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Birth of a mud volcano: East Java, 29 May 2006

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ABSTRACT
On 29 May 2006, an eruption of steam, water, and, subsequently, mud occurred in eastern Java in a location where none had been previously documented. This “pioneer” mud eruption (the first to occur at this site) appears to have been triggered by drilling of overpressured porous and permeable limestones at depths of ~2830 m below the surface. We propose that the borehole provided a pressure connection between the aquifers in the limestones and overpressured mud in overlying units. As this was not protected by steel casing, the pressure induced hydraulic fracturing, and fractures propagated to the surface, where pore fluid and some entrained sediment started to erupt. Flow rates remain high (7000–150,000 m$^3$ per day) after 173 days of continuous eruption (at the time of this writing), indicating that the aquifer volume is probably significant. A continued jet of fluid, driven by this aquifer pressure, has caused erosion and entrainment of the overpressured mud. As a result, we predict a caldera will form around the main vent with gentle sag-like subsidence of the region covered by the mud flow and surrounding areas. The eruption demonstrates that mud volcanoes can be initiated by fracture propagation through significant thicknesses of overburden and shows that the mud and fluid need not have previously coexisted, but can be “mixed” within un lithified sedimentary strata.

INTRODUCTION
Understanding how Earth recycles elements, compounds, minerals, or even sediment is a major scientific quest, which transcends several disciplines, including chemistry, biology, and earth science. In sedimentary geologic systems, the cycle time can be particularly significant. For instance, the burial of sediment (and pore fluid) to depths in excess of 5 km, and their remobilization and transport back to Earth’s surface, can take millions to tens of millions of years (e.g., Kopf et al., 2003). One prerequisite for this long-term recycling process is the development of elevated pore fluid pressure (overpressure). The excess fluid provides the required energy for the breach of seals and for the transport of a fluid-sediment mix back to the surface, where it is redeposited as sediment (e.g., Stewart and Davies, 2006; Deville et al., 2006). Mud volcano systems are one of the many expressions of this process, and many have been documented globally (Kopf, 2002; Milkov, 2000). Significant eruptive edifices can develop, which are often grossly similar in form to their more intensively studied igneous counterparts (Stewart and Davies, 2006), although substantially smaller. However, many of the fundamental processes involved in the recycling of buried fluid and sediment through mud volcano systems are poorly understood, and studies are still in their infancy. Elementary questions remain; for instance: (a) Do the mud and fluid come from the same beds, or is the fluid transported from deeper levels into mud source beds where mud is entrained? (b) How is the plumbing system that feeds mud and fluid to the surface initiated and sustained? and (c) What is the three-dimensional architecture of the feeder systems and how do they evolve through time?

On 29 May 2006, a mud eruption was observed in the Porong subdistrict of Sidoarjo in eastern Java (Fig. 1). At the time of this writing, the erupted mud pool (a) has a volume of ~0.012 km$^3$, (b) covers an area of ~3.6 km$^2$ and is up to ~10 m thick, (c) has buried 4 villages and 25 factories, and (d) displaced 11,000 people. There have been 13 fatalities as a result of the eruption (the first to occur at this site) appears to have been triggered by drilling of overpressured porous and permeable limestones at depths of ~2830 m below the surface. We propose that the borehole provided a pressure connection between the aquifers in the limestones and overpressured mud in overlying units. As this was not protected by steel casing, the pressure induced hydraulic fracturing, and fractures propagated to the surface, where pore fluid and some entrained sediment started to erupt. Flow rates remain high (7000–150,000 m$^3$ per day) after 173 days of continuous eruption (at the time of this writing), indicating that the aquifer volume is probably significant. A continued jet of fluid, driven by this aquifer pressure, has caused erosion and entrainment of the overpressured mud. As a result, we predict a caldera will form around the main vent with gentle sag-like subsidence of the region covered by the mud flow and surrounding areas. The eruption demonstrates that mud volcanoes can be initiated by fracture propagation through significant thicknesses of overburden and shows that the mud and fluid need not have previously coexisted, but can be “mixed” within un lithified sedimentary strata.

MUD VOLCANO SYSTEMS
Mud volcanoes are common on Earth (Milkov, 2000), but particularly so in compressional tectonic belts (e.g., Azerbaijan:

Figure 1. Map of Java, showing the location of the eruption in the Porong subdistrict and Purwodadi and Sangiran Dome, where other mud volcanoes have been documented.

