earth and Atmospheric Sciences
Saint Louis University
St. Louis, MO 63103
(314)658-3131.

Saint Louis University is an equal opportunity/affirmative action employer. Women, minorities, veterans, and people with disabilities are encouraged to apply.

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 and mail this coupon along with your subscription mailing label (use label from this newsletter) to: GSA, Membership Services, P.O. Box 9140, Boulder, CO 80301-9140. Or you may call with your change of address information—(303) 447-2020 or 1-800-472-1988.

(North American subscribers should report address changes 6 weeks in advance; all others, three months in advance.)

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Opportunities for Students

Visiting Fellows and Students/Institute for Rock Magnetism. Applications are invited for visiting fellowships (regular and student) lasting for up to 3 weeks during the period from March 1, 1994, through August 31, 1994.

Topics for research are open, although fellows are encouraged to take advantage of the chosen focus for cooperative reasearch in a given year. During 1994-5, the focus for research will be the connections between the fundamentals of rock magnetism and paleomagnetic observations.

Short proposals (two pages, single-spaced text plus necessary figures and tables) are due by December 17, 1993, for consideration by the Institute's Review and Advisory Committee (Richard Reynolds, Chair).

Successful applicants will be notified in early February 1994.

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

The Institute Staff (Bruce Moskowitz, Associate Director, and Christopher Hunt, Facilities Manager) will be happy to provide application forms and information necessary for proposal preparation.

Deadline for submission is December 17, 1993, at the following address: Chris Hunt, Facilities Manager, Institute for Rock Magnetism, University of Minnesota, 293 Shepherd Laboratories, 100 Union St. SE, Minneapolis, MN 55455-0128, (612) 624-5274; Fax: 612-625-7502; E-mail: chunt@staff.tc.umn.edu.

UNIVERSITY OF MINNESOTA. Opportunities with the Interdisciplinary Research Training Group (RTG) for "Paleorecords of Global Change: Understanding the Dynamics of Ecosystem Response." Rock magnetism and geochemistry (including isotopes) constitute strong research components. Stipend recipients must be citizens, nationals, or permanent residents of the U.S. Applications and additional information for the following are available from Sue Julson, University of Minnesota, Ecology, Evolution and Behavior, 1987 Upper Buford Circle, St. Paul, MN 55108. Phone (612) 624-4238; Fax: 612-624-6777.

POSTDOCTORAL FELLOWSHIP available for research training. 18 month appointment. Application deadline January 1, 1993.

GRADUATE TRAINEESHIP: 3-year traineeships available for graduate study in conjunction with interdepartmental RTG in above study. Application deadline January 15, 1993.

An Equal Opportunity Educator and Employer.

Student Travel Grants. The GSA Foundation will award matching grants to each of the six GSA Sections to assist students wishing to travel to GSA Section and Annual meetings. For applications contact individual Section secretaries. For Section information contact GSA (1-800-472-1988).

JOI/USSAC Ocean Drilling Fellowships. JOI/U.S. Science Advisory Committee is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct reseach compatible with that of the Ocean Drilling Program. Both one-year and two-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs, and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward the objectives of a specific leg or to broader themes. Proposals and applications should be submitted to the JOI office according to the following schedule: Shorebased Research (regardless of DSDP or ODP leg) 12/1/93. For more information and to receive an application packet, contact: JOI/USSAC Ocean Drilling Fellowship Program, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102 (Andrea Leader: 202-232-3900).

Student Opportunities at UT-Dallas. The Programs in Geosciences at The University of Texas at Dallas are offering two fellowships as well as competitive assistantships to qualified students. The Excellence in Education Fellowship provides support for a highly qualified incoming geoscience graduate student. An annual stipend of $15,888 is provided, including insurance benefits and waiver of out-of-state tuition. This amount is supplemented with up to $1250 in tuition waivers to offset the in-state tuition. The Anton L. Hales Fellowship in geophysics, awarded to an exceptional incoming Ph.D. applicant, carries an annual stipend of $15,000, insurance benefits, waiver of tuition and fees, and a $500 travel allowance to attend geological and geophysical meetings. Teaching and research assistantships range from $8500 per nine months for M.S. and entry level Ph.D. students to $9900 per nine months for Ph.D. candidates after passing their qualifying exam. Two additional months of summer salary are commonly available. Insurance benefits, waiver of out-of-state tuition and up to $1250 per year in tuition and fee supplements are included for supported students.

The University of Texas at Dallas is located in Richardson, a suburb of Dallas. It was created in 1969 as a component of the University of Texas System. The university is a graduate and undergraduate institution continuing the tradition of research established in the Southwest Center for Advanced Studies, the private research institute that preceded the current campus. There are approximately 8900 students of which a little less than half are graduates. The Programs in Geosciences maintain a wide range of analytical and experimental equipment as well as computer facilities for geophysical, geochemical, and other geological studies. Interested students are encouraged to contact Dr. Kent C. Nielsen, Head, Programs in Geosciences, The University of Texas at Dallas, P.O. Box 830688, Richardson, TX 75083-0688. Phone (214) 690-2401; Fax 214-690-2537, E-mail: geosci@utdallas.edu.

Services & Supplies

Call for Nominations

1994 John C. Frye Environmental Geology Award

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

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

CRITERIA FOR NOMINATION

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

BASIS FOR SELECTION

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

1993 AWARD RECIPIENT NAMED

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

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