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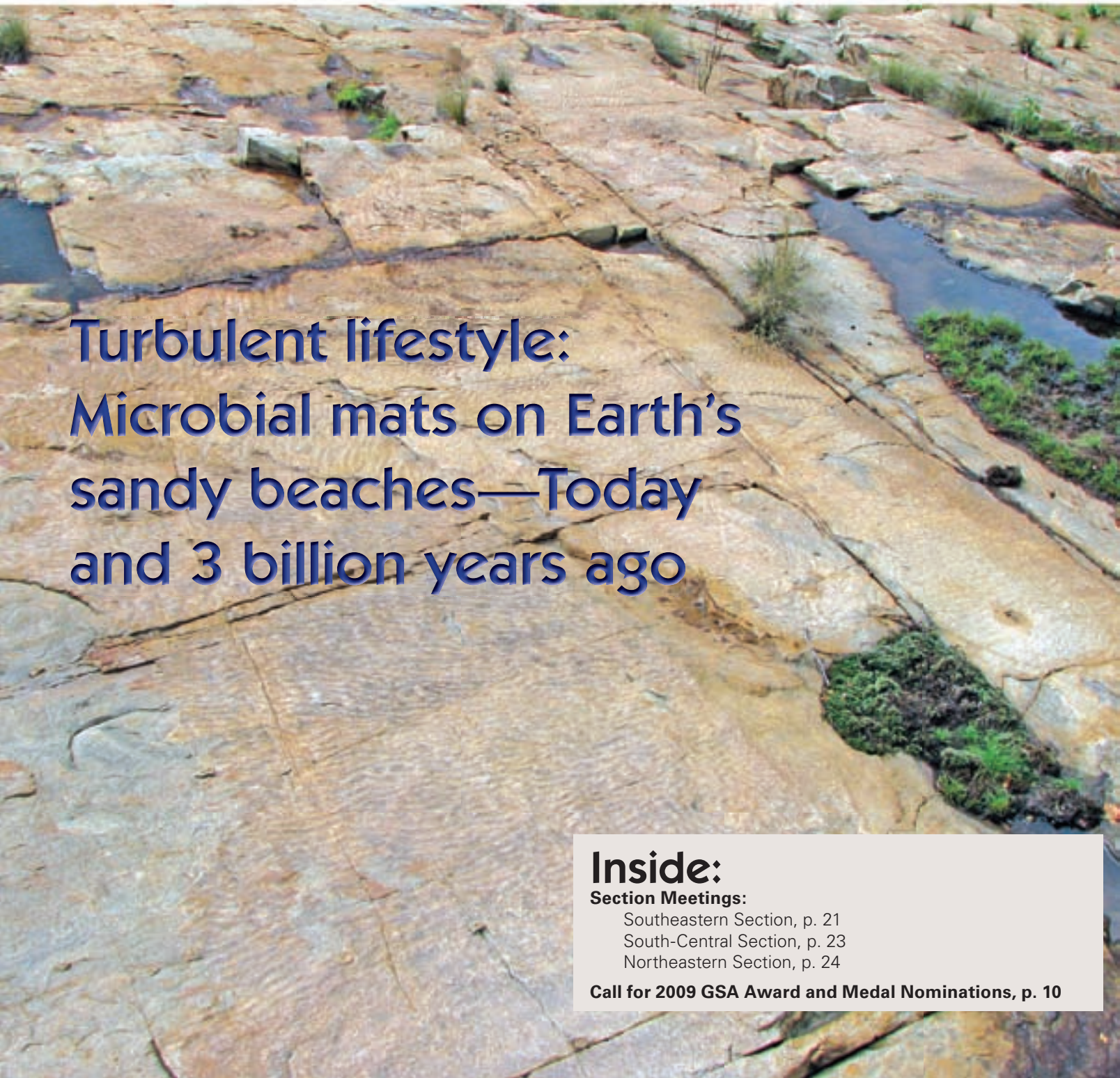
GSA TODAY

VOL. 18, No. 10 A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA OCTOBER 2008



Turbulent lifestyle: Microbial mats on Earth's sandy beaches—Today and 3 billion years ago

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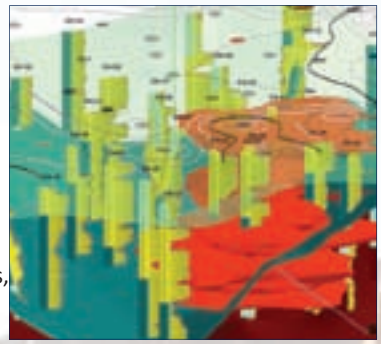

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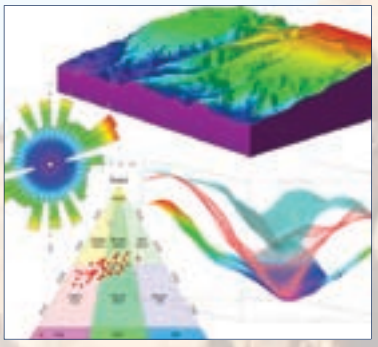

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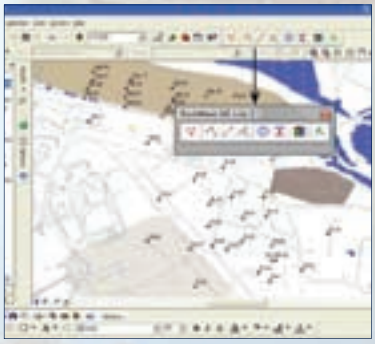

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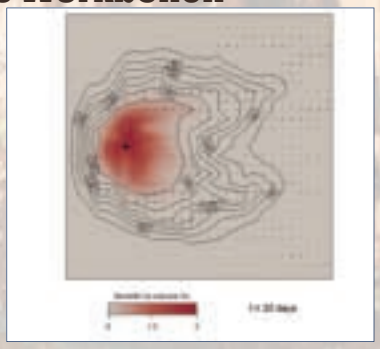

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SCIENCE ARTICLE

Cover: Multidirected ripple marks preserved in an ancient siliciclastic tidal flat of the 2.9 Ga Pongola Supergroup, South Africa. Studies in modern settings show that such a chaotic ripple mark pattern is caused by the interaction of sediment-stabilizing microbial mats with episodic storm events. In concert with a multitude of other "microbially induced sedimentary structures" (MISS), these ripple marks potentially record the oldest and most diverse cyanobacterial population in Earth's history. Photo courtesy N. Noffke. See "Turbulent lifestyle: Microbial mats on Earth's sandy beaches—Today and 3 billion years ago" by Nora Noffke, p. 4–9.

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Turbulent lifestyle: Microbial mats on Earth's sandy beaches—Today and 3 billion years ago

Nora Noffke, *Old Dominion University, Department of Ocean, Earth & Atmospheric Sciences, Norfolk, Virginia 23529, USA*

ABSTRACT

Archean Earth history is very difficult to reconstruct. Until recently, only bacterial cells preserved in chert, microborings, and stromatolites provided the few clues to ancient life. Now, siliciclastic "microbially induced sedimentary structures" (MISS) are adding to our knowledge of both past life and paleoenvironments. MISS rise from the interaction of photoautotrophic microbial mats with physical sediment dynamics in siliciclastic, shallow-marine settings. Archean MISS can be understood through observations of living microbial mats and modern biotic-physical sedimentary processes. Such geobiological studies are key to the interpretation of the early evolution of prokaryotes. For example, the 2.9 Ga Pongola Supergroup, South Africa, includes MISS that possibly point to the oldest known cyanobacterial community preserved in Earth's history.

INTRODUCTION

The question of where and when the earliest life developed on Earth is a most exciting one but also one that is difficult to answer. Time, tectonism, metamorphism, eons of subsurface microbial activity, and unfamiliar biogeochemical environments make the biota of the Archean notoriously difficult to interpret (Lowe and Tice, 2007). Geobiologists approach this problem by combining studies on living biota in modern settings with historical-geological studies on ancient bacteria and biogenic sedimentary structures preserved in Archean rocks. This paper examines "microbially induced sedimentary structures" (MISS)—traces and trace fossils caused by benthic microbial mats in siliciclastic coastal deposits today and 3 billion years ago.

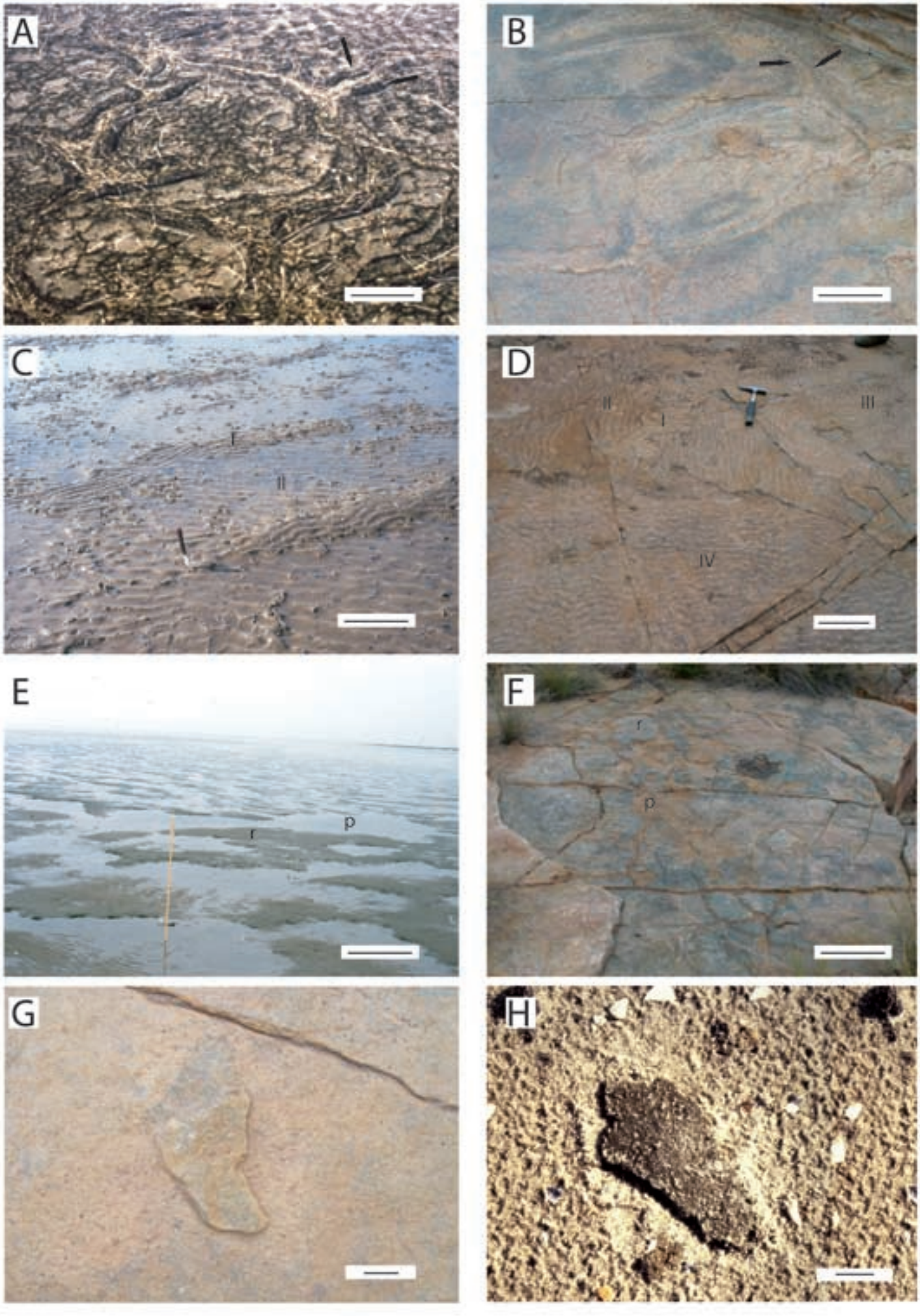
Only a few Archean (3.8–2.5 Ga) fossils and sedimentary structures allow a glimpse into Earth's oldest history. In carbonates and cherts, fossils of bacterial cells and the reef-forming stromatolites record the 3.5 Ga existence of prokaryotes (e.g., Buick, 1992; Hofmann et al., 1999; Grotzinger and Knoll, 1999; Allwood et al., 2007; Schopf et al., 2007). Tube-like fossils finely distributed in Archean seafloor basalts document the fact that living organisms even explored the upper portions of the oceanic crust (Furnes et al., 2004). Laboratory analyses reveal biomolecules in 2.7 Ga black shales in Australia (e.g., Brocks et al., 1999; Knoll, 1999), and various isotopes signal evidence of ancient life even in highly metamorphosed material such as the Isua Greenstone Belt, Greenland (e.g., Grassineau et al., 2006). However, siliciclastic deposits also bear paleontological information: trace fossils caused originally by benthic microbiota.

In the 1980s–1990s, it was suggested that crinkled upper bedding planes ("elephant skin textures") might record ancient microbial mats (e.g., Runnegar and Fedonkin, 1992; Gehling, 1999). Similar conclusions were reached by Seilacher et al. (1985) in lagoonal sediments of Solnhofen, Germany, and by Schieber (1998) in Mesoproterozoic shales of Montana, USA. Those early observations on microbial mat–related structures were summarized in Hagadorn et al. (1999), followed by a photo atlas (Schieber et al., 2007). At about the same time, the genesis of modern microbial mat–associated sedimentary structures was being elucidated (e.g., Cameron et al., 1985; Gerdes and Krumbein, 1987; Gerdes et al., 1991, 1994). The term "microbially induced sedimentary structures" (MISS) was coined in 1996, based on quantitative analyses of mat-related structures in sandy tidal flats (Noffke et al., 1996). The sixteen main types of MISS arise exclusively from the interaction of biofilms and microbial mats with the physical sediment dynamics (Noffke, 2009). This contrasts with the formation of stromatolites, in which chemical precipitation plays a major role. Because of their unique biotic-physical genesis, MISS differ significantly in morphology from stromatolites (Fig. 1).

Systematic studies, leading from modern to increasingly older deposits, have revealed that fossil MISS occur in tidal flat and shelf sandstones of Phanerozoic, Proterozoic, and Archean ages and appear not to have changed identifiably since at least 3.2 Ga (Noffke, 2000; Noffke et al., 2001, 2002, 2003, 2006, 2008). The morphologies and paleoenvironmental distribution of the structures record the former presence of photoautotrophic microbial mats.

Figure 1. Examples for microbially induced sedimentary structures (MISS) from modern sandy tidal flats (A, C, E, G) and from the fossil tidal sandstones of the 2.9 Ga Pongola Supergroup, South Africa (B, D, F, H). (A) Polygonal pattern of oscillation cracks, coast of Tunisia; scale: 12 cm. (B) Fossil oscillation cracks; scale: 8 cm. Arrows indicate margins of polygons. (C) Multidirectional ripple marks, Mellum Island, North Sea; scale: 40 cm. Two storm events are recorded (I, II). (D) Fossil example recording four storm events (I–IV); scale: 40 cm. (E) Erosional remnants (r) and pockets (p), Mellum Island, North Sea; scale: 50 cm. (F) Fossil example; scale: 100 cm. (G) Microbial mat chips, Fishermans Island, Virginia, USA; scale: 5 mm. (H) Fossil mat chips; scale: 5 mm.

GSA Today, v. 18, no. 10, doi: 10.1130/GSATG7A.1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INTERACTION OF BIOFILMS AND MICROBIAL MATS WITH PHYSICAL SEDIMENT DYNAMICS IN SILICICLASTIC DEPOSITS

Modern sandy tidal flats are widely overgrown by a great variety of benthic microorganisms, especially cyanobacteria. Initially, the microbes form thin, organic coatings around individual sand grains at the sedimentary surface. Such biofilms (Fig. 2A) are composed of cells and extracellular polymeric substances (EPS) (Decho, 1990; Dade et al., 1990). The EPS are adhesive mucilages that enable the benthic microorganisms to attach themselves to solid substrates (such as the surface of a quartz grain), to transport nutrients toward the cell, and to buffer the microbes against the changing salinities in their microhabitat. During times of little water movement, the biofilms continue to grow until an organic layer, composed of a dense and coherent network woven by millions of cyanobacterial trichomes, carpets large areas of the tidal flat surfaces (Fig. 2B) (Stolz, 2000). Other bacteria, fungi, and eukaryotes, such as diatoms, also occur in the mats.

Tidal flats are extreme environments where the twice-daily change from flooding to subaerial exposure provides harsh benthic conditions. However, the mobile trichomes of cyanobacteria are well adapted to quickly changing sedimentary dynamics (e.g., Halfen and Castenholz, 1971; Staley et al., 1989; Gerdes et al., 1991; Golubic and Knoll, 1993; Knoll and Bauld, 1989; Kruschel and Castenholz, 1998; Sumner, 2000).

Interactions of microbenthos with dynamic sedimentary regimes produce MISS. When sediment is deposited onto the mat surface, the filamentous cyanobacteria orientate themselves perpendicularly to the surface and reach into the supernatant sea water. Here they passively comb out suspended grains, a process known as "baffling and trapping" (Black, 1933). Over time, the microbes bind these particles during the formation of their mat fabrics. Binding takes place during quiet hydraulic conditions—a fact that prohibits the formation of microbial mats in strongly and constantly reworked depositional areas. This process can take from a few hours (*Oscillatoria limos*a, Hardie, 1978; Villbrandt, 1992) to a few weeks (*Microcoleus chthonoplastes*, Hardie, 1978; Gerdes et al., 1991). Microbial mats protect their sandy substrata against erosion by microbial sediment fixation. Bathurst (1967) and Neumann et al. (1970) described the sediment-stabilizing properties of microbial mats in carbonate sediments of the Bahamas. Subsequently, their field observations were supported by experiments by Meadows et al. (1990), Dade et al. (1990), and Yallop et al., 1994, and the term "biostabilization" was introduced (Paterson, 1997). A microscopic vertical section through a resin-fixed microbial mat shows that the trichomes interweave the sand grains and that the EPS glue the mineral particles together. Both microbial effects significantly increase the resistance of the tidal surface against erosion—the mats can withstand current velocities of up to 1.60 m/s (e.g., Führböter and Manzenrieder, 1987).

TYPES OF MISS

Sixteen types of MISS are generally recognized, the result of growth, biostabilization, binding, baffling, and trapping (Fig. 3). Common examples include the following (see Fig. 1):

- **Polygonal oscillation cracks:** A polygonal pattern of cracks forms in the microbial mats in hot, semiarid climates characterized by seasonal rainfall in response to periodically changing degrees of moisture (Noffke et al., 2001) (Fig. 1A). The mat polygons defined by the cracks are generally 10–50 cm in diameter. In vertical section, the mat polygons are thickened; this is caused by lateral oscillation of the mat polygons due to seasonal wet-dry cyclicity. Because the moisture decreases from the lower portions of the organic layer toward the surface, the mat shrivels during desiccation, and the mat polygon margins point upward. With more water, the microbial mat overgrows the desiccation cracks and, viewed from above, two parallel running ridges can be seen, indicating the former presence of up-shriveled polygon margins on the microbial mat surface (Figs. 1A and 1B, arrows). The seasonal repetition of desiccation and remoistening gives rise to polygonal oscillation cracks. In the 2.9 Ga Nhlazatse Section of the Pongola Supergroup, such cracks indicate that Archean paleoclimates there had seasonally high temperatures and variations in precipitation (Fig. 1B; Noffke et al., 2001, 2008).

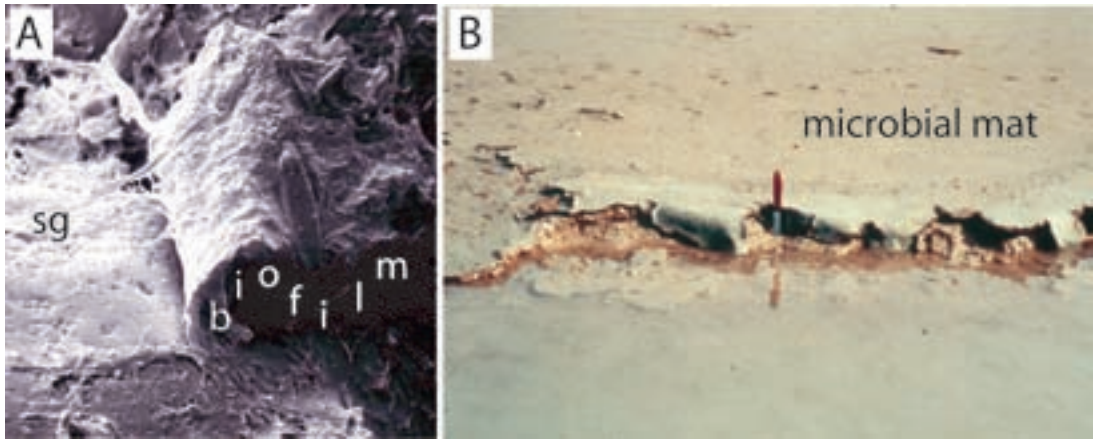

Figure 2. Biofilms and microbial mats. (A) A biofilm is a microscopic, thin organic coating composed of the bacterial mucilages (extracellular polymeric substances) and microbial cells; "sg" indicates the surface of a quartz grain. (B) Microbial mat—a macroscopic, dense and coherent layer that covers a large area of the sedimentary surface. Knife for scale (10 cm).

Figure 3. Genetic relationships and classification of microbially induced sedimentary structures (MISS). MISS are formed either by the growth of microbial mats (biomass production), binding (formation of the typical, carpet-like filamentous network), biostabilization (fixation of sedimentary grains), or baffling and trapping (accumulation of sedimentary grains by vertically oriented bacterial filaments). The MISS in the center form from all microbial activities, whereas those structures grouped around it are originated by mainly one microbial behavior (biostabilization, binding, baffling, trapping, or growth).