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Planke et al., 2003; Indonesia: Ware and Ichram, 1997), within deltas (e.g., Mississippi: Neurauter and Bryant, 1990), and submarine slopes undergoing gravitationally driven detachment (e.g., Niger delta: Graue, 2000). The volcanoes can be long-lived features, composed of a series of mud “cones,” which indicate a pulsed eruptive history (Evans et al., 2007) that can occur over $10^4$–$10^6$ yr time spans.

The term “mud volcano system” was coined by Stewart and Davies (2006) to describe the set of structures associated with a constructional edifice (mud volcano) and feeder complex that connects the volcano to its source stratigraphic unit (Fig. 2A). The system is driven by pressure and a source of fluid, which may or may not coexist with mud source beds (see Deville et al., 2003). Above the fluid source is a feeder conduit (Fig. 2B), the detailed structure of which is largely unknown. It probably consists of a complex system of fractures and mud-filled dykes (Fig. 2C) that feed a fluid-sediment mix to Earth’s surface (e.g., Morley, 2003). The fluid-sediment mix then erupts to form the “mud volcano”—a term we only use to describe the edifice (Fig. 2D).

The plumbing of mud volcano systems is poorly constrained. For instance, the mud and fluid could coexist at the time of initiation, analogous to magma (e.g., Davies and Stewart, 2005), or the fluid could be transported from a deeper source, remobilizing mud at shallower stratigraphic levels (Deville et al., 2003; Kopf et al., 2003; You et al., 2004). Some mud volcano systems are thought to comprise multiple mud chambers at different stratigraphic levels (Deville et al., 2003; Planke et al., 2003) whereas other models propose that mud volcano systems comprise significant masses of mud, in the form of bulbous-shaped diapirs (Brown, 1990; Milkov, 2000).

A “pioneer mud volcano” (e.g., Fig. 2A) is a term used by Davies and Stewart (2005) to describe the first mud volcano that erupts in a location where no mud volcano system previously existed. They envisage that if a substantial mud volcano develops, a positive feedback loop can become established where subsidence of the overburden due to loading, conduit wall-rock erosion, and volume loss at depth causes new fractures and faults to form in the overburden stratigraphy. These structural apertures provide new pathways for a fluid-mud mix.

GEOLOGIC SETTING

The East Java basin is an inverted extensional basin (Matthews and Bransden, 1995). It comprises a series of east-west-striking half-graben that were active in extension during the Paleogene and reactivated in compression during the early Miocene to Recent. The Oligo-Miocene to Recent basin was filled with shallow marine carbonates and marine muds, some of which are known to be “overpressured” (see Osborne and Swarbrick, 1997). As a result of the compressional inversion, these strata are gently folded with normal and reverse faults cutting the inversion anticline crests (see Matthews and Bransden, 1995). A small section of one of these east-west-trending anticlines was targeted by the Banjar Panji-1 exploration well.

Mud volcanoes have been documented before in East Java. For example, they are found within the crest of the Sangiran Dome (part of one of the east-west-trending Neogene folds: Watanabe and Kadar, 1985) and near Purwodadi, which is 200 km west of Lusi (Fig. 1). Overpressured lower Miocene clays probably equivalent to the Tuban or Tawun Formations (similar age to the Kujung limestone—see Matthews and Bransden, 1995).

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the well drilled the following (shallowest first): (a) the Pleistocene age Pucangan and Kabuh Formations, (b) then ~1000 m of overpressured muds with some sand interbeds (the Upper Kalibeng Formation [Pleistocene age]), (c) ~1300 m of interbedded sands and muds, and finally (d) the well penetrated a limestone (presumed to be the Kujung Formation), which was also overpressured. There was no casing set between the bottom of the hole (the Kujung Formation) and ~1743 m of the overburden, including part of the 1000 m of overpressured Upper Kalibeng Formation mud and the entire 1300 m of interbedded muds and sands (Fig. 4A). We know that (a) in the Banjar Panji-1, the pore pressures at 2130 m (700 m above the Kujung limestone) are 38 MPa (5500 psi); and (b) that in a well 5 km away called Porong-1, the pressure within the Kujung limestone aquifer was 48 MPa (6970 psi) at 2597 m.

**VOLCANO INITIATION**

**Model**

Given the pore pressure of 38 MPa (5500 psi) at 2130 m in the Banjar Panji-1 well, we calculate an overpressure of 16 MPa (2300 psi) at this depth. In the Porong-1 well, we use the pressure of 48 MPa (6970 psi) at 2597 m to calculate an overpressure of 21 MPa within the Kujung limestone. On the assumption that the Kujung limestone is a regional aquifer (which seems likely given the high continuous flow rates at Lusi), we predict the overpressure was ~21 MPa at the base of the Banjar Panji-1 at 2830 m.

