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Soil and Ecosystem Development Across the Hawaiian Islands

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ABSTRACT

Biological and geologic processes interact to drive the development of soils and ecosystems across a well-defined 4.1 m.y. sequence of rainforest sites in the Hawaiian Islands. Weathering of the parent rock is the major source of most plant nutrients in young sites, but the more readily weathered minerals are depleted by 20,000 yr, and soil fertility declines in

the oldest sites. The supply of biologically available nitrogen limits plant production early in the sequence, while phosphorus supply limits production in the oldest site. The geologic processes of weathering, mineral transformation, and leaching set boundary conditions for terrestrial systems and interact with shorter term biological processes and feedbacks that control plant production, carbon storage, and nutrient cycling.

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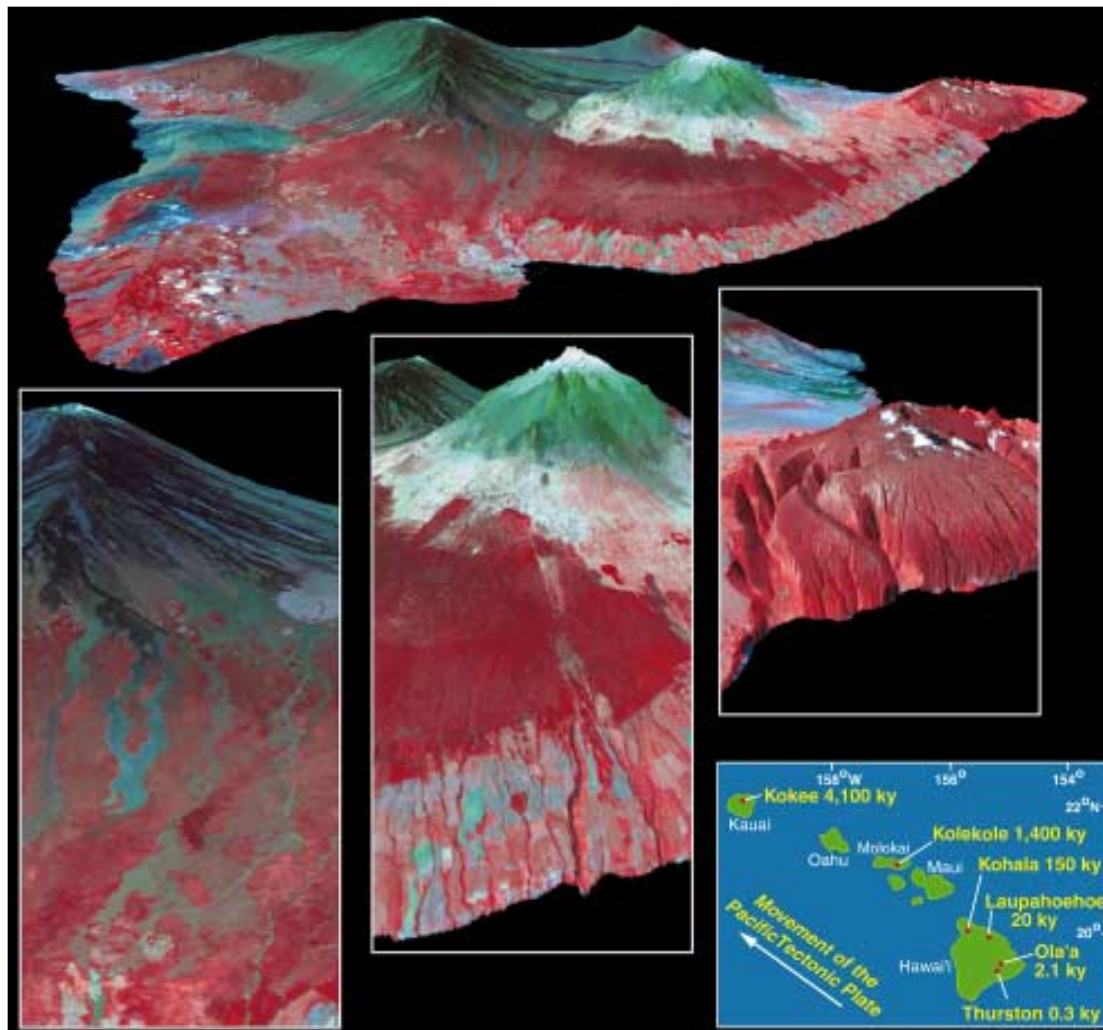
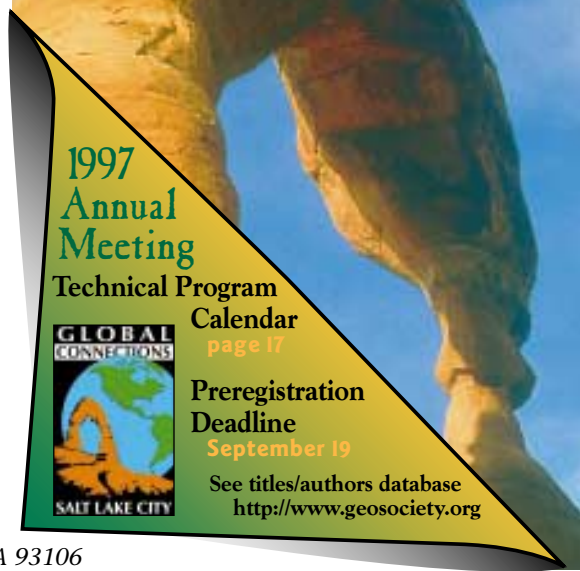


Figure 1. A perspective of the Island of Hawaii, with close-up views of Mauna Loa, Mauna Kea, and Kohala Volcanoes (left to right). The inset map shows the full sequence of sites, with ages of the underlying substrates. From southeast to northwest, each volcano is progressively older—a result of translation of the Hawaiian Islands by movement of the ocean crust over a stationary mantle plume. The development of soils slows infiltration of rainwater into the underlying lava, yielding more deeply eroded surfaces on progressively older volcanoes, as is visible here. These images are cloud-free SPOT mosaics overlain on a digital elevation model; image processing by Steven Adams at JPL.



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INTRODUCTION

Biological and geochemical processes interact to drive the development of soils and ecosystems. Over tens of thousands to millions of years, they shape characteristics as disparate and important as the development and degradation of soil fertility, the structure and dynamics of landscapes, and the role of terrestrial systems as a source or sink for atmospheric carbon dioxide. Understanding how biological and geochemical processes interact is inherently complex; it is further complicated by the fact that the underlying processes occur on very different time scales, and are studied by different communities of scientists.

A broad-brush understanding of the development of soils and ecosystems on wholly new substrates has been synthesized from studies carried out at widely different scales and summarized in several conceptual models (Walker and Syers, 1976; Jenny, 1980; Fox et al., 1991; Van Breeman, 1993). In humid areas, we recognize three broad phases of development.

1. *Building*, which begins with a new substrate deposited by receding glaciers, volcanic eruptions, or other geologic processes. The chemical weathering of primary minerals in this new substrate releases elements into soluble and biologically available forms, from which they can be used by organisms, lost via water percolating through the soil, or retained in secondary minerals in the soil. Plant growth during the building phase is constrained by slow dispersal of plants to newly exposed sites, by often-harsh physical and microclimatic conditions, and/or by the supply of fixed nitrogen (which alone among essential plant nutrients is absent from most new substrates).

2. *Sustaining*, during which the most soluble primary minerals have been depleted, but weathering of more resistant minerals continues to contribute elements

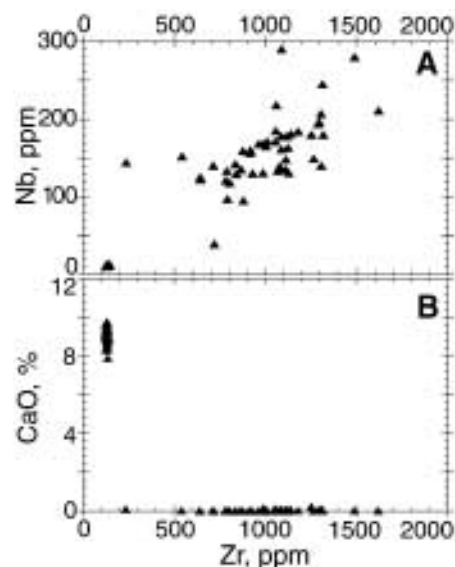


Figure 2. A: Comparison of contents of two relatively immobile elements (Zr and Nb) in rock and weathered soils. B: Comparison of an immobile element (Zr) with a mobile one (Ca). Concentrations are corrected for organic matter content. The Zr content of lava ranges between 100 and 200 ppm; Nb content is between 10 and 20 ppm; elevated values reflect concentration due to leaching of mobile elements. CaO is rapidly leached from soils, as indicated by the low values at even slightly elevated Zr levels.

to soluble pools and to buffer atmospheric and biological acidity. Clay particles that form as secondary minerals within the soil retain relatively mobile cations like Ca, Mg, and K by ion exchange. Atmospherically derived N and less mobile rock-derived elements such as P reach their maximum biological availability.

3. *Degrading*, by which virtually all primary minerals have been depleted, or are too deep in the soil to contribute to ecosystems. Atmospheric and biological acidity are no longer buffered by weather-

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In Memoriam

Charles L. Drake

Hanover, New Hampshire
July 8, 1997

Samuel J. Kozak

Lexington, Virginia
August 1997

Kenneth A. Sargent

Prospect Harbor, Maine
May 19, 1997

William M. Sandeen

Houston, Texas
September 20, 1996

Eugene M. Shoemaker

Flagstaff, Arizona
July 18, 1997

Miguel A. Uliana

Argentina
July 1, 1997

Eugene M. Shoemaker 1928–1997

GSA Fellow Eugene Shoemaker, Flagstaff, Arizona, died July 18 in a car accident near Alice Springs, Australia. Shoemaker and his wife Carolyn, who was injured in the accident, were in Australia to study impact craters. Working together, the pair had discovered many asteroids and comets, the most famous of which was Shoemaker-Levy in 1993. Among Gene Shoemaker's many honors and awards were GSA's Day Medal, in 1982, and the GSA Planetary Geology Division's first G. K. Gilbert Award, in 1983. He was employed by the U.S. Geological Survey from 1948 to 1993, and he organized and headed the USGS Center of Astrogeology.

A memorial tribute will be held at the GSA Annual Meeting in Salt Lake City.
See p. 22 for details.

Charles L. Drake 1924–1997

GSA Fellow and former president Charles L. Drake, emeritus professor, Dartmouth College, died on July 8 at his home in Norwich, Vermont. He was the main proponent of the theory that widespread volcanic eruptions, rather than a meteorite impact, led to the extinction of the dinosaurs. Chuck Drake served on numerous GSA committees, as well as committees of the National Academy of Sciences and the National Research Council. He was president of GSA in 1977, and he received the Geophysics Division's George P. Woollard Award in 1985.

Hawaiian *continued from p. 2*

ing; soils acidify and the solubility of toxic Al increases. Even relatively immobile P has been lost, or bound up in recalcitrant, insoluble, and/or physically protected forms that organisms cannot use. Biological activity is constrained by the low availability of P and/or other rock-derived elements—and unless new geologic activity (volcanism, glaciation, erosion) rejuvenates the soil, only continued degradation can be anticipated.

While many of these features of long-term soil and ecosystem development have been observed in field studies, the nature and consequences of interactions between ecological processes (on time scales of months to decades) and pedological processes (with time scales of centuries to millions of years) are little known—in large part because few places contain well-preserved landforms of vastly different ages that are underlain by similar substrates, and influenced by similar climates and biotic communities.

Crews et al. (1995) described a developmental sequence of sites in the Hawaiian Islands that offer the opportunity to integrate ecological, pedological, and geochemical approaches to understanding long-term soil and ecosystem development. We are analyzing this developmental sequence, with the aims of (1) describing the underlying patterns and processes of soil and ecosystem development, over hundreds to millions of years, (2) determining how interactions between biological and geochemical processes shape the dynamics of soils and ecosystems, and

(3) evaluating their regional and global implications.

Sequence of Sites

Several features of the Hawaiian Islands make them particularly suitable for studies of long-term soil and ecosystem development. First, the Hawaiian Islands result from the movement of the Pacific tectonic plate over a stationary “hot spot” in the mantle (Hawaii Scientific Drilling Project Team, 1996). Distance from the currently active volcanoes at the southeast extreme of the archipelago closely corresponds to substrate age (Fig. 1), and ages of the different surfaces have been characterized well on both short and long time scales (Clague and Dalrymple, 1987; Wolfe and Morris, 1996). Second, other variables can be held nearly constant. The substrate in which soil and ecosystem development begins is all mantle-derived lava, with relatively little chemical variation in space or time (Wright and Helz, 1987). The maritime tropical environment reduces the impact of Pleistocene climate change, precluding glaciation (which would reset soil and ecosystem development) except at the highest elevations. Topographic position can be kept constant by selecting sites on the well-defined constructional surfaces of the shield volcanoes, which persist as remnants into the oldest sites (MacDonald et al., 1983). Even the dominant organisms can be kept constant—the Hawaiian Islands are the most isolated archipelago on Earth, and the few species that colonized naturally have radiated to occupy an extremely broad range of environments and soils (Carlquist, 1980).

Crews et al. (1995) selected six forested sites arrayed across the Hawaiian Islands; the ages of the underlying tephra substrates are approximately 300, 2100, 20,000, 150,000, and 1,400,000 yr, and 4.1 m.y. Landforms associated with the four youngest sites are illustrated in Figure 1. All six sites are near 1200 m elevation, with 16 °C mean annual temperature, and all currently receive approximately 2500 mm of precipitation annually. All support intact rain-forest vegetation dominated by the native tree *Metrosideros polymorpha* (Kitayama and Mueller-Dombois, 1995).

The sequence is not perfect—no attempt to trade space for time can be. For example, Pleistocene climatic variations are known to have occurred in Hawaii, if in a dampened form relative to continental and temperate areas, and so sites older than 14,000 yr have undergone much of their development in conditions that differ from those of the present (Gavenda, 1992; Hotchkiss and Juvik, 1993). Other sources of variation include isostatic subsidence of the islands (Moore and Clague, 1992), differences in lava chemistry between shield-building and postshield volcanic phases (Wright and Helz, 1987), subtle effects of surface erosion, varying inputs of atmospheric dust from Asia (Fox et al., 1991), and the recent introduction of plant and animal species from outside Hawaii (Vitousek and Walker, 1989). Nevertheless, environmental variation that could affect soils and ecosystems can be constrained in Hawaii to an extent that cannot be matched elsewhere.

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RESULTS AND DISCUSSION

Weathering and Mineral Transformations

Immediately after a volcanic eruption, the lava substrate is composed primarily of glass, olivine, clinopyroxene, feldspar, and magnetite-ilmenite. These minerals weather rapidly in the high-rainfall rain-forest environment, particularly after plants become established (Cochran and Berner, 1997). We calculated the absolute loss of each element from the soil relative to an immobile component, using mass-balance procedures that take into account the initial state of the lava, volume change during soil formation, and additions of atmospheric dust. Between four and six soil profiles at each site were sampled by genetic horizon and analyzed for total element concentrations using plasma emission spectroscopy on a borate fusion for Si, Al, K, Ca, P, Mg, and Nb and by X-ray fluorescence spectroscopy for Zr. Elemental loss or gain relative to initial lava values was calculated following Brimhall et al. (1992):

$$\delta_{j,w} = \frac{(\rho_w C_{j,w} (\epsilon_{i,w} + 1) - \rho_p C_{j,p})}{\rho_p C_{j,p}} / 100.$$

where p refers to parent material, w refers to weathered soil, i refers to an immobile element, j refers to mobile elements, ρ is bulk density, C is elemental concentration in wt%, and volume change, $\epsilon_{i,w} = (\rho_{i,p} C_{i,p}) / (\rho_{i,w} C_{i,w}) - 1$ (Chadwick et al., 1990). Here we used Zr as the immobile element; Nb was similarly conservative, in contrast to mobile elements such as Ca (Fig. 2). Mass-loss values were calculated on a whole-soil basis, integrated by horizon over the top 1 m of soil (Chadwick et al., 1990). Major elements contributed by rainout of continental dust (Jackson et al., 1971; Dymond et al., 1974) were quantified on the basis of quartz and mica contents, and subtracted prior to mass-balance analysis.

As Figure 3, parts A and B show, K, Ca, Mg, and Si are leached rapidly; <10% of their initial quantities remain after 20,000 yr. Al and P are less mobile, in that >25% of initial contents remain within the soil after >1 m.y. Compared to other studies (e.g., Merritts et al., 1992; White, 1995), these rates of weathering and loss are relatively rapid, because of both the wet tropical climate and the reactive nature of lava substrate. Volume-change calculations using Zr as the immobile index element show that soil formation initially dilates the substrate by >100% (Fig. 3C), due primarily to addition of organic carbon (see below). Following this rapid dilation, there is a gradual decline in volume due to leaching losses, leading to a 50% collapse (relative to the initial substrate) by 150,000 yr. At the oldest site, 10

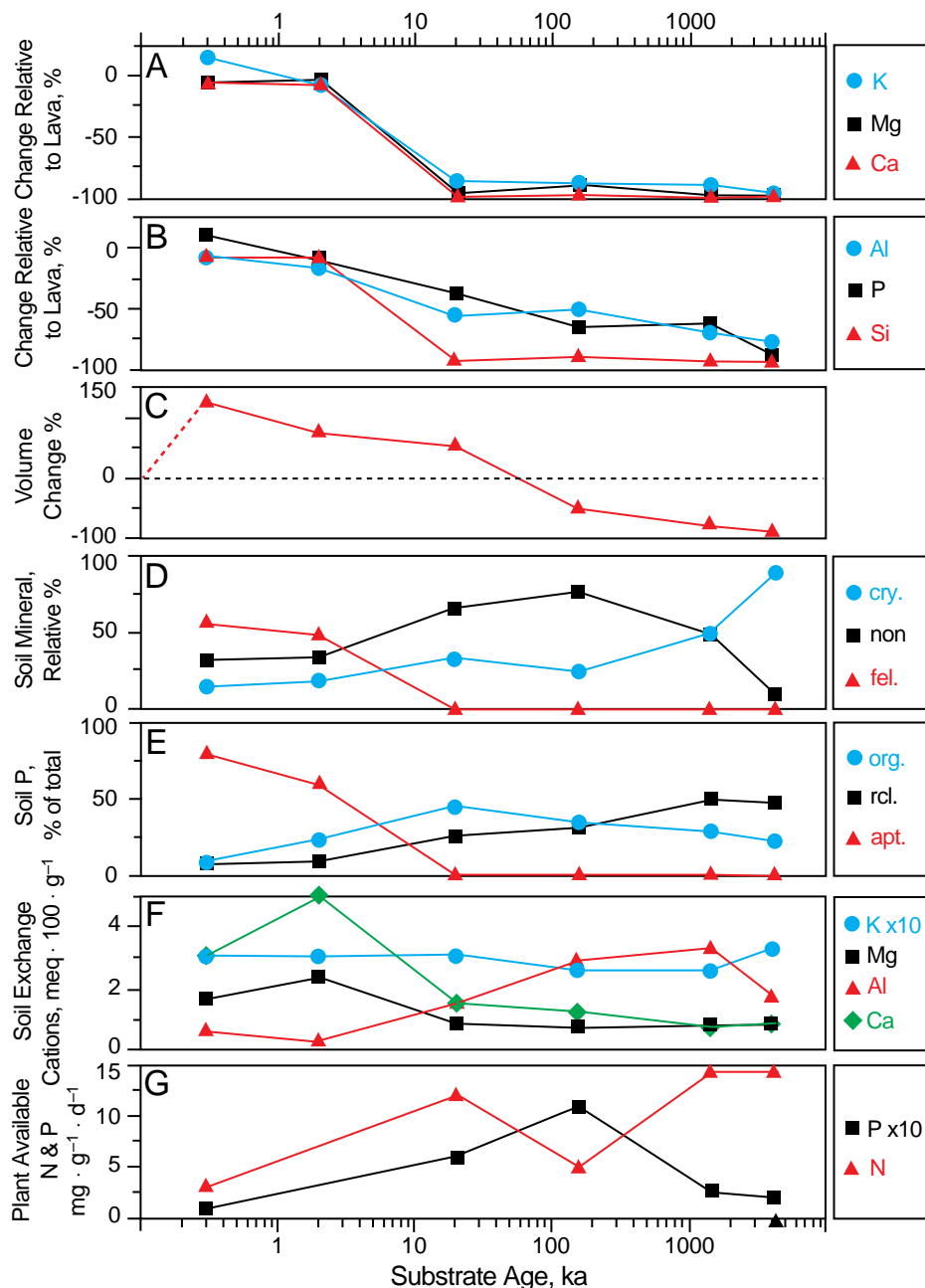


Figure 3. Weathering, mineral transformations, and plant-available nutrients during soil and ecosystem development in Hawaii. A: The fraction of parent material Ca (red), Mg (black), and K (blue) remaining in soils across the sequence. B: Fractions of parent material Si (red), P (black), and Al (blue) remaining. C: Dilation and collapse of soils due to organic matter additions and element leaching. D: The relative contribution of the primary mineral feldspar (fel.; red), of noncrystalline secondary minerals (non; black), and of crystalline kaolin and sesquioxides (cry.; blue) to soil mineralogy. E: The fraction of total soil P in the forms of the primary mineral apatite (apt.; red), organic P (org.; blue), and recalcitrant or physically protected P (ses.; black) (Crews et al., 1995). F: Exchangeably bound Ca (green), Mg (black), K (blue) (shown here $\times 10$), and Al (red). G: Resin-extractable (biologically available) inorganic N (red) and P (black) (shown here $\times 10$) in soils (Crews et al., 1995).

m of the original substrate has weathered to produce the top 1 m of soil. Soil thickness at the first five sites remains constant at about 1 m, indicating that a dynamic balance exists between atmospheric addition, weathering-driven collapse, and surface erosion for >1 m.y. On Kauai, weathering depths are greater, probably exceeding 5 m.