- **Multidirected ripple marks:** This is a chaotic pattern of patches of ripple marks of different directions (Figs. 1C and 1D). Multidirected ripple marks also occur in the supratidal zone and indicate seasonal changes in storm frequencies (Noffke, 1998). During conditions characterized by low hydraulic reworking of the sands, microbial mats start to grow, forming meter-wide patches. The original ripple marks beneath are preserved by biostabilization. On those surface portions still exposed, a storm leaves a new generation of ripple marks in a different direction. After a storm, microbial mat patches continue to enlarge laterally and overgrow those newly rippled surfaces. Another storm produces a third generation of ripple marks in the remaining sand that is not biostabilized. This repetitive alternation between mat growth, biostabilization, and reworking by storms creates the multidirected ripple marks (Noffke, 1998; independently termed by Pflüger [1999] "palimpsest ripple marks"). In the Pongola Supergroup, the multidirected ripple marks (shown in Fig. 1D) reveal a record of four storms and may indicate a storm-dominated coastline (Noffke et al., 2008).
- **Erosional remnants and pockets:** This surface structure is composed of two morphological elements: elevated surface portions that have flat tops (erosional remnants) and depressions that sometimes are rippled at the bottoms (erosional pockets) (Figs. 1E and 1F; Noffke, 1999). The extent of erosional remnants and pockets varies from at least 30 cm to many decimeters in scale. Remnants and pockets are caused by the partial erosion of a mat-stabilized sand surface and occur from the lower supratidal zone to the lower intertidal zone. An index derived from the geometries and dimensions of the erosional remnants and pockets quantifies the degrees of growth, biostabilization, and binding, as well as baffling and trapping in the formation of this structure (Noffke and Krumbein, 1999). Today, as well as in the Archean Pongola Supergroup, this index indicates the position of this surface structure on the former lower supratidal flats (Noffke and Krumbein, 1999; Noffke et al., 2008).
- **Microbial mat chips:** Centimeter-scale pieces of a microbial mat can be ripped off by bottom currents and deposited at a different site (Figs. 1G and 1H). In the fossil record, such scattered mat pieces are one of the most abundant MISS (Pflüger and Gresse, 1996; Noffke et al., 2008). They are predominantly the result of the cohesiveness of microbial mats and therefore purely related to biostabilization.

MISS occur not only as macroscopic structures, but include microscopic textures as well. Microtextures, such as oriented grains (caused by growth) or mat layer–bound grain size populations (caused by baffling and trapping), are indicative of fossil MISS and serve as criteria for their biogenic origin (e.g., Noffke et al., 2003, 2009).

SIGNIFICANCE OF MISS FOR EARTH'S GEOLOGICAL RECORD

Research on MISS is still in its infancy, and reports on modern and fossil occurrences are likely to increase as the research matures. For now, it is clear that fossil MISS were constructed by mobile and photoautotrophic microbiota. Like today, MISS-forming microbial mats appear to have been distributed

exclusively in ancient photic zones, and they occur on only moderately reworked fine sand composed of more than 95% translucent quartz (Noffke et al., 2002). The structures also are clues for the reconstruction of the paleoenvironmental settings. The few examples for MISS listed herein quantify the former current and wave dynamics in ancient settings and suggest the presence of strongly seasonal paleoclimates.

MISS are found in equivalent settings throughout Earth's history, and the recently detected Nhlazatse Section of the Pongola Supergroup shows that neither morphologies nor distributions of MISS have changed for at least 2.9 billion years (Noffke et al., 2008). Given the similarity of today's biota to the 2.9 Ga Archean biotas, it would seem that the early evolution of cyanobacteria involved rapid diversification in perhaps only 200 million years, although their first appearance is uncertain—currently estimated to be 2.7 Ga (Brocks et al., 1999; Knoll, 1999). MISS, by virtue of their ubiquity and high preservation potential, may yet contribute to the answer. The first systematic collection of MISS is deposited in the National Museum of Natural History (Smithsonian Institution) in Washington, D.C., USA.

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Manuscript received 27 December 2007; accepted 23 June 2008.

Call for Nominations

THE GEOLOGICAL SOCIETY OF AMERICA®

2009 GSA Awards and Medals

Penrose Medal

The Penrose Medal was established in 1927 by R.A.F. Penrose Jr. to be awarded in recognition of eminent research in pure geology, for outstanding original contributions, or for achievements that mark a major advance in the science of geology. This award is made only at the discretion of the GSA Council, and nominees may or may not be members of the Society. Penrose's sole objective was to encourage original work in purely scientific geology, which is interpreted as applying to all scientific disciplines represented by GSA. Scientific achievements should be considered rather than contributions in teaching, administration, or service. Mid-career scientists who have already made exceptional contributions should be given full consideration for the award.

Day Medal

The Day Medal was established in 1948 by Arthur L. Day to be awarded annually, or less frequently, at the discretion of GSA Council, for outstanding distinction in contributing to geologic knowledge through the application of physics and chemistry to the solution of geologic problems. Day's intent was to recognize outstanding achievement and inspire further effort rather than reward a distinguished career. Scientific achievements should be considered rather than contributions in teaching, administration, or service.

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 years or younger throughout the year in which the award is to be presented—*for 2009, only those candidates born* ***on or after 1 January 1974*** *are eligible*) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal (the Donath Medal) and a cash prize of US$20,000, was endowed by Dr. and Mrs. Fred A. Donath.

Honorary Fellows

GSA Council established Honorary Fellowship in 1909, and since then, except during a few war years, one or more Honorary Fellows have been elected annually. At present, GSA has 67 geologists still living who have received this honor.

Honorary Fellowship may be bestowed on individuals who have lived and developed their careers outside of North America and who have made outstanding, internationally recognized contributions to our science, or in rare circumstances, provided notable service to the Society. Under exceptional circumstances, North Americans have been named Honorary Fellows. This amendment to the award bylaws was made in 1969 to recognize the *Apollo II* astronauts.

GSA Council encourages members to submit names of qualified candidates for this honor. In preparing a nomination, it is imperative that the candidate's original research and scientific advances be stressed. The nominator should also verify all supporting data, especially degrees received, publications, positions held, etc.

How to Nominate

To ensure thorough consideration by the respective committees, please follow these nomination instructions carefully; additional information supplied will not enhance the nomination. Paper submissions will still be accepted; however, we encourage electronic submission.

For each candidate, please submit the following:

1. **Nomination form:** Please go to https://rock.geosociety.org/forms/Awardform.asp to submit the form online or for hardcopy download to submit via post.
2. **Supporting documents,** to be submitted as e-mail attachments or via post; for Penrose, Day, Young Scientist, and Honorary Fellow nominations, the following supporting documents are required:
   - a brief biographical sketch;
   - a summary (300 words or less) of the scientific contributions to geology that qualify the candidate for the award;
   - a selected bibliography of no more than 20 titles—for the Donath medal only 10 titles are required;
   - signed letters from each of five GSA Fellows or Members *in addition* to the person making the nomination. *For the Day Medal only:* letters from five scientists with at least three of those being from GSA Fellows or Members and up to two from fellows or members of the Mineralogical Society of America, Geochemical Society, or American Geophysical Union.

Award Notes

All nomination forms and submission instructions are online at www.geosociety.org/awards/ and instructions may also be obtained from GSA Grants, Awards, and Recognition, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.

The deadline for receipt of all medal, award, and recognition nominations is 1 February 2009.

THE GEOLOGICAL SOCIETY OF AMERICA®

2009 GSA Awards and Medals

GSA Public Service Award

GSA Council established the GSA Public Service Award in 1998 in honor of Eugene and Carolyn Shoemaker. This annual award recognizes contributions that have materially enhanced the public's understanding of the earth sciences or have significantly served decision makers in the application of scientific and technical information to public affairs and earth science–related public policy. This may be accomplished by individual achievement in

- authorship of education materials of high scientific quality that have enjoyed widespread use and acclaim among educators or the general public;
- acclaimed presentations (books and other publications, mass and electronic media, or public presentations, including lectures) that have expanded public awareness of the earth sciences;
- authorship of technical publications that have significantly advanced scientific concepts or techniques applicable to the resolution of earth-resource or environmental issues of public concern; or
- other individual accomplishments that have advanced the earth sciences in the public interest.

The award will normally go to a GSA member, with exceptions approved by Council, and may be presented posthumously to a descendant of the awardee.

How to Nominate

Paper submissions will still be accepted; however, we encourage electronic submission.

1. **Nomination form:** Please go to https://rock.geosociety.org/forms/Awardform.asp to submit the form online or for hardcopy download to submit via post.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - a letter of nomination (300 words or less);
   - a brief biographical sketch that clearly demonstrates the applicability of the selection criteria; and
   - a selected bibliography of no more than 10 titles.

GSA Distinguished Service Award

GSA Council established the GSA Distinguished Service Award in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Associates, and employees may be nominated for consideration, and any GSA Member or employee may submit a nomination for the award. GSA's Executive Committee will select awardees, and GSA Council must ratify all selections. Awards may be made annually, or less frequently, at the discretion of Council.

How to Nominate

1. **Nomination form:** Please go to https://rock.geosociety.org/forms/Awardform.asp to submit the form online or for hardcopy download to submit via post.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - a brief (300 words or less) letter of nomination summarizing the candidate's contributions to the Society; and
   - a brief biographical sketch that clearly demonstrates the applicability of the selection criteria.

Bromery Award for the Minorities

Randolph W. "Bill" and Cecile T. Bromery established the Bromery Fund for Minorities with the GSA Foundation in 1999 to provide support for the Randolph W. "Bill" and Cecile T. Bromery Award for the Minorities. The award is given to persons, preferably African Americans, "who have made significant contributions to research in the geological sciences, or those who have been instrumental in opening the geoscience field to other minorities."

How to Nominate

1. **Nomination form:** Please go to https://rock.geosociety.org/forms/Awardform.asp to submit the form online or for hardcopy download.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - the nominee's curriculum vitae;
   - a brief nomination letter;
   - three letters of support, at least two of which are from GSA Members and one from a member of another professional geoscience organization; and
   - *(optional)* a selected bibliography.

The deadline for receipt of all medal, award, and recognition nominations is 1 February 2009.

Call for Nominations

THE GEOLOGICAL SOCIETY OF AMERICA®

2009 GSA Awards and Medals

Subaru Outstanding Woman in Science Award

Sponsored by Subaru of America, Inc.

The Subaru Outstanding Woman in Science Award recognizes a woman who has had a major impact on the field of the geosciences based on her Ph.D. research. The generous support of Subaru of America, Inc., in conjunction with the Doris M. Curtis Fund, makes this award possible. GSA's 103rd president, Doris Curtis pioneered many new directions for geology, not the least of which was her tenure as GSA president after an unbroken chain of 102 men. Causes dear to her were women, public awareness, minorities, and education. Women are eligible for this award the first three years following their Ph.D. degree.

How to Nominate

Paper submissions will still be accepted; however, we encourage electronic submission.

1. **Nomination form:** Please go to https://rock.geosociety.org/forms/Awardform.asp to submit the form online or for hardcopy download to submit via post.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - a brief (300 words or less) letter of nomination that clearly states how the Ph.D. research has impacted the geosciences in a major way;
   - a brief biographical sketch that clearly demonstrates the applicability of the selection criteria;
   - a selected bibliography of no more than 10 titles; and
   - dissertation title and abstract.

GSA Fellowship

Fellowship is an honor bestowed annually upon the best of our profession at the spring GSA Council meeting. If you are a GSA Fellow, please review the following for updated instructions: A **GSA Fellow** may support only two nominees per election cycle and only **one** as a primary nominator. A **GSA Member** who is not a Fellow may not be a primary nominator, but may be a secondary nominator for no more than **two** nominees per election cycle.

The primary nominator is responsible for collecting the entire nomination packet (including letters of support) and must submit the nomination as one e-mail (with supporting documents as attachments) or as one package via post.

How to Nominate

Paper submissions will still be accepted; however, we encourage electronic submission.

1. **Nomination form:** go to http://www.geosociety.org/members/fellow.htm to submit the form online or for hardcopy download to submit via post.
2. **Supporting documents,** to be collected by the primary nominator and submitted as e-mail attachments or via post:
   - a letter of nomination, including a summary of the nominee's significant contributions supporting the selected criteria for election (up to one page);
   - the nominee's curriculum vitae;
   - a paragraph stating the nominee's total number of publications and a selected bibliography (up to four pages); and
   - a supporting letter of nomination from each of the secondary nominators.

AGI Medal in Memory of Ian Campbell

The AGI Medal in Memory of Ian Campbell recognizes singular performance in and contribution to the profession of geology. Candidates are measured against the distinguished career of Ian Campbell, whose service to the profession touched virtually every facet of the geosciences. Campbell was a most uncommon man of remarkable accomplishment and widespread influence, and in his career as a geologist, educator, administrator, and public servant, he was noted for his candor and integrity. To submit a nomination, go to www.agiweb.org/direct/awards.html.

The deadline for receipt of all medal, award, and recognition nominations is 1 February 2009.

THE GEOLOGICAL SOCIETY OF AMERICA®

John C. Frye Environmental Geology Award

Nomination Deadline: 31 March 2009

In cooperation with the Association of American State Geologists, GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a US$1,000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund.

Criteria for Nomination

Anyone may submit a nomination following these criteria: (1) the paper must be selected from GSA or state geological survey publications, (2) the paper must be selected from those published during the preceding three full calendar years, (3) the nomination must include a paragraph stating the pertinence of the paper, and (4) nominations must be sent to Program Officer, Grants, Awards, and Recognition, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, by 31 March 2009.

Basis for Selection

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

2008 Award Recipients Named

The 2008 award will be presented at the GSA Annual Meeting in Houston to Daniel I. Carey for The Generalized Geologic Map for Land-Use Planning map series, published by the Kentucky Geological Survey in 2007.

National Awards for 2009

Deadline: 1 February 2009

GSA Members are invited to nominate colleagues for the following awards by sending background information and vitae, specifying the award for which the candidate is being nominated, to Program Officer, Grants, Awards, and Recognition, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, +1-303-357-1028, fax +1-303-357-1070, awards@geosociety.org, by 1 February 2009.

On behalf of its member societies, the American Geological Institute (AGI) coordinates the nomination process. The AGI Member Society Council will finalize a roster of candidates at its spring 2009 meeting for nomination to the respective offices sponsoring the national awards.

The **William T. Pecora Award,** sponsored jointly by the National Aeronautics and Space Administration and the U.S. Department of the Interior, is presented annually in recognition of outstanding contributions by individuals or groups toward the understanding of Earth by means of remote sensing. This award recognizes contributions by individuals in the scientific and technical community as well as those involved in the practical application of remote sensing. Consideration will be given to sustained or single contributions of major importance to the art or science of understanding Earth through observations made from space.

The president of the United States awards the **National Medal of Science** to individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences." Many younger American scientists and engineers may now be reaching a point at which their contributions are worthy of recognition; the committee is giving increasing attention to these individuals as well as to outstanding women and minority scientists who deserve recognition.

The **Vannevar Bush Award** is presented periodically to a person who, through public service activities in science and technology, has made an outstanding contribution toward the welfare of mankind and the nation. The award is given to a senior worker in science and technology and complements the National Science Foundation's Alan T. Waterman Award (described below). The two awards are designed to encourage individuals to seek the highest levels of achievement in science and engineering and in service to humanity. Nominations should be accompanied by a complete biography and a brief citation summarizing the nominee's scientific or technological contributions to our national welfare in promotion of the progress of science.

The **Alan T. Waterman Award** is presented annually by the National Science Foundation (NSF) and National Science Board to an outstanding young researcher in any field of science or engineering supported by the NSF. Candidates must be U.S. citizens or permanent residents and must be 35 years old or younger *or* not more than five years beyond receipt of their Ph.D. as of 31 December in the year in which they are nominated. Candidates should have completed sufficient scientific or engineering research to have demonstrated, through personal accomplishments, outstanding capability and exceptional promise for significant future achievement.

Call for Applications

2009–2010 GSA–USGS

CONGRESSIONAL SCIENCE FELLOWSHIP

Work directly with national leaders, and bring your experience and expertise to bear on science and technology policy on Capitol Hill.

This Congressional Science Fellowship provides a rare opportunity to work at the interface between geoscience and public policy. Prospective candidates are GSA Members with a broad geoscience background and excellent written and oral communication skills. Minimum requirements: a master's degree with at least five years of professional experience or a Ph.D. at time of appointment. The fellowship is open only to U.S. citizens or permanent U.S. residents.

Find application information at **www.geosociety.org/csf** or contact Ginger Williams, +1-303-357-1040, gwilliams@geosociety.org. **Deadline for application:** 1 February 2009; selection of the next GSA-USGS Congressional Science Fellow will be made soon thereafter.

Put your academic and professional background, experience applying scientific knowledge to societal challenges, and passion for shaping the future of the geoscience profession to work in this coveted arena: *Apply today!*

www.geosociety.org/csf

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USGS science for a changing world

2009 Birdsall-Dreiss Distinguished Lecturer: Chunmiao Zheng

Sponsored by the GSA Hydrogeology Division.

Chunmiao Zheng.

Chunmiao Zheng of the University of Alabama has been named the 2009 Birdsall-Dreiss Distinguished Lecturer. At the request of interested institutions, he will present one of two lectures for audiences with a general interest in hydrogeology and water resources:

1. "Understanding solute transport in extremely heterogeneous porous media: Lessons learned from 25 years of research at the MADE site" ("MADE"—macrodispersion experiment).

2. "Will China run out of water?" (This lecture examines China's water scarcity problems amid the country's unprecedented economic growth.)

Zheng received a B.S. degree in geology from Chengdu University of Technology in China in 1983 and earned a Ph.D. in hydrogeology with a minor in civil and environmental engineering from the University of Wisconsin–Madison in 1988. From 1988 to 1993, he was a hydrogeologist at the environmental consulting firm S.S. Papadopulos & Associates Inc. Since 1993, he has been a professor of hydrogeology in the Department of Geological Sciences at the University of Alabama. He is also a visiting professor and founding director of the Center for Water Research at Peking University in China.

Zheng's primary research areas are contaminant transport, groundwater management, and hydrologic modeling. Zheng is developer of the widely used MT3D/MT3DMS series of contaminant transport models, and co-author of the textbook *Applied Contaminant Transport Modeling* (second edition). He is currently a member of the National Academy of Sciences' Committee on Hydrologic Science and president-elect of the International Commission on Groundwater of the International Association of Hydrological Sciences.

To request a visit to your institution, contact Chunmiao Zheng, Department of Geological Sciences, University of Alabama, Tuscaloosa, Alabama 35487, USA; +1-205-348-0579; fax: +1-205-348-0818; e-mail: czheng@ua.edu. GSA will pay transportation expenses and the host institution will provide local accommodations. **Deadline for requests:** 15 December 2008. Additional information will be posted on Zheng's Web site at http://hydro.geo.ua.edu.

THE GEOLOGICAL SOCIETY OF AMERICA®

2009 Jahns Distinguished Lecturer: Edmund Medley

Edmund Medley; photo courtesy Geosyntec Consultants

Edmund Medley has been named the 2009 Richard H. Jahns Distinguished Lecturer in Engineering Geology by the Association of Environmental and Engineering Geologists (AEG) and the Engineering Geology Division of the Geological Society of America (GSA). The Jahns award was established in 1988 in memory of Richard H. Jahns (1915–1983), who had an influential and diverse career in academia, consulting, and government. The intent of the partially funded lectureship is to encourage student and professional awareness of engineering geology through a series of lectures presented across North America during the award year. Learn more about Jahn's life and career at http://edmedley.com/blog/jl/.

Medley earned his bachelor's in applied science in geological engineering (1978) from the University of British Columbia, where he was also awarded the first Aro A. Aho Medal for academic excellence in geological engineering. His M.S. (1991) and Ph.D. (1994) degrees, both in geotechnical engineering, are from the University of California at Berkeley. In 1993, Medley was named AEG's Marliave Scholar for outstanding scholarship in engineering geology and geological engineering. Medley has presented over 150 professional and academic lectures, short courses, and MCLE (mandatory continuing legal education) credit courses and has contributed to ~50 technical writings, many describing his pioneering approaches to the engineering and geological characterization of bimrocks (block-in-matrix rocks), complex geological mixtures of rock and soil such as mélanges, fault rocks, and weathered rocks. Learn more on Medley's Web sites, bimrocks.geoengineer.org and edmedley.com.

A senior consultant in the Oakland, California, USA, office of Geosyntec Consultants, Medley has over 30 years of unusually varied international experience in geotechnical and geological engineering consulting, mineral exploration prospecting, failure investigation, litigation testifying, and research. He has consulted on major landslides, rockfall hazards, expansive/collapsing soils, tunnel failures, coastal erosion, sinkholes, and other ground movements. He is licensed/registered/chartered as an engineer and geologist in the USA, Canada, and the UK and is affiliated with several international geosciences and engineering organizations, including GSA and AEG. He was the San Francisco AEG Section Membership Committee chair between 1991 and 1993 and the San Francisco Section Short Course chair between 1995 and 1996.

Lecture Titles

Lecture abstracts are available at http://edmedley.com/blog/jl/. **Contact Medley directly at emedley@geosyntec.com to arrange lectures.**

- The least you should know about characterizing geological chaos;
- The comforts of ignorance and the benefits of arrogance: Lessons of the failure kind for the geopractitioner;
- Of elephants, earthquakes, caves and hot rock—Recent geological engineering adventures;
- Something to chew on—Rock is more nutritious than dirt;
- An introduction to the use of ground-based stereo photography in geopractice;
- Forensic investigation of the Sea Cliff Incident, an urban catastrophe;
- Reflections and snapshots from a 40-year geo-odyssey ("Shoot! This has been delightful!").

2009 GSA Section Meeting Calendar

Southeastern Section
St. Petersburg, Florida, USA
12–13 March
Abstract deadline:
9 December 2008

South-Central Section
Dallas, Texas, USA
16–17 March
Abstract deadline:
9 December 2008

Northeastern Section
Portland, Maine, USA
22–24 March
Abstract deadline:
16 December 2008

North-Central Section
Rockford, Illinois, USA
2–3 April
Abstract deadline:
30 December 2008

Cordilleran Section
Kelowna, British Columbia, Canada
7–9 May
Abstract deadline:
3 February 2009

Rocky Mountain Section
Orem, Utah, USA
11–13 May
Abstract deadline:
3 February 2009

THE GEOLOGICAL SOCIETY OF AMERICA®

Plan your 2009 Section Meeting attendance today!