We propose that the drilling of the overpressured Kujung limestone caused an influx of pore fluid into the well bore (known as a “kick”). The well bore itself provided the pressure connection from the limestone to any shallower aquifers as well as the overpressured muds of the Upper Kalibeng Formation. The eruption started with steam and water, and this did not come to the surface through the well bore, but instead took place 200–1000 m away (Fig. 4B). Therefore, the transport route for the steam and mud was not through the wellbore but through the surrounding overburden. High pore-pressure causes natural hydraulic fracturing of the sedimentary overburden (see Engelder, 1993) when pore pressures exceed the...
fracture strength. These conditions for the creation of hydraulic fractures are most likely to form in the shallowest strata not protected by steel casing. We propose that the fractures probably formed within the Upper Kalibeng Formation and propagated from 1–2 km depth to the surface over a period of hours. The depth is backed by the temperature of the erupted mud-water mix, which is 70–100 °C, indicative of rapid transport from 1.5 to 3 km depth, assuming a geothermal gradient of 25 °C/km and a surface temperature of 28 °C. Such drilling-induced fracture and fluid flow processes, where the well bore provides the

Figure 3. Satellite images of the Lusi eruption taken ~100 days after the eruption started. (A) Entire area of eruption. (B) Close-up of the main vent (marked by clouds of steam [white]), which appeared 200 m southwest of the exploration well. Both images taken September 2006, courtesy National University of Singapore Centre for Remote Imaging, Sensing and Processing (CRISP).

Figure 4. Schematic three-dimensional representations of the Lusi mud volcano showing four main developmental stages. The first three diagrams depict the evolution between May 2006 and Dec. 2006 (A–C), and the fourth diagram (D) shows the predicted next phase of evolution. (A) March to May 2006: Banjar Panji-1 well drills toward Kujung Formation, through overpressured mud (Kalibeng Formation) and interbedded sands and muds. (B) May 2006: Kujung Formation carbonates are penetrated, which leads to a “kick” (influx of fluid into the well bore). The kick causes hydrofracturing of overlying strata (probably initiated within the Kalibeng Formation). Drilling mud and pore-fluid enter the well bore, driven by the excess pressure upward, through porous and permeable strata and the fracture system. Entrainment of overpressured Kalibeng Formation muds occurred. (C) May to December 2006: entrainment of Kalibeng Formation muds causes a subterranean conduit to form, the walls of which undergo period collapse. (D) Post-2006: caldera forms around the vent, and gentle sag-like subsidence of the region where the flow extends. Smaller mud cones may be erupted as a result of conduit establishment due to foundering of the overburden stratigraphy.
necessary initial pressure communication, has been witnessed elsewhere; for example, in subsurface blowouts that occurred in Brunei in 1974 and 1979 (see Tingay et al., 2005).

At Lusi, the influx of pore water into the well bore may have initially come from the Kujung limestones, but once the heavy drilling mud had been displaced into the new fractures, fluid would have also started to flow from porous and permeable formations in the overburden. The passage of fluid into overpressured (and therefore undercompacted) mud would lead to entrainment of the un lithified sediment (Fig. 4C), which would also contribute its pore water to the mix. Mud is cohesive, and in a similar way to the entrainment of mud in sedimentary settings, the shear stress imposed by the adjacent moving water has to overcome the sediment's cohesive yield strength (e.g., Dade et al., 1992; Kranenburg and Winterwerp, 1997) for it to be entrained. Such an entrainment process has been proposed for mud volcanoes in the UK, for instance, where water from an underlying aquifer passes through mud-rich overburden, causing the formation of a subterranean cavern system (Bristow et al., 2000). The same general process has also been proposed by Deville et al. (2003) for mud volcanoes in Trinidad. We envisage that collapse of the Upper Kalibeng strata will contribute to the mixing process. It is also conceivable that the hot water in large caverns will allow convection cells to develop, which will contribute to the mixing process (e.g., Deville et al., 2003). The resultant dilute water-mud mix is moving up fractures to the surface as a fluidized sediment flow with the mud in suspension.

The mix started to erupt at the surface, driven by the pressure of the pore fluids in the Kujung limestones. Erosion of the walls of the fractures is also likely (it occurs in other mud volcanoes), and therefore a major conduit would grow upward and laterally, periodically collapsing inward. This particular mixing mechanism for mud volcanism has probably led to the very dilute composition of the mud-water mix and the high aspect ratio of the edifice.