The primary and secondary mineral composition of the soils was identified by means of X-ray diffraction and Fourier transform infrared spectroscopy, and was quantified by use of a sequence of increasingly harsh wet chemical extractions, following Chadwick et al. (1994b). After removal of the organic matter by using

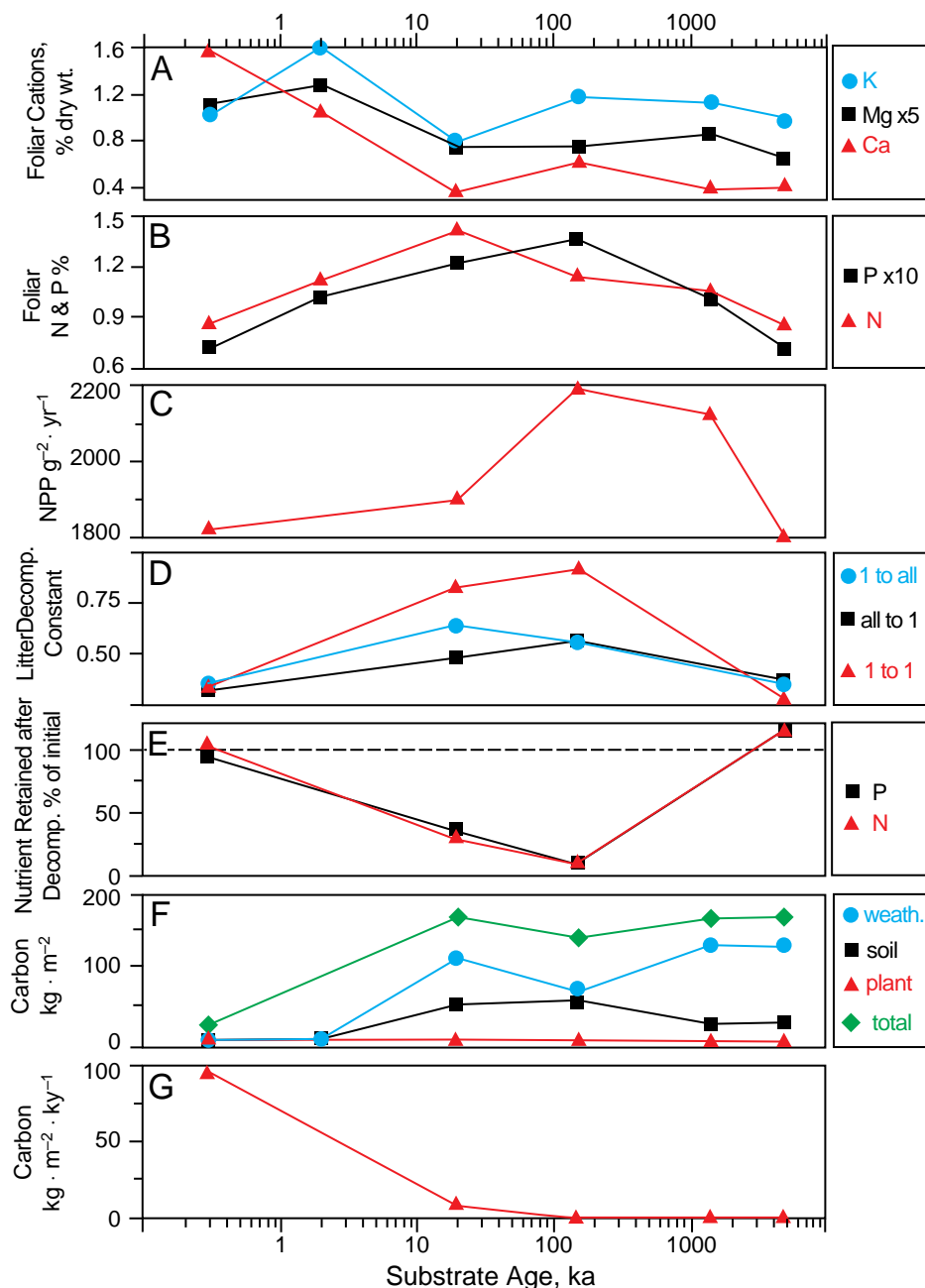


Figure 4. Plant nutrients, production and decomposition dynamics, and carbon sinks during soil and ecosystem development. A: Ca (red), Mg (black) (×5), and K (blue) in canopy leaves of the dominant tree *Metrosideros polymorpha* (Vitousek et al., 1995). B: N (red) and P (black) (×10) in *Metrosideros* leaves. C: Net primary productivity (NPP) of forests (Herbert, 1995). D: Decomposition rate (exponential decomposition constant, per year) of *Metrosideros* leaf litter, decomposed in the site where it was collected (red), collected in each site and taken to a common site (black), and collected from one site and taken to all sites (blue). E: Fraction of the N (red) and P (black) initially present in leaf litter that remains within partially decomposed litter after 2 yr (Crews et al., 1995). F: Total C storage in plant biomass (red) and in soil (black), and cumulative CO₂-C consumption during weathering (blue), in kg C · m⁻² (Herbert, 1995; Torn et al., 1997). The sum of these components is the total C sink (green). G: The rate of C sequestration per year across the sequence.

30% H₂O₂, noncrystalline minerals were determined by means of selective dissolution by acid ammonium oxalate in the dark. The residue of this dissolution was treated with Na-dithionite and Na-citrate, and the Blakemore et al. (1987) procedure was used to determine crystalline sesquioxides. Poorly crystalline minerals were then determined when this residue

was treated with 0.5 M NaOH. Finally, the residue of this procedure was heated to 500 °C, followed by dissolution in 0.5 M NaOH of the collapsed lattice, to determine kaolin; X-ray diffraction of the <2 μm fraction confirmed that the kaolin fraction was primarily halloysite. Feldspar and atmospherically derived quartz and

mica were determined on the residue of these treatments (Jackson et al., 1986).

The dominant soil minerals change dramatically along the sequence, the rapidly weatherable olivine and glass and relatively weatherable plagioclase being completely consumed by congruent weathering processes before 20,000 yr. Noncrystalline minerals (primarily ferrihydrite, allophane, and imogolite) then form a pedogenic mineral assemblage that persists for 1 m.y. or more. Allophane, imogolite, and ferrihydrite are metastable, X-ray amorphous minerals characterized by a high degree of hydration and short-range crystal order; their formation is favored over crystalline clay minerals in young soils derived from volcanic ash sources (Shoji et al., 1993). Finally, secondary kaolin and crystalline sesquioxide minerals characteristic of highly weathered tropical soils accumulate slowly, but in the two oldest soils these minerals begin to dominate the <2 μm fraction (Fig. 3D). The change from allophane-imogolite-ferrihydrite to kaolin-sesquioxide is important because the former minerals have large and reactive surface areas that bind cations, phosphorus, and soil organic matter more effectively than the latter minerals (Wada, 1989; Schwertmann and Taylor, 1989).

Transformations and losses of P are particularly significant during long-term soil and ecosystem development, both because of P's biological importance and because its inputs from the atmosphere are very small. We measured the chemical forms and hence long-term biological availability of P in these soils following Tiessen and Moir (1993). As P is lost from soil (Fig. 3B), its forms change systematically from primary minerals in the young sites, to organic P in the 20,000- and 150,000-yr-old sites, and then on to insoluble or physically protected (and hence biologically unavailable) Fe- and Al-bound P in the oldest sites (Fig. 3E).

Soil Nutrient Availability and Plant Nutrient Pools

A small fraction of each element in soil is present in solution or in readily exchangeable forms that organisms can use. Exchangeable pools of Ca and Mg decline from young to intermediate-aged substrates, and remain low thereafter—while exchangeable Al, which can inhibit root growth at high concentrations, increases across most of the sequence (Fig. 3F). Available pools of inorganic N (ammonium plus nitrate) and P both are low in the youngest site and increase into the intermediate-aged sites; P declines thereafter, while N availability remains high (Fig. 3G). Other measures of N availability yield a similar pattern (Riley and Vitousek, 1995). The low availability of P

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Hawaiian continued from p. 5

early reflects the fact that most P remains in primary minerals in young soils (Fig. 3E); the decline in available P late reflects both an absolute loss of P and the fact that the majority of residual P is in insoluble or physically protected Fe and Al oxyhydroxide-bound forms (Fig. 3, B and E).

Concentrations of elements in live tree leaves generally reflect available nutrient pools in the soil, for both the dominant tree *Metrosideros polymorpha* (Fig. 4, A and B) and for eight other species sampled across the sequence (Vitousek et al., 1995). Cation concentrations are high early and decline by 20,000 yr, while P and N concentrations increase to a peak in the intermediate-age sites and decline thereafter. Nitrogen concentrations in leaves in the older sites follow soil P availability more closely than they do soil N availability (Figs. 3G and 4B).

Plant Production, Decomposition, and Nutrient Cycling

Net primary production (NPP) of forests was determined at five sites across the sequence (Herbert, 1995). Production peaks in the intermediate-aged sites, later in the sequence than do soil or plant nutrients (Fig. 4C), and variation in NPP is small (~15%) relative to variation in other plant and soil properties. Rates of decomposition of leaf litter (senescent leaves) dropped by the dominant *Metrosideros* trees were measured at four sites, by using litter bags as described in Crews et al. (1995). Litter decomposes much more rapidly (up to threefold faster) in the intermediate-aged sites compared to either the youngest or the oldest site (Fig. 4D), despite the constancy of both precipitation and temperature across the sequence. Live leaves in these intermediate-aged sites are relatively enriched in N and P (Fig. 4B), and the trees in those sites withdraw less N and P from leaves before dropping them than do the trees in the youngest and oldest sites (Riley and Vitousek, 1995; Herbert, 1995).

This relatively efficient within-tree cycling of N and P in the youngest and oldest sites, coupled with increased leaf longevity there, maintains relatively high NPP despite low nutrient availability (Herbert, 1995). However, by reducing N and P concentrations in leaf litter, it slows rates of nutrient cycling between soil and plants. Leaf litter in the youngest and oldest sites decomposes slowly—and it is decomposition that transforms organically bound nutrients back into forms available to plants. We determined the fraction of the N and P present in freshly fallen leaf litter that remains within decomposed litter or its associated microbes (and hence not available to plants) after 2 yr of decomposition. There was little net release of plant-available N or P in the youngest

and oldest sites—indeed, in some cases microbes accumulate additional nutrients from soil or solution. However, 70%–90% of the N and P in leaf litter from more fertile intermediate-aged sites has been cycled back into plant-available forms within two years (Fig. 4E).

This difference in the regeneration of available nutrients in fertile vs. infertile sites can drive a positive feedback between plants and soil. Plants drawing upon high levels of available nutrients in soil produce tissue and litter with relatively high nutrient concentrations (Fig. 4, A and B); these decompose more rapidly than litter from infertile sites, and they regenerate available nutrients much more rapidly (Fig. 4, D and E), thereby maintaining high levels of available nutrients. Conversely, plants in infertile sites produce low-nutrient leaves that decompose and regenerate nutrients slowly, thereby accentuating low nutrient availability in soil (Vitousek, 1982; Wedin and Tilman, 1990).

Implications for Nutrient Limitation

The observed changes in nutrient availability and cycling across this Hawaiian developmental sequence are consistent with conceptual models suggesting that a low supply of N constrains biological activity on young substrates, while a low P supply does so on very old sites; the supply of N and P should be greater, and more or less in balance, in intermediate-aged sites (Walker and Syers, 1976). We evaluated this pattern experimentally in three sites on the sequence—the youngest (300 yr), the relatively fertile 20,000-yr-old site, and the oldest (4.1 m.y.) (Vitousek et al., 1993; Herbert and Fownes, 1995; Vitousek and Farrington, 1997). In each site, we fertilized with N, P, and a combined treatment that included all essential elements other than N and P, applying the nutrients to replicated plots, singly and in all factorial combinations, for at least 2 yr, as described in Vitousek and Farrington (1997).

Additions of elements other than N and P did not affect plant growth in any site. As predicted by the Walker and Syers (1976) model, additions of N stimulated growth in the youngest site, while P had no effect there. In contrast, P additions stimulated growth in the oldest site, where N had no significant effect. Neither N nor P alone increased tree growth substantially on the intermediate-aged site, although in combination they nearly doubled it (Fig. 5), suggesting that the supply of N vs. P has more or less equilibrated in this site.

Sinks for Atmospheric Carbon Dioxide

Soils and ecosystems can represent sinks for atmospheric CO₂ in three major ways. First, plants take up CO₂ and store it in accumulating biomass; wood in particu-

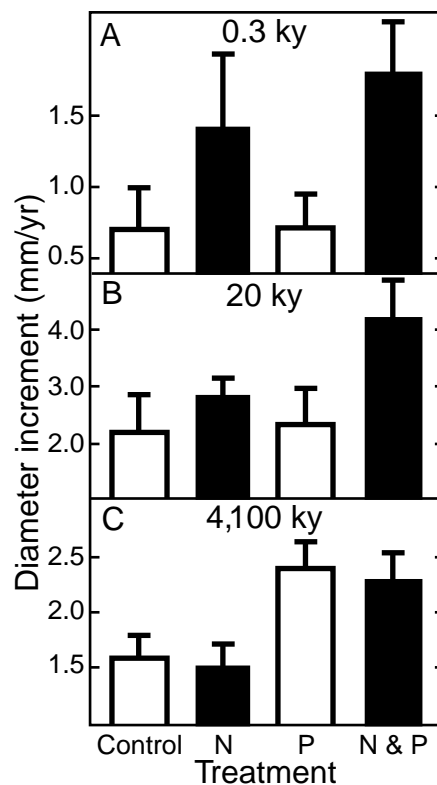


Figure 5. Nutrient limitation to plant growth during soil and ecosystem development in Hawaii (Vitousek and Farrington, 1997). Diameter growth rate of canopy *Metrosideros* trees is shown for (A) the 300-yr-old site, in control plots and in N, P, and N + P-fertilized plots; (B) the 20,000-yr-old site; and (C) the 4.1m.y.-old site.

lar can be a substantial and long-lived sink. Second, breakdown products of plants and other organisms accumulate as soil organic matter; globally, soils contain about twice as much organic C as does living plant biomass (Schlesinger, 1991). Finally, dissolved CO₂ is a source of acidity that can drive mineral weathering in soils, and the resultant HCO₃⁻ anion leaches to aquatic systems and ultimately the ocean, in association with soluble products of weathering (Chadwick et al., 1994a). Our calculation of the weathering sink assumes that HCO₃⁻ is the major anion involved in the net transport of cations. The strengths of these C sinks across the Hawaiian developmental sequence are summarized in Figure 4F. Up to 300 yr, the net removal of C from the atmosphere averages nearly 100 g • m⁻² • yr⁻¹ (Fig. 4G); each of the three sinks contributes about equally to the total. If we assume (conservatively) that forest productivity of C is constant at ~900 g • m⁻² • yr⁻¹ up to 300 yr (Fig. 4C), then the site represents a net sink for 11% of all net photosynthetic C fixation in that period.

By 20,000 yr, weathering has become the single most important C sink, followed by soil organic matter. A substantial quantity of C is removed from the atmo-

sphere between 300 and 20,000 yr, but the average rate of removal decreases substantially after 300 yr (Fig. 4G), to less than 1% of forest production. After 20,000 yr, there is no further net C storage; an increase in the weathering sink is offset by a decrease in net C storage in plants and particularly soils (Fig. 4F), the latter reflecting reduced binding of organic C by the highly weathered secondary minerals present in the oldest sites (Torn et al., 1997). Long-term C sinks are largely confined to building systems; they occur at times and in regions where geologic disturbances such as glaciation and volcanic eruptions reset soils and ecosystems to early stages of development.

IMPLICATIONS

This sequence of sites across the Hawaiian Islands represents a relatively simple set of systems within which geologic and biological processes involved in soil and ecosystem development, and their interactions and regulation, can be evaluated more or less straightforwardly. While the processes underlying long-term soil and ecosystem development here are general ones, the rates and some of the details of change in this sequence cannot be applied globally. The transitions from the building to the sustaining phase probably occur more rapidly in these Hawaiian sites than in many places, due to abundant rainfall, relatively warm temperatures year-round, and easily weathered primary minerals. Later, the alteration of secondary minerals from metastable noncrystalline allophane (and others) to crystalline kaolin and sesquioxide that accompanies the transition from the sustaining to the degrading phase is probably more rapid than the corresponding changes from illite, smectite, and/or vermiculite to kaolin and sesquioxide that occur on non-volcanic substrates.

Nevertheless, we believe that the understanding of biogeochemistry gained on this Hawaiian sequence should be broadly applicable to understanding the development of soils and ecosystems in continental as well as island systems. The release of nutrients through the weathering of primary minerals, and the eventual loss of those nutrients by leaching, are sufficient to explain the existence of building and especially degrading phases of soil development. Biological processes operating on shorter time scales interact with these geological boundary conditions to shape nutrient availability and cycling in terrestrial ecosystems. The decomposition-driven plant-soil positive feedback in particular reduces rates of nutrient cycling during the building and degrading phases of soil and ecosystem development, when the supply of particular nutrients is already low; it thereby accentuates developmental differences in nutrient availabil-

ity that are driven (ultimately) by geochemical and hydrological processes.

We believe that the variations during soil and ecosystem development outlined here, and the mechanisms controlling them, can be used to evaluate how terrestrial ecosystems function on regional and global scales. For example, the change from limitation by N in the building stage to limitation by P in the degrading stage (Fig. 5) probably represents a general feature of ecosystems. If so, the ongoing human enhancement of global N fixation and the consequent N enrichment of many terrestrial ecosystems (Galloway et al., 1995) will have their greatest effects on the composition, diversity, functioning, and carbon dynamics of terrestrial ecosystems (c.f. Aber et al., 1995; Howarth et al., 1996; Vitousek et al., 1997) that are in building rather than sustaining or degrading stages of development. Building systems are much more widespread in recently glaciated regions of the north temperate and boreal zones (and volcanic or recently uplifted mountains in the tropics) than in most of the lowland tropics, where extensive areas are underlain by geologically quiescent substrates and support highly weathered soils. Moreover, inputs of anthropogenic N now are concentrated in the north temperate region—so we are inadvertently fertilizing just those systems that are most likely to be affected by additional N.

ACKNOWLEDGMENTS

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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. These reports present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

Global Learning and Observations To Benefit the Environment (GLOBE)

Because a large percentage of GSA members are involved in education, the Global Learning and Observations to Benefit the Environment program (GLOBE) is the subject of this month's Washington Report, especially given that a National Science Foundation (NSF) Announcement of Opportunity for Science/Education Teams (NSF 97-129) for GLOBE is available. GLOBE is a network of K-12 students, teachers, and scientists from around the world working together to learn more about our environment. The GLOBE program is designed to increase scientific understanding of Earth, student achievement in science and mathematics, and environmental awareness of individuals. The GLOBE program, which is championed by vice-president Al Gore, last

requested proposals in 1994. The deadline for responding to the latest request is October 15, 1997.

In addition to NSF, the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) cooperate on GLOBE. Projects supported by the GLOBE program currently include kindergarten through twelfth-grade students at more than 1,500 schools. These students and their teachers make environmental observations following established research protocols. Data are reported via the Internet to the GLOBE Student Data Archive. More than 2,000 additional schools and other educational venues have also committed to following these

same protocols. Data collected through GLOBE are publicly available.

GLOBE also supplies training to teachers and teacher-trainers in the implementation of this program, taking its measurements, and using its learning activities, which complement the measurements. Various information resources are provided on-line, including visualizations of some data and GLOBEMail, a Web-based mail system that allows program participants around the world to communicate with one another. A tour of the GLOBE program and additional information about the announcement can be found at the GLOBE Web site at <http://www.globe.gov>.

It is anticipated that 20 to 50 proposals, including international participants on a no-exchange-of-funds basis, will be selected for the GLOBE program. Approximately 20 awards to U.S. institutions are expected to total approximately \$3.6 million per year in combined funding from the three agencies, depending on the quality of the proposals received and the availability of funds.

The NSF announcement indicates that GLOBE is seeking proposals in five specific areas:

1. Scientific Involvement in GLOBE and Its Measurements. Proposals for this area

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Hawaiian *continued from p. 7*

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Each month, *GSA Today* features a short science article on current topics of general interest. For guidelines on submitting an article, contact either *GSA Today* Science Editor:

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require environmental research using GLOBE student data and culminating in publications in the refereed scientific literature. Participants must also assume responsibility for one or more existing or new GLOBE measurement protocols. The announcement identifies a complex of activities that this area requires, including confirming protocols, supporting the overall training and outreach activities of GLOBE, participating in "Web chats," providing on-line messages and visiting GLOBE schools. Present GLOBE areas of observation include: atmosphere/climate, hydrology, land cover/biology, and soil. It is anticipated that 10 to 30 proposals will be selected, including those submitted by the international community on a no-exchange-of-funds basis.

2. Development of Learning Activities.

Proposals for the development of learning activities in support of GLOBE measurements must include the development of new learning activities that complement the GLOBE measurement protocols. The announcement indicates that GLOBE will select efforts in the development of learning activities that incorporate an inquiry-based approach, including the use of questioning, planning, and conducting investigations,

use of tools to collect and analyze data, development of explanations about conclusions of investigations, and communication of results by students. Proposals should involve and encourage use of tools such as modeling, geographic information systems, and visualizations and use of comparisons with remote sensing data in the analysis of GLOBE data. It is anticipated that five to 15 such proposals will be selected, including those submitted by the international community on a no-exchange-of-funds basis.

3. Design of U.S. Student Assessment Tools for Protocols and Learning Activities.

These proposals should include development of and ongoing support for tools that can be used to assess student understanding of all aspects of GLOBE, including assessment tools for both the protocols and learning activities. It is expected that only one award will be made for support of student assessment. For this area, proposals must be from U.S. institutions.

4. Evaluation. Proposals in this area should include the establishment of clear indicators, both quantitative and qualitative, by which the effectiveness of GLOBE can be measured with respect to a series of defined program goals. It is expected that only one award will be made for support of GLOBE evaluation.

For this area, proposals must be from U.S. institutions.

5. Development and Integration of Educational Materials. Proposals should enhance the current GLOBE Teacher's Guide and the overall set of GLOBE materials. It is expected that only one award will be made for support of development and integration of educational materials. All proposals must be from scientist-educator teams, and the principal investigator must be either a scientist for proposals in area 1 or an educator in the case of the other four areas. NSF awards to U.S. institutions and GLOBE agreements with non-U.S. institutions will be for up to four years with an approximate starting date of May 1998.

Currently, GLOBE measurements are grouped into four areas or investigations: Atmosphere/Climate, Hydrology, Land Cover/Biology, and Soil.

There is also an investigation for Global Positioning System (GPS) measurements that the students are required to make at their school and at each of their measurement sites. For each of these measurement groups, additional material is provided including background information, interviews with the principal investi-

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GSA ON THE WEB

Visit the GSA Web Site at <http://www.geosociety.org>.

From our home page you can link to many information resources. Here are some highlights:

On our **Membership** page you'll learn about the GSA Employment Service, find out how to become a GSA Campus Representative, or learn how to get forms to join GSA as a professional or as a student. You'll also find information here on how to nominate a GSA Member to Fellowship standing.

Although the **abstract deadline** for Salt Lake City has now passed, during the month of September the Web-submission system is open to receive abstracts on **late-breaking research or events**. Special conditions apply, including a \$50 fee, and a justification (see p. 16). Look under "Meetings" on GSA's home page for the link to the submittal form. This year, check our Web site to see if your abstract was accepted and, if so, when and where it is scheduled. The **Meetings** page also provides lots of other information on the GSA Annual Meeting in Salt Lake City, including symposia and theme listings, field trips, continuing education courses, special programs, registration information, and travel and lodging information.

Under **Publications**, the look and feel of the GSA Web Bookstore is changing, so check it out. You can order any GSA book, map, or transect. For authors, there's the information for contributors page, and for those seeking copyright permissions there's information on what's needed.

The *GSA Data Repository* (DRP) is here, too. You'll find all DRP entries since 1992, in Adobe Acrobat format for easy

download via your browser. These Data Repository entries supplement some articles in GSA's journals. This is a new, faster way to obtain these data.

Every month, you'll find tables of contents and abstracts of journal articles for *GSA Bulletin* and *Geology*, plus information for authors on preparation of articles for submission to GSA.

In the **Education** section, read about GSA's educational programs, including PEP (Partners for Education Program), and the Earth and Space Science Technological Education Project (ESSTEP). Find out about GSA's environment and public policy activities in the **Institute for Environmental Education** section, including updates on the GSA Congressional Science Fellowship program, the Roy J. Shlemon Applied Geology Mentor Program, and the U.S. Geological Survey-National Biological Service scientific opportunities workshop.

Under **Foundation** you will find information on the Foundation and the current annual giving campaign, a list of trustees and officers, and several ways to make a planned gift.

See the **Administration** section for information on GSA Medals and Awards, research grants, and other general information about GSA. You can also link to the pages for GSA Sections and Divisions for specific information on each of these.

gators, and a description of the context for the scientific use of the data.

Current GLOBE measurements for Atmosphere/Climate include: cloud cover and cloud type; ultraviolet flux within one hour of local solar noon; liquid precipitation within the previous 24 hours; solid precipitation within the previous 24 hours and its liquid water equivalent; total snow accumulation; pH of rain or melted snow; atmospheric temperature within one hour of local solar noon and maximum and minimum temperatures within the previous 24 hours.

Current GLOBE measurements for Hydrology include: surface water temperature; pH; conductivity of fresh water or salinity of salt or brackish water; dissolved oxygen; nitrogen as nitrate; turbidity of the water column or surface water.

Current GLOBE measurements for Land Cover/Biology include: extent of canopy and ground cover; dominant and subdominant species in the canopy and the heights and circumferences of five individuals of each of these species for forest, woodland, or shrub land sites; dominant and subdominant species, and dry biomass of one square meter during the growing season for grassland sites; manual and unsupervised classifications of 15 km by 15 km GLOBE Study Sites centered on each school using Landsat Thematic Mapper data and the Modified UNESCO Classification system and accuracy assessment of these classifications; land cover assessment at selected sample sites.

Current GLOBE measurements for Soil include: characterization of each horizon in profiles of the top one meter of soil, including structure, color, consistence, texture, sand, silt, and clay content, pH, fertility (nitrogen as nitrate, phosphate, and potassium content), bulk density, and vertical extent; soil moisture in the top 5 cm to one meter of soil; infiltration of water into the soil; soil temperature at depths of 5 and 10 cm.

The current GLOBE measurement for Global Positioning Systems (GPS) is the GPS-based location, measured directly or determined with offsets.