2009 SECTION MEETING MENTOR PROGRAM CALENDAR

STUDENTS—Meet Your Career Mentors!

Plan now to attend a Shlemon Mentor Program and/or a Mann Mentor Program in Applied Hydrogeology at your 2009 Section meeting to chat one-on-one with practicing geoscientists. These volunteers will answer your questions and share insights on how to get a job after graduation. Space for these events is limited, so plan to arrive early. Questions? Contact jnocerino@geosociety.org. *Both programs are sponsored by the GSA Foundation.*

Roy J. Shlemon Mentor Program in Applied Geoscience: This is a chance for students to discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Students will receive FREE lunch tickets in their registration packet to attend this program.

John Mann Mentors in Applied Hydrogeology Program: This event presents opportunities for undergraduate and graduate students and recent graduates interested in applied hydrogeology or hydrology as a career to interact and network with practicing hydrogeologic professionals. Whether you've already decided to head down the hydro career path or whether you just would like to know more about these career options, this meeting is for you! This program is a focused, small-scale event that features a FREE lunch for participants. Students will receive a ticket in their registration packet to attend.

SOUTHEASTERN SECTION MEETING

St. Petersburg, Florida, USA
Shlemon Mentor Program Luncheons: Thurs., 12 March, 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Fri., 13 March, 11:30 a.m.–1:00 p.m.

SOUTH-CENTRAL SECTION MEETING

Dallas, Texas, USA
Shlemon Mentor Program Luncheon: Mon., 16 March, 11:30 a.m.–1 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Tues., 17 March, 11:30 a.m.–1 p.m.

NORTHEASTERN SECTION MEETING

Portland, Maine, USA
Shlemon Mentor Program Luncheons: Mon., 23 March, 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Tues., 24 March, 11:30 a.m.–1 p.m.

NORTH-CENTRAL SECTION MEETING

Rockford, Illinois, USA
Shlemon Mentor Program Luncheons: Fri., 3 April, 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Thurs., 2 April, 11:30 a.m.–1:00 p.m.

CORDILLERAN SECTION MEETING

Kelowna, British Columbia, Canada
Shlemon Mentor Program Luncheons: Thurs., 7 May, 11:30 a.m.–12:30 p.m. *and* 12:30–1:30 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Fri., 8 May, 11:30 a.m.–1 p.m.

ROCKY MOUNTAIN SECTION MEETING

Orem, Utah, USA
Shlemon Mentor Program Luncheon: Mon., 11 May, 11:30 a.m.–1 p.m.
Mann Mentors in Applied Hydrogeology Luncheon: Tues., 12 May, 11:30 a.m.–1 p.m.

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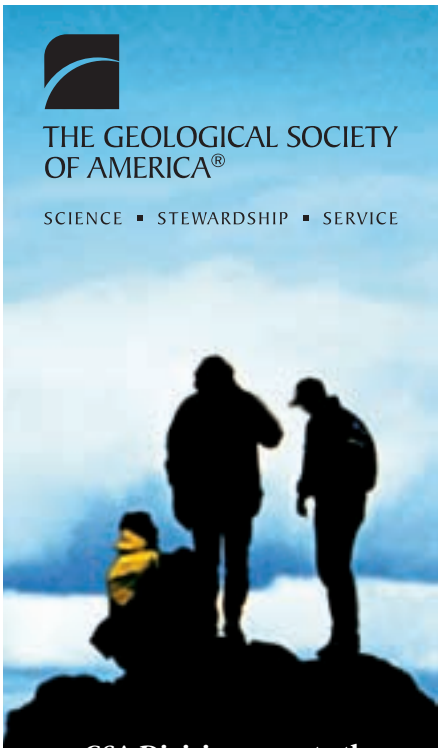

GSA Divisions create the technical program for their specialties at GSA meetings, provide opportunities for leadership and service, award professional accomplishments, and support students through travel grants, awards, mentoring programs, professional networking, and more. Express yourself and support your colleagues: Join and participate in any number of the following GSA Divisions for a nominal fee. To learn more, go to www.geosociety.org and click on "Sections and Divisions." Membership numbers are as of 31 December 2007.

Photo used with permission of Roland Gangloff.

GSA DIVISIONS:

Archaeological Geology, est. 1977. Ending 2007 with 572 members, the Archaeological Geology Division was the year's second fastest-growing GSA Division. This Division provides a forum for the presentation and discussion of papers on archaeological geology in order to stimulate and promote research and teaching in this field. Division awards include the Ripp Rapp Archaeological Geology Award, the Richard Hay Student Paper/Poster Award, and the Claude C. Albritton, Jr., Award memorial fund.

Coal Geology, est. 1954. The Coal Geology Division's 269 members come from all facets of the worldwide coal geology community, including state and national geological surveys, academia, and industry. The Division's purpose is to encourage coal research and to disseminate coal geology information to all interested parties by actively participating in thought-provoking symposia and technical sessions at GSA's meetings and through high-quality, scientifically pertinent publications. This Division sponsors a major award for outstanding contributions to the field of coal geology, the Gilbert H. Cady Award, and also recognizes the volunteered contributions of its members through its Distinguished Service Award. For students, this Division offers both the Antoinette Lierman Medlin Scholarship and a best student paper award.

Engineering Geology, est. 1947. GSA's oldest and sixth-largest Division, with 848 members, the Engineering Geology Division promotes education, research, outreach, and application of engineering geologic knowledge toward the betterment of human society by adopting sound design of buildings, structures, and facilities that assure public safety and a healthy environment. Each year, this Division honors geologists with the E.B. Burwell, Jr., Award and, along with the Association of Environmental and Engineering Geologists, commissions the Richard H. Jahns Distinguished Lecturer. Other Division awards include the Meritorious Service Award and the Distinguished Practice Award. For students, this Division also sponsors the Roy J. Shlemon Mentor Program in Applied Geology, the Shlemon scholarship for research in engineering geology, Shlemon support for attending field trips and short courses, and a best student paper award.

Geobiology & Geomicrobiology, est. 2001. The Geobiology & Geomicrobiology Division's purpose is to bring together scientists working at the interface of biology and geology and to encompass the integration of these disciplines by simultaneously promoting both the broad scope and detailed disciplinary work demanded of rigorous interdisciplinary research. Fields currently within this Division include biogeochemistry, biomineralogy, geochemical ecology, paleontology, micropaleontology, origins of life and co-evolution of planets and life, paleobiology and paleoecology, molecular paleontology and ecology, systems modeling and informatics, and astrobiology. A Geobiology & Geomicrobiology Division goal is to nurture this spectrum of fields through active encouragement and mentoring of students, who make up more than a third of this forward-looking Division's 335 members.

Geoinformatics, est. 2006. The mission of the Geoinformatics Division is to advance "Data to Knowledge," providing GSA members with an opportunity to participate in the emerging field of cyberinfrastructure. The Division actively promotes and sponsors short courses, symposia, and books that emphasize information technology–supported discovery and integration of geoscience data leading to a more comprehensive understanding of Earth and the planets as complex systems. Geoinformatics, GSA's newest Division, ended its first full year of operation (31 Dec. 2006–31 Dec. 2007) with 187 members.

Geology and Health, est. 2005. The Geology and Health Division nearly doubled in size in 2007, ending the year with 221 members. This Division is concerned with the intersection of natural or anthropogenic geological conditions with health, disease, pathology, and death in modern and fossil humans, animals, and plants. With a focus on the interdisciplinary relationship of geology to medicine, biology, chemistry, and other sciences, the Geology and Health Division fosters communication and

Build on Your Interests!

collaboration among scientists and health practitioners. The Division is initiating its first award this year for best student contribution.

Geology and Society, est. 2003. The motto of the Geology and Society Division and its 373 members is "Geology Working for Society." By increasing the geoscience community's knowledge of societal issues and improving the community's overall communication skills, this Division works to ensure accurate and intelligent dissemination of geologic information to society as a whole. To achieve this end, the Geology and Society Division leaders encourage all GSA Members to join. This Division sponsors a best student paper award.

Geophysics, est. 1971. The Geophysics Division facilitates the presentation and discussion of the challenges and ideas of scientists interested in geophysics, fosters communication among geophysicists and other earth scientists, and promotes research and publication. This Division sponsors the George P. Woollard Award and lecture for outstanding contributions to geology through the application of the principles and techniques of geophysics. For students, who make up more than a third of this growing Division's 499 members, the Division offers the Allan V. Cox Student Research Grant and the Geophysics Division Student Research Grant Award.

Geoscience Education, est. 1991. The purpose of the Geoscience Education Division, GSA's fifth-largest Division with 1,090 members, is to foster the active participation of GSA Members in all aspects of earth science education. This GSA Division complements and expands on the contributions of GSA's Education & Outreach group, the National Earth Science Teachers Association (NESTA), the National Association of Geology Teachers (NAGT), the National Science Teachers Association (NSTA), and other similar organizations. The Geoscience Education Division sponsors the Biggs Earth Science Teaching Award.

History of Geology, est. 1976. The GSA History of Geology Division's 386 members work to encourage the study and communication of the history of geology. The Division sponsors technical sessions at GSA meetings and honors geologists for their research, writing, and historical work through the Mary C. Rabbitt History of Geology Award, the Gerald M. and Sue T. Friedman Distinguished Service Award, and the History of Geology Student Award. The "Rock Stars" articles in *GSA Today*, highlighting the life and work of "giants in geology," are submitted through this Division.

Hydrogeology, est. 1959. The second-largest GSA Division, with 1,612 members, the Hydrogeology Division focuses on the geologic aspects of hydrogeology, the role of geology in the hydrologic cycle, and the importance of hydrogeology to society and science. The Division has a well-established mentor program for students looking at careers in hydrology or hydrogeology: the John Mann Mentors in Applied Hydrogeology Program. The Birdsall-Dreiss Distinguished Lecturer honorees are named by this Division, along with the O.E. Meinzer Award, the Division's Distinguished Service Award, and the Hydrogeology Division Student Research Grant Awards.

International, est. 1989. The International Division has 232 members and was established to provide a forum for meetings, symposia, and lecture tours on the geology of regions beyond North America and to provide a focal point for the exchange of views with non–North American geologists. This Division also raises funds for overseas colleagues to attend GSA Annual Meetings, aids in the distribution of books and journals to underfunded overseas institutions, and works to strengthen ties with overseas geoscientific societies. The International Division honors renowned international geologists or those studying the geology of regions beyond North America with the Distinguished Career Award. With all this, the role of the Division is still expanding and evolving to support GSA's increasingly global perspective.

Limnogeology, est. 2002. The Limnogeology Division, which ended 2007 with 241 members, encourages research on both ancient and modern lakes around the world, the collaboration of scientists from all disciplines on lake research, the communication of lake research, and the fostering of student research and careers in lake studies. This Division sponsors a Meritorious Service Award and the Kerry Kelts Research Awards for students.

Planetary Geology, est. 1981. The mottos of the Planetary Geology Division, which grew to 592 members in 2007, are, "One planet just isn't enough!" and "The GSA Division with the biggest field area!" Awards sponsored by this Division include the G.K. Gilbert Award, the Eugene M. Shoemaker Impact Cratering Award for students, the Career Achievement Award, the Stephen E. Dwornik Student Research Paper Award, and (jointly with the Meteoritical Society) the Pellas-Ryder Award for the best student paper in planetary science.

continued on p. 20

Photograph by Marli Bryant Miller, www.marlimillerphoto.com.

GSA DIVISIONS: Build on Your Interests! *continued*

Quaternary Geology and Geomorphology, est. 1955. The Quaternary Geology and Geomorphology Division is GSA's third-largest Division, ending 2007 with 1,506 members. This Division facilitates communication among scientists in these fields and the presentation of their research and ideas to the wider scientific community. Several awards are sponsored by this Division: the Kirk Bryan Award for Research Excellence, the Distinguished Career Award, the Farouk El-Baz Award for Desert Research, the Don J. Easterbrook Distinguished Scientist Award, the Robert K. Fahnestock Memorial Research Award, and the J. Hoover Mackin and Arthur D. Howard student research awards. The Gladys W. Cole Memorial Research Award, funded through GSA Foundation, is also presented by this Division.

Sedimentary Geology, est. 1985. The Sedimentary Geology Division, GSA's fourth-largest Division, ended 2007 with 1,118 members, over one-third of whom are students. This Division works to ensure the presentation of sedimentary-related topics and sessions at GSA meetings and actively nurtures the work of students by offering the Sedimentary Geology Division Student Research Grant Award and by providing financial aid for students to attend Division-sponsored short courses and field trips. The Laurence L. Sloss Award for outstanding accomplishments in sedimentary geology and contributions to GSA is also sponsored by this Division.

Structural Geology and Tectonics, est. 1980. Ranked the largest GSA Division at the end of 2007 with 1,729 members, the Structural Geology and Tectonics Division focuses on the geometry and mechanisms of natural and experimental deformation at all scales. It works to promote the research of scientists in these fields and to facilitate communication and discussion at all levels of the earth sciences. This Division offers a Career Contribution Award for advancement of the science of structural geology and tectonics, a Best Paper Award, and a Division Student Research Grant Award.

GSA Divisions: Be a part of the action! Support your science: volunteer, participate, lead, grow, and make a difference.

THE GEOLOGICAL SOCIETY OF AMERICA®

SOUTHEASTERN

58th Annual Meeting
St. Petersburg, Florida, USA

12–13 March 2009

Evening Skyline, St. Petersburg, Florida, USA. Photo by Jamie Beverly from http://commons.wikimedia.org/wiki/Image:Skyline_StPetersburgFL.jpg.

LOCATION

The University of South Florida (USF) Dept. of Geology is hosting the 2009 GSA Southeastern Section Meeting (cosponsored by the USF Geology Alumni Society) at the Hilton St. Petersburg Bayfront Hotel in St. Petersburg, Florida, USA. The meeting area offers a variety of geologically interesting venues: excellent examples of covered karst, pristine and human-influenced coastlines, natural springs, sinkholes, and both freshwater and saltwater wetlands.

CALL FOR PAPERS

Abstract Deadline: 9 December 2008

Technical Sessions

Please submit your abstract online at **www.geosociety.org/meetings.** An abstract submission fee of US$10 will be charged. If you cannot submit the abstract online, please contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

Symposia

1. **The State of Florida's Geology.** Tom Scott, Florida Geological Survey.
2. **MARGINS—Science at the End of the Decade.** Jeff Ryan, University of South Florida.

Theme Sessions

1. **Geologic Maps, Digital Geologic Maps, Geophysical Maps, and Derivatives from Geologic Maps (Posters).** Michael W. Higgins and Ralph F. Crawford, The Geologic Mapping Institute.
2. **Evaluating Educational Outcomes in Geoscience Courses and Curricula.** Laura Wetzel, Eckerd College; Dorien McGee, University of South Florida.
3. **Undergraduate Research (Posters).** *Cosponsored by the Council on Undergraduate Research–Geosciences Division.*
4. **Cave and Karst Studies in Florida (Posters).** Lee Florea, Western Kentucky University; Jason Polk, University of South Florida.
5. **Climate Events Recorded in Cave Speleothems.** Bogdan Onac, University of South Florida; Philip van Beynen, University of South Florida.
6. **Morphodynamics of Coastal Depositional Systems.** Ping Wang, University of South Florida.

REGISTRATION

Early Registration Deadline: 9 February 2009
Cancellation Deadline: 16 February 2009

Online registration will begin December 2008. For further information, or if you have special requirements, please contact the local committee chair, Jeff Ryan, ryan@shell.cas.usf.edu, Dept. of Geology, University of South Florida, 4202 East Fowler Ave., Tampa, FL 33620, USA, or the technical program chair, Eric Oches, roches@bentley.edu.

Detailed information on field trips, workshops, student opportunities, the guest program, symposia, and theme sessions for this meeting is on the Web at www.geosociety.org/sectdiv/southe/09mtg/.

FIELD TRIPS

1. **The Geology and Evolution of the Florida Keys.** Al Hine, University South Florida; Gene Shinn, U.S. Geological Survey–St. Petersburg.
2. **Tidally Dominated Coastlines of the Florida Gulf Coast.** Ping Wang, University of South Florida.
3. **Florida's Paleontologic Record: The Nature of Shell Beds.** Roger Portell, Florida Museum of Natural History.
4. **Central Florida's Phosphate District: The Current and Future Mining.** Tom Scott, Florida Geological Survey.
5. **West-Central Florida's Springs: Beauty, Problems, and Prospects.** Tom Scott, Florida Geological Survey.

WORKSHOP

1. **Using the Explore Geoscience Classroom Resources to Engage K–12 Educators in Teaching Geology.** Chris McLelland, The Geological Society of America; Gary Lewis, The Geological Society of America.

ACCOMMODATIONS

A block of rooms has been reserved at the Hilton St. Petersburg Bayfront Hotel, 333 First Street South, St. Petersburg, FL 33701-4342, USA, at US$189 + 12% hotel tax per night. Please call the Hilton St. Petersburg Bayfront reservation line, +1-727-894-5000, or the Hilton general reservation line, +1-800-445-8667, and request a reservation under "SE GSA 2009."

OPPORTUNITIES FOR STUDENTS

Mentor Programs

The **Roy J. Shlemon Mentor Program in Applied Geoscience** (www.geosociety.org/mentors/shlemon.htm) is designed to extend the mentoring reach of individual professionals from applied geology to undergraduates and graduate students.

The **Mann Mentors in Applied Hydrogeology Program** (www.geosociety.org/mentors/mann.htm) presents mentoring opportunities for undergraduate, graduate, and recent graduate students with a declared interest in applied hydrogeology as a career.

Travel Grants

Find information and applications for student travel grants at http://core.ecu.edu/geology/neal/gsa/travel.html or via a link at www.geosociety.org/sectdiv/.

Volunteers

The local committee and officers of GSA's Southeastern Section rely on student volunteers to help meetings run smoothly, and we are pleased to offer student volunteers free registration for the meeting in return for ~6 hours of volunteer work. Contact student volunteer coordinators Dorien McGee, dmcgee@mail.usf.edu, and Alain Volentik, volentik@mail.usf.edu for more information.

Photo courtesy Tampa Bay & Company.

THE GEOLOGICAL SOCIETY OF AMERICA®

SOUTH-CENTRAL

43rd Annual Meeting
Dallas, Texas, USA

16–17 March 2009

3. **Medical Geology.** Bob Finkelman, rbf@usgs.gov.
4. **Tectonics.** Mark Cloos, University of Texas at Austin, cloos@mail.utexas.edu; Randy Keller, University of Oklahoma, grkeller@ou.edu.

Anyone interested in proposing additional theme sessions should contact the technical program chair, Bob Stern, rjstern@utdallas.edu.

Photo courtesy Dallas Convention and Visitor's Bureau.

LOCATION

University of Texas at Dallas Conference Center, 800 W. Campbell Road, Richardson, Texas 75080, USA.

CALL FOR PAPERS

Abstract Deadline: 9 December 2008

Technical Sessions

Please submit your abstract online at **www.geosociety.org/meetings.** An abstract submission fee of US$10 will be charged. If you cannot submit the abstract online, please contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

Several sessions are already planned for the meeting:

1. **The Barnett Shale**. John Breyer, Texas Christian University, j.breyer@tcu.edu.
2. **Water Resources and Challenges of N-Central Texas.** Jack Sharp, University of Texas at Austin, jmsharp@mail.utexas.edu; Tom Brikowski, University of Texas at Dallas, brikowi@utdallas.edu.

FIELD TRIPS

At present we are planning a pre-meeting field trip to examine the Oligocene Volcanics of Big Bend, Texas (led by E.Y. Anthony) and a post-meeting field trip to examine the cyberstructural geology of the Arbuckle Mountains, OK (M. Abdelsalam and C. Aiken). Anyone interested in proposing other field trips should contact field trip chair Mohamed Abdelsalam, abdelsam@mst.edu.

SHORT COURSES AND WORKSHOPS

Proposals for Workshops and Short Courses should be sent to Bob Stern, rjstern@utdallas.edu by 10 September 2008.

CONTACT INFORMATION

Detailed information on field trips, workshops, student opportunities, the guest program, symposia and theme sessions for this meeting is listed at www.geosociety.org/sectdiv/.

For further information, or if you have special requirements, please contact the meeting chairs: Local Committee Chair John Ferguson, ferguson@utdallas.edu or Technical Program Chair Bob Stern, rjstern@utdallas.edu.

THE GEOLOGICAL SOCIETY OF AMERICA®

NORTHEASTERN

44th Annual Meeting
Portland, Maine, USA

22–24 March 2009

Photo courtesy Convention and Visitors Bureau of Greater Portland.

LOCATION

Portland is a vibrant city with a thriving waterfront, great restaurants, and an active art community. The Holiday Inn by the Bay, our meeting location, has been used for two previous, highly successful NEGSA meetings, and upgraded facilities promise even better things for 2009.