**Pressure Drive**

If a continuous 2830 m column of an erupting mud-water mix has a density of 1.3 g cm⁻³, based on an assumed water: mud ratio of 80:20, the mud column would exert a pressure of 36 MPa (5225 psi) at the bottom of the Banjar Panji-1 exploration hole. This pressure is 12 MPa less than our estimate of the pressure within the Kujung limestone (48 MPa); therefore, it is most likely that the flow that is being witnessed is driven by this pressure difference. Gas exsolution and expansion (Brown, 1990) are not considered important lift mechanisms at present.

**NEXT DEVELOPMENTAL STAGES**

Maintenance of flow depends upon one of two factors. If there is a continuous pathway to the surface due to the subsurface erosion of the conduit walls, the influx of the pore fluid and eruption will continue until the aquifer pressure equals the pressure due to the vertical column of erupting mud-water mix (i.e., 12 MPa). Alternatively, if mud gains access to the surface through fractures that remain open against the minimum stress, flow will reduce substantially only when the fracture closure pressure is reached; this pressure will depend on the depth at which the fracture(s) occur. Once the pressure drive abates, the compaction of the extruded and intruded mud can cause low levels of mud-water eruption, potentially for years or decades to come, as noted in other mud volcanoes such as Pipar in Trinidad and many mud volcanoes in Azerbaijan between violent (active) eruptive phases.

If our model of entrainment of the mud within the Upper Kalibeng Formation is correct, then unless the pore pressure drops to allow flow to stop, the subterranean caverns will undergo collapse (Fig. 4D). We predict that the region around the vent will form a caldera and that the area of the mud flow will undergo less significant sag-like subsidence. This subsidence pattern is consistent with the behavior of other mud volcanoes (Stewart and Davies, 2006). The subsidence that caused the fracture of a gas pipeline buried by the mud volcano and dam system indicates that collapse may have already started.

**DISCUSSION**

**Induced by Drilling or Earthquake?**

We propose that Lusi is the direct result of connection of a high-pressure fluid at depth with shallow sediments at a depth at which fractures can be initiated. Once initiated, the fractures would have propagated to the surface, driven by the deep pressure. Drilling activity has allowed this connection, and our preferred model is that the earthquake that occurred two days earlier is coincidental. The primary reasons for not considering an earthquake to be the trigger or contributing factor are (a) no other mud volcano eruptions were reported in Java at the same time; (b) the earthquake preceded the eruption by two days; seismogenic liquefaction usually occurs during earthquake-induced shaking of sediment (e.g., Ambraseys, 1988); (c) there are no reports of a “kick” during the earthquake or immediately afterward; and (d) sand, rather than mud, is more conducive to liquefaction due to earthquake shaking because it is a non-cohesive, granular sediment. An earthquake could have generated new fractures and weakened the uncased section of the well, but it would be highly coincidental for an earthquake-induced fracture to form 200 m away from this well and provide the entire fracture network required for an eruption on the Earth’s surface.

**Initiation and Subterranean Mixing**

A fundamental question in mud volcano system studies is how they are initiated. The model proposed by Brown (1990), Van Rensbergen et al. (1999), Davies and Stewart (2005), and Stewart and Davies (2006) is that hydrofractures can penetrate several kilometers of the crust and transport a fluid-sediment mix that erupts to form a pioneer volcano. Because in this case we know that the mud-water mix has been transported ~2 km through the overburden, through new or reactivated fractures, the Lusi eruption supports the models proposed by these authors.

The Lusi eruption also strengthens the concept that rather than the source water and the source mud coexisting in the same stratigraphic unit (mudrocks at 2.0 km depth have strength and not the porosity of 70%-80% required for the Lusi sediment composition), the fluid has a deeper source, and mud is entrained from within the overburden (e.g., Bristow et al.,
main vent. Modeling and direct measurement of the inevitable the coming months with more dramatic collapse surrounding the several kilometers wide should undergo sag-like subsidence over continue for many months and possibly years to come. A region difficulty, but the unabated 173 days of very active eruption indicate water is transported from deeper successions. establishment of a subterranean mixing system, into which multi-kilometer depths, which triggers fluid flow and the rapid scale of sediment mobilization, triggered by drilling activity, has not been documented before. A combination of factors account for this being so rare: (1) the penetration of an over-pressured mud that is susceptible to erosion followed by (2) the penetration of an agger that releases large volumes of pore water and (3) the man-made pressure linkage provided by 1.7 km of open hole section.