Detailed GLOBE Measurement Protocols are found in the GLOBE Teacher's Guide and are available on the World Wide Web at <http://www.globe.gov>. The full GLOBE Teacher's Guide in printed form can be obtained from Jean Fitch at GLOBE (202) 395-7600, or by e-mail at fitch@globe.gov. ■

GSAF UPDATE

Valerie G. Brown, Director of Development, GSA Foundation

FROM THE GROUND UP The Point of Gifts to GSA: Part II

Last month we introduced some of the 67 gift funds managed by the Foundation for the benefit of GSA programs. The opportunities created by these funds are so vital to GSA's services and outreach that the topic deserves further elaboration.

In addition to the general use funds described last month, there are many that target more specific applications to promote the education of future geoscientists, to assist the research of established professionals, and to recognize the achievements of senior scientists. Some of these funds have been endowed by generous donors to provide an impetus to furthering geoscience education and research. Outstanding examples include:

- **Birdsall Award Fund**, established with a bequest from the Birdsall estate to support a distinguished lectureship in hydrogeology.
- **Gladys W. Cole Memorial Research Award**, created by W. Storrs Cole to promote research by active professionals in the geomorphology of semi-arid and arid terrain in the United States and Mexico.
- **W. Storrs Cole Scholarship Fund**, which resulted from a bequest from the Cole estate to promote research by active professionals in invertebrate micropaleontology.
- **Young Scientist Award/Donath Medal**, established by Fred and Mavis Donath to encourage and motivate young scientists early in their careers.
- **Arthur D. Howard Fund**, endowed by a bequest from Arthur Howard and administered by the Quaternary Geology and Geomorphology Division to provide research and education grants.
- **Lipman Research Fund**, established with a gift from the Howard and Jean Lipman Foundation to support student research grants in volcanology and petrology.
- **Rip Rapp Archaeological Geology Award**, established by George R. Rapp, Jr., to fund achievement awards from the Archaeological Geology Division.
- **Shlemon Mentors Fund**, created by Roy Shlemon to enable the GSA sections to engage expert lecturers at the yearly section meetings.

Other funds have been established by GSA members in memory of such esteemed colleagues as:

- **Claude C. Albritton, Jr.**, a co-founder of the Archaeological Geology Division, whose memorial fund will provide scholarships to graduate students inter-

ested in careers in teaching and academic research.

- **Doris M. Curtis**, the first woman president of GSA, whose memorial fund supports the education of deserving women students of geology.
- **Shirley J. Dreiss**, chair of the Department of Earth Sciences at the University of California, Santa Cruz, whose memorial fund is administered in conjunction with the Birdsall Fund to support an annual Birdsall-Dreiss Distinguished Lectureship in Hydrogeology.
- **John C. Frye**, a long-time Illinois state geologist and pioneer in the field of environmental geology and a former GSA executive director, whose memorial fund is administered jointly by GSA and the American Association of State Geologists, to present an annual award for the best published paper on environmental geology.
- **J. Hoover Mackin**, a geomorphologist and outstanding academician whose memorial fund, under the direction of the Quaternary Geology and Geomorphology Division, provides an annual award for exceptional student research.
- **Antoinette Lierman Medlin**, a pace-setting professional in coal geology, whose memorial fund provides scholarships to full-time students with an interest in this specialty.

All of the funds are testimony to the vision and commitment of GSA's members investing in the advancement of their profession. ■

This month's bumper sticker:

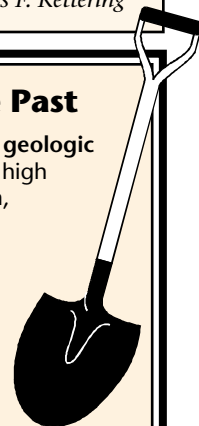
"The greatest thing this generation can do is to lay a few stepping stones for the next generation."

—Charles F. Kettering

Digging Up the Past

Most memorable early geologic experience: Climbing a high mountain in desperation, to discover beneath me the expected fossil-rich Miocene half grabens of the Cunningham and Big Creek Parks of Colorado-Wyoming.

—John Montagne





Donors to the Foundation, June 1997

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France Offers Chateaubriand Fellowships in Science and Technology

If you are working toward your Ph.D. in science or engineering, or if you have completed it in the last three years, you may qualify for a fellowship from the French government to conduct research in France. Some of the fellowships are cosponsored by French companies. The research would be performed in a French university or in a public or private laboratory. Candidates must be accepted by a French laboratory in order to be eligible for this fellowship program.



You may use existing contacts between your laboratory and a French research institution. If you do not have such contacts, you may register on the Web (<http://www.chateaubriand.amb-wash.fr>). In this case, your file will be submitted to directors of various laboratories in France who will be able to contact you directly.

Fellowships are available for a 6 to 12 month period, with a monthly stipend of \$1800 for a doctoral fellow and \$2200 for a postdoctoral fellow. Health insurance and a round-trip ticket are also provided. Only completed applications received before **December 1, 1997**, will be accepted. Applicants must be U.S. citizens and registered in a university in the United States or in a U.S. national laboratory. For further information:

Embassy of France
Office for Science and Technology
Chateaubriand Fellowship
4101 Reservoir Road, NW
Washington, DC 20007-2176
(202) 944-6261
fax: 202-944-6244
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Engaging the National Science Education Standards

David W. Mogk, Chair, GSA Education Committee



At the start of this new school year, we look forward to our educational mission with high hopes and great expectations. It is a time of new opportunities and challenges—and it is also an appropriate time to assess priorities and responsibilities. With the publication of the National Science Education Standards (NSES; National Research Council, 1996), the geoscience community has a remarkable opportunity to promote geoscience education in the nation's K–12 schools and beyond. Through the NSES, the earth and space sciences have attained parity with other physical and life sciences in recognition of the importance of our disciplines in achieving scientific literacy for all citizens. This is an opportunity that the geoscience community cannot afford to miss. All geoscientists have something to offer in response to the goals of the NSES, and as a community, we all have much to gain.

BACKGROUND

The NSES were developed in response to a national mandate from professional societies and governmental agencies to improve scientific literacy across the nation. The National Research Council (NRC) was commissioned to coordinate the development of the NSES. The NSES build on the recommendations of earlier projects such as publications of the American Association for the Advancement of Science Project 2061, Science for All Americans (1989) and Benchmarks for Scientific Literacy (1993), and the National Science Teachers Association Scope, Sequence and Coordination Project. Input to, and review of, the NSES was solicited from the breadth of stakeholders in science education.

GOALS

- The goals of the NSES are to “educate students ... to
- experience the richness and excitement of knowing about and understanding the natural world;
 - use appropriate scientific processes and principles in making personal decisions;
 - engage intelligently in public discourse and debate about matters of scientific and technological concern; and
 - increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers.”

The NSES have been developed to provide quality science education for ALL students. The national goal of a scientifically literate citizenry requires both excellence and equity in science education. The NSES state that all students should have “the opportunity to learn science ... [with] access to skilled professional teachers, adequate classroom time, a rich array of learning materials, accommodating work spaces, and the resources of the communities surrounding their schools.” The NSES call for major changes in how we teach science to our children, recognizing science as an active process, going beyond “hands-on” activities, and most important, incorporating inquiry at the core of our science education activities. The NSES provide criteria by which to judge the quality of science education at many levels—“the quality of what students should know and be able to do; the quality of science programs ...; the quality of science teaching; the quality of the systems that support science teachers and programs; and the quality of assessment practices and policies.” The NSES also provide criteria for local communities to judge which curricula, staff development, or assessment activities are appropriate to meet local needs and expectations. The NSES bring coordination, consistency, and coherence to the overall improvement of science education across the nation.

AREAS OF EMPHASIS

The NSES encompass six important areas requisite for quality science education: science teaching, professional development, assessment, science content, science education programs, and science education systems. The content standards may be of particular interest to the geoscience community. It is recommended that in grades K–4 all students should develop an understanding of properties of earth materials, objects in the sky, and changes in earth and sky; grades 5–8, structure of the Earth system, Earth's history, and Earth in the solar system; and grades 9–12, energy in the Earth system, geochemical cycles, origin and evolution of the Earth system, and origin and evolution of the universe. It must be emphasized that the NSES do not require a specific curriculum (i.e., prescribed organization of content). The content standards can be organized and presented with different emphases and perspectives accord-

ing to local needs, opportunities, and resources.

HOW TO HELP

Given the breadth and scope of the NSES, there is clearly a lot of work to be done. To reap the benefits of broader exposure of the geosciences through the NSES, the geoscience community must be actively engaged in their implementation. The first important step is to acquire first-hand knowledge about the NSES. Copies of the standards can be ordered directly from the National Academy Press bookstore (<http://www.nap.edu/bookstore/>). The Geoscience Education Division will sponsor the symposium “Engaging the National Science Education Standards” at the GSA Annual Meeting in Salt Lake City, Monday, October 20, 1:30–5:30 p.m. Speakers will include those who have been engaged in the initial development of the NSES, development of new instructional materials and methods, effective use of the standards in the K–12 classroom, and supporting activities on college campuses and government agencies.

Whatever your role as a geoscientist, you can help to expand public awareness about the geosciences through your personal involvement with implementation of the NSES. Earth science teachers and administrators in the K–12 schools are clearly at the forefront; these colleagues must be confident in their ability to master content and utilize effective practices in the classroom. College and university faculty have a special obligation to contribute to the preparation of future teachers, who compose a large student clientele in our introductory courses, by working with colleagues in education departments to make sure appropriate content is used in science teaching methods courses, in advising students about career possibilities in earth science education, and as we revise our college curricula in anticipation of enrollment of students who have experienced K–12 standards-based science education. Researchers can work to translate exciting new scientific discoveries into effective classroom activities. Government and industry workers can mobilize resources (host field trips, provide materials, serve in a mentoring capacity for teachers and students) to facilitate imple-

SAGE Remarks continued on p. 13

mentation of the NSES. GSA and other professional societies can promote the NSES through their own educational programs, as is being done in GSA's Science Awareness through Geoscience Education (SAGE) program (e.g., Earth and Space Science Technological Education Project, Technology Learning Center, Geoscience Education Through Intelligent Tutors). Geoscientists who are parents can regularly review their children's classroom activities related to the earth sciences to ensure that they are coherent with the goals of the NSES, and we can all take an active role in the review of policies related to science education in general, and to the Earth sciences specifically, at the local, state, and national levels.

To effectively promote the NSES, collaborative efforts of the entire geoscience community will be needed. GSA's Partners for Education Program (PEP) is a great place to get started (visit the Education Center at www.geosociety.org). Membership in PEP is free and is open to all education and geoscience professionals. PEP maintains a database of scientist and educator partners, and enhances communications between members through newsletters and access to information for materials and workshops; an e-mail partner program is being developed. The frequency and nature of partnering activities is completely left up to the individual members, depending on need and time available. True partnerships between educators and geoscience professionals is key to improving geoscience education, and PEP provides excellent materials with tips for effective collaborations. Our colleagues in K-12 education bring a wealth of experience of how students learn best, a sense of which activities are age-appropriate for students, and ways in which new topics can best be integrated into existing curricula, and our teacher colleagues are also enthusiastic students. Professional geoscientists bring a world of knowledge and experience that should be shared through a variety of educational experiences. We all benefit from these partnerships—students and teachers, the geoscience professionals, and the general public.

There are great opportunities and challenges ahead for geoscience education. The NSES provide a national framework for revitalization of K-12 science education, and the geosciences have a central role to play. GSA is responding proactively to the standards, through the numerous education programs that it supports. We hope that the general membership of GSA will also make personal commitments to become informed about the standards, and to work toward their effective implementation in our own life settings. ■

GSA Awards Research Grants

June Forstrom, GSA Grants Administrator

The GSA Committee on Research Grants met in Boulder, Colorado, on April 18-19, 1997, and awarded \$303,960 to 188 graduate student applicants, and \$21,000 for the Gladys W. Cole and W. Storrs Cole Awards to two postdoctoral applicants. Committee members for 1997 are Susan L. Longacre (Chair), James N. Connelly, Duncan M. FitzGerald, James P. Hibbard, Noel C. Krothe, Paul M. Myrow, Thomas L. Patton, and Thomas O. Wright (National Science Foundation conferee).

COLE AWARDS FOR POSTDOCTORAL RESEARCH

Peter U. Clark, Oregon State University, was awarded the Gladys W. Cole Memorial Research Award for 1997 to support his project "Developing an Improved Chronology of Late-Pleistocene Alpine Glaciation, Western U.S." This award is restricted to support research for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico.

The W. Storrs Cole Memorial Research Award, which is restricted to support research in invertebrate micropaleontology, was presented this year to Charles A. Ross, Bellingham, Washington, for his project "Paleobiogeographic Significance and Stratigraphic Zonation of Carboniferous and Permian Fusulina, Antler Orogenic Belt, Eastern Nevada."

Eligibility for both Cole awards is restricted to GSA Members and Fellows between 30 and 65 years of age.

STUDENT AWARDS

This year, proposals were received from 478 students, of which 188 (39%) were awarded grants. Of these recipients, 78 are master's candidates, and 110 are doctoral candidates. Proposal requests totaled \$908,827 for an average of \$1,901. The average award was \$1,616.

The committee determined that an additional 39 proposals were worthy of support. An additional \$53,000 would have been required to fund these proposals at an appropriate level. Had these additional proposals been funded, the funding rate would have been 47%.

Fourteen alternate candidates were selected by the committee in the event that some of the grantees return all or part of their grant funds because they change their research project or receive funds from another source.

The committee's budget included \$150,000 from the Penrose Endowment and the Pardee Memorial, \$100,000 from the National Science Foundation, \$6,000

from the Second Century Fund (donations by Unocal and the Lipman Research Fund), \$7,050 from the Harold T. Stearns Award Fund, the Geophysics Division, the Sedimentary Geology Division, and the Structural Geology and Tectonics Division; and \$1,572 returned too late in 1996 to be re-awarded last year. The budget also included \$38,300 from the GSA Foundation, an amount that included \$10,300 from the Research Fund (including \$2,000 from Mobil Oil), \$17,425 from GEOSTAR and Unrestricted funds, and \$10,575 from various restricted special funds and the Engineering Geology and Hydrogeology Divisions.

The recipients of student research grants awarded by GSA divisions and sections will be announced in the October issue of *GSA Today*.

Outstanding Mention. The Committee on Research Grants specially recognized 34 of the proposals as being of exceptionally high merit in conception and presentation:

Russell Hughes Abell, Virginia Polytechnic Institute and State University, "An Adsorption and Coprecipitation Study: Mn Oxyhydroxides and Their Scavenging of Pb under Oxidizing Conditions"

Mark R. Besonen, University of Massachusetts, "The Frequency and Intensity of Hurricane and Large Storm Events in Southern New England through the Late Holocene"

Karen L. Boven, University of Michigan, "Stable Isotope Systematics of Municipal Waste Landfills: Landfill Dynamics and Groundwater Contamination"

Beverly Chomiak, New Mexico Institute of Mining and Technology, "Analysis of Single Fluid Inclusions by Quadrupole Mass Spectrometry (QMS)"

Shawn G. Clouthier, Michigan State University, "Indigeneity and Phylogeny Implications of Osteocalcin Sequences Determined by Matrix-Assisted Laser Desorption Ionization Mass Spectrometry"

Janet H. Curran, Colorado State University, "Flow Resistance and Sediment Storage Characteristics of Large Woody Debris in Headwater Streams of the Cascade Range, Washington"

Rhawn F. Denniston, University of Iowa, "Reconstructing Seasonal Climatic Shifts Using C-O Isotopes of Fluorescent/Non-Fluorescent Bands in Speleothem Calcite"

Katrina J. Edwards, University of Wisconsin—Madison, "Oxidation of Pyrite and the Production of Acid Mine Drainage

Grants continued on p. 14

Grants continued from p. 13

at Iron Mountain, CA: Mechanisms and Microorganisms”

Jennifer L. Eigenbrode, Indiana University, “Holocene Terrestrial Climate Change at Millennial Resolution from Soda Lake Sediments, California”

Annette Summers Engel, University of Cincinnati, “Dolomite within Movile Cave, Romania: Pioneering Geomicrobiological Investigations for a Tenacious Problem in Geology”

David L. Fox, University of Michigan, “Stable Isotope Ecology of Proboscideans from Port of Entry Pit, Oklahoma (Early Hemphillian)”

Andrew Gilbert, East Carolina University, “Chronostratigraphic Relationships of Known Archaeological Sites to Holocene Episodes of Barrier Island Development in Dare and Currituck Counties, North Carolina”

Lori M. Goetsch, University of Iowa, “Bulk Waste/Hydric Soil Mixtures: Their Utility and Performance as Substrates in Constructed Wetlands for Wastewater Treatment”

Lisa Greer, University of Miami—RSMAS, “A High Resolution Analysis of Holocene Climate Change (5,000 to 9,000 ybp) in the Dominican Republic using Scleractinian Corals from Lake Enriquillo”

Martin F. Helmke, Iowa State University, “Combined Use of Large-Core Laboratory Experiments and Discrete Fracture Modeling to Evaluate Contaminant Transport through Fractured Till”

Ulrike Maria Huber, University of Colorado, “Linkages Between Past Climate,

Vegetation and Fire Regimes in Southernmost Patagonia and Tierra del Fuego”

Gary B. Hughes, University of Pennsylvania, “Paleotemperatures Below the Photic Zone: Stable Isotope Measurements of Sclerosponge Skeletal Silica and Carbonate”

Stephen D. Keane, University of Michigan, “Trace Element Thermobarometry: Zr and Ti in Garnet”

Mandy J. Munro, University of Alberta, “The Origins of Hummocky Terrain”

Charles Narwold, Humboldt State University, “Late Quaternary Faulting Along the Quinn River Fault Zone, South-eastern Oregon”

William David Orndorff, Virginia Polytechnic Institute and State University, “Geothermobarometry of Retrograde Metamorphism Associated with Ductile Shear Zones: An Integrated Study Using Solid Phase Equilibria, Fluid Inclusions, and Quartz Petrofabrics”

William H. Peck, University of Wisconsin—Madison, “Empirical Calibration of Oxygen Diffusion Rates in Zircon”

Anthony J. Rossman, Miami University, “Determining the Significance of the Autochthonous (Indigenous) Microbial Community in the Transport of Allochthonous (Invasive) Bacteria”

Hallie J. Sims, University of Chicago, “Temporal Patterns in Late Paleozoic and Early Mesozoic Seed Morphology: Implications for Paleoecological Dynamics”

Anna C. Snider, University of New Mexico, “Platform-to-Basin Cyclicity Expressed in the Middle Cambrian Mixed Carbonate-Siliciclastics; House Range, Western Utah”

Gary S. Solar, University of Maryland, “Tracking Granite Magma Transfer Through the Crust: Constraints from Field Relations of Migmatites and Plutons, and the Geochemistry of Garnet”

Donna M. Surge, University of Arizona, “Paleoecology and Geochemistry of Bivalve Shells: Implications for Pre-disturbance Environmental Conditions of Three Estuaries, SW Florida”

Deborah J. Thomas, University of North Carolina, Chapel Hill, “Comprehensive Study of Foraminiferal Carbonate Diagenesis: Application to the Upper Paleocene–Lower Eocene of ODP Site 1001”

Georgios P. Tsoflias, University of Texas, Austin, “Use of Ground Penetrating Radar for the Characterization of Fractures in Geologic Formations and Their Contribution to Fluid Flow”

Liping Wang, University of Michigan, “Fe-Mg Order-Disorder Experimental Studies on Orthopyroxenes”

Jennifer M. Wenner, Boston University, “The Role of High-Silica Granites in the Sierra Nevada Batholith as End Members in a Mixing Process That Generates Average Continental Crust”

Nicholas S. F. Wilson, Dalhousie University, “The Role of Maturing Organic Matter in the Spatial Distribution of Sulfides in the El Soldado (Central Chile) Copper Deposit”

Catherine Helen Yansa, University of Wisconsin—Madison, “Late Quaternary Vegetation and Climate Change on the Northern Great Plains”

Ronald B. Zelt, Colorado State University, “Silvertip Watersheds Erosion and Sedimentation Study”

Gretchen L. Blechschmidt

Research Award. This award supports research for women interested in achieving a Ph.D. in the geological sciences and a career in academic research. This year’s recipient is Leanne Pyle of the University of Victoria, for her project “Lower Paleozoic Stratigraphy and Conodont Biostratigraphy and Paleoecology of the Ordovician-Silurian Kechika and Road River Groups, Northern British Columbia.”

John T. Dillon Alaska Research

Award. John Dillon was noted for his radiometric dating work in the Brooks Range, the results of which have had a major impact on the geologic understanding of this mountain range. The recipient of this award is Jason P. Briner, Utah State University, for “Pleistocene Glacial Chronology of the Southwestern Ahklun Mountains, Alaska.”

Robert K. Fahnestock Award.

This award honors the memory of Ken Fahnestock, who was a member of the Committee on Research Grants. It is awarded to the applicant with the best

Fellowship and Award Opportunities

Research Fellowship at University of Wyoming

The Bernard L. Majewski Fellowship provides a stipend of \$2,500 in support of research conducted in the archival collections at the American Heritage Center at the University of Wyoming. Acceptable areas of research include history, oral history, historical archaeology, environment and natural resources, business, or economic history pertaining to economic and petroleum geology. The deadline for applications for the 1998 fellowship is **December 15, 1997**. For application information, contact Manager, International Archive of Economic Geology, American Heritage Center, P.O. Box 3924, University of Wyoming, Laramie, WY 82071, (307) 766-6506, fax 307-766-5511, mgrafel@uwyo.edu, <http://www.uwyo.edu/ahc/iaeg/majewann.htm>.

Tyler Prize for Environmental Achievement

The Tyler Prize is awarded for “(a) the protection, maintenance, improvement or understanding of ecological and environmental conditions anywhere in the world; or (b) the discovery, further development, improvement, or understanding of known or new sources of energy.” Nominations for the 1998 Tyler Prize must be received by **October 1, 1997**; related credentials, supporting material, and letters of reference must be received by October 8. For further information, contact Jerome B. Walker, Tyler Prize, Office of the Provost, University of Southern California, Los Angeles, CA 90089-4019, (213)740-6559, fax 213-740-1313, jbwalker@mizar.usc.edu, http://www.usc.edu/dept/provost/Tyler_Prize.

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Grants continued from p. 14

proposal in sediment transport or related aspects of fluvial geomorphology. The 1997 recipient is Ronald B. Zelt, Colorado State University, for "Silvertip Watersheds Erosion and Sedimentation Study."

Lipman Research Award. The Lipman Research Fund is supported by gifts from the Howard and Jean Lipman Foundation to promote and support student research grants in volcanology and petrology. Peter W. Lipman, president of the Lipman Foundation, was the recipient of a GSA research grant in 1965. The 1997 Lipman Award recipient is William H. Peck, University of Wisconsin, Madison, for "Empirical Calibration of Oxygen Diffusion Rates in Zircon."

Bruce L. "Biff" Reed Scholarship Award. The Bruce L. "Biff" Reed Scholarship Award was established in Reed's memory to provide grants to graduate students pursuing studies in the tectonic and magmatic evolution of Alaska primarily, and also can fund other geologic work in Alaska. This year's recipient is Darin C. Snyder, Miami University (Ohio), for "Petrogenesis and Tectonic Significance of Granitoid Magmatism at White Mountain, Nabesna District, Alaska."

Alexander Sisson Research Award. Family members of Alexander Sisson established a fund in his memory to promote and support research for students pursuing studies in Alaska and the

Caribbean. The recipient of the award this year is Lisa Greer, University of Miami, for "A High Resolution Analysis of Holocene Climate Change (5,000 to 9,000 ybp) in the Dominican Republic using Scleractinian Corals from Lake Enriquillo."

Harold T. Stearns Fellowship Award. Harold Stearns established this award in 1973 and to date it has funded 68 student grants totaling \$59,000. The 1997 recipients, for research on aspects of the geology of the Pacific Islands and the circum-Pacific region, are: Lisa A. McBee, California State University, Long Beach, for "Using Global Positioning System (GPS) and Gravity to Detect the Possible Presence of a Rotating Mini-Plate Along the Southern San Andreas Fault in the Mecca Hills"; Britt H. Norlander, University of Minnesota, Twin Cities, for "The Role of Granite Emplacement in the Localization of Strain during Extensional Collapse of an Orogen: The Shuswap Metamorphic Core Complex, British Columbia"; Michael Pulver, University of Connecticut, for "Early-stage Ductile Deformation in the Hinterland of the Taiwan Mountain Belt: A Qualitative Estimate of Strain Symmetry on the Basis of Fold Geometries and Quartz C-Axis Fabric Patterns"; and Nicholas S. F. Wilson, Dalhousie University, for "The Role of Maturing Organic Matter in the Spatial Distribution of Sulfides in the El Soldado (central Chile) Copper Deposit."