CALL FOR PAPERS

Abstract Deadline: 16 December 2008

Please submit your abstract online at **www.geosociety.org/meetings.** An abstract submission fee of US$10 will be charged. If you cannot submit the abstract online, please contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

2009 NEGSA Symposia

1. **Sea Level and Salt Marsh Ecogeomorphology.** Beverly Johnson, Bates College, bjohnso3@bates.edu; Julia Daly, Univ. of Maine at Farmington, dalyj@maine.edu.
2. **Orogenesis and Arc Collisions: From Models to Observations of Modern and Ancient Orogens.** Tim Byrne, Univ. of Connecticut, tim.byrne@uconn.edu; Cees van Staal, Geological Survey of Canada, cvanstaa@nrcan.gc.ca; Peter Koons, Univ. of Maine, peter.koons@maine.edu.
3. **Aspects of Transatlantic Research on Magma Systems.** David Gibson, Univ. of Maine at Farmington, dgibson@maine.edu; Dan Lux, Univ. of Maine at Orono, dlux@maine.edu; Martin Feely, National University of Ireland, martin.feely@nuigalway.ie.
4. **Climatic Change: Perspectives and Insights from Hothouse and Icehouse Climates in Deep Time.** David Sunderlin, Lafayette College, sunderld@lafayette.edu; Kira Lawrence, Lafayette College, lawrenck@lafayette.edu.
5. **Modern Glacial Processes and the Glacial Sedimentary Record: In Honor of Joe Hartshorn.** Carl Koteff, USGS, ckoteff@cox.net; Tom Weddle, Maine Geological Survey, thomas.k.weddle@maine.gov; Michael J. Retelle, Bates College, mretelle@bates.edu.
6. **Lakes and Environmental Change.** Brad Hubeny, Salem State College, bhubeny@salemstate.edu; Lisa Doner, Plymouth State Univ., donerl@mac.com.
7. **Provenance and Orogenic History of Ganderia: Key Element in the Mid-Paleozoic Accretionary History of the Appalachian Orogen.** Sandra Barr, Acadia Univ., sandra.barr@acadiau.ca; Cees van Staal, Geological Survey of Canada, cvanstaa@nrcan.gc.ca.
8. **The Boston Basin and Beyond: In Honor of Margaret D. Thompson.** Jean Crespi, Univ. of Connecticut, jean.crespi@uconn.edu.
9. **Natural Hazards: Supporting Mitigation to Avoid Future Costs.** Laurence Becker, Vermont Geological Survey, laurence.becker@state.vt.us.
10. **Mineral Resources of the Northeastern United States and Eastern Canada.** William Kelly, New York State Museum–New York State Geological Survey, wkelly@mail.nysed.gov; Marian Lupulescu, New York State Museum–New York State Geological Survey, mlupules@mail.nysed.gov.
11. **Maine Groundwater: Sustainable Aquifer Use through Monitoring and Regulation.** Robert Marvinney, Maine Geological Survey, robert.g.marvinney@maine.gov; Carol White, C.A. White & Associates, cawhite@smemaine.com.

2009 NEGSA Theme Sessions

T1. **Geologic Maps as Tools for Resource and Environmental Issues (Posters).** Robert G. Marvinney, Maine Geological Survey, robert.g.marvinney@maine.gov.

T2. **From Road Salt to Arsenic and Other Environmental Contaminants in Hydrologic Systems.** Rudi Hon, Boston College, hon@bc.edu; Bill Brandon, U.S. EPA, brandon.bill@epa.gov; Joseph Ayotte, USGS, jayotte@usgs.gov.

T3. **Critical Zone Processes.** Amanda Albright Olsen, amanda.olsen@psu.edu.

T4. **The Use of LiDAR and Remote Sensing to Locate Glacial Landforms: Recent Discoveries and New Insights.** Patrick A. Burkhart, Slippery Rock State Univ.,

patrick.burkhart@sru.edu; Jack Livingston, Slippery Rock State Univ., jack.livingston@sru.edu.

T5. **Geoarchaeology: Sites, Substrate, Sources, and Context.** Alice R. Kelley, Univ. of Maine at Orono, akelley@maine.edu; Allen Gontz, Univ. of Massachusetts–Boston, allen.gontz@umb.edu.

T6. **Glacial and Paraglacial Coasts: Stratigraphy, Processes, and Geomorphology.** Dan Belknap, Univ. of Maine at Orono, belknap@maine.edu.

T7. **Rheology, Kinematics, and Strain Localization in Faults and Shear Zones.** Scott Johnson, Univ. of Maine at Orono, johnsons@maine.edu; Michael Williams, Univ. of Massachusetts at Amherst, mlw@geo.umass.edu; Christopher Gerbi, Univ. of Maine, christopher.gerbi@maine.edu.

The following Theme Sessions will run jointly with the Maine Water Conference.

T8. **Habitat Restoration in North Atlantic Watersheds.** Karen Wilson, Univ. of Southern Maine, kwilson@usm.maine.edu; Noah P. Snyder, Boston College, noah.snyder@bc.edu; Ellen M. Douglas, Univ. of Massachusetts–Boston, ellen.douglas@umb.edu.

T9. **Using Monitoring Data to Influence Management and Conservation of Aquatic Ecosystems.** Tom Danielson, Maine Dept. of Environmental Protection–Bureau of Land and Water Quality, thomas.j.danielson@Maine.gov.

T10. **What's Different about Our Waters? Maine's Lakes and Streams in a Regional Context.** Peter Vaux; Sarah Nelson, Univ. of Maine.

T11. **Impacts of Climate Change on Water Resources.**

T12. **Land Conservation and Management Strategies for Protecting Water Quality.**

T13. **The Community-Based Conservation Model as Management Tool: Integrating Theory with Practice.**

T14. **Getting Back to Clean: Practices for Restoring the Quality of Urban Impaired Streams.**

T15. **Habitat Restoration in North Atlantic Watersheds.** Karen Wilson, Univ. of Southern Maine; Noah P. Snyder, Boston College, noah.snyder@bc.edu; Ellen M. Douglas, ellen.douglas@umb.edu.

T16. **Competitive Demands for Groundwater Resources in the Northeast Survey.** Martha Nielsen, USGS–Maine Water Science Center, mnielsen@usgs.gov.

T17. **Implications of Renewable Energies on Water Resources.**

FIELD TRIPS

Direct your field trip proposals to field trip chair Henry "Spike" Berry at henry.n.berry@maine.gov.

1. **Coastal Storms, Sediment Budgets, and Mitigating Engineering in Saco Bay.** Stephen M. Dickson, Maine Geological Survey, stephen.m.dickson@maine.gov; Peter A. Slovinsky, Maine Geological Survey, peter.a.slovinsky@maine.gov.
2. **Geology Cruise around Inner Casco Bay.** Arthur M. Hussey II, Bowdoin College (emeritus), hussgeo@gwi.net.

WORKSHOP

1. **Using the Explore Geoscience Classroom Resources to Engage K–12 Educators in Teaching Geology.** Chris McLelland, The Geological Society of America; Gary Lewis, The Geological Society of America.

REGISTRATION

Early Registration Deadline: 16 February 2009
Cancellation Deadline: 23 February 2009

Online registration begins December 2008. **For further information,** or if you have special requirements, please contact the local committee chair, Art Goldstein, +1-207-602-2371, agoldstein@une.edu.

Details on field trips, workshops, student opportunities, the guest program, and symposia and theme sessions are online at www.geosociety.org/sectdiv/.

ACCOMMODATIONS

Hotel Registration Deadline: 21 February 2009

A block of rooms has been reserved at the Holiday Inn by the Bay at US$125+tax per night. Please call +1-800-345-5050 to request a reservation under "NEGSA 2009."

GEOLOGIC PAST

Highlighting Articles from past issues of *GSA Bulletin*

1928 *GSA Bulletin* Rocks!

Forty years after The Geological Society of America was formed, *GSA Bulletin* was rocking with papers of interest and substance by some of the best in the field. The following are highlights from the 1928 volume (v. 39).

First, **Happy 100th Birthday to the Paleontological Society!** The society was formed in 1908 as a GSA Section, and in 1928 was still publishing its Presidential Addresses in *GSA Bulletin*. In his 30 Dec. 1927 address (published in the March 1928 *GSA Bulletin*, p. 387–402), Paleontological Society President **William A. Parks** first attempts to define geology and paleontology in their relationship to each other. He describes time as the "motif of geology" (p. 388)—stating geology should be regarded as a form of history. He then writes, "If it be admitted that time is the outstanding principle of geological science, then paleontology, which is undoubtedly our best means of determining relative time, rises to the first rank among the manifold phases of geology." This, he says, is in opposition to the common reduction of paleontology at that time to the role of "handmaid of geology." Parks describes "the ideal geologist as a man equipped with every means of solving the problems involving time, as nearly all geological problems do," and decried the attitude of specialization, "I have heard paleontologists disclaim with equanimity any knowledge of mineralogy … and mineralogists and economic geologists similarly renounce the devil and all his works, including fossils. I think there is grave error in that attitude" (p. 389). Parks' remarks include his view of how an academic program for geology and paleontology should look in the university system. He finishes with a call for a better understanding of "the chain of life" (p. 400) in a section titled "Paleontology and Evolution."

"Dead Sea Problem: Rift Valley or Ramp Valley" (June 1928, p. 490–542) by 1928 GSA President **Bailey Willis** introduces the term "ramp valley" as opposed to "rift valley" to describe "a trough that has been produced by the upthrust of two masses forming escarpments which face one another across the intervening lowland" (p. 501). Much of the paper centers on comparing this "Rift versus Ramp" as observed in the Dead Sea Trough (p. 510). Willis, who was president of the Seismological Society from 1921 to 1926, supplies "earthquake evidence" for his argument, writing, "It is not often that the geologist is favored with direct evidence of the dynamic activity of the structure which he is investigating. … A severe earthquake shook Palestine and Transjordania on July 11, 1927. I happened to arrive in Jerusalem on July 12, and … was afforded the opportunity to investigate" (p. 541). Willis then relays his observations and ends his paper by noting that "conclusions drawn from the geologic evidence" of the 11 July earthquake indicate "that the Dead Sea lies in a Ramp valley" (p. 542). Willis was awarded the GSA Penrose Medal in 1944.

In the September 1928 *GSA Bulletin* (p. 643–701), **J Harlen Bretz** continues his quest to have the channeled scablands understood by the geologic community and his "Spokane Flood hypothesis" accepted. Bretz' writing in "Bars of Channeled Scablands" conveys his conviction as well as his frustration, "Gravel deposits in which the combination of topography,

The Columbia Plateau. Image courtesy Jacques Descloitres, Moderate Resolution Imaging Spectroradiometer (MODIS) Land Rapid Response Team, NASA, http://visibleearth.nasa.gov/view_rec.php?id=2011.

composition, structure, and magnitude is unlike anything described in geological literature are widely distributed over the channeled scablands of the Columbia Plateau in Washington and thence along the Snake and Columbia rivers as far down as Portland, Oregon. They record extraordinary conditions of origin. … The writer's interpretation of channeled scabland is so great a departure from prevailing conceptions of rivers and river work that numerous suggestions have been made by other geologists looking toward more acceptable, more conventional explanations. In none of them, however, is there an adequate appreciation of the character of these gravel deposits, perhaps because no adequate descriptions have been made by the writer" (p. 643–644). Bretz uses this paper to further describe and diagram as clearly as possible the scablands and the channels within them, but in the end admits, "The writer has not yet adjusted all the items to a sequential series of events and has no satisfactory explanation for the cause of the hypothecated flood, but the argument for the hypothesis is not yet closed" (p. 701).

The December 1928 issue features two articles by **Frank Bursley Taylor,** the second of which (p. 1001–1016) is titled "Bearing of Distribution of Earthquakes and Volcanoes on their Origin." Taylor is the American geologist who at the GSA Annual Meeting in Baltimore, Maryland, USA, on 29 Dec. 1908, first brought up the idea of continental drift. Indeed, his introduction notes, "This paper is one of a series by the writer on sliding continents and the making of mountain ranges" (p. 1001). Taylor summarizes earlier papers, explaining that they "show that the ranges of the Tertiary mountain belt are the product of horizontal crustal movements of continental extent" and emphasizing that "the moving continents slid from high latitudes toward lower latitudes in both hemispheres" (p. 1002). Taylor believed the only force that could cause such continental movement had to be a "tidal force … not in the water tide of the ocean, but in the body tide of the planet" (p. 1005). He goes on to discuss the pattern of earthquake epicenters from 1899 to 1911 and the "general distribution of volcanoes," concluding, "Strictly speaking, earthquakes are not the cause of volcanoes, nor are volcanoes the cause of more than local earthquakes, but sliding continental crust-sheets, which cause mountain folds and great deep faults and fissures of the crust, are the cause of both" (p. 1014–1015).

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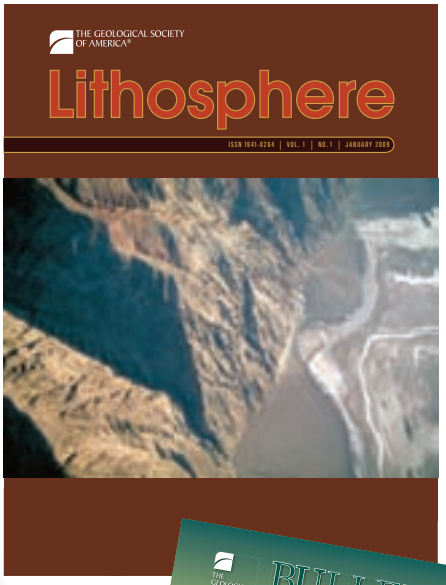

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SPECIAL COMMENTARY

Integrated Geological Resources Management for Public Lands: A Template from Yellowstone National Park

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ABSTRACT

Geological resources are often a neglected component of comprehensive natural resource management programs, and yet, all ecosystems are built upon the physical or abiotic foundation of the landscape. Geological resources pose hazards and create technical challenges while also providing both irreplaceable ecosystem functions and significant education. Our valuable geological resources are also invaluable indicators of environmental change. It is critically important that geological resource management be a central component of a comprehensive natural resource management plan.

Public lands account for nearly a third of the land area in the United States, but most public land management agencies do not have sufficient geological expertise on staff; external geoscientists complete much of the geological research and study on public lands. The effort to integrate geological resources into natural resource management, and the shortage of geological expertise within public land management staff, indicate the need for a widely applicable template for framing geological resource management. A functional structure is proposed for a comprehensive geological resource management program that can be adapted to a wide variety of public land administration scenarios. Specific examples from Yellowstone National Park show the importance of geological resource considerations in planning, construction, education, protection, hazard mitigation, and other activities. This paper also serves as a call for involvement by the larger geological community to address society's need for comprehensive geological resource management to be more fully integrated into natural resource management on our public lands.

INTRODUCTION

Natural resource management is often thought to be focused primarily on biological components of an ecosystem, and it is typically dominated by this focus. When geological resources *are* "managed," it is most likely for extraction purposes or hazard mitigation. "Management" of the environment or resources is also sometimes misconstrued to mean manipulation. Even in Flawn's *Environmental Geology,* he refers to the "honorable field of civil engineering" when discussing management of the "physical system" (Flawn, 1970, p. 191). Berger (1998) describes both national and international environmental reports that disregard abiotic components of ecosystems and their functional roles. Management considerations of geological resources are typically limited in scope to specifically address extraction of resources (e.g., fossil fuels), ecosystem restoration (e.g., the Everglades), environmental protection (e.g., soil erosion), resource protection (e.g., water resources), hazard mitigation (e.g., volcanic hazards), archaeology and paleoanthropology (e.g., prehistoric artifacts), and land-use planning (e.g., coastal zone management). A case has not been identified in which a comprehensive, fully integrated geological resources management plan has been developed for maintenance and protection of a public land resource base.

The United States government owns 655 million acres—nearly 29% of the total U.S. land area (Vincent et al., 2001). State, county, and municipal governments hold additional lands. The U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), and Fish and Wildlife Service (FWS) manage 96% of federally owned land. Whereas extractive activity does occur on public land, national park lands are generally preserved.

External investigators from academia and other federal agencies perform much of the geological research and data collection on public lands. While federal service agencies such as the U.S. Geological Survey (USGS) are charged with providing the nation with reliable information for the management of geological resources, including extraction, the NPS, BLM, USFS, and FWS are distinctly land management agencies. As such, administrators of public lands must be responsible for the inventory, monitoring, and management of their geological resources, just as they are for management of biological and cultural resources. The direct and immediate relevance to the geological community is that most public land agencies and municipal governments do not have extensive geological expertise on staff; yet, comprehensive resource management must be grounded in the physical system. The NPS has clearly stated that "assistance from the broader geologic community is important to supporting park resource management" (National Park Service, 2006). Geological resources management is critically relevant for the integrity of entire ecosystems, for sensible resource use and protection, and for human safety.

Here I present the foundation of a geological resources management plan that was developed while I served as the supervisory geologist for Yellowstone National Park. For the purpose of this paper, the plan is presented in the form of a template, making it applicable for public land administration, land-use, and resource management situations. Moreover, this template could be modified to correspond to the typical divisions of local government entities to allow adoption within municipalities. My intent is to more comprehensively integrate geological resources into the traditional, biocentric natural resources management practices that are applied to public lands. This proposed integrated geological resources

doi: 10.1130/GSATG23A.1

management plan offers a functional structure for understanding, managing, and protecting any unique geological environment. Examples from Yellowstone are cited, indicating the types of resources in need of protection as well as those that impact land-use planning and public land infrastructure. This draft plan benefited from review in peer forums (e.g., Doss, 2000, 2001a, 2002) and was presented in formal settings ranging from the Smithsonian Institution, USGS Headquarters, and at joint USGS/NPS workshops.

DEFINING THE GEOLOGICAL RESOURCE BASE

Geological resources comprise both features and processes. Features include stream channels, wetlands, geysers, and fossils. Processes might be groundwater flow, rockfalls, hydrothermal discharge, or erosion. Geological resource management should not inherently imply manipulation. Most large-scale geological processes cannot be aggressively changed, and in fact, the NPS is charged to "…allow geologic processes to proceed unimpeded" (National Park Service, 2000).

In Yellowstone National Park, the direct tangible influence of geological factors on total ecosystem function is readily observed (Fig. 1). Unique thermophile communities thrive in the varied hydrothermal discharges of the park. The seasonal migrations of ungulates, such as elk and bison, and consequently predators, are partly controlled by the high heat flow from the Yellowstone hotspot and the distribution of fine-grained glacial deposits that retain moisture and support lush herbaceous growth through the dry season. Vertical movements of the Sour Creek resurgent dome at LeHardy Rapids alter Yellowstone Lake levels and disrupt spawning movements of native cutthroat trout in the Yellowstone River. Park visitation is periodically marred by hydrothermal fatalities and road closures from mass movements. While Yellowstone may be an exemplary "display case" for geological resources, every landscape and all public lands have unique geological resources and resource management concerns.

Geological processes operate on different time and spatial scales. In Yellowstone, geological processes relevant to resource

Figure 1. (A) Bison exploiting Yellowstone's high heat flow in the Mud Volcano area. Heat flow reduces snow pack, keeping food available year-round to ungulates living on the high altitude Yellowstone Plateau. (B) Colors in hydrothermal features such as Grand Prismatic Spring represent distinct thermophile communities thriving in waters of different temperatures. (C) Rockfall in Gardner Canyon closed the only year-round Yellowstone entrance road. (D) Cutthroat trout leaping the LeHardy Rapids along the Yellowstone River (National Park Service photo). LeHardy Rapids develops from uplift on the adjacent Sour Creek Resurgent Dome within the Yellowstone caldera.

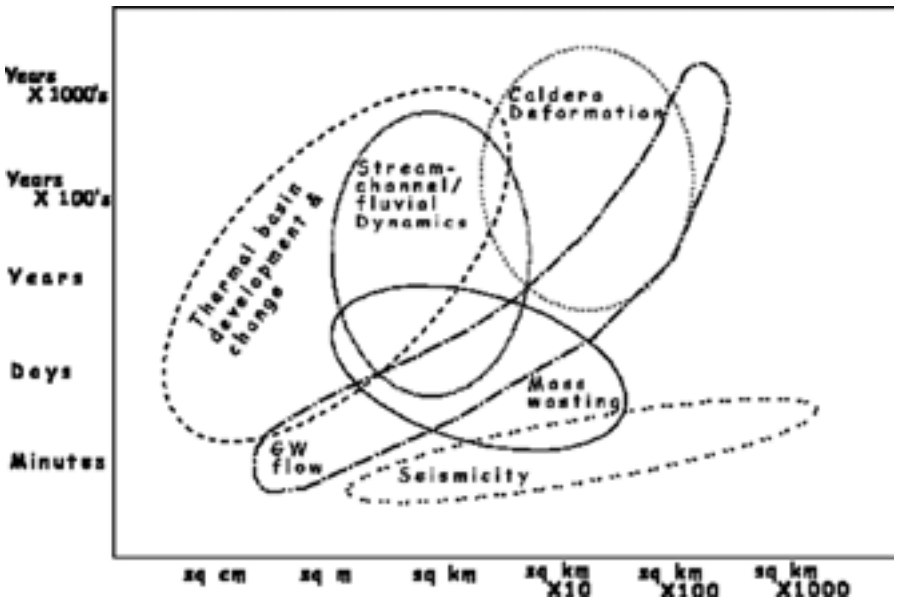

Figure 2. An approximation of the scale-rate relationship among several active geological processes in Yellowstone. Note that several of the processes converge on scales of less than a mile and less than a year.

management span temporal scales from seconds to thousands of years and spatial scales from centimeters to hundreds of kilometers (Fig. 2). Several of these dynamic processes converge on scales of less than a kilometer and less than a year. Visualizing geologic processes that operate on human time scales and within the boundaries of developed public lands may assist land managers in prioritizing management objectives. Every ecosystem includes geological features and processes that form "targets of management," including those that (1) are at risk of damage and theft (e.g., fossils); (2) pose inherent risks and hazards to visitors and staff (e.g., seismicity); and (3) demand close scrutiny relative to construction and infrastructure (e.g., mass movements).

Key to formulating resource management plans is an inventory of the geologic resources that need management oversight and of existing data and research results. It may be appropriate to first broadly characterize the resource base in order to facilitate development of such an inventory. In Yellowstone, 10 categories of geological resources have been identified (with representative research citations), including volcanic features and volcanism (Christiansen, 2001); landscapes, landforms, and glacial features (Shovic, 1996); lithological resources (Christiansen, 2001; Fritz, 1980); water quantity and quality (Farnes et al., 1999; Metesh et al., 1999; Elliott and Hektner, 2000; Marcus et al., 2001); hydrothermal features and discharge (Fournier et al., 1991; Johnson et al., 2003; Husen et al., 2004); mass movements (e.g., Wieczorek et al., 2000; Doss, 2001b); seismicity (Waite and Smith, 2004); caves (Barnosky, 1994); paleontological resources (Santucci, 1998); and soils (Rodman et al., 1996).

Of potential relevance to a land management agency, geoindicators are geological features and processes active near Earth's surface and on a human time frame that are high-resolution measures of change in ecosystem function, sustainability, and health (Berger, 1997). Analyses of geoindicators serve to identify environmental signals that might warn of impending change and help communicate that change to land managers and decision makers. Geoindicators can help focus a public land management plan on processes that are active on a human time frame and those that display the greatest likelihood of requiring immediate response. A description of individual geoindicators is not within the scope of this paper, but the NPS has adopted the geoindicator approach to implement some of its formal strategic planning goals (Higgins, 2000).