CONCLUSIONS
It is very likely that Lusi was initiated as a result of an access by a high-pressure aquifer at depths in the region of 2.5–2.8 km through an open-hole section of the Bajar Panji-1 well to depths at which fractures could be initiated. Lusi indicates that mud volcanoes can be initiated by fractigration propagation from multi-kilometer depths, which triggers fluid flow and the rapid establishment of a subterranean mixing system, into which water is transported from deeper successions.

Prediction of the next developmental stages is fraught with difficulty, but the unabated 173 days of very active eruption indicate a large agger has been penetrated, and we can be confident that some sort of eruptive activity (perhaps lower-level) will continue for many months and possibly years to come. A region several kilometers wide should undergo sag-like subsidence over the coming months with more dramatic collapse surrounding the main vent. Modeling and direct measurement of the inevitable land subsidence will help to predict what the future impact the Lusi mud volcano has on the local population.

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REFERENCES CITED
Manuscript received 1 November 2006; accepted 10 December 2006.
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Part II (See page 11 of the December 2006 GSA Today for Part I)

A journal relies on its referees. Ideally, referees should accept as many review requests as possible and return their reviews in a timely manner. Ideally, they should also be perspicacious, incisive, and fair, remarking equally on the strengths and weaknesses of a manuscript. As many editors have commented, the ideal reviewer reviews as he or she would like himself or herself to be reviewed. As a token of our appreciation for reviewers who have fulfilled these demanding criteria, the editors of *GSA Bulletin* and *Geosphere* have nominated the following as “exceptional reviewers.”

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(85% academic, 9% applied, 6% government)

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**Meeting Wrap-Up**


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Abstract Submission Deadline:
1 March 2007

For complete abstract submission details and updates on speakers, fellows, and deadlines, please go to http://www.agu.org/meetings/ja07
The full text of all 2006 citations and responses is online at: www.geosociety.org/aboutus/awards

For a paper copy of any or all of the citations and responses, please contact:
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2006 DIVISION AWARDS

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Peter J. Mehringer
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Vance Haynes and Gary A. Huckleberry, Citationists

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Kenneth P. Kodama
Lehigh University
Lisa Tauxe, Citationist

GILBERT CADY AWARD
James C. Hower
University of Kentucky
Leslie F. Ruppert, Citationist

E.B. BURWELL, JR., AWARD
Martin G. Culshaw
British Geological Survey
Alan W. Hatheway, Citationist

MARY C. RABBITT HISTORY OF GEOLOGY AWARD
Sandra Herbert
University of Maryland
Baltimore County
Michelle L. Aldrich, Citationist

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2006 DIVISION AWARDS

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Michael S. Kelley, Citationist

O.E. MEINZER AWARD
Karsten Pruess
Lawrence Berkeley National Laboratory
Michael A. Celia, Citationist

STRUCTURAL GEOLOGY & TECTONICS CAREER CONTRIBUTION AWARD
John F. Dewey
University of California, Davis
Celâl Şengör, Citationist

LAURENCE L. SLOSS AWARD
Gerald M. Friedman
Brooklyn College and Northeastern Science Foundation
Larry D. Woodfork, Citationist

DISTINGUISHED CAREER AWARD
Eldridge M. Moores
University of California, Davis
Yildirim Dilek, Citationist

KIRK BRYAN AWARD
David R. Montgomery
University of Washington
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KIRK BRYAN AWARD
Mark T. Brandon
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Glenn David Thackray, Citationist

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GSA TODAY, FEBRUARY 2007
The History of Geology Division announces a new award to recognize service contributions to the history of geology: The Gerald M. and Sue T. Friedman History of Geology Distinguished Service Award.

In naming the new award after Gerald and Sue Friedman, the Division recognizes their exceptional and continuous service to the Division since its establishment in 1976, as well as their contributions to the discipline of the history of geology for more than 40 years. Among their major contributions are the creation of the Northeastern Science Foundation (Troy, N.Y.) and establishment of the journal *Northeastern Geology and Environmental Science*, which frequently includes papers on the history of geology. Gerald Friedman was the first editor and founder of *Oil-Industry History*, the only peer-reviewed journal devoted to the history of the oil and gas industry, and was the founding editor of the journal *Earth Sciences History*. The Friedmans were also directly involved in the founding of the History of Earth Sciences Society.