Marion E. Bickford Research Award. Colleagues of Marion "Pat" Bickford at Syracuse University established this one-time award in appreciation and recognition of his accomplishments. The grant recipient is William E. Steinhart, Syracuse University, for "Isotopic Study of the La Ronge Arc, a Critical Element in the Trans-Hudson Orogen, Canada."

Industrial Donations and Awards. Industrial donations this year amounted to \$7,000 (\$2,000 from Mobil Oil Corporation; and \$5,000 from Unocal Corporation). The 1997 recipients are: Amy E. Clifton, Rutgers University, for "Geometry, Spatial Distribution and Scaling Relationships of Faults in Oblique Rift Zones"; Elias Gomez, Cornell University, for "A Quantitative Approach to the Tertiary Tectono-Stratigraphic Development of the Middle Magdalena Basin and Adjacent Foothills of the Eastern and Central Cordilleras in Colombia"; Vladimir V. Liakhovitch, Southern Methodist University, for "A Combined Isotope (C, O, H and Sr) and Chemical Study of Crude Oils and Formation Waters from the Upper Cretaceous Woodbine and Lower Cretaceous Travis Peak Formations, East Texas Basin"; Susan Jennifer Reid, University of Calgary, for "Characteristics of Paleokarst Reservoirs—A Study of the Pekisko Formation, Twining Field, Alberta, Canada"; and Jennifer A. Zampino, University of Texas, Austin, for "Bacteria and the Origin of Calcite-Sulfur Alteration Zones, Delaware Basin, West Texas." ■

Other applicants recommended for funding are the following:

Christon Mark Achong
Peter N. Adams
Lesleigh Anderson
Robert Asher
Nicoleta Badescu
Charles M. Bauer
Claire L. Beaney
Rebecca Beavers
Deborah Bergfeld
Katherine Jean Bergk
Jennifer Ann Borgert
Donna D. Carlson
Bart Lewis Cattanch
Rebecca Chrisfield
Aaron Garner Clack
Jesse Coburn
Brian Perry Coffey
Monika Cogoini
Kari M. Cooper
Carol Merritt Dehler
Cari Deyell
Toby Joseph Dogwiler
Neil Duffin
Stan P. Dunagan
Michael T. Dunn
Louis Scott Eaton
Evan Edinger
Michael Emilio
Jeffrey C. Evans

Sharon N. Feldstein
Joseph Ferraro
Kendall B. Fountain
Barbara Ann Fowler
Anke M. Friedrich
Todd G. Fritch
James J. Galluzzo, Jr.
Antonio F. Garcia
Carmala N. Garziona
Terry W. Gebhardt
Steven L. Goodbred, Jr.
Carrie Graff
Laura A. Guertin
Stacy Marie Gunn
Jochen Halfar
Jenney M. Hall
Leslie E. Hasbargen
Jeremy K. Hourigan
Christopher H. House
Richard G. Hoy
John V. Hurley
Abdelazim A. Ibrahim
Michael P. Joy
Thomas J. Kalakay
Paul Kapp
Glenn B. Kays
Daniel Clay Kelly
Dale A. Kerner
Elizabeth M. King

David A. Korejwo
Stefan B. Kosanke
Marianne Kozuch
Robert G. Kruppa
Mark A. Kulp
Robert Max Langridge
Thomas J. Lapen
Jennifer C. Latimer
Eung-Seok Lee
Katherine F. Lee
Mary L. Leech
Lindsey R. Leighton
Edward Little
Timothy R. Long
Jason J. Lundquist
Laura Elaine Maley
Daniel V. Malmon
David M. Manaker
Bryan G. Mark
Aaron J. Martin
Jennifer A. Martin
Sara Eva Martinez-Alonso
Theodore Clifford
McCarthy, III
Jana G. McClain
Gerald G. McCloskey
Allen K. McNamara
Jeremy David Middleton
German Mora

Stephanie Moret
Carrie Morrill
Eric Mueller
Beth M. Nadeau
Thomas D. Olszewski
Nathan Washburn
Onderdonk
Tatyana M. Pak
Laura Parent
Erika Parkin
Cynthia C. Parnow
Michael B. Parsons
Joel L. Pederson
Pamela J. Perry
Carlie J. Phipps
Christopher J. Pluhar
Caleb J. Pollock
Reir Kenneth Pufahl
Wilson R. Ramirez
Toby A. Rickabaugh
Laura Rico
Brook C. D. Riley
Tammy M. Rittenour
Melanie Rohr
Seth J. Sadofsky
Hilary Sanders
Stephen A. Schellenberg
Konrad E. Scheltema
Lori Schuh

Gordon Seitz
David Selby
Mary C. Simmons
William Jay Sims
Steven J. Singletary
Dena M. Smith
Joshua B. Smith
Glen Snyder
Noah P. Snyder
Luigi Solari
Brad A. Sporleder
Pamela Buzas Stephens
Kathy Goetz Troost
Kathleen Trowbridge
Ruben D. Uribe
Kenneth M. Veit
Laura C. L. Velazquez
Tim F. Wawrzyniec
Mark Webster
Cynthia A. Werner
Karen Elizabeth
Whittlesey
David A. Williams
Christopher M. Wurster
Yongliang Xiong
Oscar Yepes
Amy E. Young
Paul Harrison Zehfuss
Brian R. Zurbuchen

**Job Hunting
in the Geosciences**

Tuesday, October 21, 1:00 to 3:00 p.m.; Marriott, Park City Room. Sponsored by the *Association for Women Geoscientists*

Learn the job-hunting skills necessary to survive in today's changing and challenging job market. These skills may be applied to jobs in government, industry, and academia. Topics covered include searching for advertised jobs, networking, resume and C.V. writing, and interviewing skills.

Limit: 40. Fee: \$30 (includes AWG Guide: Resume Writing for Geoscientists). Send check or credit card number to Jeanette Leete, AWG Executive Director, Association for Women Geoscientists, 4779 126th N., White Bear Lake MN 55110-5910, (612) 426-3316, leete@macalester.edu.

For information contact: Pranoti Asher, Dept. of Geology, Georgia Southern University, Statesboro, GA 30460-8149, (912) 681-5361.

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**Announcing ...
Late-Breaking Research Sessions**

for Salt Lake City 1997 GSA Annual Meeting
October 20–23, 1997, Salt Palace Convention Center

**Exciting new data or breakthroughs
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Present your work at the GSA Annual Meeting this fall!



Special instructions for submitting an abstract for the Late-Breaking Research Sessions:

- ◆ An abstract on late-breaking research may be submitted after September 1 until midnight, September 30, 1997.
- ◆ Abstracts must be submitted using the Web form; they may not be submitted on paper or by e-mail: <http://www.geosociety.org>.
- ◆ Space will be limited and selection will be based on scientific merit.
- ◆ The author will be asked to provide a brief explanation of why the abstract deserves consideration after the usual deadline for this meeting.
- ◆ The author may designate either oral or poster, although space limitations may require reclassification.
- ◆ Because of scheduling limitations, you may present only one volunteered paper in oral or poster mode. If you have already had a volunteered abstract accepted, please do not submit another.

Abstract Fee: For this meeting, a nonrefundable abstract fee of \$50 must accompany each Late-Breaking Research abstract submitted. Our Web template form will ask for credit-card information. We have installed one of the best known and most respected Secure Server systems for transmission of your credit-card data to fully protect your confidential information.

Schedule: Abstracts will be reviewed by the Annual Program Committee. Electronic acceptance notices will be sent out the first week in October giving the place and time of presentation. Late-Breaking Research Sessions: Oral, Tuesday, October 21, p.m.; and Poster, Thursday, October 23, p.m.

Publication: The abstracts will not be published in the abstract volume, although they will be published on the Web along with the Web abstracts and paper copies will be made available on site.

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Create your own personal schedule for the meeting ... GSA Technical Sessions on the Web.

There will be 188 technical sessions presented during the course of the meeting. Of these, symposia (invited papers) and theme sessions (volunteered papers submitted to a specific topic) are referred to by a number that precedes the title. All other sessions are referred to by disciplines, such as Geochemistry I, II. Sessions are oral unless poster is indicated.

1997 Technical Program Calendar

All technical sessions held at Salt Palace Convention Center.

SUNDAY, OCTOBER 19

Session #	Time	Sponsor/Description	Location
1	8:00 a.m.	S01. Ore Deposits through Time I	25IF
2	8:00 a.m.	S02. Organic Perspectives on Geochemical Processes I	150G
3	1:30 p.m.	S01. Ore Deposits through Time II	25IF
4	1:30 p.m.	S02. Organic Perspectives on Geochemical Processes II	150G
5	1:30 p.m.	S02. Organic Perspectives on Geochemical Processes III (Posters)	Hall C
6	1:30 p.m.	S03. Concepts in Geoecology and Ecosystem Management: Applying New Knowledge from the Interface of the Life and Earth Sciences	250BC
7	1:30 p.m.	T15. Field-Based Investigations on School or Campus Sites: Examples That Work (Posters)	Hall C

MONDAY, OCTOBER 20

8	8:00 a.m.	Geochemistry I: Experimental and Theoretical Aqueous Geochemistry	251AB
9	8:00 a.m.	Geoscience Education I: Real and Virtual Field and Lab Experiences	257
10	8:00 a.m.	Paleontology/Paleobotany I: Biotic Transitions	Ballroom D
11	8:00 a.m.	Quaternary Geology and Geomorphology (Posters)	Hall C
12	8:00 a.m.	Remote Sensing (Posters)	Hall C
13	8:00 a.m.	Sedimentology, Carbonates I: Deposition, Diagenesis, and Characteristics of Ancient Carbonates	256 A-C
14	8:00 a.m.	Structural Geology I: Fold and Thrust Belts	Ballroom H
15	8:00 a.m.	Tectonics I: Tectonics Around the World	25IF
16	8:00 a.m.	Topics in Economic Geology (Posters)	Hall C
17	8:00 a.m.	S04. Micropaleontology of the Cretaceous Western Interior Seaway: Integration of the Tethyan and Boreal Record	260
18	8:00 a.m.	S05. Geomicrobiology: Interactions Between Microbes and Minerals	Ballroom AC
19	8:00 a.m.	S06. Exploring Life in the Solar System	255A-C
20	8:00 a.m.	S07. New Developments in Coal and Coalbed Methane Evaluation and Exploitation	258
21	8:00 a.m.	T02. Plutons, Volcanoes, and Ore Deposits I (Posters)	Hall C
22	8:00 a.m.	T04. Hydrogeology of Landslides	259
23	8:00 a.m.	T06. Concepts in Geoecology and Ecosystem Management: Applying New Knowledge from the Interface of the Life and Earth Sciences	150G
24	8:00 a.m.	T10. Isotopic Mapping: The "0.706 Line" Twenty Years Later—A Tribute to Ronald W. Kistler	151A-G
25	8:00 a.m.	T17. Paleoseismology: Contributions to and Issues in Evaluating Seismic Hazards I	Ballroom E
26	8:00 a.m.	T25. Recent Advances in Density-Dependent Fluid Flow and Solute Transport	250EF

Session #	Time	Sponsor/Description	Monday (continued)	Location
27	8:00 a.m.	T28. Progress in Dating Young Groundwater I		25IDE
28	8:00 a.m.	T52. Impact Deposits in the Sedimentary Record I		250BC
29	8:00 a.m.	T62. The Coast Shear Zone (Southeastern Alaska and British Columbia), a Fundamental Crustal Feature		Ballroom F
30	1:30 p.m.	Geochemistry II: Geochemistry of Soils and Weathering		257
31	1:30 p.m.	Igneous Petrology I: Volcanism and Basaltic Magmas		250EF
32	1:30 p.m.	Marine Geology (Posters)		Hall C
33	1:30 p.m.	Metamorphic Petrology I		258
34	1:30 p.m.	Micropaleontology (Posters)		Hall C
35	1:30 p.m.	Paleoceanography/Paleoclimatology (Posters)		Hall C
36	1:30 p.m.	Paleontology/Paleobotany (Posters)		Hall C
37	1:30 p.m.	Paleontology/Paleobotany II: Function, Behavior, and Assemblages		259
38	1:30 p.m.	Quaternary Geology/Geomorphology I: Last Glacial Maximum and Earlier Events		260
39	3:30 p.m.	Sedimentology, Carbonates II: Deposition, Diagenesis, and Characteristics of Modern Carbonates		250BC
40	1:30 p.m.	Sediments, Clastic		150G
41	1:30 p.m.	Stratigraphy I: Proterozoic and Paleozoic Stratigraphy		Ballroom D
42	1:30 p.m.	S08. Exhumation of High- and Ultrahigh-Pressure Rocks		Ballroom F
43	1:30 p.m.	S09. Engaging the National Science Education Standards		Ballroom H
44	1:30 p.m.	SI0. The Anatomy and Attenuation of Chlorinated Solvent Plumes in Granular Aquifers		151A-G
45	1:30 p.m.	S32. International Surveys (Posters)		Hall C
46	1:30 p.m.	T03. Geomicrobiology: Interactions Between Microbes and Minerals I		256A-C
47	1:30 p.m.	T17. Paleoseismology: Contributions To and Issues in Evaluating Seismic Hazards II		Ballroom E
48	1:30 p.m.	T22. Hydrogeology of Continental Rift Systems		25IF
49	3:30 p.m.	T26. Hydrochemistry of Poorly Confined Aquifer Systems		25IDE
50	1:30 p.m.	T28. Progress in Dating Young Groundwater II		25IDE
51	1:30 p.m.	T35. Volcanic Eruptions: From the Deep Oceans to Deep Space I		25IAB
52	1:30 p.m.	T42. Geomorphology in Drylands		255A-C
53	1:30 p.m.	T52. Impact Deposits in the Sedimentary Record II		250BC
54	3:30 p.m.	T63. Cenozoic Tectonic Evolution of Northern Tibet		Ballroom E

TUESDAY, OCTOBER 21

55	8:00 a.m.	Archaeological Geology (Posters)		Hall C
56	8:00 a.m.	Environmental and Engineering Geology (Posters)		Hall C
57	8:00 a.m.	Geochemistry (Posters)		Hall C
58	8:00 a.m.	Micropaleontology		258
59	8:00 a.m.	Structural Geology II: Microstructures, Ductile Fabrics, and Regional Structural Studies		Ballroom H
60	8:00 a.m.	Volcanology		Ballroom D
61	8:00 a.m.	SII. Hotspots from the Top Down: What Are They?		Ballroom F

Session #	Time	Sponsor/Description	Tuesday (continued)	Location
62	8:00 a.m.	SI2. Process from Pattern in the Fossil Record		255A-C
63	8:00 a.m.	SI3. Isotopes and Earth Surface Processes		Ballroom AC
64	8:00 a.m.	SI4. The Costs and Values of Geoscience Information		257
65	8:00 a.m.	T05. Trace Metals in the Environment: Sources, Transport, and Fate— A Tribute to Ernest E. Angino		151A-G
66	8:00 a.m.	T07. Conservation Geology—Restoring and Maintaining Ecosystems		259
67	8:00 a.m.	T13. Earth System Science Laboratories for the Introductory Undergraduate Level		150G
68	8:00 a.m.	T24. Approaches to Understanding Groundwater Flow and Contaminant Transport in Carbonate Aquifers I		251F
69	8:00 a.m.	T29. Isotopic Tools for Detection of the Origin and/or Fate of Environmental Contaminants		251DE
70	8:00 a.m.	T32. DNAPL Migration and Remediation in Fractured Rock		250EF
71	8:00 a.m.	T35. Volcanic Eruptions: From the Deep Oceans to Deep Space II		251AB
72	10:00 a.m.	T37. Volatiles in Planetary Mantles and Basalts		251AB
73	8:00 a.m.	T50. Unexplored Microbial Worlds: Evidence from Occurrences of Unique Microbial Sedimentary Structures		260
74	8:00 a.m.	T53. New Perspectives on Neoproterozoic Earth History		256A-C
75	8:00 a.m.	T57. Processes and Mechanics of Fault Nucleation and Growth		250BC
76	8:00 a.m.	T58. Triassic-Jurassic Structural and Stratigraphic Record of Cordilleran Tectonics: Linking Processes from the Active Margin to the Colorado Plateau		Ballroom E
77	3:30 p.m.	Coal Geology		260
78	1:30 p.m.	Crustal Structure and Tectonic Processes		Ballroom H
79	1:30 p.m.	Economic Geology I: Base and Precious Metals in Near-Surface Hydrothermal Systems		Ballroom E
80	1:30 p.m.	Experimental and Other Petrology and Mineralogy		257
81	1:30 p.m.	Late-Breaking Research in Earth Science I		250BC
82	1:30 p.m.	Paleoclimatology: Stratigraphy, Sedimentology, and Paleosols		259
83	1:30 p.m.	Planetary Geology: To Mars and Back		255A-C
84	1:30 p.m.	Quaternary Geology/Geomorphology II: Holocene-Recent Glacial Processes and Climates		250EF
85	1:30 p.m.	Structural Geology (Posters)		Hall C
86	3:30 p.m.	T24. Approaches to Understanding Groundwater Flow and Contaminant Transport in Carbonate Aquifers II		251F
87	1:30 p.m.	Tectonics (Posters)		Hall C
88	1:30 p.m.	SI5. Recent Advances in Studying Earth from Space: What Students Should Know		151A-G
89	1:30 p.m.	SI6. Geochemical Records of Hydrologic Response to Climate Change		Ballroom D
90	1:30 p.m.	SI7. Tectonic, Climatic, and Eustatic Controls on Sedimentation in Continental Rifts		Ballroom AC
91	1:30 p.m.	SI8. Archaeological Geology of Arid Environments. Dedicated to the Late Jonathan O. Davis		256A-C
92	1:30 p.m.	SI9. Student Research and Interdisciplinary Connections (Posters)		Hall C
93	1:30 p.m.	T09. Submarine Plateaus and Hotspot Islands, Young and Old: Identification and Role in Continental Growth		Ballroom F
94	1:30 p.m.	T30. Role of Natural Organic Matter and Particulate Colloids in Solute Fate and Transport		150G
95	1:30 p.m.	T39. The Geosciences in Context: Values, Sustainability, Culture, and Curricula		258

Session #	Time	Sponsor/Description	Tuesday (continued)	Location
96	1:30 p.m.	T 43. The Bonneville Lake Basin from a Global Perspective		25IAB
97	1:30 p.m.	T 47. Influence of Geomorphic Processes on Biological Communities		25IDE
98	1:30 p.m.	T57. Processes and Mechanics of Fault Nucleation and Growth II (Posters)		Hall C

WEDNESDAY, OCTOBER 22

99	8:00 a.m.	Coal Geology (Posters)		Hall C
100	8:00 a.m.	Geochemistry III: Low-Temperature Inorganic and Organic Geochemistry		Ballroom D
101	8:00 a.m.	Geoscience Information		258
102	8:00 a.m.	Paleontology/Paleobotany III: Resolution of the Record		257
103	8:00 a.m.	Public Policy: Issues in Education and the Environment		25IF
104	8:00 a.m.	Sedimentology (Posters)		Hall C
105	8:00 a.m.	Stratigraphy (Posters)		Hall C
106	8:00 a.m.	Tectonics II: North American Cordillera I		Ballroom H
107	8:00 a.m.	S20. Iapetus Ocean, Its Birth, Life, and Death: The Wilson Cycle. In Honor of Charles L. Drake		Ballroom AC
108	8:00 a.m.	S21. Geology and Ore Deposits of the Oquirrh and Wasatch Mountains		25IAB
109	8:00 a.m.	S23. Predictive Modeling in the Earth Sciences: Application and Misapplication to Environmental Problems		151A-G
110	8:00 a.m.	S24. Celebrating 50 Years of the Engineering Geology Division: The Past, Present, and Future of Geoscience in the Public Interest		260
111	8:00 a.m.	S26. Recent Advances in Chemical Hydrogeology: A Tribute to William Back's 50-Year Career		25IDE
112	8:00 a.m.	T01. Geologic Mapping and GIS: Digital Map Production, Methods of Publication, and Expanded Uses of the Data (Posters)		Hall C
113	8:00 a.m.	T03. Geomicrobiology: Interactions between Microbes and Minerals II		256A-C
114	8:00 a.m.	T08. Plume Tails and Continental Lithosphere: A Multidisciplinary Approach to the Snake River Plain and Other Continental Plume Tracks I		Ballroom F
115	8:00 a.m.	T11. Earth Science Education for Pre-Service Teachers		150G
116	8:00 a.m.	T19. Geologic Mapping: Past, Present, and Future I (Posters)		Hall C
117	8:00 a.m.	T27. Investigations of Transport Processes in Fractured Rock Using Groundwater Tracers I		250EF
118	8:00 a.m.	T33. Theoretical Molecular Methods in Earth Sciences		259
119	8:00 a.m.	T36. The Galilean Satellites: Exploring Their Connections		250BC
120	8:00 a.m.	T 45. Environmental Impacts on Western Rivers		255A-C
121	8:00 a.m.	T60. Extreme Continental Extension: Examples from Around the World and New Insights from Quantitative Modeling I		Ballroom E
122	1:30 p.m.	Archaeological Geology		25IF
123	1:30 p.m.	Geochemistry IV: Groundwater, Surface Water, and Environmental Geochemistry		Ballroom D
124	1:30 p.m.	Geophysics (Posters)		Hall C
125	3:30 p.m.	History of Geology		250EF
126	1:30 p.m.	Hydrogeology (Posters)		Hall C
127	1:30 p.m.	Metamorphic Petrology II		260

Session #	Time	Sponsor/Description	Wednesday (continued)	Location
128	1:30 p.m.	Paleoceanography		259
129	1:30 p.m.	Paleontology/Paleobotany IV: Evolutionary Morphology		258
130	1:30 p.m.	Quaternary Geology/Geomorphology III: Tectonic Geomorphology and Landforms		250EF
131	1:30 p.m.	Tectonics III: North America Cordillera II		Ballroom H
132	1:30 p.m.	S22. The Archbishop Ussher Symposium: Quantifying Earth History		151A-G
133	1:30 p.m.	S25. Advocacy, Ethics, and the Geosciences: Problems of Facts and Values in Environmental Issues		250BC
134	1:30 p.m.	S27. Late Ordovician Mass Extinction–Silurian Recovery and Associated Perturbations of Global Earth Systems		255A-C
135	1:30 p.m.	S28. Environmental Mineralogy: Science and Politics		Ballroom F
136	1:30 p.m.	T02. Plutons, Volcanoes, and Ore Deposits II		251AB
137	1:30 p.m.	T03. Geomicrobiology: Interactions Between Microbes and Minerals III		256A-C
138	1:30 p.m.	T08. Plume Tails and Continental Lithosphere: A Multidisciplinary Approach to the Snake River Plain and Other Continental Plume Tracks II (Posters)		Hall C
139	1:30 p.m.	T12. Approaches to Undergraduate Teaching of Geophysics		150G
140	1:30 p.m.	T27. Investigations of Transport Processes in Fractured Rock Using Groundwater Tracers II (Posters)		Hall C
141	1:30 p.m.	T46. Arroyos: Hydroclimatology, Quaternary Geology, and Riverine Processes		251DE
142	1:30 p.m.	T54. Records of Paleoclimate and Tectonic Evolution of Continental Interiors: Latest Results from Scientific Drilling and Coring		257
143	1:30 p.m.	T56. The Geologic Record of Three-Dimensional Strains in Extended Continental Crust		Ballroom E
144	1:30 p.m.	T59. Iapetus Ocean, Its Birth, Life, and Death: The Wilson Cycle		Ballroom AC
145	1:30 p.m.	T60. Extreme Continental Extension: Examples from Around the World and New Insights from Quantitative Modeling II		Ballroom E