REGULATORY FRAMEWORK FOR GEOLOGICAL RESOURCES MANAGEMENT

Legal and regulatory mandates must frame and guide a geological resources management program on public lands and comprise federal and state legislation, contracts, and agency directives. The Wilderness Act of 1964 states that geologic features of scientific, educational, scenic, or historical value may be a defining attribute of wilderness areas. The National Environmental Policy Act of 1969 (NEPA), the basic national charter for environmental protection, is the policy of the federal government to "preserve important historic, cultural, and natural aspects of our national heritage." The Federal Cave Resources Protection Act of 1988 preserves significant caves on federal lands for use in scientific, educational, and recreational pursuits. The Federal Water Pollution Control Act (Clean Water Act of 1972) is designed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The NPS obtains and uses water for park purposes under the Reserved Water Rights and Prior Appropriation Doctrines. The Geothermal Steam Act of 1970 prohibits leasing of federally owned geothermal resources in all units of the National Park System, and the 1988 amendments to the act dictate that the "Secretary shall maintain a list of significant thermal features" and "shall maintain a monitoring program for significant thermal features." Where paleontological resources occur in an archaeological context, the Archaeological Resources Protection Act of 1979 provides protection.

NPS policy dictates that geologic resources will be preserved and protected as integral components of park natural systems (National Park Service, 2000). The NPS assesses the impacts of

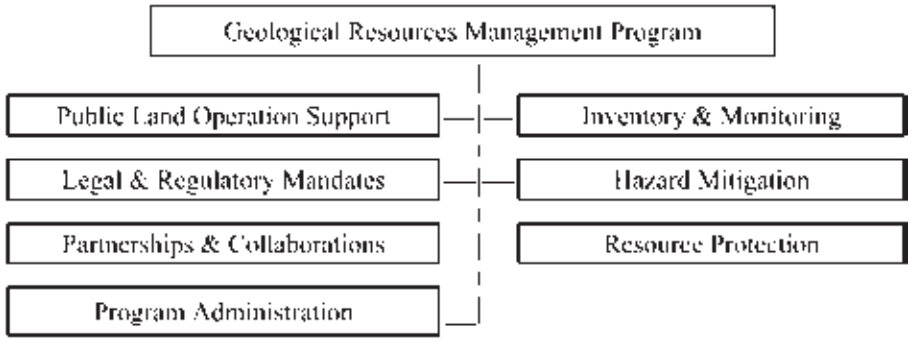

Figure 3. A proposed functional structure for a geological resources management plan for public lands. Functional divisions in this plan template can be applied to different public lands and through different management entities.

natural processes and human-related events on geologic resources, maintains and restores the integrity of existing geologic resources, integrates geologic resource management into NPS operations and planning, and interprets geologic resources for park visitors. Further, geologic processes are allowed to proceed unimpeded except when (1) directed by congress; (2) emergencies threaten life and property; (3) there is no other feasible way to protect natural resources, park facilities, or historic properties; or (4) necessary to restore impacted conditions and processes. Other geological resources in NPS guidelines include karst, geologic hazards, geologic features, paleontological resources and their contexts, caves, geothermal and hydrothermal resources, and soils. Specifically for Yellowstone, the Yellowstone Park Act of 1872 calls for "…the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition." Similar enabling legislation exists for most public lands.

PROGRAM PRIORITIES, OBJECTIVES, AND STRUCTURE

Management and operation of most public lands by a land management agency impact, or are impacted by, geological resources and processes in some way. A comprehensive resource management program must identify priority, site-specific needs and must be responsive to land-use and regulatory demands. In most cases, priorities fall within the broad categories of hazard mitigation, resource use, resource protection, and education. Identified priorities can assist in the development of long-term program goals and strategies. The draft plan for Yellowstone lists four primary priorities. First, geological hazards to humans and infrastructure must be acknowledged and hazard mitigation plans developed. Second, the program must interact with all aspects of park operations to assure appropriate application of geological information to planning, construction, and mitigation, and must include measures to foster productive external collaborations. Third, the program must meet regulatory obligations for inventory of thermal features, development of hazard response plans, and administration of water rights compacts. Finally, the program should conduct regular and comprehensive outreach to park staff and visitors, particularly the interpretation division, to provide direct education and information regarding the dynamic nature of Yellowstone's geologic resources.

Broad objectives for a geological resources management program should be (1) active integration of geological knowledge into operations and planning; (2) facilitation and coordination of external geologic investigations directed at identification and mitigation of geologic hazards; (3) integration of geological knowledge throughout existing and proposed resource management programs; and (4) collaboration with external investigators in geological research as it relates to resource management.

In order to meet stated objectives, this geological resources management template is developed with a functional structure (Fig. 3). In contrast to a disciplinary or topical structure (e.g., by species in a biological resources program), a functional structure for program administration focuses on operational need as opposed to categories of operations. The need for a management program arises from three explicit observations and concerns: (1) the geologically related mandates placed upon the resource; (2) the needs of the various constituents of the public land operations; and (3) the dynamic nature of the geological features and processes on public land.

Development of a natural resource program based on a functional-operation standard offers many benefits. First, the program would be more responsive to immediate needs. Second, the program would be need-driven, as opposed to discipline-driven, and thus be better suited for development of programmatic vision resulting from systematic needs. Third, this type of program would have an appropriate level of overlap among divisions so that critical functions could be addressed within more than one area of concern (e.g., geological hazards can be addressed in inventory and monitoring, hazard mitigation, and resource protection). Finally, and perhaps most important, program personnel would not be restricted in duties and responsibilities by disciplinary labels. Staff will, by default, possess a disciplinary expertise, but the program and position responsibilities would be built around functional needs.

PROGRAM FUNCTIONS

Support of Public Lands Operations

In considering a functional approach to program implementation, a practical plan can use documented and observed needs from across a land management structure as an indicator for program development and as a realistic guide for operations. In addition, normal operations in other divisions may

Table 1. List of divisions and primary responsibilities in Yellowstone National Park land management operations

Operational Division	Primary Responsibility
Resource Management and Visitor Protection	Law enforcement, visitor and staff safety, visitors' services office
Interpretation	Public education, visitor center operations
Maintenance	Repair and rehabilitation of park infrastructure
Public Affairs	Constituent relations, Freedom of Information Act requests, press and media contacts
Concessions	External contract management
Planning	Infrastructure and landscape planning, environmental assessments, compliance
Yellowstone Center for Resources	Natural and cultural resource management and protection, Spatial Analysis Center

benefit a geology program. The land management staff in Yellowstone is organized into seven broad divisions (Table 1). Each of these divisions has a mission and set of responsibilities, but, as is true of any complex organization, there are areas of shared responsibility. Most public lands and municipalities have analogous divisions of responsibilities. What follows are examples of the integration of geological resources management with the various park operation divisions at Yellowstone.

Division of Resource Management and Visitor Protection

Collaborative work with resource management and visitor protection staff includes forensics related to hydrothermal hazards (geological evidence collection), discussions of signage for hazards, and investigations of resource theft involving geological materials such as sinter and travertine. In one case, an individual was advertising a sample of travertine from Yellowstone for sale on a well-known Internet auction house. The resource management staff is directly involved with mitigation and/or remediation of resource damage such as that caused by visitor use, vehicle accidents, fuel spillage and pipeline damage, and impacts caused by planned construction. Division staff also offer assistance to geological resource management by collection of snow-water equivalence data from snow survey sites and with water rights issues such as monitoring irrigation withdrawals. Incidents include enhanced erosion near streamside pullouts, hydrothermal fatalities, diesel spills in alluvial sediments, and sewage spills from damaged infrastructure (Fig. 4).

Interpretation and Concessions

Interpretive staff need geological expertise for seasonal interpreter training, editing and preparation of trail guides, reviews of books under consideration for sale in visitor centers, conceptual planning for new educational video productions, and modifications to geological exhibits in visitor centers and wayside exhibits. As new geological research in parks leads to new conclusions, interpretations, and insight, interpreters and educators must be updated. Doss and Doss (1995) proposed the reasoning behind, methods for, and benefits of facilitating knowledge transfer in national parks. It is clear that all constituents, including educators, researchers, land managers, and the public, benefit from the active engagement of earth scientists with interpreters and other land management staff. Concessioners (tour guides) involved in programming and interpretation of natural resources for the public also require training on local geological resources.

Figure 4. National Park Service geology and visitor protection staff investigating a backcountry hydrothermal accident site (note sandals in hot spring). Geologists mapped sediment disturbances (footprints—lower photo) in hot spring floor to assist in accident reconstruction.

Planning and Public Affairs

The planning office prepares construction designs and standards for park projects and prepares environmental assessments for NEPA compliance in construction and renovation projects, all requiring geotechnical assistance. Public affairs personnel need a "point of contact" for press and media inquiries regarding geological resources. Geology program staff accompany film crews and photographers seeking access to sensitive or dangerous thermal areas and also prepare briefing statements and press releases on geological issues.

Maintenance

The maintenance division is involved in maintaining, upgrading, monitoring, and construction of park infrastructure. In many cases, those activities require geotechnical investigations and information regarding slope and substrate stability and properties. Maintenance staff conduct systematic monitoring, such as roadbed condition, slope stability, and groundwater quality associated with water treatment facilities. Maintenance is also often the "first responder" to crisis incidents such as hazardous fluid spills and rockfalls.

Table 2. Geological resources posing hazards or in need of protection in Yellowstone National Park*

Hazards
Hydrothermal explosions
Large-magnitude seismicity
Mass movements
Other hydrothermal hazards
Subsidence
Erosion
Volcanic eruptions
Require Protection
Water quantity
Water quality
Paleontological resources
Hydrothermal features
Yellowstone Lake features
Caves
Lithologic resources
obsidian, sinter, petrified wood, travertine
Soils
Type sections

*Resources that define priority inventory and monitoring needs.

Yellowstone Center for Resources

Geological knowledge should be incorporated within the plans and projects of other natural and cultural resource programs. The geology program provides tangible assistance to the fisheries program by evaluating sediment transport, erosion, and stream channel dynamics adjacent to a fish-monitoring weir. High-resolution Yellowstone Lake bathymetry generated by cooperative USGS research (e.g., Morgan et al., 2007) also greatly benefits the fisheries program in their efforts to eradicate the invasive and detrimental lake trout illegally introduced into Yellowstone Lake. The program consulted on sediment transport studies in rivers and water-quality monitoring throughout the park and provided the vegetation management program with geological and soils information for a study of vegetation in the Absaroka volcanic terrane. Cultural resource programs have needs related to evaluation of geological history, sediment, source materials, and stratigraphic setting of archaeological resources, and investigation of the potential use of natural geological materials (mud, rocks, hot springs) in ceremonial events and customs.

Geologic Hazard Mitigation

The mitigation, where feasible, of geological hazards must be a priority for a geological resources management program (Table 2). While the NPS allows geological processes to operate unimpeded, steps can be taken to reduce hazards on public lands. The management program must include directives to identify specific locations where events might pose the greatest risk and attempt to forecast when, at what rate, and at what magnitude these events might occur (Fig. 5). In addition, the program should work directly with external collaborators to facilitate projects aimed at identifying and mapping hazard areas. Priority hazards in Yellowstone likely include hydrothermal explosion events, large-magnitude seismicity, and mass movements in developed or front-country areas.

Geologic Resource Protection

Geological resources in need of protection include those that are sensitive, rare, or commercially valuable (Fig. 6; Table 2). Efforts to protect these resources include comprehensive inventory compilations (e.g., Santucci et al., 2001). A geology program should benefit all appropriate divisions on issues of theft investigation, signage, trail construction and routing, protection and closure areas, and Freedom of Information Act restrictions, where appropriate, for the protection of these resources. For

Figure 5. Avalanche control along the East Entrance road at Sylvan Pass utilizes a WWII-era Howitzer. The gun site sits at the base of a nearly vertical, >1000-ft (300-m) exposure of the Eocene Absaroka Volcanics. Firing and detonation blasts during avalanche control periodically generated rockfalls that put National Park Service staff at risk.

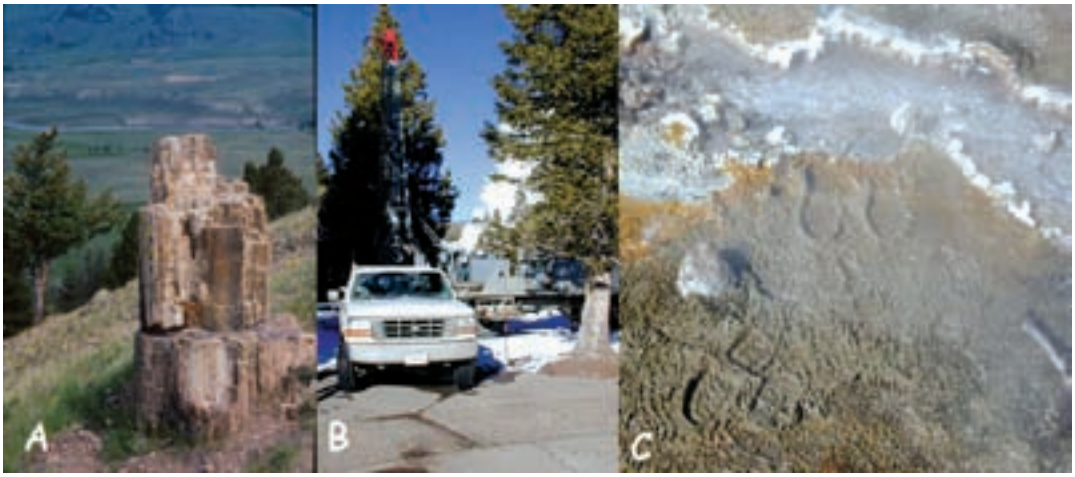

Figure 6. Geological resources in need of protection include rare or valuable materials and geological processes. (A) One of the many in situ petrified stumps found within the Eocene Absaroka Volcanic deposits. (B) Geotechnical drilling in close proximity to an erupting Old Faithful geyser in preparation for new Visitor Center planning and construction. (C) Sinter damaged by foot traffic along a thermal runoff channel near a historically significant hot spring.

example, many public lands contain stratigraphic type sections that should be inventoried for their protection because type sections can represent an important historical resource.

Legal and Other Mandates

Mandates form a critical functional component of any resource management program. Federal, state, local, and agency-specific mandates upon the NPS and other specific land units require land managers to address the applicable resource management concerns. In addition, the USGS is federally mandated under the Stafford Act (Public Law 93-288) to issue timely warnings of potential geologic disasters in the United States to the affected populace and civil authorities. This mandate to USGS applies to all lands.

Partnerships and External Collaborations

The USGS carries out part of its Stafford Act responsibility with the Volcano Hazards Program. This mandate upon the USGS was, in part, the motivation for development of the Yellowstone Volcano Observatory (YVO) in 2001. The YVO is aligned with the USGS Volcano Hazards Program in a similar manner to the Hawaii, Cascades, Long Valley, and Alaska Volcano Observatories. Yellowstone has a vested interest in the issuance of volcanic and seismic warnings, and as such, is positioned within the YVO to be an equal partner and coordinator in research direction, monitoring strategy, and hazard plan development. The geology program provides the Yellowstone National Park coordinating scientist for the YVO and participates in planning events and regular volcano activity updates.

Partnerships and collaborations are fundamentally important components of geological resources management programs on public lands. Morgan (2007) represents an excellent example of this collaboration in Yellowstone. On public lands, much of the geological work conducted over the past century has been part of an organized and integrated program administered by the USGS that comprises investigations from the geologic, water resources, and biological resources divisions. Other federal agencies involved in geological investigations on public lands include the USFS, the FWS, the Natural Resources Conservation Service, and NASA. In Yellowstone, state agency partners that participate in geologic investigations include the Montana Bureau of Mines and Geology, Montana Fish Wildlife and Parks, and the Wyoming Game and Fish Department. Numerous academic institutions have faculty and research personnel who focus their efforts in Yellowstone National Park. The research permitting office in Yellowstone reviews permits for NEPA compliance, keeps categorized records of permit applications, and compiles annual investigator reports.

Inventory and Monitoring

Any public land is best served in its resource management initiatives when those resources are initially inventoried and subsequently monitored (Table 2). In many ways, the list of features for inventory mirrors the list of resources to be protected, and the inventory process is a means to develop an integrated database and a protection plan. A comprehensive inventory also provides a standard against which change can be measured and assessed, and an inventory of geological hazards is a prerequisite for hazards mitigation. A comprehensive inventory of all geological features in any specific area is likely impossible; however, those resources that may be most threatened (e.g., accessible by visitors, in areas of active surface processes, in areas of previous disturbance, or planned construction sites) should be priorities for inventory and monitoring.

In Yellowstone, inventories of hydrothermal features and thermophiles are ongoing, as are USGS stream gauging activities on Soda Butte Creek and the Lamar, Yellowstone, and Gardiner rivers, as well as snow course survey measurements of snowpack for runoff and moisture predictions. The YVO is coordinating seismic, regional GPS, some hydrothermal, and other monitoring efforts. The maintenance division regularly monitors water quality in the vicinity of treatment facilities, and those data can be invaluable for park-wide monitoring.

Program Administration

An important resource management program function is the conduct of "inreach," or education of peers and management on the justification, roles, and need for a geological resources management program. In many ways, the *inreach* of this program is accomplished by interactions during operations support.

Administration of any program includes program development, modification, and enhancement as needs warrant. A fully functional program will provide guidance, advice, and serve as a management tool that is, ideally, personnel-independent. The program must also result in the generation of initiatives and proposals that achieve program goals. Initiatives can include interdivisional partnerships and collaborations with external agencies and individual investigators.

SUMMARY

Geological resources on public lands result from processes that have operated throughout geological history but remain active; impart challenges to park operations, management, and policy; pose risks to visitors and staff; and provide opportunities for education and interpretation. Public land managers have the obligation to be responsible for the inventory, monitoring, and management of geological resources in the same manner as they manage biological and cultural resources. Yet in many cases, the larger geological community is in the primary position of collecting the geological data and generating research results on public lands. The management of geological resources in our public lands is critically relevant for the integrity of all resources and ecosystems.

The functional structure of the proposed Geological Resources Management Program permits and encourages land managers to focus effort on operational need. It also encourages external geoscientists to interpret how their work may fit in the larger context of geological resources management. The availability of a functional geological resources management program aimed at understanding the diversity of geological features and processes will help assure the safety of visitors and staff, the appropriate use of our natural resources, the accurate education of visitors and staff, and a more thorough understanding of the magnificent resources preserved in our public lands.

ACKNOWLEDGMENTS

Many individuals have provided written information used in the preparation of the draft plan, including Ann Rodman, Vince Santucci, and Dr. Robert Smith. I thank John Varley, Wayne Brewster, Ann Deutch, Ann Rodman, Tom Olliff, Diane Chalfant, Bob Higgins, and the entire National Park Service staff for their help during my tenure at Yellowstone. My effort and time in the park was rewarding in large part because of some remarkable interactions with geologists like Lisa Morgan, Pat Shanks, Bob Christiansen, Ken Pierce, Marianne Guffanti, Bob Smith, and Duncan Foley. I also thank the University of Southern Indiana Pott College of Science and Engineering for its support and Tony Maria, Heidi Doss, and Stephen Johnston for their thoughtful reviews of this manuscript.

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Donna L. Russell, *Director of Operations*

Support for GSA Programs

The GSA Foundation provides support for many GSA programs and projects. During the past year, the Foundation provided support for the following:

- GeoCorps™ America Interns
- GSA Public Service Award
- Shlemon Mentor Program
- Geology in Government Mentor Program
- Geology in Industry Program
- GSA's Annual Meeting
- Subaru Outstanding Woman in Science Award
- Matching Student Travel Grants for the Sections
- Research Grants
- Teacher Advocate Program
- Field Forums
- International Travel Grants
- Outstanding Earth Science Teacher Awards
- Congressional Science Fellowship

Many of these programs and awards were partially supported through the Greatest Needs Fund. To help the Foundation maintain this kind of support, please direct your donations to the Greatest Needs Fund by using the coupon at the bottom of this article or via the Foundation's Web page, **gsafweb.org.** We sincerely appreciate your continued support!

Planned Giving Options Give Donors the Ability to Give Generously Today and in the Future

At this time of the year, thoughts turn to planned giving and tax benefits. The following are several ways that you can include the GSA Foundation in your plans. Current tax laws encourage charitable giving as a way to reduce income taxes for those who itemize on their returns.

Cash gifts are the easiest and most effective way to give to the GSA Foundation. Subject to certain tax limits, you can receive a full tax deduction for the amount of your cash gift in the year you make your gift. The higher your tax bracket, the more potential for tax savings.

Gifts of stocks, bonds, mutual funds, and real estate that have appreciated in value and have been owned for more than one year can result in triple tax savings. You may receive an income tax deduction on the market value, not the original price, of the securities or real estate, thereby bypassing any capital gains tax on that gain or growth since the time of purchase. Opportunities for state capital gains tax savings may also exist.

Bequests provide a way for you to remember the GSA Foundation in your will and can reduce inheritance taxes. Your will can designate gifts of cash, securities, or other property, or a percentage of the remainder of your estate. Suggested legal wording:

For a specific bequest:

"I leave [dollar amount] to the Geological Society of America Foundation, Inc., P.O. Box 9140, Boulder, CO 80301-9140, USA, to be used for general purposes."

For residual bequests:

"All the rest, residue, and remainder of my estate, real and personal, I give, devise, and bequeath to the Geological Society of America Foundation, Inc., P.O. Box 9140, Boulder, CO 80301-9140, USA."

Gifts of life insurance can be made in the form of a new policy or an existing policy. Premiums paid by the donor on a donated life insurance policy qualify for charitable tax deductions. If an existing policy is paid in full, your charitable contribution is generally the replacement value or the cost basis of the policy.

Gifts of retirement plan assets can be arranged through naming the GSA Foundation as a beneficiary of your retirement plan or IRA. This option is especially effective in minimizing estate taxes. Retirement assets can also be placed in charitable trusts, maximizing your financial and estate planning benefits.