THURSDAY, OCTOBER 23

146	8:00 a.m.	Chemical and Isotope Hydrogeology		250EF
147	8:00 a.m.	Environmental and Engineering Geology I		250BC
148	8:00 a.m.	Geoscience Education II: Earth System Science, Environmental Education, and Teaching Strategies		151A-G
149	8:00 a.m.	Igneous Petrology (Posters)		Hall C
150	8:00 a.m.	Isotopic Paleoclimatology and Paleoceanography		255A-C
151	8:00 a.m.	Metamorphic Petrology (Posters)		Hall C
152	8:00 a.m.	Mineralogy/Crystallography (Posters)		Hall C
153	8:00 a.m.	Paleontology/Paleobotany V: Biotic Distribution: Patterns and Constraints		257
154	8:00 a.m.	Planetary Geology (Posters)		Hall C
155	8:00 a.m.	Precambrian Geology (Posters)		Hall C
156	8:00 a.m.	Quaternary Geology/Geomorphology IV: Hillslope and Aeolian Processes		251AB
157	8:00 a.m.	Stratigraphy II: Mesozoic and Cenozoic Stratigraphy		256A-C
158	8:00 a.m.	Structural Geology III: Brittle Structures		Ballroom F
159	8:00 a.m.	Volcanology (Posters)		Hall C

Session #	Time	Sponsor/Description	Thursday (continued)	Location
160	8:00 a.m.	S29. Global Connections: Environmental Justice in the Americas and Abroad		Ballroom E
161	8:00 a.m.	S30. Deciphering Exhumation from the Sedimentary Record		Ballroom AC
162	8:00 a.m.	S31. Geologic Mapping: Past, Present, and Future		259
163	8:00 a.m.	T14. Concepts of Mapping in Geoscience Education		150 G
164	10:00 a.m.	T16. Great Geological Vacations in North America—How They Can Enhance Geoscience Literacy I		150G
165	8:00 a.m.	T23. Investigations of Hydrogeologic Systems		25IDE
166	8:00 a.m.	T34. Applications of Plant Taphonomy to Paleoenvironmental, Paleogeographic, and Paleoclimatic Problems		260
167	8:00 a.m.	T38. The Southern Laurentian Late Proterozoic: What Happened? (Posters)		Hall C
168	8:00 a.m.	T41. Natural Background Chemistry and Environmental Decision-Making		Ballroom H
169	8:00 a.m.	T44. Great Basin Aquatic Geology		25IF
170	8:00 a.m.	T51. Origin of Mudrocks: Modern Processes and Ancient Examples		258
171	8:00 a.m.	T61. Advances of the Neotectonics in Latin America		Ballroom D
172	1:30 p.m.	Economic Geology II: (a) Precious and Base Metals Associated with Metamorphic Terranes, (b) Metal and Fluid Evolution in the Porphyry Environment		150G
173	1:30 p.m.	Environmental and Engineering Geology II		250BC
174	1:30 p.m.	Geochemistry V: Hydrothermal to High-Temperature Geochemistry		Ballroom D
175	1:30 p.m.	Geoscience Education (Posters)		Hall C
176	1:30 p.m.	Igneous Petrology II: Plutons and Granitic Rocks		250 EF
177	1:30 p.m.	Late-Breaking Research in Earth Science II (Posters)		Hall C
178	1:30 p.m.	Mineralogy/Crystallography		25IDE
179	1:30 p.m.	Paleontology/Paleobotany VI: Life on Land		256A-C
180	1:30 p.m.	Petroleum Geology		257
181	1:30 p.m.	Precambrian Geology: From Flambeau to Zimbabwe via the Adirondacks		Ballroom E
182	1:30 p.m.	Tectonics IV: Tectonics of Asia		Ballroom F
183	1:30 p.m.	T16. Great Geological Vacations in North America—How They Can Enhance Geoscience Literacy II (Posters)		Hall C
184	1:30 p.m.	T19. Geologic Mapping: Past, Present, and Future II		259
185	1:30 p.m.	T21. Hydrogeology of Diagenesis		255A-C
186	1:30 p.m.	T48. Feedbacks Between Tectonic and Surface Processes in Orogenesis		Ballroom AC
187	3:30 p.m.	T49. Advances in Deciphering and Modeling Stratigraphic and Depositional Processes of Paleozoic Basins		255A-C
188	1:30 p.m.	T65. Advances in the Geology of Mexico		Ballroom H

GSA Headquarters Services Area

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In addition to the regular exhibit hours, the Services area will be open again on Thursday, from 9:00 a.m. to 2:00 p.m.

Visit Us!

In Memoriam

In late July of this year, we lost the winner of the very first G. K. Gilbert award, and a great scientist and colleague, when Gene Shoemaker was tragically taken from us by a traffic accident.

A memorial tribute to Gene will be held on Tuesday evening, October 21, in the Salt Palace Convention Center at the Annual Meeting in Salt Lake City just prior to the special Mars Pathfinder session at 7:00 p.m. in Ballroom AC. Sponsored by the *Planetary Geology Division*.

Graduate School Information Forum

Monday, October 20 through Wednesday, October 22, 9:00 a.m. to 4:00 p.m.; SPCC: Hall A
Drop in to visit any schools listed; no appointment necessary. This list includes participating schools at press time; a complete list of schools and their scheduled days will be posted at the forum information table.

Institution	Mon.	Tues.	Wed.		Mon.	Tues.	Wed.
Ball State University		◆			Texas A & M University		◆
Clemson University	◆				Texas Tech University	◆	◆
Cornell University	◆	◆			University of Alabama		◆
Florida State University		◆			University of Alaska, Fairbanks	◆	◆
George Washington University		◆			University of California, Riverside	◆	◆
Graduate School of the City University of New York	◆				University of Delaware		◆
Idaho State University		◆			University of Kentucky		◆
Indiana University	◆	◆			University of Maryland at College Park	◆	◆
Indiana University, Purdue University at Indianapolis	◆				University of Massachusetts	◆	
Iowa State University of Science & Technology	◆	◆			University of North Dakota	◆	
Massachusetts Institute of Technology	◆	◆			University of Pennsylvania	◆	
Montana State University		◆			University of Pittsburgh	◆	
Montana Tech of the University of Montana	◆				University of South Florida, Tampa	◆	
New Mexico Institute of Mining and Technology		◆			University of Texas at Arlington	◆	
New Mexico State University, Las Cruces		◆			University of Texas at Dallas	◆	◆
Pennsylvania State University, University Park		◆			University of Notre Dame	◆	◆
Rice University	◆	◆			Utah State University		◆
Southern Illinois University at Carbondale	◆				Vanderbilt University		◆
State University of New York at Binghamton	◆				Virginia Polytechnic Institute & State University	◆	◆
					West Virginia University		◆
					Yale University	◆	◆ ◆

International Surveys

GSA Goes Global! International Geological Surveys Attending 1997 Meeting

The 1997 International Survey Program Organizing Committee invited geological surveys from around the globe to participate in a unique international program in conjunction with the GSA Annual Meeting. Many of these surveys accepted the invitation and will have displays throughout the week in Exhibit Hall B.

The program includes a technical poster session on global geology and exhibits on

new geological or environmental developments in various countries. This is an opportunity to meet and talk geology with your colleagues from around the world.

An invitation-only, hosted reception will be held for these international colleagues, program sponsors, business and industry representatives, and government officials on Saturday evening.

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Sponsored by: Geological Society of America and the GSA International Division, U.S. Geological Survey, Association of American State Geologists, U.S. Department of Energy, State of Utah

Heads Up, Students

BREAKFAST IS READY ... AND IT'S FREE ...

Monday, October 20, 7:30 a.m.

Start the meeting off right on Monday morning by joining us for free breakfast. What's the occasion? The first-ever, soon-to-be-annual GSA Student Reception to welcome and honor students. There will be a ticket in your preregistration envelope that will get you into the buffet, which runs from 7:30 to 8:30 a.m. For students registering on site, tickets will be available at the registration area.

GSA President, George Thompson and other GSA officers will be on hand to visit with you informally and to listen to your expectations of GSA. There will be a very brief program, but otherwise you're welcome to meet friends and to chat with people representing graduate schools. This event will be in Hall A of the Salt Palace Convention Center—in the Graduate School Information Forum Area. Just look for the signs. Exxon is our sponsor for this new and taste-full event. Think: geosociety@saltpalace.bkfst.org.



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American Institute of Professional Geologists (AIPG)—Utah Chapter

Officially joined GSA as an Associated Society in 1997



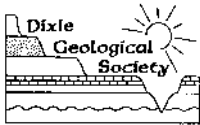
The American Institute of Professional Geologists is a nonprofit organization with over 5,000 members. The purposes of AIPG are (1) advancement of the geological sciences and the profession of geology, (2) establishment of qualifications for professional geologists, (3) certification of the qualifications of individual member geologists to the public, (4) promotion of high standards of ethical conduct among its members and within the profession of geology, and (5) representation of and advocacy for the geological profession before government and the general public.

Arizona Geological Society (AGS)



The object of the Arizona Geological Society (AGS) is the promotion and encouragement of interest in the science of geology and in the geology of the State of Arizona. The AGS (1) holds monthly meetings, (2) organizes geological field trips, and (3) occasionally publishes books and maps.

Dixie Geological Society (DGS)



The Dixie Geological Society serves southwestern Utah, northwestern Arizona, and southeastern Nevada. The goal of the DGS is to encourage public understanding and use of the geological sciences, particularly as they relate to the surrounding Colorado Plateau and Basin and Range physiographic provinces.

Four Corners Geological Society (FCGS)



The Four Corners Geological Society holds meetings in Durango, Colorado, and Farmington, New Mexico. FCGS conducts field and river trips and symposiums, publishes books, awards annual scholarships to graduate students, and participates in educational endeavors. For additional information: <http://www.trg-tech.com/FCGS/>; cbmatt@frontier.net or P.O. Box 1501, Durango, CO 81302.

Geological Society of Nevada (GSN)—Elko and Southern Chapters



The Geological Society of Nevada is a nonprofit, educational organization whose principal objective is to promote the advancement of geological sciences, especially as they relate to Nevada. GSN supports the dissemination of information through meetings, field trips, publications and academic endeavors. Membership is open to professional geologists, students, prospectors or anyone else with an interest in the geological sciences and/or the goals of the GSN.

Grand Junction Geological Society



The Grand Junction Geological Society was founded in the fall of 1953 by a group of geologists primarily engaged in uranium exploration. The object of the Society is to advance basic and applied geology, as well as engineering and other branches of science associated with the study and development of mineral resources. Meetings are held monthly except during June, July, and August. Joint meetings are occasionally held

with other local organizations representing mining and engineering professions. Members are mainly involved in the fields of uranium, petroleum, oil shale, coal, and metals. The logo, which depicts the Book Cliffs, Grand Mesa, and the interests of the members, was adopted in 1982.

Montana Geological Society



Montana Geological Society

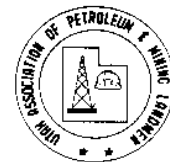
The Montana Geological Society is a nonprofit organization headquartered in Billings, Montana. The objective of the Society is to promote interest and research in geology and allied sciences and their practical application, and to encourage fellowship and cooperation among its members. These objectives are met by hosting field trips and conferences, book and newsletter publications, continuing education programs, and monthly luncheon meetings. Visitors and guests are always welcome at all Society functions and gatherings.

Society for Mining, Metallurgy and Exploration, Inc. (SME)—Utah Chapter



Founded in 1914, the Utah Section of SME is a professional society with the goals of promoting information exchange and professional development for Utah's minerals industry. Members of the section are united by a common bond, the desire to contribute to and preserve the fund of knowledge of the arts and sciences vital to the economic extraction and utilization of fuels, metals, and nonmetallic minerals found within the earth's crust.

The Utah Petroleum and Mining Landmen's Association



The Utah Petroleum and Mining Landmen's Association is a chapter of AAPL focusing on local and national issues affecting both petroleum and hard rock land issues in the northern Rocky Mountain region. Meetings are held the first Thursday of each month. For membership information, contact the Association at P.O. Box 11833, Salt Lake City, UT 84147.

Utah Geological Association (UGA)



The Utah Geological Association was formed in 1970 to serve the geologic community in Utah. The UGA publishes a monthly newsletter and holds monthly luncheon meetings with invited speakers. Each year the UGA holds a field conference and publishes a guidebook on some aspect of Utah geology.

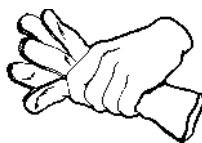
Utah Geological Survey (UGS)



The Utah Geological Survey's mission is to make Utah richer and safer by generating, interpreting, preserving, and distributing geological, paleontological, archaeological, and paleoecological information. Created by the Utah Legislature in 1931, the Survey is divided into five programs: Applied Geology, Economic Geology, Geologic Mapping, Geologic Extension Service, and Environmental Sciences.

Panel Throws Down Gauntlet

Bill Dickinson, Tucson, Arizona



Some years back, I was asked to join the U.S. Geodynamics Committee, the arm of the National Research Council charged to foster and encourage studies of the dynamic behavior of Earth. When I asked myself what special function I could serve on the committee, I decided that an effort to highlight the need for more trenchant analysis of sedimentary basins would be my most useful contribution. Accordingly, the first committee meeting I attended, I called attention to the vital position that basin research occupies in both theoretical and applied geoscience.

On the one hand, the strata of sedimentary basins constitute our most tangible record of Earth history. When interpreted correctly, they not only contain the most detailed record of the elevation changes of the lithosphere through time, thus providing ground truth for much geodynamic analysis,

but also provide the only extant record of paleoceanography, paleoclimatology, paleoecology, and so forth for the deep past. Even the geochemical patterns preserved within basin fill give us our only serious means for hindcasting patterns of subsurface fluid flow that evolve through time.

On the other hand, basin fills are the greatest repositories of fossil energy reserves and ground-water resources so important for industrial society, and offer potential sites for the deep disposal of hazardous wastes far below sensitive surface environments. As the principal charge to the National Academy of Sciences is to provide independent advice to the federal government on scientific matters important for the public welfare, it seemed to me that evaluation of the status of basin research was an appropriate task for the National Research Council to undertake.

My suggestion was accepted into the system and, after undergoing much needed refining and sharpening, came back to the committee, which I chaired by then, for action. The decision was

made to appoint a study panel charged with identifying (1) the important scientific problems that can be addressed by fresh multidisciplinary studies of sedimentary basins, (2) the kinds of new or developing technologies and data sets that can be brought to bear on those problems, and (3) the cross-disciplinary ties that are required to address the problems effectively.

After widespread consultations both inside and outside NAS-NRC circles, as is characteristic for such enterprises, a 14-person study panel was duly appointed,

with me as chair. Although there was no conscious attempt to tap GSA expertise, 10 of the other panel members are also GSA members. Five of the GSAers on the panel are also AGU and AAPG members, but the GSA membership is clearly a body of geoscientists crucial for success in a wide range of basin studies.

The point of the panel exercise

was to produce a brief summary of the status of things in basin research and point out what was needed for real advances in the field. Panel deliberations were a bootstrap operation from start to finish, but crucial minimal support was provided jointly by DOE, NSF, and the USGS, agencies always on the lookout for independent ideas that might be useful for their programmatic planning.

We tacked one session on the back end of a U.S. Geodynamics Committee meeting, and another one on the front end of a national GSA meeting, thus reducing costs. The rest of the time we conferred by e-mail, a vehicle that makes effective interaction possible at arm's length in logistical terms.

In the panel report (Dynamics of Sedimentary Basins: National Academy Press, 1997, 43 p.), we tried our best to phrase the scientific language in terms accessible intellectually, if not in its operational details, to nongeoscientists. Much of our report will be old hat to GSA readers, but I think some of the perspective offered can

stimulate fresh thinking, even among those knowledgeable about basin analysis.

The central recommendation of the report bears repeating here, simply because it represents a scientific gauntlet thrown down at the feet of the geoscience community. The panel calls for the development of an integrated basin model, or set of interrelated models, encompassing the full range of behaviors exhibited by sedimentary basins in their origins and subsequent evolution. The idea is not to deny the great diversity of sedimentary basins, but to develop a general theory from which the history of each individual basin can be seen as a specific unique case.

The vision represents a challenge for several reasons. For one thing, tectonic and sedimentological and paleogeographic and other constraints need to be treated in suitable systematic and coordinated fashion. For another, groups of geoscientists unfamiliar now to one another need to collaborate on joint cross-disciplinary investigations oriented toward the problem, rather than toward the separate disciplinary arenas. Professional societies like GSA have a strong potential role to play, by fostering the kind of broad-based perspective needed as they design appropriate future meetings and symposia.

I believe, and I think all panel members would share my view, that basin research, taken in its widest sense, has the emerging potential to provide one unifying focus for future research across much of the range of geoscience. There is nothing like a tangible problem to get the creative juices flowing! ■

Groups of geoscientists unfamiliar now to one another need to collaborate on joint cross-disciplinary investigations oriented toward the problem, rather than toward the separate disciplinary arenas. Professional societies like GSA have a strong potential role to play, by fostering the kind of broad-based perspective needed.

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NORTHEASTERN SECTION, GSA 33rd Annual Meeting

Portland, Maine • March 19–21, 1998

The hosts for the 1998 meeting of the Geological Society of America Northeastern Section are geologists from the University of Southern Maine, the Maine Geological Survey of the Natural Resources Information and Mapping Center (Maine Department of Conservation), the University of Maine at Farmington, Bates and Bowdoin Colleges, and Lepage Environmental Services, Inc.

Meeting in conjunction with the GSA Northeastern Section will be the Eastern Section of SEPM, the Northeastern Section of the Paleontological Society, the Eastern and New England Sections of the National Association of Geoscience Teachers, Association for Women Geoscientists, and Council on Undergraduate Research Geology Division. The meeting will be held at the Holiday Inn by the Bay, 88 Spring Street, Portland, Maine.

CALL FOR PAPERS

Papers are solicited from students and professionals to be included in the following types of sessions: general oral and poster sessions; theme sessions, which are composed of volunteered papers focusing on specific topics; and symposia, which consist mostly of invited papers. Volunteer presentations that are consistent with one of the symposia are also solicited. If you wish to present a paper at a symposium, contact the convener of the symposium.

ABSTRACTS

Abstracts must be submitted camera-ready on the official 1998 GSA section meeting abstract form in accordance with instructions on that form (e.g. approximately 250 words). Abstract forms are available from: Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 161, ncarlson@geosociety.org.

Send one original plus five copies of all abstracts to be considered to: Marc C. Loiselle, Technical Program Co-chairman, Maine Geological Survey, 22 State House Station, Augusta, ME 04333-0022, (207) 287-5826, marc.c.loiselle@state.me.us. Authors submitting for a symposium or a theme session should send an extra copy of the abstract to the appropriate (first listed) contact person for that technical session.

Only one volunteered paper may be presented by an individual; however, a person may also be a coauthor on papers presented by others. Additional papers may be presented by individuals invited for symposia.

Abstracts due: November 14, 1997

SYMPOSIA

Prospective authors should contact the conveners directly. General information regarding symposia may be obtained by contacting Henry N. Berry, Symposia Chairman, Maine Geological Survey, 22 State House Station, Augusta, ME 04333-0022, (207) 287-7179, henry.n.berry@state.me.us.

1. Tectonic History of the Eastern Margin of the Appalachians: New England and Atlantic Canada.

Dave West, Dept. of Geology, Earlham College, Richmond, IN 47374, (765) 983-1231, westd@earlham.edu; and Sandra Barr, Dept. of Geology, Acadia University, Wolfville, Nova Scotia B0P 1X0, Canada, (902) 585-1340, sandra.barr@acadiau.ca.

2. Coastal Geology and Public Issues.

Robert Marvinney, Maine Geological Survey, 22 State House Station, Augusta, ME 04333, (207) 287-2804, fax 207-287-2353, robert.g.marvinney@state.me.us; and Sue Halsey, Dept. of Environmental Protection, Office of Environmental Planning, P.O. Box 418, Trenton, NJ 08625-0418, (609) 292-0950, fax 609-292-4608, shalsey@dep.state.nj.us.

3. Two Decades of Progress in Maine Geology.

Robert Marvinney, Maine Geological Survey, 22 State House Station, Augusta, ME 04333, (207) 287-2804, fax 207-287-2353, robert.g.marvinney@state.me.us.

4. The Sebago Batholith.

John Creasy, Dept. of Geology, Bates College, Lewiston, ME 04240, (207) 786-6153, jcreasy@abacus.bates.edu; David Gibson, Dept. of Natural Sciences (Geology), University of Maine, Farmington, ME 04938, (207) 778-7402, dgibson@maine.maine.edu; and Henry Berry, Maine Geological Survey, 22 State House Station, Augusta, ME 04333, (207) 287-7179, henry.n.berry@state.me.us.

5. Late Quaternary Paleohydrology of Northeastern North America.

Heather Almquist-Jacobson, Dept. of Geological Sciences and Institute for Quaternary Studies, University of Maine, Orono, ME 04469, (207) 581-1502, almquist@maine.maine.edu.

6. Deglacial History and Relative Sea-Level Changes, Northern New England and Adjacent Canada.

Thomas K. Weddle, Maine Geological Survey, 22 State House Station, Augusta, ME 04333, (207) 287-7170, fax 207-287-2353, thomas.k.weddle@state.me.us; and Michael J. Retelle, Dept. of Geology,

Bates College, Lewiston, ME 04240, (207) 786-6155, fax 207-786-8334, mretelle@abacus.bates.edu.

7. Results from FEDMAP, STATEMAP, EDMAP, and NATMAP: National Cooperative Geologic Mapping Programs in the USA and Canada (POSTER ONLY).

Peter Lyttle, U.S. Geological Survey, M.S. 908, Reston, VA 20192, (703) 648-6943, fax 703-648-6937, plyttle@usgs.gov; and Michael Cherry, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, (613) 943-0774, fax 613-992-5051, mcherry@gsc.nrcan.gc.ca.

8. Evolution of Tidal and Nontidal Wetlands.

(Sponsored by Eastern Section of SEPM) Jim Pizzuto, Dept. of Geology, University of Delaware, Newark, DE 19716, (302) 831-2710, fax 302-831-4158, pizzuto@udel.edu.

9. Educating the Public about Earth Scientists: How We Can Put OURSELVES in the Limelight.

R. Laurence (Larry) Davis, Dept. of Biology and Environmental Sciences, University of New Haven, 300 Orange Ave., West Haven, CT 06516, (203) 932-7108, fax 203-931-6097, rldavis@charger.newhaven.edu.

10. The Contributions of Marland Billings and Katherine Fowler-Billings to Understanding the Geology of New England.

Peter Robinson, Dept. of Geosciences, University of Massachusetts, Amherst, MA 01003, (413) 545-2593 or 2286 (message), probinson@geo.umass.edu; and Dykstra Eusden, Dept. of Geology, Bates College, Lewiston, ME 04240, (207) 786-6152, fax 207-786-8334, deusden@abacus.bates.edu.

THEME SESSIONS

The 1998 GSA Northeastern Section meeting committee invites papers related to the following broad themes of current interest. These sessions are similar to symposia in that they focus on specific topics, but each is an open forum where the papers are volunteered. Prospective authors are encouraged to contact the conveners directly. General information regarding theme sessions may be obtained by contacting Henry N. Berry (see symposia).

1. The Role of Hydrogeologists in the 21st Century.

Grover Emrich, Emrich and Associates, 1488 Hancock Lane, Wayne, PA 19087, (610) 296-5068, emrich@aol.com.

2. Fractured Rock Hydrology and Contaminant Transport.

Andrews Tolman, Gerber-Jacques Whitford, 174 South Freeport Rd., Freeport, ME 04032, (207) 865-6138, atolman@jacqueswhitford.com.

3. Geoaerchaeology: Using Geologic Techniques to Model Past Environments.

Alice R. Kelley, Dept. of Geological Sciences, University of Maine, Orono, ME 04469, (207) 581-2056, akelley@maine.maine.edu; and David Sanger, Dept. of Anthropology, University of Maine, Orono, ME 04469, (207) 581-1897, sanger@maine.maine.edu.

4. Evolution of the New England Coast.

(Sponsored by Eastern Section of SEPM) Daniel F. Belknap, Dept. of Geological Sciences, University of Maine, Orono, ME 04469-5711, (207) 581-2159, belknap@maine.maine.edu; and Duncan FitzGerald, Dept. of Earth Sciences, Boston University, 675 Commonwealth Ave., Boston, MA 02215, (617) 353-2530, dunc@crsa.bu.edu.

5. Evidence and Impacts of Storms in Shallow Marine Environments.

(Sponsored by Eastern Section of SEPM) Carrie Kievman, Dept. of Geology & Meteorology, Kean College of New Jersey, Union, NJ 07083, (908) 527-2515, ckievman@turbo.kean.edu.

6. Economic Mineral Deposits of Northeastern North America.

William Kelly, New York State Geological Survey, 3140 CEC, Albany, NY 12230, (518) 474-7559, fax 518-486-3696, wkelly@museum.nysed.gov; and Robert Altamura, Dept. of Geology & Planetary Science, University of Pittsburgh, Johnstown, PA 15904, (814) 269-2942, fax 814-269-7261, altamura+@pitt.edu.

7. Teaching with Fossils.

(Sponsored by the Paleontological Society) Steve Good, Dept. of Geology & Astronomy, West Chester University, West Chester, PA 19383, (610) 436-2203, sgood@wcupa.edu.

8. Paleontology as a Tool for Interpreting Ancient Depositional Environments.

(Sponsored by the Paleontological Society) Steve Good, Dept. of Geology & Astronomy, West Chester University, West Chester, PA 19383, (610) 436-2203, sgood@wcupa.edu.

9. Environmental and Engineering Geophysics.

David Lesmes, Dept. of Geology and Geophysics, Boston College, Chestnut Hill, MA 02167, (617) 552-0839, lesmes@bc.edu.

10. Archaeological Stone Artifacts: Contributions to Sources, Petrology, and Distribution.

O. Don Hermes, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2192, fax 401-874-2190, dhermes@uriacc.uri.edu; Stephen Pollock, Dept. of Geosciences, University of Southern Maine, Gorham, ME 04038, (207) 780-5353, fax 207-780-5167, pollock@usm.maine.edu; and Nathan Hamilton, Dept. of Geography and Anthropology, University of Southern Maine, Gorham, ME 04038, (207) 780-5049, fax 207-780-5167, casco@usm.maine.edu.

11. Internet Applications in Introductory Geoscience Courses.

Willis Hayes, Dept. of Geosciences, University of Southern Maine, Gorham, ME 04038, (207) 780-5890, fax 207-780-5167, hayes@usm.maine.edu.

12. **Undergraduate Research** (POSTER ONLY). (Sponsored by the Council on Undergraduate Research Geology Division) Larry Malinconico, Dept. of Geology, Lafayette College, Easton, PA 18042, (610) 250-5193, fax 610-252-3904, malincol@lafayette.edu.

STUDENT AWARDS AND TRAVEL ASSISTANCE

The GSA Northeastern Section will give awards for the best oral paper and best poster session presented by students. A faculty mentor may be a junior author, but a major part of the paper or poster session must represent work by the student author. Designate papers submitted for this award at the bottom of the abstract form.

The GSA Northeastern Section will award travel grants to students who present papers (oral or poster) of which she or he is author or coauthor and the presenter at the meeting. The Section will also award student research grants to undergraduates in 1998.

For applications for travel assistance and guidelines for student research, contact Kenneth N. Weaver, Secretary-Treasurer, Northeastern Section, GSA, c/o Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21821-5210, (410) 554-5532, fax 410-554-5502.

SHORT COURSE

Environmental Hydrogeology.

(Sponsored by Eastern Section of SEPM) Saturday, March 21. A one-day introduction to practical environmental hydrogeology for geologists with little first-hand experience in environmental consulting. Basic subsurface hydrology principles, the environmental regulatory framework, and Phase 1, 2, and 3 assessments will be discussed. Instructor: Eric Eslinger, Alpha Earth, Inc., Glenmont, New York. For details and registration information, contact Kathy Browne, Dept. of Geological and Marine Sciences, 2083 Lawrenceville Rd., Rider University, Lawrenceville, NJ 08648-3099, (609) 895-5408, browne@enigma.rider.edu.

FIELD TRIP

Geology of the Portland Water Front by Narrow Gauge Railroad. Professor of geology (Bowdoin College) and engineer Arthur Hussey will lead daily excursions via original narrow gauge railway equipment owned by the Maine Narrow Gauge Railroad and Museum.

EXHIBITS

Booth and table exhibit space will be available in the large convention hall at the Holiday Inn by the Bay. Reduced rates are available for educational or not-for-profit groups. For further information and space reservation, contact Irwin Novak, Exhibits Coordinator, Dept. of Geosciences, University of Southern Maine, Gorham, ME 04038, (207) 780-5025, novak@usm.maine.edu.

SPECIAL EVENTS

Map Blast, Thursday evening, March 19. This special, informal session is for the display and discussion of newly published, unpublished, or progress geologic maps of any sort. Maps should have a title and a stand-alone explanation. This

is not a poster session, and abstracts are not required and will not be published. Authors must be present. Contact Tom Weddle (thomas.k.weddle@state.me.us) or Henry Berry (henry.n.berry@state.me.us), Maine Geological Survey, 22 State House Station, Augusta, ME 04333-0022, (207) 287-2801, fax 207-287-2353.

Breakfasts, Luncheon Meetings, and Business Meeting Receptions.

Paleontological Society, Northeastern Section; National Association of Geoscience Teachers, Eastern and New England Sections; SEPM, Eastern Section; National Association for Women Geoscientists; and GSA Northeastern Section Management Board.

The **Welcoming Reception** will be on Wednesday, March 18. The **GSA Northeastern Section banquet** will be on Friday, March 20.

HOUSING

A large block of rooms has been reserved for meeting participants at the Holiday Inn by the Bay (1-800-345-5070). The meeting area has easy access by road and ample parking. To ensure guaranteed room rates, reserve your room before *February 18, 1998*.

CHILD CARE

Child care arrangements will be coordinated by Linda L. Pollock, Dept. of Geosciences, University of Southern Maine, Gorham, ME, (207) 780-5353, fax 207-780-5167, pollock@usm.maine.edu.

ACCESSIBILITY FOR REGISTRANTS WITH SPECIAL NEEDS

The GSA Northeastern Section is committed to making every event at the 1998 meeting accessible to all people interested in attending. You can indicate special requirements, such as an interpreter or wheelchair accessibility, on the meeting registration form, or contact Stephen Pollock (see Detailed Information below).

REGISTRATION

Registration will be handled by GSA headquarters. To obtain low registration fees and to assist planning by the local committee, please preregister. Registration forms will appear in the December 1997 issue of *GSA Today*.

Preregistration deadline: February 13, 1998

DETAILED INFORMATION

Complete information on registration, accommodations, and activities will appear in the December 1997 issue of *GSA Today* and as part of the *Abstracts with Programs* for 1998 mailed in late February 1998. For additional information or suggestions, contact the general chairman, Stephen G. Pollock, Dept. of Geosciences, University of Southern Maine, Gorham, ME 04038, (207) 780-5353, fax 207-780-5167, pollock@usm.maine.edu. ■

SOUTH-CENTRAL SECTION, GSA 32nd Annual Meeting

Norman, Oklahoma • March 23–24, 1998

The School of Geology and Geophysics and the Oklahoma Geological Survey at the University of Oklahoma invite you to the annual meeting of the South-Central Section of the Geological Society of America. The meeting will be held Monday, March 23, and Tuesday, March 24, on the University of Oklahoma campus; the technical meetings will be held at the Oklahoma Center for Continuing Education (OCCE), with opening activities and Sunday workshops at the Sarkeys Energy Center.

CALL FOR PAPERS

Papers are invited for presentation at both symposia and in general sessions in oral or poster format. Oral presentations will be 15–20 minutes. Poster sessions will be set up for at least four hours, and authors will be available for two hours. Volunteered abstracts not included in symposia will be scheduled for regular technical sessions. Anyone wishing to organize a symposium should contact Sara Moody, School of Geology and Geophysics, University of Oklahoma, 810 Sarkeys Energy Center, Norman, OK 73019, (405) 325-3257, fax 405-325-3140, smooody@ou.edu.

SYMPOSIA

- 1. Innovative Ideas for College-level Field Trips and Labs.** Mike Soreghan, OU School of Geology and Geophysics, and Neil Suneson, Oklahoma Geological Survey.
- 2. Application of Trace Elements and Isotopes to Igneous and Sedimentary Systems.** Barry Weaver, OU School of Geology and Geophysics.
- 3. Geologic Mapping (STATEMAP).** Ken Johnson, Oklahoma Geological Survey.
- 4. Climatic Signals in Paleozoic Strata of the Mid-Continent.** R. Douglas Elmore, Gerilyn Soreghan, David Deming, and Tom Dewers, OU School of Geology and Geophysics.
- 5. Near-Surface Geophysics.** Alan Witten, OU School of Geology and Geophysics.
- 6. Rock Mechanics and Fractured Reservoirs.** T. Gene Scott, OU Rock Mechanics Institute.
- 7. Mid-Continent Basement Character.** R. E. Denison, University of Texas at Dallas, and W. R. Van Schmus, University of Kansas.
- 8. Taphonomy: New Looks at Fossilization.** Walter Manger, University of Arkansas, and P. K. Sutherland, OU School of Geology and Geophysics.
- 9. Geoscience Information.** Claren Kidd, Youngblood Geology Library, OU School of Geology and Geophysics.

- 10. History of Geology.** Ken Taylor, OU History of Science Department.
- 11. Pennsylvanian-Permian Boundary—New Biostratigraphic and Sequence Stratigraphic Data.** J. Chaplin, Oklahoma Geological Survey.

WORKSHOP

Learning from the Fossil Record, for K–12 teachers.

FIELD TRIPS

The location of the University of Oklahoma, in the southern mid-continent, is ideally suited to research in a wide variety of geologic settings, including the Ouachita foldbelt, the Southern Oklahoma aulacogen (Arbuckle and Wichita Mountains) and adjacent basins and platform.

The field trips are being organized by the Oklahoma Geological Survey. If you have questions concerning the trips, please contact Ken Johnson, Oklahoma Geological Survey, 100 E. Boyd, Sarkeys Energy Center, Norman, OK 73019, (405) 325-3031, fax 405-325-7069.

The following trips are tentative.

- 1. Basement Rocks of the Southern Oklahoma Aulacogen.** R. E. Denison, E. Lidiak, J. P. Hogan, and M. C. Gilbert.
- 2. Middle Carboniferous of the Southwestern Ozark Mountains.** W. Manger and P. K. Sutherland.
- 3. Permian Geology of the Oklahoma City Area.** L. Hemish and N. Suneson.
- 4. Biostratigraphy and Sequence Stratigraphy of the Pennsylvanian-Permian Boundary in Kansas and Oklahoma.** D. Boardman II, S. Mazzullo, and M. Nestell.

ABSTRACTS

Abstracts for all sessions and symposia must be submitted camera-ready on official 1998 GSA section meeting abstract forms. These forms are available from Abstracts Coordinator, GSA, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 161, ncarlson@geosociety.org.

Send an original and five copies of the abstract (for both volunteered and

invited papers) to: Judson Ahern, School of Geology and Geophysics, University of Oklahoma, 100 E. Boyd St., Suite 810, Norman, OK 73019-0628. No abstract fee will be charged.

Indicate on the abstract form your preference for a poster or oral session, or the symposium (if any) appropriate to your research.

**Abstract deadline:
December 1, 1997**

Attendees are encouraged to order an abstract book when they pay their GSA annual dues. There will be only a limited number of abstract books available for purchase on-site.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be available. Space rental is \$175, which will include one complimentary registration. Exhibitors are encouraged to set up on Sunday afternoon. For information concerning exhibits, contact Jane Weber, Oklahoma Geological Survey, 100 E. Boyd, Sarkeys Energy Center, Norman, OK 73019, (405) 325-3031, fax 405-325-7069.

SPECIAL EVENTS

The **Welcoming Party** will begin at 5 p.m. on Sunday, March 22, in the Sarkeys Energy Center. On-site registration will be available beginning at 1 p.m., and those who have preregistered may pick up their name badges, tickets for the dinner, and programs at that time.

The **South-Central Section Dinner** will be on Monday, March 23. Tickets must be purchased in advance.

STUDENT PAPERS AND TRAVEL GRANTS

Awards will be given for the best student presentation in both oral and poster formats. Awards will be based on quality of research and effectiveness of presentation. Limited funds for travel expenses are also available. Only papers written solely by students will be eligible for student awards. To be considered for a travel stipend and/or the best-paper awards, students should attach a note to the submitted abstract stating their interest in being considered. Charles Harper, OU School of Geology and Geophysics, will administer these student awards.

PREREGISTRATION

**Preregistration deadline:
February 6, 1998**

Preregistration by mail will be handled by the School of Geology and Geophysics. Registration forms will appear in

South-Central continued on p. 29

the December 1997 issue of *GSA Today*. Please take advantage of the lower registration fees and register by February 6. All field-trip participants must preregister for the meeting. Registration fees are as follows. *Preregistration*: GSA members—\$50, nonmembers—\$60, GSA student members—\$25, nonmembers—\$30. *On-site registration*: GSA members—\$60, nonmembers—\$70, GSA student members—\$30, nonmembers—\$35.

HOTEL ACCOMMODATIONS AND HOUSING

We have reserved the Sooner Hotel, on the OU campus and adjacent to the OCCE Forum Building where the meeting is being held. The rate is \$38 single and \$42 double. Complimentary continental breakfast is included. Separate cottages (suites) are also available. Rates are: \$65 double, \$70 triple, and \$75 quad occupancy. Complimentary continental breakfast is included. The deadline for reserving rooms at these rates is *February 20, 1998*. Housing reservation information will be included in the final announcement (December 1997 *GSA Today*). Also see the Web site <http://hoth.gcn.ou.edu/~jahern/scgsa/index.html>. ■

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1998
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Preliminary Announcement and Call for Papers

NORTH-CENTRAL SECTION, GSA 32nd Annual Meeting

Columbus, Ohio • March 19–20, 1998

The Department of Geological Sciences, Ohio State University (OSU), in conjunction with the College of Mathematical and Physical Sciences, the Bryd Polar Research Center, the Division of Geological Survey of the Ohio Department of Natural Resources (ODNR), and the U.S. Geological Survey Water Resources Division, will host the 32nd Annual Meeting of the North-Central Section of the Geological Society of America. The meeting will be in the Ohio Union, Orton Hall, Mendenhall Laboratories, and the Faculty Club on the Ohio State University campus. Societies and organizations meeting with the North-Central Section include the Association for Women Geoscientists, the East-Central Section of the National Association of Geoscience Teachers, the Geology Division of the Council on Undergraduate Research, the Great Lakes Section of SEPM, the North-Central Section of the Paleontological Society, and the Pander Society.

CALL FOR PAPERS

Papers on all topics listed on the GSA abstract form are invited from students and professionals for presentation in oral or poster general sessions and theme (volunteered) sessions. Presentations that may fit into one of the symposia (invited and volunteered papers) are also solicited.

Those interested in presenting a paper in a symposium should contact the symposium convener and/or ask on the submitted abstract form that the abstract be considered for a particular symposium.

SYMPOSIA

- 1. Ecology and Evolution of Encrusting and Boring Organisms.** Halard Lescinsky, Dept. Life and Earth Sci., Otterbein College, Westerville, OH 43081, (614) 823-1565, fax 614-823-3042, hlescinsky@otterbein.edu.
- 2. Spreading the Good Word: The Importance of Outreach Programs in Geoscience Education.** David H. Malone, Dept. Geography-Geology, Illinois State University, Campus Box 4400, Normal, IL 61790-4400, (309) 438-2692, fax 309-438-5310, dhmalon@ilstu.edu; and G. G. Anderson, Dept. Earth Sci., St. Cloud State University, St. Cloud, MN 56301-4498.
- 3. Hot Topics in Conodont Biochronology.** Mark Kleffner, Dept. Geol. Sci., OSU at Lima, 4240 Campus Dr., Lima, OH 45804-3576, (419) 221-1641 ext. 208, fax 419-221-1658, kleffner.1@osu.edu; and Walter C. Sweet, Dept. Geol. Sci., OSU, 155 So. Oval Mall, Columbus, OH 43210, (614) 292-2326, fax 614-292-1496, sweet.2@osu.edu.
- 4. Conodont Evidence for Impacts and Extinctions.** Charles A. Sandberg, U.S. Geological Survey, Box 25046, MS 940, Federal Center, Denver, CO 80225, (303) 236-5763, fax 303-236-0459, sandberg@usgs.gov.

5. Geology of Ohio. Thomas Berg, State Geologist and Chief, Geological Survey Division, ODNR, Fountain Square, Bldg. B, Columbus, OH 43224, (614) 265-6576, fax 614-447-1918, berg@nrult1.dnr.ohio.gov.

6. The Contribution of Bedrock and Glacial Debris to the Quality of Life in the Midwest. E. Scott Bair, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-6197, fax 614-292-7688, esbair@hydro.mps.ohio-state.edu.

7. Global Change and Natural Climate Variability Recorded in Mountain Glaciers. Lonnie G. Thompson, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-2616, fax 614-292-7688, and Byrd Polar Research Center, 082C Scott Hall, 1090 Carmack Rd., Columbus, OH 43210, (614) 292-6652, fax 614-292-4697, thompson.3@osu.edu.

8. Sedimentologic and Paleocologic Approaches to Interpreting Sea-Level Changes and Sequence Stratigraphy. Brian Witzke, Iowa Geological Survey, 109 Trowbridge Hall, University of Iowa, Iowa City, IA 52242-1319, (319) 335-1590, fax 319-335-2754, brian-witzke@uiowa.edu.

9. R. L. Bates Symposium on Industrial Minerals. D. E. Pride, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-9523, fax 614-292-7688, pride.1@osu.edu; and R. O. Utgard, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-0138, fax 614-292-7688, rutgard@summit.bor.ohio.gov.

10. Geophysics for Shallow-Depth Site Characterization. Paul Wolfe, Dept. Physics and Geol. Sci., Wright State Univ., Dayton, OH 45435, (937) 775-2990, fax 937-775-3462, paul@taurus.gl.wright.edu; and Jeffrey J. Daniels, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH

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43210, (614) 292-4295, fax 614-292-7688, jdaniels@geols.mps.ohio-state.edu.

11. **The Midwest Response of Physical Systems to Abrupt Climate Change.**

Tom Lowell, Dept. Geology, Univ. Cincinnati, Cincinnati, OH 45226-0013, (513) 556-4165 or 3732, fax 513-556-6931, Thomas.Lowell@uc.edu; and Donald Pair, Dept. Geology, Univ. Dayton, Dayton, OH 45469-2364, (937) 229-2936, fax 937-229-2889, pair@neelix.udayton.edu.

POSTER SESSIONS

Students and professional geologists are encouraged to take advantage of this effective means of presentation. Please indicate Poster Session on the GSA abstract form.

Poster Session for Undergraduate Research. Karen H. Fryer, Dept. Geology and Geography, Ohio Wesleyan University, Delaware, OH 43015, (614) 368-3618, fax 614-368-3999, khfryer@owu.edu.

ABSTRACTS

Abstracts must be submitted camera-ready on official GSA abstract forms in accordance with instructions on the forms, which are available from Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140: (303) 447-2020, ext. 161, ncarlson@geosociety.org. Abstract forms may also be obtained from David Elliot, Program Coordinator, NC-GSA, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, fax 614-292-7688, delliot@magnus.acs.ohio-state.edu, and from GSA Campus Representatives at most colleges and universities in the North-Central Section area.

Abstracts deadline: November 14, 1997

Send one original and five copies to David Elliot, Program Coordinator, North-Central Section GSA, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-5076, fax 614-292-7688, delliot@magnus.acs.ohio-state.edu. Abstracts submitted for inclusion in symposia or theme sessions should be sent directly to the first symposium organizer listed for each symposium or theme session. Contributors desiring acknowledgment of receipt of the abstract should include a stamped, self-addressed envelope or postcard.

WORKSHOPS

1. **Geology of the Serpent Mound Disturbance—A Core Workshop.**

Greg Schumacher, Mark Baranowski, and Mack Swinford, Geological Survey Division, Ohio Department of Natural Resources.

2. **Learning from the Fossil Record.**

Halard Lescinsky, Dept. Life and Earth Sci., Otterbein College, Westerville, OH 43081,

(614) 823-1565, fax 614-823-3042, hlescinsky@otterbein.edu.

3. **ESSTEP Workshop for High School and College Earth Science Teachers: Effective Use of Computer-Based Technologies in the Classroom.**

David H. Malone, Dept. Geography-Geology, Illinois State University, Campus Box 4400, Normal, IL 61790-4400, (309) 438-2692, fax 309-438-5310, dhmalon@ilstu.edu; and Fred Siewers, Dept. Physical Sci., Rock Valley College, 3301 N. Mulford Rd., Rockford, IL 61114, (815) 654-4385, faps3fs@rvcc.il.us.

FIELD TRIPS

Field trip coordinators are Douglas E. Pride, Dept. Geological Sciences, OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-9523, fax 614-292-7688, pride.1@osu.edu; and Thomas Berg, Geological Survey Division, ODNR, Fountain Square, Bldg. B, Columbus, OH 43224, (614) 265-6988, fax 614-447-1918, thomas.berg@dnr.state.oh.us. The trips listed here are provisional.

Premeeeting

1. **Field Excursion to a Longwall Coal Mine.**

Douglas L. Crowell, Geological Survey Division, ODNR.

2. **Field Excursion to an Underground Salt Mine.** Thomas M. Berg, State Geologist and Chief, Geological Survey Division, ODNR.

Postmeeeting

1. **Hydrogeology Tour of Acid Mine Drainage in Southeast Ohio.**

Dina Lopez and Mary Stoertz, Ohio University.

2. **Quaternary Geology Along the Eastern Margin of the Scioto Lobe.**

John Szabo, University of Akron.

3. **Sedimentology and Provenance of the Permo-Carboniferous of Athens County, Southeastern Ohio.**

Elizabeth Gierlowski-Kordesich and Joseph P. Smith, Ohio University.

4. **Geology Along the Towpath: Stones of the Ohio and Erie and Miami and Erie Canals.**

Joe Hannibal, Cleveland Museum of Natural History.

STUDENT PAPER AWARDS AND TRAVEL-ASSISTANCE GRANTS

The North-Central Section will award \$100 each for up to eight outstanding student papers. The principal author and presenter must be a graduate or undergraduate student. Abstracts of papers submitted for consideration for these awards should be identified as such on the abstract form.

Travel-assistance grants will be offered on a first-come, first-served basis, with priority given to students presenting oral reports or poster sessions. Application forms are available from William I. Ausich, Chairperson, North-Central Section, GSA, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210 (614) 292-0069, fax 614-292-7688, ausich@mps.ohio-state.edu. Applications for travel assistance must be received no later than *February 7, 1998*.

BUSINESS MEETINGS AND SOCIAL EVENTS

The **GSA North-Central Section Management Board** will hold its business meeting with breakfast on Thursday, March 19, 1998.

Breakfast meetings will also be scheduled for **GSA Campus Representatives** and the **Association for Women Geoscientists**.

A **Welcoming Reception** will be held in the Ohio Union on Wednesday evening, March 18, 1998, and the **Annual Banquet** will be in the Faculty Club on Thursday evening, March 19.

The **North-Central Section of the Paleontological Society**, the **Pander Society**, and the **Great Lakes Section of SEPM** will meet jointly for lunch at noon on Thursday, March 19.

A luncheon will also be scheduled on Friday for the **National Association of Geoscience Teachers**.

HOUSING

The 1998 GSA North-Central Section meeting will coincide with the State High School Basketball Tournament, which is held on the Ohio State University campus, so rooms in motels and hotels close to campus will probably be completely booked far in advance of our meeting. However, we have blocks of rooms in several motels north of the university, readily accessible by car or on local bus lines. A list of the names, telephone numbers, and room rates will be available in the December 1997 issue of *GSA Today*. Registrants are responsible for making their own housing arrangements.

REGISTRATION

Preregistration deadline: February 13, 1998. The registration form will be in the December 1997 issue of *GSA Today*.

GSA is committed to making every event at the 1998 North-Central Section meeting accessible to all persons interested in attending. You can indicate special requirements, such as an interpreter or wheelchair accessibility, on the registration form.

The *Abstracts with Programs* book may be purchased with your GSA membership or on-site in the registration area.