Life income gifts can be made through charitable remainder trusts, charitable lead trusts, charitable gift annuities, and pooled income funds. These arrangements offer substantial tax savings while providing an annual income to you, your family, or others. When appreciated assets or property are placed in these arrangements, the assets are reinvested and diversified and may produce a greater yield for the donor or beneficiaries.

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Or donate online at **www.gsafweb.org**

EarthCaching

Let Earth Be Your Teacher!

EarthCaching, an earth science–based subset of the highly successful adventure game, geocaching, started after a GSA member mentioned at the 2003 GSA Annual Meeting in Seattle that GSA should "look into geocaching." Since then, the program, developed and operated by the GSA Education & Outreach (E&O) Department, has grown from that great member idea into a global phenomenon.

EarthCaching takes people to sites of geological and geographical interest around the planet. Using their Global Positioning System responders (or GPSr), people discover a site listed on the EarthCache Web site, www.earthcache.org, then undertake an educational task before logging their find on the Internet.

After a few "finds," visitors often go on to develop their own EarthCache. It's not difficult to develop an EarthCache—all you need is a great site people can visit to learn about some aspect of earth science, and then follow the guidelines on the Web. Every EarthCache is reviewed by GSA staff before it is approved and released to the caching community.

To date there are 3,700 EarthCaches around the globe—at least one on every continent and in 75 countries beyond the United States. E&O expects that by the end of 2008 that number will grow to 5,000. EarthCaches have been visited by over 265,000 people, and that number is growing exponentially. It's a great way for teachers, parents, and grandparents to share the wonder of earth science with young people, and we encourage everyone to try their hand. With so many EarthCaches already, chances are that there is at least one close to where you live or holiday.

GSA also has a reward system for people who visit three or more EarthCaches. The "EarthCache Master" program awards pins to geocachers who have met the criteria and apply online. The highest recognition level, platinum, rewards an EarthCacher who has visited at least 20 sites in more than five states or countries and developed at least three approved EarthCaches. So far, 188 people have reached this level, and some 2,400 have met the basic, or "bronze," level for visiting three EarthCaches.

Over the past two years, the National Geographic Society Education Foundation has sponsored the development and production of an educators guide for using EarthCaching in the classroom as well as some training for national facilitators who instruct teachers around the country. The educators guide is free at **www.earthcache.org.**

The EarthCaching project is also proudly supported by Subaru of America Inc. and has several partners, such as the U.S. National Parks, the Geological Society of Australia, and Groundspeak, the company that operates geocaching.

It's easy to become involved in EarthCaching. All you need is a GPSr, a sense of adventure, and a willingness to let Earth be your teacher!

"The Niagara of the West"—Shoshone Falls, Idaho, USA—just one of the thousands of EarthCache sites to explore at www.earthcache.org. Photo by K.E. Asmus.

Watch EARTH Now!

EARTH online is now producing original videocasts of Earth-related news.

The videocasts, available on EARTH online at www.earthmagazine.org and on YouTube, cover current geologic news, including natural disasters, current research and public policy affecting the geosciences. Anchored by staff writers of the magazine, the videocasts supplement EARTH's regular earth science news items throughout the month.

SERVING THE GEOSCIENCES WORLDWIDE AGI THE AMERICAN GEOLOGICAL INSTITUTE

EARTH magazine (formerly named *Geotimes*) is published by the American Geological Institute.

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Positions Open

ASSISTANT PROFESSOR WITH EXPERTISE IN MINERALOGY AND/OR PETROLOGY ILLINOIS STATE UNIVERSITY

The Department of Geography-Geology at Illinois State University seeks applications for a tenure-track position at the rank of **Assistant Professor** with expertise in **Mineralogy and/or Petrology**. The preferred starting date is 16 August 2009. A Ph.D. in Geology or closely related field is preferred, but ABD candidates will be considered.

Illinois State offers a B.S. in geology, a B.S. in earth and space science education, and an M.S. in hydrogeology. The department seeks a candidate with a strong potential for scholarly research, publication, and undergraduate teaching in Mineralogy and/or Petrology. The subspecialty of the successful candidate is open. A strong interest and experience in conducting field-based research that involves undergraduate students is desired. The successful candidate will teach a combination of general education, undergraduate-level courses in Mineralogy and Petrology, and other advanced courses of interest. The ability to participate in the instruction of our capstone summer field geology course is preferred. The potential for a significant startup package exists.

Illinois State University is a research-intensive university with an annual enrollment of approximately 20,000 students. The university is located in the Bloomington-Normal metropolitan area of central Illinois with a population of approximately 150,000. The Department of Geography-Geology offers B.S./B.A. degrees in Geography, a B.S. degree in Geology, and an M.S. degree in Hydrogeology.

Please send applications to Chair, Mineralogy-Petrology Search Committee, Department of Geography-Geology, Illinois State University, Normal, Illinois, 61790-4400, USA. Applications should include a cover letter, curriculum vita, statements outlining current and future research interests and teaching philosophy, three letters of recommendation, and all college and university transcripts. For full consideration, all application materials should be received by **30 November 2008**. No e-mail applications will be accepted. Inquiries about the application process should be directed to Dr. David Malone, dhmalon@ilstu.edu, +1-309-438-2692. Additional information about the department and the community can be found at www.geo.ilstu.edu. Filling this position is contingent upon budgetary approval.

Illinois State University is an Equal Opportunity, Affirmative Action University encouraging diversity.

TENURE-TRACK FACULTY POSITION WILLIAMS COLLEGE

The Geosciences Department at Williams College invites applications for a tenure-track appointment beginning 1 July 2009. We seek a colleague in the broad areas of paleoclimatology and climate science to teach introductory and upper level courses in climate change and environmental geology. We are particularly interested in scientists who use innovative geochemical methods to reconstruct past climates or GIS tools to understand modern climate trends and who can contribute to the Center for Environmental Studies at Williams College.

The Geosciences Department is committed to providing excellent training for future geoscientists, as well as teaching earth science as part of a balanced liberal-arts education. The successful candidate must therefore demonstrate potential for excellent teaching as well as interest in undergraduate student research. Our facilities include a GIS-remote sensing lab, ICPMS, SEM, and environmental analysis lab. Further information about the Department can be found at www.williams.edu/Geoscience.

Applicants should have a Ph.D. or dissertation completed by the time of appointment, some teaching experience, and a vigorous research program suitable for undergraduate student involvement. Appointment normally is at the beginning assistant professor level, although a more senior appointment is possible under special circumstances. Deadline for applications is 31 October 2008.

Please send a letter of application—which should include a statement of teaching and research philosophy, curriculum vitae, and contact information for three references—to Paul Karabinos, Chair of Geosciences, Williams College, 947 Main Street, Williamstown, MA 01267, USA.

Williams College is a coeducational liberal arts institution located in the Berkshire Hills of western Massachusetts with easy access to the culturally rich cities of Albany, Boston, and New York City. Williams College is committed to building a diverse and inclusive community where members from all backgrounds can live, learn, and thrive.

Williams has built its reputation on outstanding teaching and scholarship and on the academic excellence of its students. Please visit the Williams College Web site, www.williams.edu.

SEDIMENTOLOGIST/STRATIGRAPHER POSITION EASTERN ILLINOIS UNIVERSITY

The Department of Geology/Geography at Eastern Illinois University invites applications for a tenure-track position at the rank of Assistant Professor with primary expertise in sedimentology and stratigraphy to begin August 2009. A Ph.D. at the time of appointment and a commitment to excellence in teaching, research, and service are required. The successful candidate will be expected to teach general-education courses in introductory earth science and major courses in sedimentology and stratigraphy, as well as develop an upper level course in the candidate's specialty such as basin analysis, sequence stratigraphy, or energy resources (e.g., related to petroleum, coal, natural gas, uranium). The successful candidate will be expected to teach laboratory sections, conduct field work and field trips, and assist with the department's field camp. The Department at EIU is student-oriented, encourages mentoring of undergraduate research, and applied regional studies.

Send a letter of application that includes statements on teaching philosophy/experience and research experience/interests, curriculum vitae, three letters of reference, and copies of undergraduate and graduate transcripts, by 15 October 2008; review of applications will begin then and continue until the position is filled. All application credentials, except official transcripts, which must be sent via mail, must be sent by email as Word or PDF attachments to Dr. Kathleen Bower, Search Committee Chair, kmbower@eiu.edu. Official transcripts should be sent to Dr. Kathleen Bower, Department of Geology/Geography, 600 Lincoln Avenue, Charleston, IL 61920, USA. For more information on the position and the department, check our home page www.eiu.edu/~geoscience.

Eastern Illinois University is an equal opportunity, equal access, affirmative action employer committed to achieving a diverse community.

TENURE-TRACK FACULTY POSITIONS IN SEDIMENTARY GEOLOGY AND GEOLOGIC CARBON SEQUESTRATION, PENN STATE

The Department of Geosciences seeks to hire two tenure-track faculty members, one in the area of Sedimentary Systems and the other in Geologic Carbon Sequestration with a preferred starting date of 1 July

THE PETROLEUM INSTITUTE
ABU DHABI, UNITED ARAB EMIRATES

Institution: The Petroleum Institute (PI) was created in 2001 with the goal of establishing itself as a world-class institution in engineering education and research in areas of significance to the oil and gas and the broader energy industries. The PI's sponsors and affiliates include Abu Dhabi National Oil Company and four major international oil companies. The campus has modern instructional laboratories and classroom facilities and is now in the planning phase of three major research centers on its campus. The PI is affiliated with the Colorado School of Mines, the University of Maryland (College Park), and Leoben and Linz Universities. PI is in the process of developing future working relationships with other major universities and research institutions around the world to capitalize on joint research areas of interest. For additional information, please refer to the PI website: **www.pi.ac.ae.**

PETROLEUM GEOSCIENCES ENGINEERING POSITIONS

The Petroleum Institute in Abu Dhabi is seeking applications in Petroleum Geosciences Engineering for the following positions:

Program Director
Faculty at all levels
(Chaired and Distinguished Professor,
Professor, Associate Professor, Assistant Professor)
Research Associate
Research Assistant
Lab Engineer
Post Doc Fellows

Candidates are encouraged to submit applications at the earliest convenience. Review of applications begins upon receipt and positions remain open until successfully filled.

Details are available on PI-web site: **http://www.pi.ac.ae/jobs**

CLASSIFIED ADVERTISING

2009. Outstanding candidates who creatively apply theoretical, observational, and/or experimental approaches in their research are encouraged to apply. Applicants should have a doctoral degree in geosciences or related fields and a record of scholarship and potential for developing a vigorous externally funded research program at Penn State. They are expected to contribute to core teaching in geosciences and interdisciplinary teaching and research.

Geology of Sedimentary Systems. We seek an individual with broad interests in sedimentary geology and the expertise to interpret depositional environments, paleoclimates, sea level changes, and/or coastal evolution from sedimentary facies studies and stratal architecture, and/or to reconstruct sedimentary basin evolution from facies patterns and stratigraphy. Particular consideration will be given to candidates who employ integrative approaches to understanding fundamental sedimentary processes ranging from pore to basin scale, including field-oriented approaches and physical or numerical modeling. Our preference is to make the appointment at the Assistant Professor level; however, outstanding candidates at higher ranks are encouraged to apply.

Geologic Carbon Sequestration. Areas of expertise to be considered include integration of geological, geochemical, and geophysical data to analyze sequestration reservoirs, strategies, and impacts. This includes, but is not limited to, experimental and modeling expertise in formation evaluation, petrophysics, fluid mechanics, and/or kinetics or reactive transport considerations applied to water-rock-hydrocarbon-CO2 mixtures. Also desirable are candidates who investigate formation characteristics utilizing field data and/or imaging using three-dimensional seismic data analysis through time (4D) to unravel subsurface structure and the temporal evolution of reservoir fluids, stress state, and flow properties such as fracture density, porosity and permeability distribution. The Carbon Sequestration position is part of a large initiative to hire 24 new faculty members at the University to advance energy related research and educational activities under the umbrella of the Penn State Institutes of Energy and the Environment (PSIEE). We prefer to fill this position at the Assistant Professor level, however, outstanding candidates at higher ranks are encouraged to apply.

Review of applications will begin 1 November 2008 and will continue until a suitable candidate is found. Applications should include a complete vita, a statement outlining teaching and research interests, and names and addresses of four or more references. Send application materials to: Search Committee Chair, 503 Deike Building, The Pennsylvania State University, University Park, PA 16802, USA.

We encourage applications from individuals of diverse backgrounds. For more information on the Department of Geosciences and PSIEE go to www.geosc.psu.edu and www.psiee.psu.edu.

Penn State is committed to affirmative action, equal opportunity and the diversity of its workforce.

ASSISTANT PROFESSOR
SEDIMENTARY PETROLOGY/
GEOCHEMISTRY OR NEOTECTONICS
BOONE PICKENS SCHOOL OF GEOLOGY
OKLAHOMA STATE UNIVERSITY (OSU)

The Boone Pickens School of Geology at Oklahoma State University (OSU) seeks applications for a tenure-track faculty position in either sedimentary petrology/geochemistry or neotectonics. The appointment will be at the assistant professor level and effective August 2009. The applicant is required to have a Ph.D. degree in geology or related field at the time of appointment. The applicant must show promise of an outstanding research program and be committed to excellence in teaching. The successful candidate will be expected to supervise M.S. and Ph.D. level graduate students and develop courses in his or her specialty. In addition they will participate in teaching introductory geology courses.

Candidates should submit a letter of application, including a discussion of research interests and approach to teaching, along with a curriculum vitae; academic transcripts; and the names, addresses, e-mail addresses, and phone numbers of three references to: Assistant Professor Position Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031, USA; phone: +1-405-744-6358, fax: +1-405-744-7841. Screening of Candidates will begin in January 2009 and continue until the position is filled.

More information on OSU and the Boone Pickens School of Geology can be found on the Web at http://osu.okstate.edu and http://geology.okstate.edu, respectively. Inquiries about this position may be directed to Dr. Jay Gregg, jay.gregg@okstate.edu. Committed to health and safety Oklahoma State University maintains a tobacco free work environment. Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

DEPT. OF EARTH AND ENVIRONMENTAL SCIENCES
TENURE-TRACK POSITION IN BIOGEOSCIENCE
VANDERBILT UNIVERSITY

The Department of Earth and Environmental Sciences at Vanderbilt University invites applications for a tenure-track faculty position in the general area of Biogeoscience. This position, effective the Fall 2009 semester, is at the Assistant Professor level.

We seek an individual who is aimed at the highest standards of scholarship in research and teaching at both the undergraduate and graduate (M.S., Ph.D.) levels, and who will be attracted by opportunities at Vanderbilt for interaction with a diverse, enthusiastic faculty and student body in the Earth and environmental sciences and related fields. We welcome applications from candidates pursuing theoretical, experimental, and/or field-based work. The specific research specialty is open. Examples of fields of interest include, but are not limited to, climate change and paleoclimate; origin and evolution of the biosphere; critical zone processes; biogeochemical cycling; ecological processes (floral and/or faunal); and extinction patterns and processes. We seek an individual with interest in both ancient and modern biological systems.

Applications should include a vita, a statement of research and teaching interests, and names of at least three references (including mail and e-mail addresses and phone numbers). Select applicants will be later asked to provide student evaluations of teaching (if available). Applications should be submitted by e-mail in PDF or MS-Word format to EESposition@vanderbilt.edu; up to three representative papers may be attached. Address questions to Molly F. Miller, Interim Chair, Department of Earth and Environmental Sciences, Vanderbilt University, VU Station B Box 351805, 2301 Vanderbilt Place, Nashville, TN 37235-1805, USA. Review of applications will begin 22 December 2008. Vanderbilt is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

FULL-TIME, ASSISTANT PROFESSOR
OF GEOSCIENCES, CLIMATE SCIENCES
SKIDMORE COLLEGE

Description: The Department of Geosciences invites applications for an opening in Climate Sciences at the level of Assistant Professor to begin Fall 2009. The Department seeks a candidate with strong teaching skills who will build and maintain an active research program with students. For this position we seek a teacher/scholar with background in climatology, oceanography, geochemistry, or geophysics as related to one or more of the following: climate dynamics, geochemical cycles, ocean-atmosphere interaction, climate diagnostics and analysis, and basic processes in atmospheric and ocean dynamics. Course coverage includes Introduction to Oceanography, Climatology, and upper-level courses in the candidate's area of expertise. The position also involves contribution to all-college requirements, e.g., by way of Interdisciplinary Seminar (topic open) for first year students. The College offers start-up funds, pre-tenure sabbaticals, and internal grants, however, the successful candidate is also expected to seek and obtain external research funding. Skidmore College is a liberal arts institution of approximately 2,200 students and 200 full-time faculty, located in upstate New York. Skidmore College also seeks to attract an academically and culturally diverse faculty, welcoming application from women and men of diverse background.

Qualifications: A Ph.D. in the geosciences or a related field is required and preference will be given to those candidates with teaching experience. The review process of this position will begin 1 January 2009.

Apply to: Candidates should send a vitae, evidence of excellence in teaching and scholarship, and three letters for recommendation to: Kyle Nichols, Chair, The Department of Geosciences, Skidmore College, 815 North Broadway, Saratoga Springs, NY 12866, USA.

STRUCTURAL GEOLOGIST, UNIVERSITY OF AKRON

The University of Akron, Department of Geology and Environmental Science (GES), invites applications for a tenure-track Assistant Professor position with a structural geology focus starting 24 August 2009. This is a 9-month, tenure-track position. A Ph.D. in a geoscience related field prior to appointment, along with the ability and willingness to teach a junior level structural geology class and field camp, are required. Applicant is expected to engage in professional service and to develop an externally funded research program that engages Masters-level and undergraduate students.

UA serves about 25,000 students, and is a public institution of the University System of Ohio. Our department houses 10+ faculty members with diverse research specialties that include a focus on terrestrial records of environmental change and geoscience education. We offer bachelor and masters level degrees under a variety of options. See www.uakron.edu/geology for department details. Please submit a letter of application, full C.V., statements of research and teaching interest, and names of three references to Dr. David Steer; Chair, Structural Search Committee; Department of GES; University of Akron; Akron, OH 44325-4101. Review of applications will begin on 15 November and continue until the position is filled. The University of Akron is committed to a policy of equal employment opportunity and to the principles of affirmative action in accordance with state and federal laws.

PETROLOGIST
OHIO UNIVERSITY

The Department of Geological Sciences at Ohio University invites applications for a Tenure-track Assistant Professor to begin in September 2009. We are seeking an individual whose research interests are in igneous petrology, or a closely allied field, and who is qualified to teach courses such as petrology, earth materials, and petrography. The successful applicant will possess a Ph.D. in geology, be committed to excellence in teaching at both the undergraduate and graduate level, develop a strong research program supported by external funding, and augment our planetary and structural/metamorphic expertise. Candidates must have outstanding leadership, management, and interpersonal skills to relate to a wide diversity of faculty, staff, students and community members.

Ohio University is a Research-Extensive institution, enrolling 19,500 students on the Athens campus and more than 8,000 students on five regional campuses. The College of Arts and Sciences includes 340 tenured and tenure-track faculty members and contains 19 departments, 8 of which offer the doctoral degree. Further information about Ohio University may be found at the university's Web site: http://www.ohio.edu.

Applicants must apply online via the Quicklinks site, www.ohiouniversityjobs.com/applicants/Central?quickFind=54688, and attach a vita, description of research interests, statement of teaching philosophy, and the names and addresses of three referees. An electronic copy of the most recent paper may be attached. Search Committee Chair, Department of Geological Sciences, 316 Clippinger Laboratories, Athens, OH 45701-2979, USA. Position will remain open until filled; for full consideration, apply by 1 December 2008. Ohio University is an affirmative action/equal opportunity employer. For further information concerning the department and its faculty, visit www.ohiou.edu/geology.

TENURE TRACK FACULTY POSITIONS IN GLOBAL CHANGE: CRYOSPHERE AND SEA-LEVEL IMPACTS
UNIVERSITY OF MICHIGAN

The University of Michigan's Departments of Geological Sciences (GS) and Atmospheric Oceanic and Space Sciences (AOSS) announce five tenure-track positions in the field of Global Change: Cryosphere and Sea-Level Impacts. Pending final approval, the objective of this cluster hire is to advance cross-disciplinary research in Global Change research as part of the University of Michigan's interdisciplinary junior faculty initiative. Candidates are sought in the fields of (1) Glaciology, (2) Climate and Ice Sheet Modeling, (3) Coastal Processes, (4) Physical Oceanography, and (5) Regional Climate Modeling. Candidates will be appointed at the assistant professor level with a university year appointment in either GS or AOSS, but will be expected to interact with the cluster cohorts in both departments, as well as existing faculty.

1. Glaciology. The preferred candidate will make observations of ice-sheet physics and how ice-sheets respond to climate change. Areas of interest include empirical studies of glacial and sub-glacial hydrology, bed characteristics, ice-sheet dynamics and mass balance. We expect the successful candidate will employ observational techniques such as, but not limited to, remote sensing, high-precision gravity measurements, and/or innovative field techniques.

2. Climate and Ice Sheet Modeling. The preferred candidate will develop and conduct numerical modeling of ice-sheets and advance their coupling with global and regional climate models. Emphasis will be placed on

predicting recent, present, and future changes in polar ice volume and its implications for sea-level rise and freshwater discharges into the ocean.

3. Coastal Processes. The preferred candidate will conduct model and/or field-based investigations of the impacts of sea-level rise on coastal regions. Areas of expertise could include: (1) the effects of sea-level inundation and storm surges on coastal circulation and urban areas, ecosystems, and freshwater availability; (2) integration of regional climate and ocean circulation to understand coastal processes and/or (3) studies of the variability and magnitude of past storm surges.

4. Physical Oceanography. The preferred candidate will use field, observational and/or theoretical techniques to study physical oceanographic processes near the ice-ocean interface. Areas of interest include, but are not limited to, ocean circulation and convection, calving/ablation processes, dynamics of ice-sheet buttressing by marine ice shelves, and/or processes controlling sea ice.

5. Regional Climate Modeling. The preferred candidate will employ and develop techniques for using regional climate models to study atmosphere-ocean, atmosphere-land, or ocean-land interfaces at finer resolution than is possible in global models. Preference will be given to candidates who have demonstrated innovative methods for downscaling climate predictions to understand processes of discernable human relevance in coastal areas.

Successful candidates are expected to establish independent research programs and contribute to undergraduate and graduate teaching. A complete application will include a cover letter, curriculum vitae, statement of present and future research plans, statement of teaching experience and interests, and names of at least five persons who can provide letters of recommendation. The applicant should identify in the cover letter the position being applied for. Additional information about the departments can be found at www.lsa.umich.edu/geo and http://aoss.engin.umich.edu. Applications should be sent to Global Change Search Committee (Re: Position 1, 2, 3, 4, or 5), Department of Geological Sciences, University of Michigan, 1100 N. University Avenue, Ann Arbor, MI 48109-1005

For full consideration applications should be received before 1 November 2008. Questions concerning these positions should be directed to glbch-search@umich.edu. The University of Michigan is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply. The University is supportive of the needs of dual career couples.

GEOLOGICAL ENGINEERING PROGRAM
COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN–MADISON

The Geological Engineering Program of the University of Wisconsin–Madison invites applications for a senior faculty member with a strong research program and distinguished record for creative research and scholarship. Must have leadership and development skills needed to direct the Geological Engineering Program. An outstanding reputation in the field of specialty is a primary requirement. Applicants in any field of specialty within geological engineering will be considered.

Information on the Geological Engineering Program and the position available can be found at www.engr.wisc.edu/gle/. Apply by 15 November 2008 to ensure consideration. UW-Madison is an equal opportunity/affirmative action employer. We promote excellence through diversity and encourage all qualified individuals to apply. Please submit application letter, CV, and list of at least three references to GLESearch@engr.wisc.edu.

EARTH AND ENVIRONMENTAL SCIENCE
UNIVERSITY OF PENNSYLVANIA

The Department of Earth and Environmental Science at the University of Pennsylvania invites applications for an assistant professorship in earth and environmental science. The position is expected to be filled at the assistant professor level but exceptional senior candidates will be considered. The research and teaching interests of the successful candidate will broaden and complement the Department's current activities in the areas of earth history and surficial processes. Further information about the Department may be sought at www.sas.upenn.edu/earth/.

The successful candidate will maintain an active research program while teaching graduate and undergraduate courses in earth and environmental science. Applicants should submit their curriculum vitae, a statement of research and teaching interests, and a selection of up to 4 representative reprints online at https.facultysearches.provost.upenn.edu/applicants/Central?quickFind=50624.

Applicants for the level of assistant professor should also include the names and contact information of three external referees.

The Search Committee will begin to evaluate applications on 1 November 2008, and the position can begin 1 July 2010. The search will remain open until the position is filled. The University of Pennsylvania is an affirmative action/equal opportunity employer and is strongly committed to diversity. Women and minorities are encouraged to apply.

INORGANIC MATERIALS OR MINERAL PHYSICS
ADVANCED MATERIALS SCIENCE AND ENGINEERING CENTER (AMSEC)
WESTERN WASHINGTON UNIVERSITY

The Advanced Materials Science and Engineering Center (AMSEC) of Western Washington University invites applications for a tenure-track faculty position at the assistant professor level in the broadly-defined field of inorganic chemistry/physical properties of natural and synthetic materials. Subdisciplines may include mineral physics, inorganic and crystal chemistry, materials and mineral magnetism, and related areas. Applications from individuals with research interests of an applied nature or with potential for collaborations with industry are welcomed. A Ph.D. degree in a materials related field is required. See Web site, https://jobs.wwu.edu/JobPostingsBrowse.aspx?CatID=85, for full application requirements. This interdisciplinary position will include appointments in two departments, to be determined based upon the candidate's specialty discipline. AMSEC is a new $1.2 million research and education center, with faculty from Chemistry, Physics, Engineering Technology, and Geology. The successful candidate is expected to establish a vigorous, externally-funded research program involving undergraduate and graduate students and to teach courses related to their field of expertise. Applicants should submit a cover letter; full CV; statement of research plans; statement of teaching philosophy; and arrange to have 3 professional references sent to Tina Copsey, MS 9079, Western

Sedimentary Geology Faculty Positions

Texas A&M University – Department of Geology and Geophysics

The Department of Geology and Geophysics at Texas A&M University invites applications for two tenure-track faculty positions in sedimentary geology, broadly defined. Areas of interest include but are not limited to fundamental and applied problems in sedimentary processes ranging from pore to basin scale, depositional environments, sequence stratigraphy, basin architecture, sea level change and coastal evolution, and energy and natural resource science. At least one position will be offered to an individual working at the basin scale. We will consider applicants at all academic ranks. Successful applicants will be expected to develop and maintain vigorous, externally funded research programs and contribute to undergraduate and graduate teaching. We are a collaborative broad-based department within the College of Geosciences, which includes the Departments of Oceanography, Atmospheric Science, Geography, and the Integrated Ocean Drilling Program. Opportunities for collaboration also exist within the Department of Petroleum Engineering.

Interested candidates should submit electronic versions of a curriculum vita, statement of research interests and teaching philosophy, the names and email addresses of at least three references, and up to four reprints by email attachments, to the Chair of the Sedimentary Geology Search Committee, sedsearch@geo.tamu.edu. Screening of applications will begin October 31, 2008s and will continue until positions are filled. A Ph.D. is required at the time of employment.

The Department of Geology and Geophysics (geoweb.tamu.edu) is part of the College of Geosciences, which also includes the Departments of Geography, Oceanography, and Atmospheric Sciences, Sea Grant, the Geochemical and Environmental Research Group (GERG), and the Integrated Ocean Drilling Program (IODP). Texas A&M University, a land-, sea-, and space-grant university, is located in a metropolitan area with a dynamic and international community of 152,000 people. Texas A&M University is an affirmative action/equal opportunity employer committed to excellence through the recruitment and retention of a diverse faculty and student body and compliance with the Americans with Disabilities Act. We encourage applications from minorities, women, veterans, and persons with disabilities. Texas A&M University also has a policy of being responsive to the needs of dual-career partners (hr.tamu.edu/employment/ dual-career.html).

Washington University, 516 High St., Bellingham, WA 98225-9079, USA. Review of applications will begin on 15 October 2008 and the position is open until filled. WWU is an equal opportunity employer.

ASSISTANT PROFESSOR—ALL RESEARCH AREAS
INDIANA UNIVERSITY–PURDUE UNIVERSITY
FORT WAYNE (IPFW)

The Department of Geosciences at Indiana University–Purdue University Fort Wayne (IPFW) invites applications from all research disciplines for a tenure-track position at the assistant professor level. The successful applicant will demonstrate strong teaching skills, and be able to lead undergraduate courses in introductory geology, the solar system, GIS, structural geology, and geomorphology. Teaching loads are typically 9–11 contact hours each week.

Geoscience faculty maintain active research programs. The department is well-supported in both equipment (e.g. thin section lab, SEM/EDX, wet chemistry, XRD, Total Station, etc.) and funding opportunities for new faculty. Fully staffed the department consists of six faculty, a technician and a secretary. IPFW is located in the state's second largest city and is a division 1 school enrolling over 12,000 students in a broad spectrum of disciplines. The area supports a diversity of arts, professional sports, fairs and other activities. Housing is very affordable.

Send curriculum vitae, undergraduate and graduate transcripts (unofficial OK), names and contact information for three references, and a letter that highlights strengths and interests to: Anne Argast, Search Committee Chair, Department of Geosciences, Indiana University-Purdue University Fort Wayne, 2101 East Coliseum Blvd., Fort Wayne IN 46805, USA. E-mail questions to Argast@IPFW.edu. Ph.D. required, thought ABDs near completion are encouraged to apply. Review of applications will begin 3 November 2008. IPFW is an equal opportunity, equal access, affirmative action employer.

ASSISTANT PROFESSOR IN HYDROGEOLOGY
DEPARTMENT OF GEOLOGY
UNIVERSITY AT BUFFALO, SUNY

We invite applications for a tenure-track assistant professor position in hydrogeology. We seek a scientist with demonstrated physical hydrogeology expertise who will compliment our existing strength in this and related disciplines. Of particular interest are researchers who have field experience in characterizing watershed or regional scale systems, groundwater-surface water interactions and/or contaminant transport or remediation in geological systems.

We expect faculty to develop and maintain an innovative, extramurally funded research program. The successful applicant must have a Ph.D. degree at the time of appointment, demonstrated research publication potential, and a commitment to effective teaching. Teaching duties will include undergraduate and graduate level courses in the candidate's specialty. More information about our department can be found at www.geology.buffalo.edu.

Applications must be submitted through the UB Jobs Web site at www.ubjobs.buffalo.edu/applicants/Central?quickFind=52161 by 1 Nov. 2008, when we will begin our review of candidates. The University at Buffalo is an Equal Opportunity Employer/Recruiter.

TENURE-TRACK POSITION, HYDROCLIMATOLOGY
MICHIGAN STATE UNIVERSITY

The Department of Geography at Michigan State University is seeking applications for a tenure-track position in hydroclimatology. The appointment will be at the rank of Assistant Professor, beginning August 2009. A Ph.D. degree in geography or closely related discipline such as atmospheric science, environmental science, geology, and hydrology is required at the time of appointment. Research interests should include land-atmosphere interactions related to the hydrologic cycle. Expertise in environmental and related modeling is preferred. International experience or a demonstrated interest in international regions is an advantage. The successful candidate will be expected to participate in interdisciplinary research and contribute to MSU's strengths in climatology and climate change research, geomorphology, groundwater hydrology, Great Lakes studies, biogeography, paleoenvironments, and environmental decision-making. Duties include developing an externally funded research program, teaching undergraduate and graduate student courses, and mentoring graduate students. Applicants should send a letter stating research interests, a current CV, and names of three referees. Michigan State University is an equal opportunity institution and strongly encourages applications from women and minorities. Apply to: Professor Julie Winkler, Search Committee Chair, 116 Geography Building, Michigan State University, East Lansing, MI 48824-1117, winkler@msu.edu, +1-517-353-9186. Review of applications will begin 1 December 2008 and continue until the position is filled. Geography 38-326.

TENURE TRACK POSITION
EARTH SYSTEM SCIENTIST,
SEDIMENTARY PROCESSES, BOSTON COLLEGE

The Department of Geology and Geophysics at Boston College seeks to hire an Assistant Professor in the broad area of Earth System Science with a focus in Sedimentary Processes to start in Fall 2009. Areas of expertise might include (but are not limited to): basin analysis, reflection seismology, sediment transport, global environmental change, and biogeochemical processes in sedimentary systems. The successful candidate will be expected to develop a vigorous externally funded research program integrated with excellence in teaching within the geology-geophysics-environmental geoscience curriculum at both the undergraduate and graduate levels, including teaching a course in Sedimentology and Stratigraphy for majors. Information on the department, faculty, and research strengths can be viewed at www.bc.edu/geosciences. Applicants should send a curriculum vita, statements of teaching and research interests, and the names and contact information of at least three references as a single PDF-file e-mail attachment to sed_position@bc.edu. Review of applications will begin on 14 November 2008. Department faculty will be available at the GSA and AGU fall meetings to meet with applicants. Boston College is an academic community whose doors are open to all students and employees without regard to race, religion, age, sex, marital or parental status, national origin, veteran status, or handicap.

GEOLOGY, BRYN MAWR COLLEGE

The Department of Geology at Bryn Mawr College invites applications for a full-time, tenure-track Assistant Professor position to begin 1 July 2009 in the general area of paleontology. Ph.D. expected at the time of appointment. Applicants are expected to demonstrate strong potential for excellent teaching and creative research, as well as an interest in offering courses in paleontology, historical geology and evolution. The candidate's research interest ideally will complement other faculty members in our department. We would welcome expertise in one or more of the following areas: paleoceanography, paleoecology, paleogeography, geomicrobiology, stable isotope geochemistry, Earth system science or geoarchaeology.

Located in suburban Philadelphia, Bryn Mawr College is a highly selective liberal arts college for women who share an intense intellectual commitment, a self-directed and purposeful vision of their lives, and a desire to make meaningful contributions to the world. Bryn Mawr comprises an undergraduate college with 1,200 students, as well as coeducational graduate schools in some humanities, sciences, and social work. The College participates in a consortium together with Haverford and Swarthmore Colleges and the University of Pennsylvania. Bryn Mawr College is an Equal Opportunity, Affirmative Action Employer. Minority candidates and women are especially encouraged to apply.

Applicants should submit a cover letter, CV, a statement of teaching and research goals, and the names and contact information of three references to: Geology Paleo Search Committee, Department of Geology, Bryn Mawr College, 101 N. Merion Avenue, Bryn Mawr, PA 19010-2899, USA.

Deadline for application: 15 November 2008.

TENURE TRACK ASSISTANT PROFESSOR
EARLHAM COLLEGE

The Department of Geosciences at Earlham College invites applications for a tenure track position beginning

in Fall 2009. Candidate area of specialization is open; however, successful applicants will likely:
—be broadly trained in earth science;
—compliment our existing strengths in process sedimentology and tectonics;
—provide undergraduate students with research opportunities in their subfield;
—demonstrate interest in teaching a wide variety of undergraduate geology classes.

Course responsibilities include participation in introductory geoscience and environmental science courses, as well as upper-level courses in his or her specialty. We expect that the candidate will participate in the Environmental Science program, supervise undergraduate student research projects, and participate in the senior capstone seminar. A Ph.D. is required and previous teaching experience at the undergraduate level is preferred. Women, underrepresented minorities, and Quakers are especially encouraged to apply. Interested candidates should send curriculum vitae, materials demonstrating teaching effectiveness, and a statement detailing how your research interests will enhance the education of undergraduate students, along with the full contact information of at least three references to: Dr. Andrew Moore, Department of Geosciences, Earlham College, 801 National Rd. West, Richmond, IN 47374, USA, +1-765-983-1672, moorean@earlham.edu. Applications may be submitted electronically to moorean@earlham.edu. To ensure full consideration, please submit applications by 1 November. For expanded information, please visit Earlham's jobs page at http://www.earlham.edu/jobs.

MINERALOGY/PETROLOGY, DENISON UNIVERSITY

The Department of Geosciences at Denison University invites applications from candidates with a background in mineralogy, petrology and high-temperature geochemistry for a tenure-track position (assistant professor) to begin in Fall 2009. We seek a broadly trained scientist to teach physical geology, earth materials, igneous/metamorphic petrology and other courses that complement our program. The ideal candidate should be committed to teaching excellence in a liberal arts setting, have a strong field background, have broad interests beyond their specialty, and be able to provide a balance of classroom, field and laboratory experiences for our students. A Ph.D. at the time of appointment is required. Denison is a highly selective liberal arts college strongly committed to, and supportive of, excellence in teaching and active faculty research that involves undergraduate students.

All application materials will be handled electronically at https://employment.denison.edu.

Please include a letter of application; statements of your approaches to teaching and research in a liberal arts setting; a vita; academic transcripts; and contact information for three references. Please contact Dr. Tod Frolking, Department of Geosciences, Denison University, Granville, OH 43023, USA; +1-740-587-6217; frolking@denison.edu, for more information about the position. Application materials should be posted by 15 October 2008 for full consideration. We encourage early applications. We would like to meet with candidates attending GSA, 6–8 October, and invite finalists to campus in early November. Denison University is an Affirmative Action, Equal Opportunity Employer. In a continuing effort to diversify our Campus Community, we strongly encourage women and people of color to apply.

TENURE-TRACK POSITION
EXPLORATION GEOPHYSICS
BOONE PICKENS SCHOOL OF GEOLOGY
OKLAHOMA STATE UNIVERSITY

The Boone Pickens School of Geology at Oklahoma State University (OSU) invites applications and nominations for a geophysicist with strong research background to fill a tenured or tenure-track position in exploration geophysics at any rank (assistant, associate, or full professor). In addition, distinguished applicants with demonstrated international reputations, meeting the requirements for full professor will be considered for the Boone Pickens Chair of Exploration Geophysicist. Applicants are required to have a Ph.D. degree in geophysics or related field at the time of appointment.

The applicants should have a broad background in the geophysical sciences. Specific research areas may include, but are not restricted to seismology, seismic data processing and quantitative seismic analysis for reservoir characterization, reflection seismology, electromagnetic techniques, and ground penetrating radar. Applicants must have a strong research and publication record and a demonstrated ability to attract external funding. Salary and benefits will be competitive and commensurate with experience and future potential.

The successful candidate will be expected to pursue a vigorous research program and help strengthen our petroleum geosciences program. The candidate will supervise M.S. and Ph.D. students and develop courses in his or her specialty and participate in preparing students for employment in the energy and environmental industries.

The successful candidate will join a faculty of twelve geoscientists, including two other geophysicists, and will be part of a sedimentary geology and tectonics research group that include six other faculty and has close ties to the petroleum industry. The School of Geology has a well equipped geophysical laboratory with a Geometrics 48 channel seismograph, an Iris Syscalpro 10 channel resistivity system, an AGI Supersting resistivity system, a Scintrex C-G5 gravimeter, a Geometrix control source audio magnetelluric system (Stratagem), a Pulse Ekko GPR system, a Geonics EM-34 system, a Geometrics 858 Cs vapor magnetometer, and state of the art software for processing both potential field and seismic data. In addition the School has recently constructed the Devon Teaching and Research Laboratory, which contains state-of-the-art 3-D image processing facilities.

Applicants are encouraged to submit a complete vita/resume, statement of research and teaching interests, and a list of five references, including names, phone numbers, e-mail addresses, and complete mailing addresses to: Geophysics Search, Boone Pickens

MILLERSVILLE UNIVERSITY

Department of Earth Sciences
Geology/Environmental Geology

Full-time, tenure-track Assistant Professor position available, ideally starting January 2009 but no later than August 2009. Teach upper-level and introductory undergraduate courses in the Geology and Environmental Geology Programs. Scholarly growth, including mentoring of undergraduate research. Participate in academic service.

Required: Ph.D. in geological sciences completed by the time of appointment. Evidence of: ability and desire to teach courses in the Geology and Environmental Geology Programs ranging from large-enrollment introductory courses for non-majors to upper-level courses for majors that incorporate field and laboratory components; expertise in a combination of hydrogeology and geophysics; eagerness to serve as research mentor to undergraduates; and effective oral and written communication skills. Completion of a successful interview that includes research presentation, which also serves as teaching demonstration.

Preferred: Willingness to operate Millersville's broadband seismometer. Experience applying geophysical techniques to solve environmental problems. Proficiency using groundwater modeling software. Evidence of commitment to working in a diverse environment.

The Department of Earth Sciences is one of seven departments in the School of Science and Mathematics and is recognized as a flagship of Millersville University. There are nine faculty members (3 Geologists, 4 Meteorologists, 2 Oceanographers), and three support staff. We offer B.S. degree programs in Geology, Meteorology, Ocean Sciences and Coastal Studies, and Earth Sciences Education. In addition to the traditional GEOL B.S. degree, we offer a B.A. in Earth Sciences with an option in Environmental Geology. The GEOL program has dedicated laboratory facilities and equipment including a digital networked broadband seismic station, engineering seismograph, 12 gauge and stamper seismic source, proton precision magnetometer, resistivity meter, and surveying total station. In addition, the department has a server cluster for geological modeling, high bandwidth connectivity on Internet 2, Access Grid capabilities, streaming video, and maintains licenses for IDL, Fortran, MatLab, and ArcGIS. With geology, meteorology and ocean sciences housed in same department, rich opportunities exist for cross-disciplinary faculty-student research. Millersville University is a member of the Marine Science Consortium located at Wallops Island, VA where it maintains a 46' research vessel, laboratories, dining, and housing facilities. Millersville University is a founding member of the University Corporation for Atmospheric Research Academic Affiliates Program and participating institution of the American Geological Institute. For more information about the University and Department, see **www.millersville.edu** and **www.millersville.edu/esci**

Full consideration given to applications received by **October 31, 2008**. Send letter of application addressing qualifications, curriculum vitae/resume, statement of teaching philosophy and research interests, copies of all transcripts, and three current letters of recommendation addressing qualifications to: **GEOL Search, Department of Earth Sciences/GSA1008, Millersville University, P.O. 1002, Millersville, PA 17551-0302**

An EO/AA Institution

CLASSIFIED ADVERTISING

School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031. Phone: (405) 744-6358. Fax: (405) 744-7841. Screening of candidates will begin in November 2008 and will continue until the position is filled. The starting date for this position will be Fall Semester 2009 or as negotiated.

Inquires about this position may be directed to Dr. Estella Atekwana, estella.atekwana@okstate.edu, or Dr. Jay Gregg, jay.gregg@okstate.edu, at the above address. More information on OSU and the Boone Pickens School of Geology can be found on the Web http://osu.okstate.edu/ and http://geology.okstate.edu/, respectively.

Committed to health and safety Oklahoma State University maintains a tobacco-free work environment.

Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

Fellowship Opportunities

POSTDOCTORAL FELLOWSHIPS
AMERICAN MUSEUM OF NATURAL HISTORY

The Department of Earth and Planetary Sciences of the American Museum of Natural History invites applications for Research Fellowships in residence for postdoctoral investigators and established scientists to carry out projects in collaboration with department staff. Appointments are for six months to two years. Areas of interest include high-temperature and high-pressure geochemistry, meteoritics and planetary science, mineralogy, mineral deposits, petrology, and volcanology.

The application deadline for the 2008–2009 academic year is 15 November 2008. Applicants should discuss potential research projects with a curator before submitting applications. For further information see http://research.amnh.org/grants/resprog.html and contact Dr. James Webster, +1-212-769-5401, jdw@amnh.org.

AMNH is an equal opportunity employer.

U.S. GEOLOGICAL SURVEY MENDENHALL POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM

The U.S. Geological Survey (USGS) invites applications for the Mendenhall Postdoctoral Research Fellowship Program for Fiscal Year 2010. The Mendenhall Program provides opportunities to conduct research in association with selected members of the USGS professional staff. Through this Program the USGS will acquire current expertise in science to assist in implementation of the science strategy of its programs. Fiscal Year 2010 begins in October 2009.