DETAILED INFORMATION

Detailed information concerning registration, hotel and motel accommodations, alternative opportunities in Columbus and central Ohio, technical sessions and symposia, and field trips and workshops will appear in the December 1997 issue of *GSA Today*. Inquiries, requests, or suggestions should be directed to William I. Ausich, Chairperson, GSA North-Central Section, Dept. Geol. Sci., OSU, 125 So. Oval Mall, Columbus, OH 43210, (614) 292-0069, fax 614-292-7688, ausich@mps.ohio-state.edu. ■

Setting the Agenda for U.S. Science and Technology Policy

Tamara Nameroff, 1996–1997 GSA Congressional Science Fellow

The continuing clash in Congress over the proper role for the federal government in supporting research and development illustrates the growing pains of U.S. science and technology (S&T) policy in the post-Cold War era. Budget proposals from the Clinton Administration over the past five years have tried to refocus S&T policy on successful American competition in the global market. The Administration has redirected some funding from traditional federal support of basic research and education to programs that directly involve the government in the protection and promotion of technological development. During the last Congress, this policy resulted in a political train wreck between critics who labeled the Administration's programs as "Democratic big spending and ... pork" (Bloch and Cheney, 1993) and those who feared that eliminating support for industrial R&D would "undo the Federal science establishment, crippling parts of it beyond repair" (Broad, 1995). This ideological difference is manifest again in the 105th Congress as the budget is debated.

Science and technology are significant drivers of economic prosperity. According to the Department of Commerce, S&T may account for as much as 50% of the nation's long-term growth, mostly through enhancement of economic productivity. Unfortunately for scientists working in an

era of budget cutting, establishing the exact relationship between the level of R&D spending and its beneficial outcomes is difficult. The time lag from initial scientific research and technology development to successful introduction of a technology into the marketplace is commonly measured in decades. The long time frame and unpredictability of the innovation and commercialization processes makes it nearly impossible for industry or government to know which basic research programs will lead to new technologies and which specific technologies will be globally successful. Both the Administration and Congress acknowledge the important role of basic research—the President's budget proposal protects the major science agencies from the worst of the cuts needed to balance the budget by 2002, and the Congress hasn't made any major efforts to gut the substance of these proposals. However, the verdict is still out on an acceptable role for the federal government to play in national R&D efforts when it comes to other types of scientific endeavors.

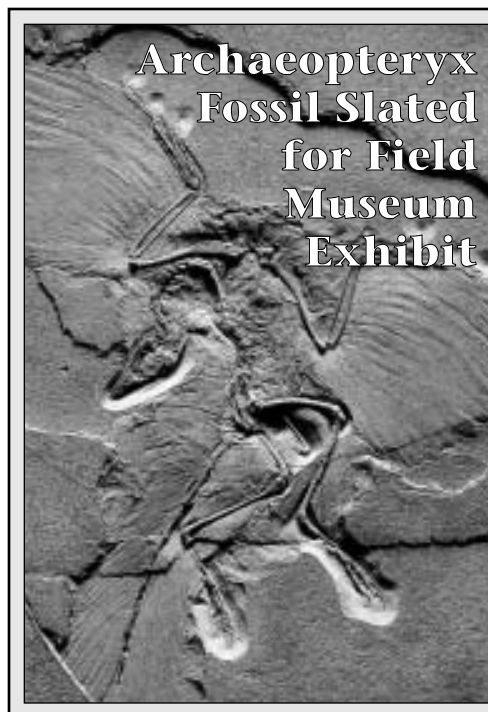
One of the fundamental disagreements on S&T policy between the Clinton Administration and the Congressional majority centers on the role of government in supporting science and technology for economic development. Where some see an opportunity to use government to assist the American economy,



others see "corporate welfare." As these issues are considered in Congress this year, I think it is instructive to examine how our principal economic competitors deal with this issue. Certainly a science and technology policy that places the United States at a competitive disadvantage to other countries is not in the country's best interests.

Publicly funded programs in the European Union and Japan place greater emphasis on support for both applied research and adoption of new technologies than on fundamental research. Since 1970, Japan and Germany have spent a larger share of their national income on nondefense research and development than has the United States. In addition, the national R&D efforts of these countries are targeted on areas believed to be important for future economic development. The net result is that while the U.S. leads the world in basic research in most

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Archaeopteryx Fossil Slated for Field Museum Exhibit

The world's oldest known bird fossil, *Archaeopteryx*, will be on exhibit to the public for the first time in North America, October 4–19, 1997, at The Field Museum in Chicago. Of the seven skeletal specimens of *Archaeopteryx*, all from the Solnhofen limestone quarries of Germany, the one to be displayed at The Field Museum is the most recent discovery, found in 1992.

Along with the exhibit "*Archaeopteryx: The Bird That Rocked the World*," The Field Museum will offer lectures and activities for a wide range of ages, giving participants an opportunity to learn about the bird in depth. The Field Museum is open from 9 a.m. to 5 p.m. daily. For further information, call (312)922-9410, or fax 312-554-9630.

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fields, it invests considerably less relative to foreign countries in the types of technological innovation that ensure continued economic growth in the near future.

To match the competitive edge provided to foreign industries by their governments, the Clinton Administration, like the Bush Administration before it, has supported government-industry partnership programs to assist the development of emergent, "pre-competitive" technologies. The partnerships attempt to accelerate the development of promising technologies that would be unlikely to be developed in time to compete in rapidly changing world markets. An example of this type of program is the Partnership for a New Generation of Vehicles (PNGV). Under this program, government and industry scientists from the major American auto makers are working collaboratively to develop a car with the same attributes as the Ford Taurus that would get 80 miles per gallon of gasoline at comparable cost to less fuel efficient cars. Cost-sharing between government and industry ensures that the research is industrially relevant and that the program remains

focused on the goal of improved turnaround time for the innovation process.

Critics of such programs have suggested that they are counterproductive in the long run because industries that work in partnership with the government would become ineffective competitors. They point to the sometimes heavy-handed involvement of the government in the market to "pick winners"—technologies mandated by the government to succeed (high-definition TV, for example)—and the failure of these technologies to thrive because they were selected without regard to consumer preferences. In addition, critics suggest that a large portion of the federal resources made available to such programs goes to big corporations that can afford to make the investments without federal assistance. Indeed, a Government Accounting Office report found that 40% of the funding made available under the program to develop pre-competitive technologies went to large companies.

The heart of the debate really is whether investments in pre-competitive technologies are inherently different from other investment decisions made by businesses. According to Mary Good, former Undersecretary for Technology at the

Department of Commerce, government-industry projects focus on "high-risk, long-term issues" that differ fundamentally from the short-term investment strategies on which corporations typically focus. In addition, the majority of partnership programs, like the PNGV, involve groups of corporations that wouldn't normally work together without the carrot of federal assistance. Whether these arguments are strong enough to satisfy Congressional critics remains to be seen.

REFERENCES CITED

Bloch, E., and Cheney, D., 1993, Technology policy comes of age: Issues in Science and Technology, p. 55-60.

Broad, W. J., 1995, G.O.P. budget cuts would fall hard on civilian science: New York Times, May 22, sec. A1, p. 6.

Tamara Nameroff is the 1996-1997 GSA Congressional Science Fellow. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 1434-HQ-96-GR-02768. The views and conclusions contained in this article are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government or GSA. ■

Congressional Science Fellowship 1998-1999

The Geological Society of America is accepting applications for the 1998-1999 Congressional Science Fellowship. The Fellow selected will spend a year (September 1998-August 1999) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

CRITERIA

The program is open to highly qualified Ph.D. earth scientists. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy problems.

AWARD

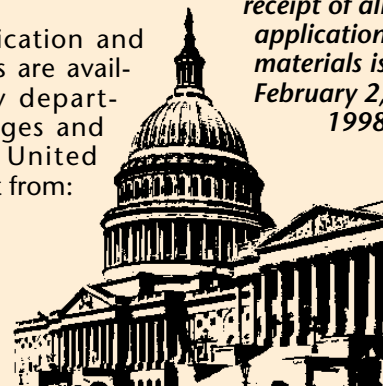
The GSA Congressional Science Fellowship carries with it a \$42,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (GSA regrets that the fellowship is available only to U.S. citizens, and employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact the AAAS or the Geological Society of America.)

TO APPLY

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from:

Executive Director
Geological Society
of America
P.O. Box 9140
Boulder, CO 80301

Deadline for receipt of all application materials is February 2, 1998

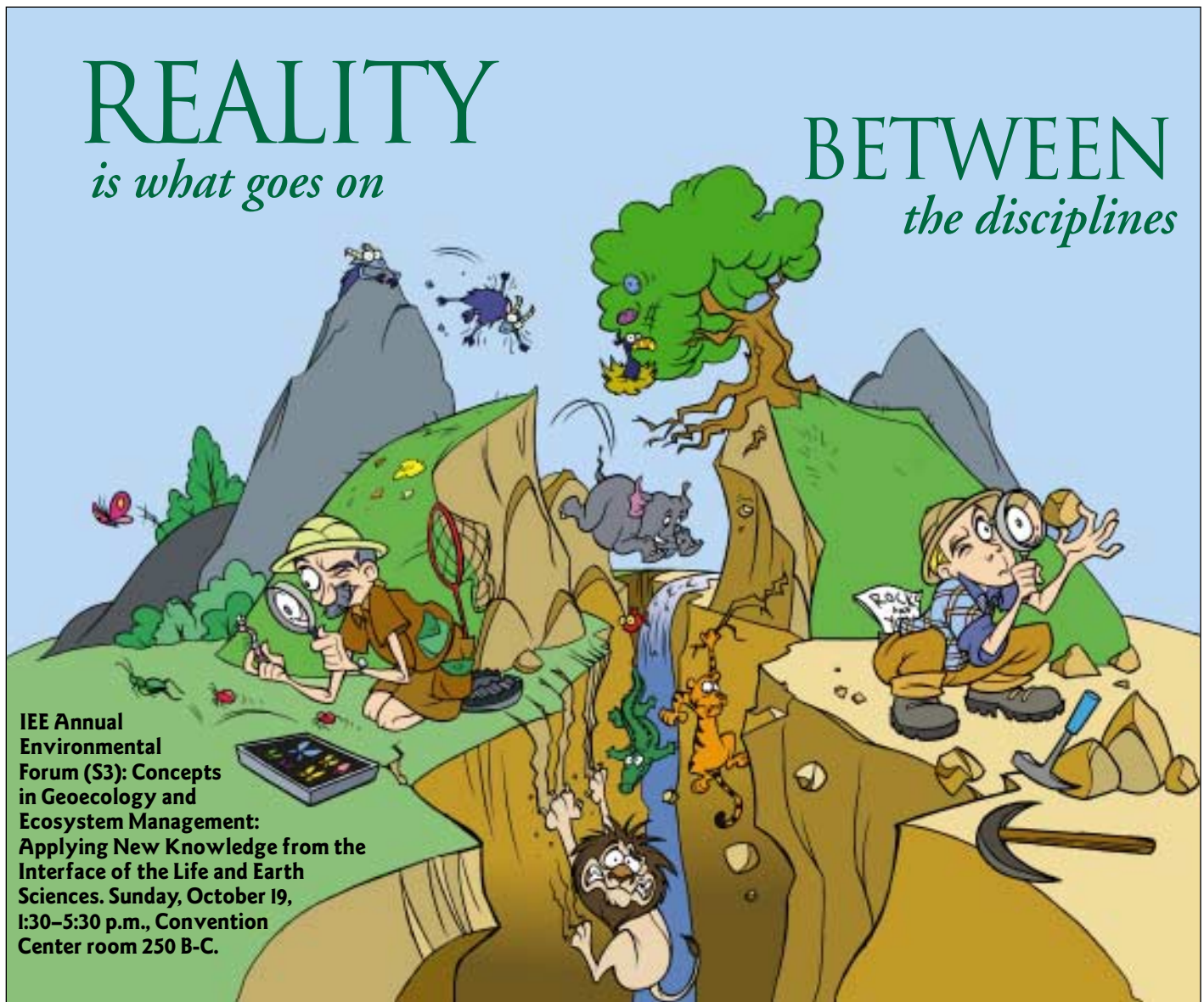


The Geological Society of America

Outside the Box: IEE-Sponsored Events at the GSA Annual Meeting in Salt Lake City

REALITY
is what goes on

BETWEEN
the disciplines



IEE Annual Environmental Forum (S3): Concepts in Geocology and Ecosystem Management: Applying New Knowledge from the Interface of the Life and Earth Sciences. Sunday, October 19, 1:30–5:30 p.m., Convention Center room 250 B-C.

The boundaries of scientific disciplines reflect the minds of scientists, not the reality of the environment. As human impacts on the environment continue to accelerate, successful management of life-sustaining ecosystems will depend on our ability to understand the dynamics of complex natural systems. Necessary insight into these dynamics is not likely to emerge from the traditional framework of disciplinary reductionist science. This year's Annual Environmental Forum, at the GSA meeting in Salt Lake City, explores the realm of geocology, an emerging area of interdisciplinary inquiry that investigates the relationships between physical and biological systems—and the contingent consequences of these relationships.

Forum Speakers

- Steven M. Stanley, Studying the Deep History of the Earth-Life System
- Dennis Fenn, Challenges to Integrating the Natural Sciences
- James Patton, Landscape Evolution and Tropical Forest Biota
- Roy Plotnick, Modeling the Effects of Landscape Heterogeneity on Ecosystems
- Karen Prestegaard, Integrated Ecological and Geomorphological Field Experiments
- Bruce Douglas, Bedrock Geology and Geoecology in the Northern Rocky Mountains
- Cathleen May, Congruency, Coincidence, and Geoecological Contingency

IEE-Sponsored Events *continued on p. 34*

IEE-Sponsored Events *continued from p. 33*

IEE is also sponsoring technical sessions on a range of geoenvironmental issues.

As a follow-up to the Annual Environmental Forum, a theme session on geocological concepts (T6) will be held on Monday, October 20, 8:00 a.m.–12:00 noon, Convention Center room 150 G.





Incoming GSA President Victor Baker has teamed up with Orrin Pilkey to convene a symposium called “Predictive Modeling in the Earth Sciences: Application and Misapplication to Environmental Problems” (S23). This session will discuss the use (and abuse) of predictive modeling in the areas of hydrogeology, shoreline processes, and global climate change. Wednesday, October 22, 8:00 a.m.–12:00 noon, Convention Center room 151 A-G.

Two sessions will explore a range of ethical and cultural issues that face geoscientists. A theme session on “The Geosciences in Context: Values, Sustainability, Culture, and Curricula” (T39) investigates the implications of an earth science perspective for a range of political, economic, and environmental issues. Tuesday, October 21, 1:30–5:30 p.m., Convention Center room 258. Then, a symposium on “Advocacy, Ethics, and the Geosciences” (S25; cosponsored by the National Association of Geoscience Teachers) will examine the connections between scientific facts and the values of a society that uses geologic knowledge to achieve social or economic ends. Wednesday, October 22, 1:30–5:30 p.m., Convention Center room 250 B-C.

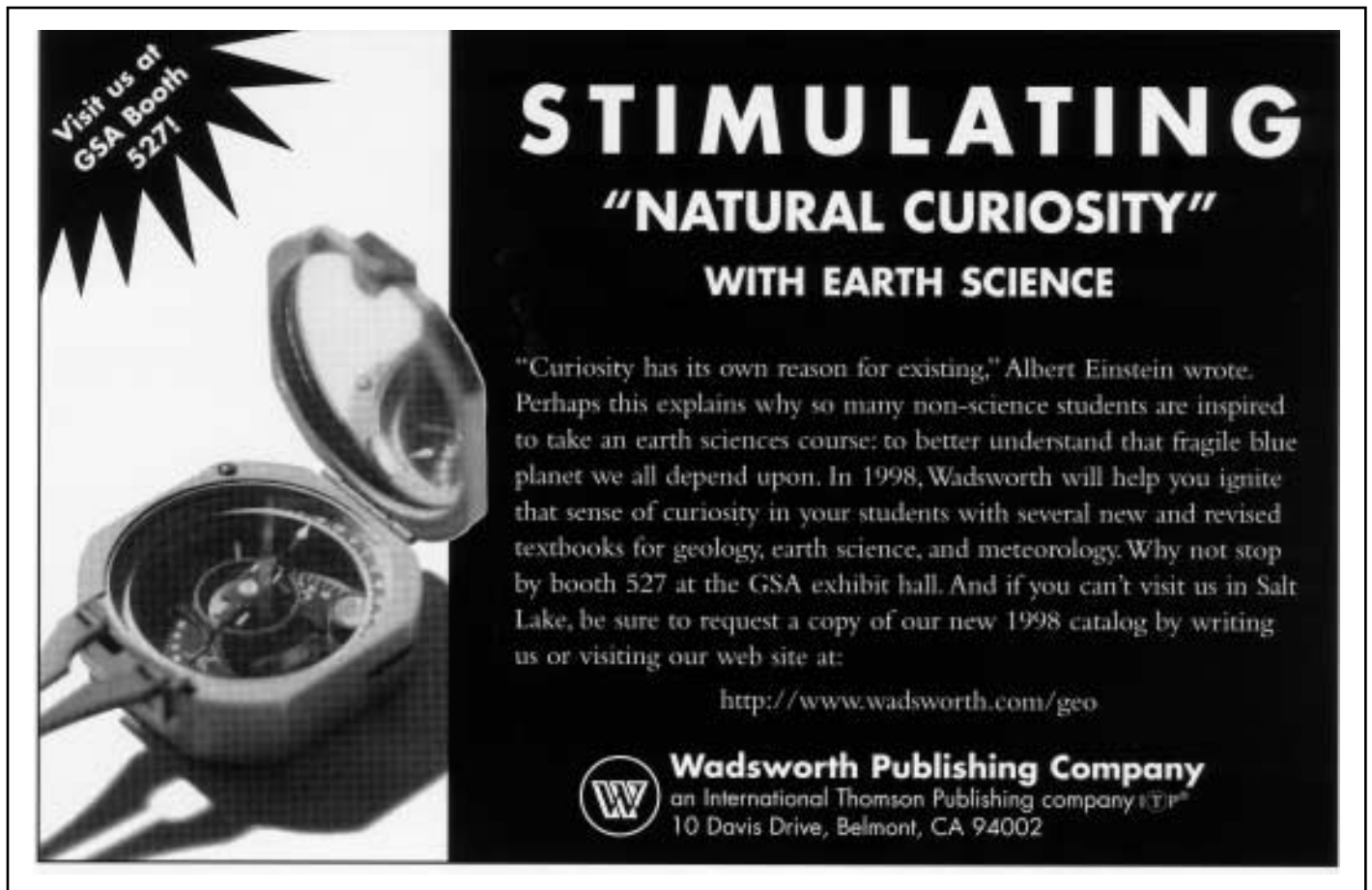
IEE and the National Association of Black Geologists and Geophysicists are cosponsoring a symposium on “Global Connections: Environmental Justice in the Americas and Abroad” (S29). The geosciences offer valuable tools, perspectives, and

knowledge that can create important insights into the distribution of adverse environmental impacts in society. This is the third year that GSA has hosted a session on environmental justice issues. Thursday, October 23, 8:00 a.m.–12:00 noon, Convention Center Ballroom E.

Additional IEE-sponsored theme sessions include:

-  **T7: Conservation Geology: Restoring and Maintaining Earth's Ecosystems.** Tuesday, October 21, 8:00 a.m.–12:00 noon, Convention Center room 259.
-  **T41: Natural Background Chemistry and Environmental Decision-making.** Cosponsored by the *International Association for Geochemistry and Cosmochemistry*. Thursday, October 23, 8:00 a.m.–12:00 noon, Convention Center Ballroom H.
-  **T45: Environmental Impacts on Western Rivers.** Cosponsored by the *Quaternary Geology and Geomorphology Division*. Wednesday, October 22, 8:00 a.m.–12:00 noon, Convention Center room 255 A-C.
-  **T47: Influence of Geomorphic Processes on Biological Communities.** Cosponsored by the *Quaternary Geology and Geomorphology Division*. Tuesday, October 21, 1:30–5:50 p.m., Convention Center room 251 D-E.

Finally, a disciplinary session on Public Policy: Issues in Education and the Environment will be held on Wednesday morning, October 22, 8:00–10:00 a.m., in Convention Center room 258. ■




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Only new or changed information is published in *GSA Today*. A complete listing can be found in the **Calendar** section on the Internet: <http://www.geosociety.org>.

1997 Penrose Conferences

September

September 10–15, **Faults and Subsurface Fluid Flow: Fundamentals and Applications to Hydrogeology and Petroleum Geology**, Albuquerque and Taos, New Mexico. Information: William C. Haneberg, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, 2808 Central Ave. SE, Albuquerque, NM 87106, (505) 262-2774, fax 505-255-5253, haneberg@nmt.edu. For more information, see <http://www.nmt.edu/~haneberg/Fluids.html>.

September 23–28, **Tectonics of Continental Interiors**, Cedar City, Utah. Information: Michael Hamburger, Dept. of Geological Sciences, Indiana University, Bloomington, IN 47405, (812) 855-2934, fax 812-855-7899, hamburg@indiana.edu.

1998 Penrose Conferences

May

May 14–18, **Linking Spatial and Temporal Scales in Paleoecology and Ecology**, Solomons, Maryland. Information: Andrew S. Cohen, Dept. of Geosciences, University of Arizona, Tucson, AZ 85721, (520) 621-4691, fax 520-621-2672, acohen@geo.arizona.edu.

June

June 4–12, **Evolution of Ocean Island Volcanoes**, Galápagos Islands, Ecuador. Information: Dennis Geist, Dept. of Geology, University of Idaho, Moscow, ID 83844, (208) 885-6491, fax 208-885-5724, dgeist@uidaho.edu.

July

July 4–11, **Processes of Crustal Differentiation: Crust-Mantle Interactions, Melting, and Granite Migration through the Crust**, Verbania, Italy. Information: Tracy Rushmer, Dept. of Geology, University of Vermont, Burlington, VT 05405, (802) 656-8136, fax 802-656-0045, trushmer@zoo.uvm.edu.

1997 Meetings

October

October 3–6, **Ecology and Mining History of the Gold Discovery**, Coloma, California. Information: Gregg Wilkerson, Bureau of Land Management, 3801 Pegasus Dr., Bakersfield, CA 93308-6837, (805) 391-6081, gwilkerson@ca.blm.gov.

October 31–November 1, **Geologic Association of New Jersey Annual Meeting**, Economic Geology of Northern New Jersey, Whippany, New Jersey. Information: Alan I. Benimoff, Dept. of Applied Sciences, College of Staten Island CUNY, Staten Island, NY 10314-6600, (718) 982-2835, fax 718-982-2830, benimoff@postbox.csi.cuny.edu.

November

November 17–19, **Maintaining Gender Diversity in the Federal Work Force During Periods of Downsizing: Effects on the Retention of Female Scientists, Engineers, and Technicians**, Washington, D.C. Information: (202) 334-1841, fax 202-334-2753, lskidmor@nas.edu, <http://www2.nas.edu/cwse>.

1998 Meetings

February

February 23–25, **International Conference on Airborne Electromagnetics**, Sydney, Australia. Information: Airborne EM Conference Secretariat, c/o Well Done Events, P.O. Box 1758, North Sydney, NSW 2059, Australia, phone 61-44-460-318, fax 61-44-460-319, judy@welldone.com.au.

March–April

March 30–April 4, **American Society for Photogrammetry & Remote Sensing and Resource Technology Institute Annual Conference**, Tampa, Florida. Information: ASPRS/RTI Annual Conference, 5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814-2160, (301) 493-0290, fax 301-493-0208.

May

May 18–20, **Geological Association of Canada–Mineralogical Association of Canada–Association professionnelle des géologues et géophysiciens du Québec**, Quebec City, Canada. Information: Conference Secretariat Quebec 1998, Dept. géol. et génir géol., Université Laval, Sainte-Foy, Québec G1K 7P4, Canada, (418) 656-2193, fax 418-656-7339, quebec1998@ggl.ulaval.ca, <http://www.gglulaval.ca/quebec1998.html>.

July

July 8–10, **Geological Society of South Africa Geocongress '98**, Pretoria, South Africa. Information: Congress Secretary, phone 27-12-8411167, fax 27-12-8411221, eaucamp@geoscience.org.za, <http://www.geoscience.org.za/geocongress>.

August

August 9–12, **4th International Symposium on Environmental Geotechnology and Global Sustainable Development**, Boston, Massachusetts. Information: Hilary I. Inyang, CEEST, University of Massachusetts, One University Ave., Lowell, MA 01854, (508) 934-2285, fax 508-934-3092, inyangh@woods.uml.edu. (*Abstracts deadline: November 15, 1997.*)

September

September 26–27, **Evolution of Structures in Deforming Rocks**, Canmore, Alberta, Canada. Information: Shoufa Lin, c/o Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, fax 61 3-995-7997, slin@gsc.nrcan.gc.ca, <http://www.nrcan.gc.ca/ess/cgd/ctg98/>.