Opportunities for research are available in a wide range of topics. The postdoctoral fellowships are 2-year appointments. The closing date for applications is 12 November 2008. Appointments will start October 2009 or later, depending on availability of funds. A description of the program, research opportunities, and the application process are available at http://geology.usgs.gov/postdoc. The U.S. Geological Survey is an equal opportunity employer.

Opportunities for Students

Predoctoral Fellowships. American Museum of Natural History (AMNH)–Lamont Doherty Earth Observatory (LDEO) (Columbia University). The Department of Earth & Planetary Sciences of the American Museum of Natural History invites applications for predoctoral fellowships from students interested in the Ph.D. program in the fields of high-temperature and high-pressure geochemistry, meteoritics and planetary science, mineralogy, mineral deposits, petrology, and volcanology. Non-U.S. citizens are eligible. Students must apply simultaneously to Columbia University; research is under the direction of a museum curator, and work is carried out at AMNH and/or LDEO. Fellows receive a full 12-month stipend and fully paid tuition; support is guaranteed for 4 years if the student remains in good standing.

Applicants should contact Dr. James Webster, +1-212-769-5401, jdw@amnh.org, to discuss their interests and background before applying.

Applications to AMNH are due 30 November 2008. Please include a resume of academic background, work experience, research interests, and the names of three scientists familiar with your work. Application and information are available at http://research.amnh.org/grants/gradprog.html, http://research.amnh.org/earthplan, www.ldeo.columbia.edu/, and www.columbia.edu/cu/gsas/.

Houston Energy Fellow and Flagship Graduate Research Assistantship in Isotope Biogeochemistry and Geomicrobiology. A four-year Ph.D. assistantship is available in the Department of Geology and Geophysics, Louisiana State University. The research project will utilize multiple stable isotopes to study denitrifying and sulfate-reducing microorganisms to understand modern and ancient metabolic processes. The applicant should have a strong academic background in geology, aqueous geochemistry, and/or microbiology. Excellent oral/written communication skills and teamwork spirit are essential. The assistantship includes a stipend of $25,000, summer support, and $3000 for additional research expenses. Funding is in place to begin work as early as January 2009. Please contact Dr. Annette Engel, aengel@lsu.edu, or Dr. Huiming Bao, bao@lsu.edu, for more information. Visit http://geol.lsu.edu/aengel/Flagship%20Assistantship.htm and www.geol.lsu.edu/ for details about our department.

Travel Tours

2009 Arctic Sea Expedition is seeking accredited scientific voyagers to provide abstracts in the following areas:

- Arctic plate tectonic status
- Arctic global warming status
- Aurora Borealis and geomagnetic status
- Planetary core geology and polar status
- Deep ocean chemistry
- Atmospheric anomalies
- Arctic sea floor topography
- Sub-ice photography
- Infrared ocean floor spectroscopy

This is a single voyage to an uncharted Arctic sea region recently opened by Arctic melting. Filmed documentary may include some or all participants in the finished production. Accommodations and fees included in $25k per person. Sponsorships and grants are welcome. Contributors must submit abstracts no later than 15 October 2008. There are 84 positions available aboard a 23 kiloton icebreaker for 15 days. The expedition will not take place unless all positions are filled. Qualifying abstracts will be contacted for full proposals. Make all inquiries to Arctic Expedition, PO Box 266, Odessa, WA 99159, USA.

TEMPLE UNIVERSITY®

TWO TENURE-TRACK POSITIONS

Department of Earth and Environmental Science

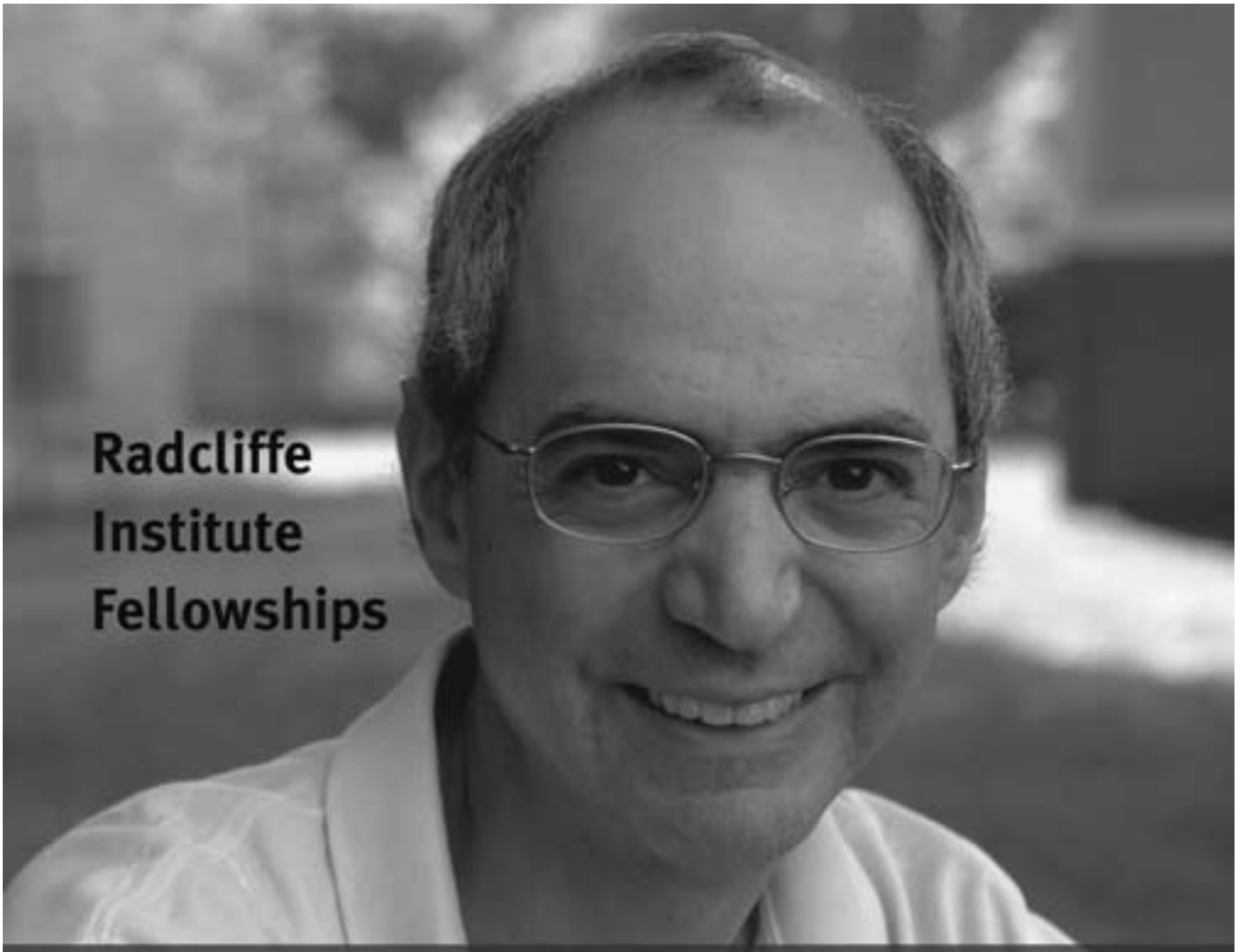
The Department of Earth and Environmental Science is entering a period of growth with plans to implement a Ph.D. program. This year the department seeks to fill two tenure-track faculty positions to begin in August 2009 with research interests in Stable Isotope Geochemistry of Ecosystems/Marine Environments OR Geohazards.

The geochemist will be expected to establish a stable isotope laboratory that can be used for multidisciplinary research and be involved in graduate (Master's and Ph.D.) and undergraduate education. We welcome applicants with interests in the use of stable isotopes to address issues related to climate change, nutrient cycling and ecological tracers, and atmospheric/groundwater contaminants. The geohazards applicant is expected to conduct research that addresses problems such as slope stability/landslides, coastal erosion and processes, or seismic/volcanic hazards. Applications with interests in geohazards in the developing world are especially encouraged.

Exceptional candidates at any level (assistant, associate or full professor) are encouraged to apply. Application materials should be sent to **Chair, Search Committee, Department of Earth and Environmental Science, Room 326 Beury Hall, Temple University, Philadelphia, PA 19122 or geology@temple.edu.** Interviewing of candidates will begin on October 1, 2008 and continue until the positions are filled.

We will conduct preliminary interviews at the Annual Geological Society of America meeting in Houston this October. More information on our department is available at **http://www.temple.edu/geology/.**

Temple University is an equal opportunity, equal access, affirmative action employer committed to achieving a diverse community (AA, EOE, M/F/D/V). The department specifically invites and encourages applications from women and minorities.



Radcliffe Institute Fellowships

The Radcliffe Institute for Advanced Study at Harvard University annually awards academic-year fellowships that enable scientists to pursue promising, innovative research while participating in the Institute's diverse scholarly community.

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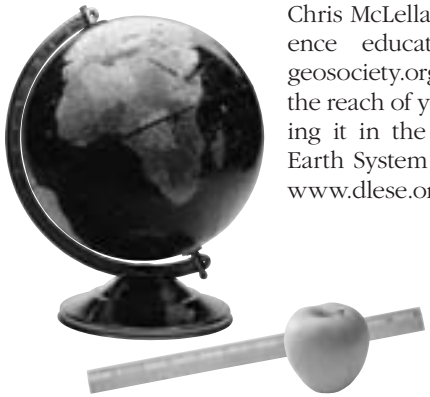

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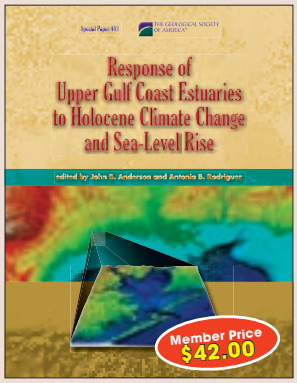

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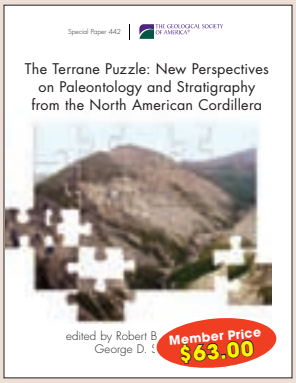

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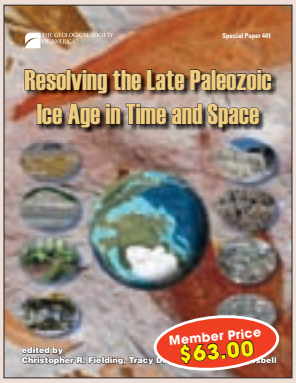

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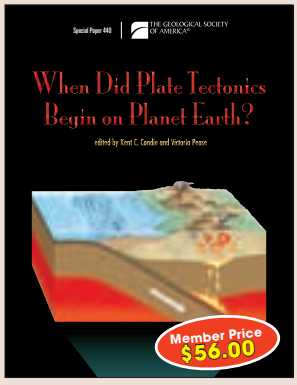

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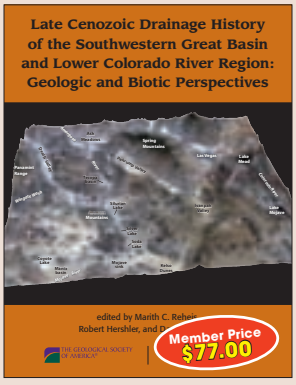

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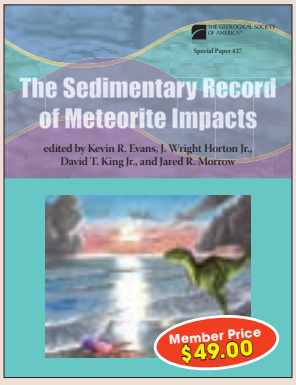

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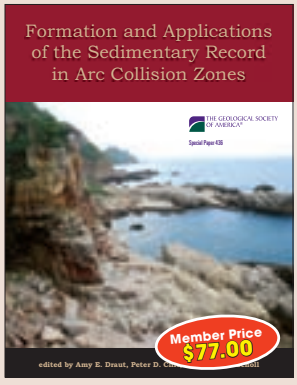

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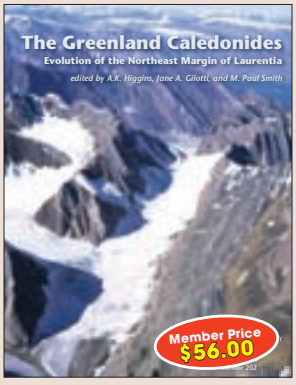

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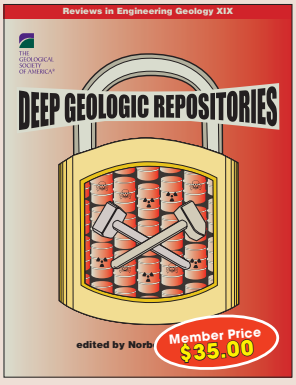

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Accreditation: Wrong Path for the Geosciences

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INTRODUCTION: THE "GRAND CHALLENGES"

Earth scientists are in a unique position to contribute to pressing issues of great societal relevance, from managing water supplies to extending the supply of fossil fuels and other energy sources, mitigating the effects of natural hazards, evaluating environmental health, and predicting and mitigating the consequences of global warming. Geoscience departments have a unique responsibility to address these issues effectively as they educate students, build research programs, and provide outreach and service to society. It is in this light that we examine the potential impact of accreditation of geoscience bachelor degree programs (B.A. and B.S.) now under development by a coalition of professional societies as presented in the September *GSA Today* (GSA Ad Hoc Committee on Accreditation [GSA ad hoc comm.], 2008).

The potential effects of accreditation on departments and their students would differ depending upon the nature of the accreditation system. Herein, we consider the effects of a moderately formal system comparable to that used by the American Chemical Society: a rigid curriculum, detailed accounting, and review by an external disciplinary board (similar to Model 3 in the GSA survey; GSA ad hoc comm., 2008). Our perspectives on the effects of accreditation come from a variety of institutions: Six of the authors are geoscience faculty and two are university administrators (a dean and a provost) with broad views of other science and engineering fields with accredited degree programs.

We are deeply concerned that national accreditation would have a negative impact on geoscience departments and their missions to educate both future geoscientists and science-literate citizens. These missions can be more effectively accomplished through promoting strong, flexible geoscience departments and professional licensing than by constraining undergraduate geoscience education.

WOULD A STANDARDIZED CURRICULUM BE THE BEST SOLUTION FOR UNDERGRADUATE EDUCATION?

One of the most important roles of geoscience departments is to train future geoscientists, and the push to accredit geoscience degrees is, of course, aimed at this role. But is a rigid undergraduate curriculum really the best way to train future geoscientists? Undergraduate geoscience curricula around the country have evolved organically and are characterized both by notable variety (Drummond and Markin, 2008) and long-term success in producing career geoscientists. Most departments have given a great deal of thought to the sequence of core courses and have made decisions that provide students with the best education possible, especially given the local resources available.

What would we lose if we were to standardize the undergraduate core curriculum? For one, we would lose flexibility and innovation. Accreditation restricts departments to matching their curricula to externally imposed standards. Departments would be less likely to innovate for fear of losing accreditation. This has been a significant issue in other disciplines with accredited undergraduate programs, such as chemistry and engineering. At the course level, instructors would feel pressure to "teach to the test," possibly discouraging them from adapting their courses to reflect evolving best practices in higher education.

The National Science Foundation and the National Research Council have continually emphasized the importance at the undergraduate level of developing higher order thinking skills, providing hands-on learning experiences, and applying knowledge to solving problems, rather than simply transmitting content. Accreditation is likely to focus on specific course content at the expense of providing students with opportunities to use their knowledge to solve problems and think critically.

Industry and agencies want employees who can solve problems. Future geoscience graduates must be able to adapt to an ever-broadening range of careers in water, energy, climate policy, resources, land use, and education. A rigidly defined national curriculum would not provide the flexibility necessary to adequately prepare students for these diverse fields. Even careers that are more suited to traditional training (e.g., the extractive industries) are likely to hire increasingly versatile geoscientists as the nature of these industries change.

Geoscience departments also have an opportunity to educate future citizens and professionals in other fields. Not all geoscience majors become career geologists; in fact, most students do not identify a specific career before graduation. Society could benefit enormously if more business people, politicians, and lawyers were trained in geoscience at the undergraduate level. For many of these professions, the choice of undergraduate major is flexible; geoscience departments have a golden opportunity to recruit bright students interested in the Earth. This is unlikely to happen, however, if accreditation requires adoption of a rigid undergraduate curriculum, thereby eliminating the flexibility that is most likely to draw those students.

WOULD ACCREDITATION BE DESIRABLE FOR GEOSCIENCE DEPARTMENTS?

Many departments are struggling with small numbers of majors, and an alarming number of institutions have closed their geoscience departments. The next decade is likely to be one of fiscal hardship in

GSA Today, v. 18, no. 10, doi: 10.1130/GSATG25GW.1

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public higher education (National Governors Association and National Association of State Budget Officers, 2008). Geoscience departments have fewer majors than currently accredited fields, and administrators faced with the accreditation costs, especially in providing additional faculty to cover required courses, might target geoscience departments of marginal size or strength for closure.

To thrive, geoscience departments need to attract more majors, develop interdisciplinary programs that better prepare students to tackle societal problems related to the earth sciences, and make themselves more broadly relevant. We are deeply concerned that an accreditation program, with its prescribed curriculum, would not result in a windfall of majors but would actually make it far more difficult for geoscience departments to succeed and grow.

Accreditation is likely to decrease the number of geoscience majors. Geoscience remains a major of discovery, and our ability to accommodate a range of interests has helped the discipline rebound from the sharp enrollment decline that followed the last oil price bust. Many majors choose geology because of their interest in the Earth but make careers in other fields. A rigid, pre-professional curriculum would not serve these students well and would likely redirect them to earth-science–related programs not as prescriptive in curricular design, such as geography and environmental science.

Much of cutting-edge geoscience lies at the interface among disciplines. A rigid accreditation curriculum focusing on traditional geology would hamper interdisciplinary education. By restricting curriculum flexibility, accreditation would also be at odds with attempts to increase enrollment in geoscience departments by focusing on important new areas of study. New degree programs that couple geoscience with other sciences and with public policy, business, and law require flexibility. Many departments, however, are not in a position to develop new degrees and must instead broaden existing bachelor's degree programs; accreditation would hinder such progress.

Geoscience departments have lost clout on campus in part because they have not demonstrated relevance to the larger scientific and societal issues of our time, but our "Grand Challenges" are unrivaled and provide the geosciences with potential for great visibility on campus, among the general public, and with our elected representatives. Adopting a rigid accreditation curriculum focused on traditional geologist preparation will not help departments demonstrate that geoscience is the discipline most relevant to the societal and environmental issues that we face today.

The work involved in achieving and maintaining accreditation is also a major concern. Time spent on instituting procedures, maintaining records, conducting evaluations, and organizing reviews would draw on time used to innovate and improve course quality.

WOULD ACCREDITATION ACCOMPLISH ITS AIMS?

Increased recognition and support for the geosciences is one of the most commonly cited rationales for pursuing accreditation. Yet, accrediting undergraduate curricula isn't likely to accomplish this aim even if all departments choose to develop accredited degrees. It is likely that many geoscience departments would simply opt out of a national accreditation system. Small departments already have some of the strongest educational programs and produce many students who go on to be highly successful in graduate programs. Many small departments are not large enough to cover all of the disciplines likely to be required by accreditation, and informal feedback suggests that many Research-1 departments would also undoubtedly forego accreditation—they have little to lose from non-participation because their graduates hold respected degrees from highly regarded universities. Accreditation might appeal to public institutions at regional and/or urban campuses where professional programs typically dominate, but costs required to comply with external accreditation standards could place such departments in jeopardy of program cuts or closure.

ALTERNATIVES, CONCLUSIONS, AND NEXT STEPS

Two directions offer promising alternatives to accreditation. The first is a growing movement to identify the ideas and concepts that characterize geoscience literacy and to publish this synthesis (Earth Science Literacy Initiative, www.earthscienceliteracy.org). The second is creation of community-developed standards (not accreditation), which might usefully include big ideas, skills, and modes of inquiry that lead to positive student learning outcomes and are of practical benefit in all geoscience careers.

Licensing of professional geologists is an important component for increasing public and political recognition and support for our science and profession, but such licensing should take place *after* the baccalaureate (National Association of State Boards of Geology, www.asbog.org). GSA's efforts would be well spent in promoting an increase in the number of states that require professional geologist licensure.

At the undergraduate level, no one wins with accreditation—not the students, not the departments, not the profession, not society. Challenges facing earth scientists are likely to change during students' careers, and we must educate them to be adaptable, broad-based thinkers, capable of solving complex problems and articulate solutions. The prescribed curriculum that typically comes with accreditation would eliminate departmental flexibility to tailor curricula and train students to address the planet's ever-changing problems in a local context.

Our opposition to accreditation differs significantly from the general response to the GSA survey (GSA ad hoc comm., 2008). We wonder if the result is due to a low response rate from academic geologists. We also note that the pro-accreditation preface of the survey must have biased the response. We urge the coalition of professional societies charged with developing an accreditation system to solicit a larger faculty response before moving forward, and we urge geoscience faculty to become involved in the debate on accreditation—the stakes are high and the future of our field depends on it. To register your agreement and concerns, please visit www.ipetitions.com/petition/geoscience.

ACKNOWLEDGMENTS

The authors thank Dave Fastovsky, Steve Johnston, and Anne Veeger for helpful reviews.

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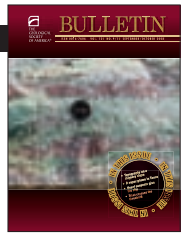

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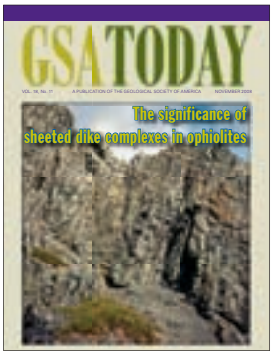

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