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GSA ANNUAL MEETINGS

■ 1998

Toronto, Ontario, Canada

October 26–29

Metro Toronto Convention Centre
Sheraton Toronto Centre Hotel and Towers

General Chairs: *Jeffrey J. Fawcett, University of Toronto*
Peter von Bitter, Royal Ontario Museum

Technical Program Chairs:

*Denis M. Shaw, Dept. of Geology, McMaster University,
Hamilton, Ontario L8S 4M1, Canada,
shawden@mcmaster.cis.mcmaster.ca*

*Andrew Miall, Dept. of Geology, University of Toronto,
22 Russell St., Toronto, Ontario M5S 3B1, Canada,
miall@quartz.geology.utoronto.ca*

Due date for symposia and theme proposals: **January 2, 1998**

Call for Field Trip Proposals:

We are interested in proposals for single-day and multi-day field trips beginning or ending in Toronto, and dealing with all aspects of the geosciences. Please contact the Field Trip Chairs listed below.

*Pierre Robin, Dept. of Geology, University of Toronto, Erindale
Campus, Mississauga, Ontario L5L 1C6, Canada,
probin@credit.erin.utoronto.ca*

*Henry Halls, Dept. of Geology, University of Toronto, Erindale
Campus, Mississauga, Ontario L5L 1C6, Canada,
hhalls@credit.erin.utoronto.ca*

CALL FOR CONTINUING EDUCATION COURSE PROPOSALS

Due December 1, 1997

The GSA Committee on Continuing Education invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines. Continuing Education courses may be conducted in conjunction with all GSA annual or section meetings. We are particularly interested in receiving proposals for the 1998 Toronto Annual Meeting or the 1999 Denver Annual Meeting.

Proposals must be received by December 1, 1997.

Selection of courses for 1998 will be made by February 1, 1998. For those planning ahead, we will also consider courses for 1999 at that time.

For proposal guidelines or information, contact:

Edna Collis, Continuing Education Coordinator,
GSA headquarters, 1-800-472-1988, ext. 134,
E-mail: ecollis@geosociety.org.

For Information on any GSA Meeting

**1-800-472-1988 or
(303) 447-2020, ext. 133**

E-Mail: meetings@geosociety.org

WWW: <http://www.geosociety.org>



VICTOR E. MONNETT PROFESSOR OF ENERGY
RESOURCES
SCHOOL OF GEOLOGY AND GEOPHYSICS
COLLEGE OF GEOSCIENCES
UNIVERSITY OF OKLAHOMA

The University of Oklahoma invites applications and nominations for the Victor E. Monnett Professor of Energy Resources. The Professorship was funded by alumni in honor of Dr. V. E. Monnett who was director of the School of Geology and Geophysics for 30 years. The Monnett Professorship provides a key element of the School's teaching and research program.

This is an endowed senior position in the general area of energy resources, with tenure and at the rank of full professor, in the **School of Geology and Geophysics in the College of Geosciences**. The primary area of expertise sought is in structural geology, particularly in those aspects relevant to the oil and gas industry. The University is seeking a highly distinguished individual with vision, commitment, and leadership abilities to establish a program of interdisciplinary teaching, research, and service. The successful candidate is expected to be a great teacher, a mentor of students, an intellectual leader, and an accomplished researcher in the profession with ability to attract significant external funding.

The University of Oklahoma is a major, comprehensive, state-supported university located approximately 20 miles south of Oklahoma City in the city of Norman. The campus contains a wide range of state-of-the-art facilities supporting teaching and research in energy and the environment. **The Sarkeys Energy Center**, which houses the College of Geosciences and a portion of the **College of Engineering**, is a premier 350,000 square foot academic facility with 200 teaching and research laboratories located on the Norman Campus. It is the focus of much of the University's energy research, and the program center for key energy research growth areas of strategic importance to the University. In particular, the Center houses the internationally recognized **Rock Mechanics Institute** with which it is hoped the successful applicant will maintain a strong collaborative relationship.

Salary and benefits will be commensurate with experience and are negotiable. Starting date is negotiable. The position is available as early as 1 January 1998.

Initial screening of complete applications will begin on 1 November 1997. The search will remain open until the position is filled. Complete applications will consist of a letter of interest from the applicant, current vita/resume, and a list of references (with addresses, telephone and FAX numbers, and email addresses) that the search committee may contact. Questions or requests for additional information should be directed to Dr. John P. Castagna, Search Co-Chair, at email address castagna@ou.edu or phone (405) 325-6697. Address all applications and nominations to: **Monnett Professorship Search Committee, University of Oklahoma, Sarkeys Energy Center, 100 E. Boyd Street, Room 710, Norman, Oklahoma 73019-1008**

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women and Minorities are Encouraged to Apply. The University of Oklahoma has a policy of being responsive to the needs of dual-career couples.

A 20th Anniversary Celebration of Achievement

October 16–9 at Snowbird, Utah

The comprehensive conference program invites you to:

- ◆ celebrate the achievement of women,
- ◆ embrace perceptions and wisdom of eminent women scientists,
- ◆ envision future changes,
- ◆ engage in networking and mentoring, and
- ◆ participate in training opportunities.

Successful women geoscientists will present their stories as models to encourage others. Field trips and technical sessions will enhance the technical expertise of participants, and along with networking, provide opportunities for the exchange of pertinent information and career strategies. Come talk with eminent women scientists!

PERSPECTIVES immediately precedes the 1997 Geological Society of America Annual Meeting in Salt Lake City, and will offer a full program of speakers, field trips, and networking.

For the preliminary program, visit our Web site, <http://flint.mines.edu:4502> or the UGS home page: <http://utstdpwww.state.ut.us/~ugs/awgmtg.htm>. Or contact Sandy Eldredge, (801) 537-3328, nrugs.seldreg@state.ut.us, or write to: Perspectives, P.O. Box 521788, Salt Lake City, UT 84152-1788.

CLASSIFIED ADVERTISING

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

Classification	Per Line for 1st month	Per line for each addtl month (same ad)
Situations Wanted	\$1.75	\$1.40
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first 25 lines	\$0.00	\$2.35
additional lines	\$1.35	\$2.35
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

STRUCTURAL GEOLOGY/PLANETARY GEOLOGY/GEOPHYSICS

The Department of Geography & Geology at Mount Holyoke College invites applications for an anticipated full-time, tenure-track position at the Assistant Professor level, contingent upon final approval, beginning September 1998. The successful candidate must have a Ph.D. in structural geology, planetary science, geophysics, or a related field and will be expected to teach structural geology, introductory geology, and other courses related to his or her area of expertise. The ideal person will also be able

and willing to teach introductory and/or advanced courses in either the Physics Department or Astronomy Department.

Mount Holyoke College is committed to providing an excellent liberal-arts education for women of diverse backgrounds. The college values both high-quality teaching and research, especially research involving undergraduates in meaningful ways. Additional strengths would include a strong field orientation, interest in using our Geoprocessing/GIS lab, or potential interaction with students and colleagues within our Five-College consortium (which includes Amherst, Smith, and Hampshire colleges and the University of Massachusetts). To apply, send curriculum vitae, a one-page statement of immediate teaching and research goals, and names of three references to: Steven R. Dunn, Department of Geography & Geology, Mount Holyoke College, South Hadley, MA 01075.

Applications will be reviewed as they are received, but must be received by January 1, 1998. Mount Holyoke is committed to fostering cultural diversity and multicultural awareness in its faculty, staff and students and is an Affirmative Action/Equal Opportunity employer. Women and minorities are especially encouraged to apply.

GRAND VALLEY STATE UNIVERSITY PETROLOGY AND GEOSCIENCE ED POSITIONS

Two tenure-track assistant professor of geology positions, one new, one a retirement vacancy, fall, 1998.

Igneous Petrologist and/or Volcanologist with Ph.D.: Preference will be given to candidates with expertise in an additional subdiscipline (mineralogy, GIS/remote sensing/geological mapping, or tectonics/neotectonics). A strong commitment to teaching and doing research with undergraduate students is essential. Besides petrology, teaching responsibilities may include introductory courses, mineralogy, field methods, advanced mapping/GIS, or global tectonics.

Geoscience Educator with Doctoral Degree: Expertise in geoscience education and a strong commitment to teaching are essential. Besides teaching introductory courses and those in the area of specialty, the successful candidate should expect to develop rigorous introductory/advanced courses, act as a liaison between the department and the School of Education and K-12 teachers, develop the use of computers in education, and take the lead in the development of a M.S. degree in Earth Science Education.

The Department and Programs: The Geology Department's 70+ majors are divided between geology majors and earth science or group-science education majors. Of the geology majors, approximately half go to graduate school, and half obtain positions in the environmental field. The department's goal to strengthen the environmental program makes it desirable that one or more candidates have environmental expertise or experience.

To apply: Send a letter of interest, a vita, a succinct statement of teaching philosophy, and the names, addresses, and phone numbers of three references to: Patricia Videtich, Chair, Department of Geology, Grand Valley State University, Allendale, Michigan 49401. The selection process will begin November 10, 1997, and continue until the positions are filled. GVSU is an Affirmative Action/ADA and Equal Opportunity Employer.

HYDROLOGY/SURFICIAL PROCESSES THE COLLEGE OF WOOSTER

Applications are invited for a tenure-track assistant professor position in the Department of Geology at The College of Wooster beginning August 1998. The successful candidate is expected to develop an introductory level course in environmental geology and upper level courses in hydrogeology and surficial processes/geomorphology; he/she also will occasionally teach a second-level course on processes and concepts in geology and a First-Year Seminar course in critical inquiry. Wooster has a strong undergraduate senior independent study program in which the successful candidate will participate as an advisor. Candidates with an interest in the role of fluids in shallow Earth's crust and who are able to work with existing faculty and student research programs in structural geology, hydrothermal processes, and paleoenvironmental analysis are especially encouraged to apply. Applicants for this position should have a Ph.D.

The College of Wooster is a highly selective liberal arts institution with an enrollment of approximately 1700 men and women. The department consists of four faculty members and approximately 50 geology majors. The department is housed in a recently-renovated building and possesses a variety of modern research equipment, including

GSA SECTION MEETINGS — 1998

NORTHEASTERN SECTION, March 19–21, Holiday Inn by the Bay, Portland, Maine. Submit Abstracts to: Marc C. Loiselle, Maine Geological Survey, 22 State House Station, Augusta, ME 04333-0022, (207) 287-2801, marc.c.loiselle@state.me.us. *Abstracts Deadline: November 14, 1997.*

NORTH-CENTRAL SECTION, March 19–20, Ohio State University, Columbus, Ohio. Submit abstracts to: David H. Elliot, Dept. of Geological Sciences, Ohio State University, 125 South Oval Mall, Columbus, OH 43210, (614) 292-5076, delliot@magnus.acx. *ohio-state.edu. Abstracts Deadline: November 14, 1997.*

SOUTH-CENTRAL SECTION, March 23–24, OU Continuing Education Center, Norman, Oklahoma. Submit abstracts to: Judson Ahern, School of Geology & Geophysics, University of Oklahoma, 100 E. Boyd St., Suite 810, Norman, OK 73019-0628, (405) 325-3253, jahern@ou.edu. *Abstracts Deadline: December 1, 1997.*

SOUTHEASTERN SECTION, March 30–31, Embassy Suites, Charleston, West Virginia. Submit abstracts to: Peter Lessing, WV Geological & Economic Survey, P.O. Box 879, Morgantown, WV 26507-0879, (304) 594-2321, lessing@geosrv.wvnet.edu. *Abstracts Deadline: November 21, 1997.*

CORDILLERAN SECTION, April 7–9, California State University, Long Beach, California. Submit abstracts to: James C. Sample, Dept. of Geological Sciences, California State University, Long Beach, CA 90840, (562) 985-4589, csample@csulb.edu. *Abstracts Deadline: December 12, 1997.*

ROCKY MOUNTAIN SECTION, May 25–26, Northern Arizona University, Flagstaff, Arizona. Submit abstracts to: Wendell Duffield, U.S. Geological Survey, 2255 Gemini Road, Flagstaff, AZ 86001, (520) 556-7000, wduffield@iflag2.wr.usgs.gov. *Abstracts Deadline: December 12, 1997.*

an XRD, SEM, fluid inclusion stage, cathodoluminescence microscope, paleomagnetic laboratory, and a seismometer.

Interested persons should send a letter of application, a curriculum vitae, and three letters of recommendation by October 15, 1997, to Dr. Lori Bettison-Varga, Chair of the Search Committee, Department of Geology, The College of Wooster, Wooster, Ohio 44691, in order to be considered for an interview at the GSA meeting in Salt Lake City. Closing date is November 15. The College of Wooster is an equal opportunity/affirmative action employer.

COMPUTER SYSTEMS ADMINISTRATOR UNIVERSITY OF MINNESOTA

The Department of Geology and Geophysics is seeking a full-time computer systems administrator to support research and teaching in the area of computational geosciences. This position could be funded at 32–40 hours per week (part or full time). The position will complement existing strengths within our department in computational geophysical fluid dynamics and scientific visualization.

SALARY: Commensurate with background, education, and experience.

RESPONSIBILITIES: This individual would be responsible for maintaining the department's computer resources consisting of approximately 65 personal-computer computers and 18 UNIX (SGI) workstations. The individual will be encouraged to obtain funding and conduct research in the area of computational geosciences or the use of computer resources to improve teaching of geosciences in the K–12 through university level. System administration responsibilities will include: maintenance of the software and operating systems; maintaining the Ethernet network; teaching workshops for new students in the use of UNIX; setting up new machines; performing regular backups; maintaining/upgrading the departmental web page.

PREFERRED QUALIFICATIONS: M.Sc. or Ph.D. degree in Geological Sciences is strongly preferred with a strong background in computer science. Training and/or experience in IBM compatible, Macintosh, and UNIX system administration as well as demonstrated teaching and research skills. Experience in a wide range of personal computer software applicable to the geological sciences is desired. Good oral and written communication skills required as well as a willingness to learn and adapt to new environments.

APPLICATION PROCEDURES: Applicants should send a curriculum vitae, undergraduate and graduate transcripts, a letter summarizing teaching and research experience and goals, and three letters of reference to Kathy Ohler, Department of Geology & Geophysics, 310 Pillsbury Dr., SE, Minneapolis, MN 55455. Recruitment remains open until position is filled. Application review will begin on SEPTEMBER 25, 1997.

The University of Minnesota is an equal opportunity educator and employer.

TENURE-TRACK FACULTY POSITION IN ENVIRONMENTAL GEOCHEMISTRY DEPARTMENT OF GEOSCIENCES THE PENNSYLVANIA STATE UNIVERSITY

The Department of Geosciences at Penn State seeks an exceptional individual in the area of environmental geochemistry, for a tenure-track faculty position to be filled at any level. Rank, salary, and tenure-status will be commensurate with prior experience and qualifications.

We seek an outstanding scientist and educator pursuing research in one or more of the following areas: chemical hydrogeology, environmental geochemistry, biogeochemistry, geomicrobiology, soil geochemistry or mineralogy, and/or mineral surface-water interaction. We are particularly interested in individuals whose research spans one or more of these fields and includes application to modern and/or paleo-environmental problems.

The successful candidates will join a large, dynamic and well-equipped department dedicated to innovative teaching and research, which seeks a national and international leadership role in this field. There are opportunities for campus-wide collaborative research and teaching in the hydrosciences. Appointment as affiliates of the Earth System Science Center, an interdisciplinary research center in the College of Earth and Mineral Sciences and/or the Center for Environmental Geochemistry are possible.

Applicants should demonstrate a history of, or potential for, funded research and high-quality teaching. A Ph.D. is required at the time of appointment. Applications should include a complete resume, examples of published work, a statement outlining teaching and research interests and the names and addresses of at least four (4) individuals

who could provide references. Send application materials to: Head, Department of Geosciences, 503 Deike Bldg., The Pennsylvania State University, University Park, PA 16802.

The search process will continue until suitable candidates are identified.

An Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

VISITING POSITION IN QUATERNARY SOILS UNIVERSITY OF IOWA

The Department of Geology, University of Iowa, seeks a Visiting Professor, who is an outstanding teacher and researcher in the area of Quaternary studies, with focus on soils and associated surficial materials. The appointment will begin in August 1998 and extend for 2 years, with the possibility of starting January 1998 for 2.5 years. Teaching responsibilities will involve at least four courses per year. These will include two upper-level undergraduate/graduate courses: Modern and Ancient Soils, and Glacial and Pleistocene Geology, and one of our general education courses (Earth History and Resources). Other courses would depend on the candidate's expertise and departmental needs, and may include a portion of Remote Sensing. The successful candidate should have a Ph.D. and be active in research that will complement ongoing Quaternary research and surficial-process programs in the Department. Women and minorities are encouraged to apply. Applicants should send a complete resume (including a bibliography and statement of teaching and research interests) and have three letters of recommendation sent to: Dr. Richard G. Baker, Search Committee Chair, Department of Geology, University of Iowa, Iowa City, Iowa 52242-1379 (phone: 319-335-1827; fax: 319-335-1821; e-mail: rgbaker@blue.weeg.uiowa.edu). Final evaluation of the applicants will begin on December 1, 1997, and continue until the position is filled. The University of Iowa is an affirmative action–equal opportunity employer.

STRUCTURAL GEOLOGIST UNIVERSITY OF IOWA

The Department of Geology invites applications for a tenure-track position in structural geology. Field-oriented individuals with a wide range of interests in structural geology and tectonics are especially encouraged to apply. The appointment will begin in August 1998 at the assistant professor level. We seek an outstanding researcher and teacher who will best accommodate the diverse missions of the department. Teaching responsibilities for an academic year will include a one-semester course in structural geology at the junior-senior level and two additional classes/seminars at the undergraduate or graduate level. The successful candidate should have a Ph.D. and be active in research that will complement other research programs in the department. Women and minorities are especially encouraged to apply. Applicants should send a complete resume (including a bibliography and statement of teaching and research interests) and have at least three letters of recommendation sent to: Dr. C. T. Foster, Search Committee Chair, Department of Geology, University of Iowa, Iowa City, Iowa 52242-1379 (phone: 319-335-1818; fax: 319-335-1821). Final evaluation of the applicants will begin on December 1, 1997 and continue until the position is filled. The University of Iowa is an affirmative action–equal opportunity employer.

DEPARTMENT CHAIR IN GEOLOGY

COLBY COLLEGE seeks a dynamic individual to join the Department of Geology with an appointment as either Associate or Full Professor and Chair of the Department beginning September 1, 1998.

Applicants for this position should be established scientists with a reputation for excellence in both teaching and research. Areas of expertise are open, but should complement the strengths of the two existing and continuing department members in mineralogy/petrology and economic geology and in Quaternary geology and paleoecology. The department plans to launch a search for the fourth tenure-track slot in autumn, 1998, under the leadership of the new chair.

Colby College is a highly selective, nationally ranked private, residential, undergraduate, liberal arts institution with an enrollment of approximately 1700 full-time students, of whom some 40 are declared majors within the Department of Geology. The College is located within the Maine Slate Belt of the northern Appalachians; Paleozoic sediments, metasediments, and intrusives dominate the geologic record of the State, with a surficial blanket of late Quaternary glacial and postglacial sediments.

All faculty are expected to maintain active research programs, and the successful candidate must be able to direct research appropriate for undergraduates; the Department currently requires all majors to undertake and complete independent research as part of their course of study.

To apply, please send letter of intent and complete CV, including the names of at least three persons whom the search committee may contact as references on teaching and research; candidates will be contacted prior to writing to referees. Address applications to: Chair of Search Committee, Dept. of Geology; Colby College; 5800 Mayflower Hill; Waterville, Maine 04901-8858. The Committee will begin evaluating applicants on 17 November, 1997, and continue until the position has been filled.

Colby College is an AA/EEO employer and especially encourages applications from women and minorities. For more information on the College and Department, please visit our Web site at <http://www.colby.edu/geology/>.

STRUCTURAL GEOLOGY/TECTONICS UNIVERSITY OF WISCONSIN—MADISON

The Department of Geology and Geophysics invites applications for a tenure-track faculty position at the assistant professor level. The deadline for applications is November 7, 1997, and the position will be available for the Fall 1998 semester. Applications are encouraged from a broad range of specialties in the areas of tectonics and structural geology. The successful applicant will be expected to develop an active, externally-funded research program, including supervising M.S. and Ph.D. students. Demonstrated ability to teach undergraduate structural geology and field methods is required. A Ph.D. is required. Applications, including a statement of research and teaching interests, curriculum vitae, contact information for at least three references, and copies of up to five publications, should be sent to: Prof. Clark Johnson, Tectonics/Structure Search Chair, Dept. of Geology and Geophysics, University of Wisconsin—Madison, 1215 W. Dayton St., Madison, WI 53706. Additional information on the department may be found at <http://www.geology.wisc.edu>. The U.W. Madison is an EO/AEE and encourages women and minorities to apply. Unless confidentiality is requested in writing, information regarding the applicants must be released upon request. Finalists cannot be guaranteed confidentiality.

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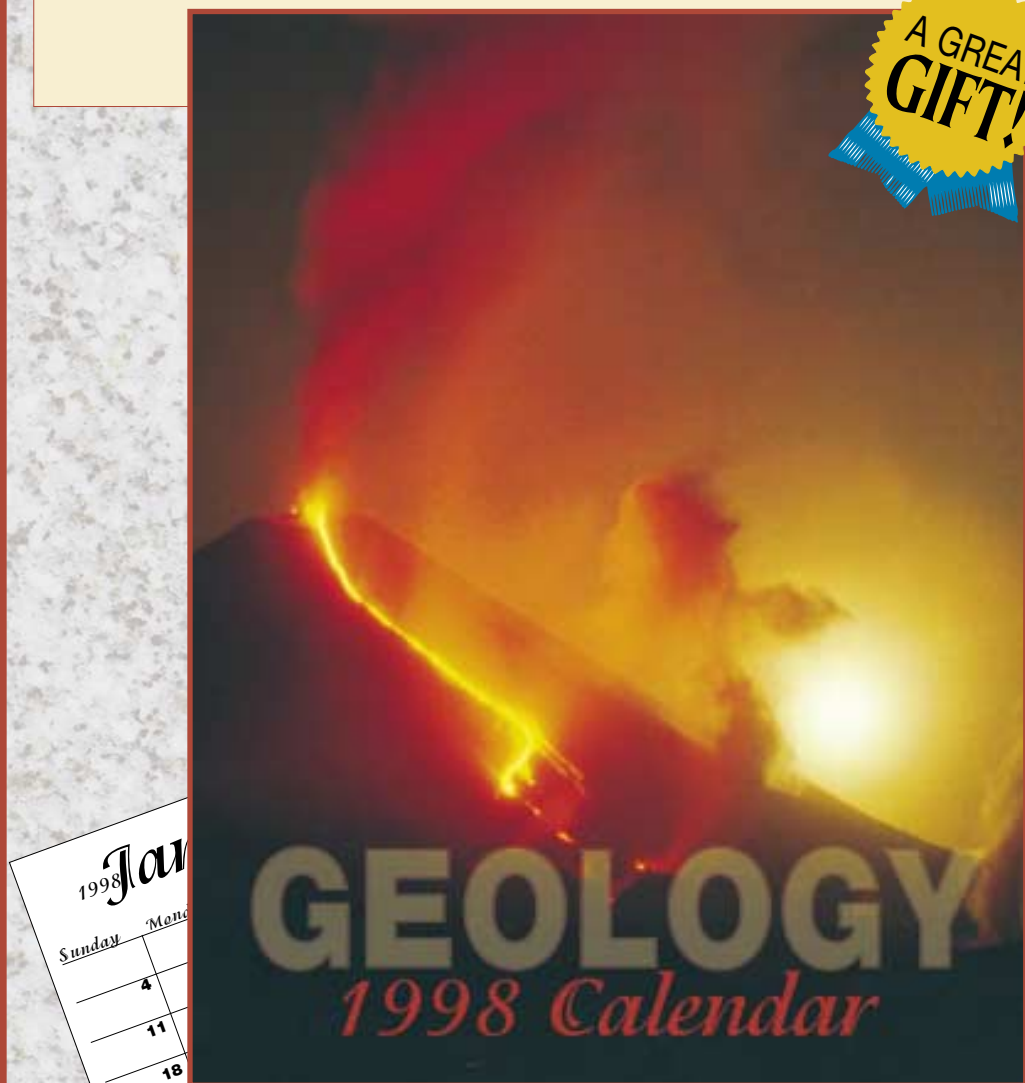


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