Gerald and Sue Friedman functioned as a team as active contributors to the History of Geology (HoG) Division for as long as it has existed, and both were present when the Division was created (see *GSA Today*, v. 16, no. 10 [October 2006], p. 38–39).

**First Recipient: Robert N. Ginsburg**

The first recipient of The Gerald M. and Sue T. Friedman History of Geology Distinguished Service Award is Robert N. Ginsburg of the University of Miami. This award was presented at the GSA Annual Meeting in Philadelphia in October 2006 by Citationist Kennard Bork.

The following is a brief excerpt from the citation:

In presenting this award to Robert Ginsburg, we are celebrating our own “Rock Star” as the first winner of our Division’s Gerald M. and Sue T. Friedman History of Geology Distinguished Service Award. Bob Ginsburg is one of those “idea persons” who constantly generates important concepts for the good of the order. Probably the most visible of his many productive brainstorms is the “Rock Star” series, short biographies of geologists that appear in *GSA Today*. The series has been a major success since its inception in 1995. It has demonstrated the power of historical vision to educate a readership, while illuminating major contributors to geology’s past. …

Another legacy from the fertile mind of Robert Ginsburg is the idea of our highly successful History of Geology student receptions at the annual GSA meetings. They bring younger people into the Division through the enticement of genuine camaraderie. You will notice that Bob is a senior person with a young mind. He is constantly attuned to teaching and involving others in exciting endeavors. …

… He has been a significant force within GSA, serving as a member of GSA Council, as Annual Meeting Co-Chair, and on numerous committees…

Please see the HoG Division Web site, http://gsahist.org, for Bork’s full citation as well as Ginsburg’s response.

*William R. Brice
Secretary-Treasurer, GSA History of Geology Division*
Upcoming Award Deadlines

Funds supporting all but the national awards are administered by the GSA Foundation.

Applications Due

15 Feb. 2007: Antoinette Lierman Medlin Scholarship in Coal Geology. Coal Geology Division. Please send applications to Glenn B. Stracher, Dept. of Geology, East Georgia College, Swainsboro, GA 30401, USA, fax +1-478-289-2050, stracher@ega.edu. For details, see the January 2007 issue of GSA Today or go to www.uky.edu/KGS/coal/GSA/awards.htm.

Nominations Due

20 Feb. 2007: Laurence L. Sloss Award for Sedimentary Geology.** Sedimentary Geology Division. Send nominations electronically to Paul Link, secretary, Sedimentary Geology Division, linkpaul@isu.edu.

28 Feb. 2007: Gilbert H. Cady Award.** Coal Geology Division. Send three copies of the nomination to Christopher J. Carroll, Colorado Geological Survey, 1313 Sherman St., Suite 715, Denver, CO 80203-2239, USA, +1-303-866-3501, chris.carroll@state.co.us.

31 Mar. 2007: John C. Frye Environmental Geology Award.* For details, follow the link at www.geosociety.org/aboutus/awards/ or see the October 2006 issue of GSA Today.

2 Apr. 2007: Don J. Easterbrook Distinguished Scientist Award.** Quaternary Geology and Geomorphology Division. Send nominations to Jack F. Shroder Jr., Dept. of Geography & Geology, University of Nebraska, Omaha, NE 68182-0199, USA, jshroder@mail.unomaha.edu.

2 Apr. 2007: Farouk El-Baz Award for Desert Research.** Quaternary Geology and Geomorphology Division. Send nominations to Lisa L. Ely, Dept. of Geological Sciences, 400 E University Way, Central Washington University, Ellensburg, WA 98926, USA, +1-509-963-2821, ely@cwu.edu.

30 Apr. 2007: National Awards.* William T. Pecora Award, National Medal of Science, Vannevar Bush Award, and Alan T. Waterman Award. For details, see the October 2006 issue of GSA Today or go to www.geosociety.org/aboutus/awards/national.htm.

GSA's Geophysics Division seeks nominations for the George P. Woollard Award. This annual award recognizes outstanding contributions to geology through the application of the principles and techniques of geophysics. The award is presented at each annual GSA meeting in conjunction with the Geophysics Division and the Structural Geology and Tectonics Division business meetings. A highlight of the presentation is the honorary George P. Woollard Technical Lecture by the recipient before the award ceremony, providing an overview of and musings on his or her work. Nominations should include a description of the nominee's specific contributions and their scientific impact. Submit nominations online by 15 February 2007 at http://geoscience.unlv.edu/pub/GSA_Geop/woollard.html.

*You may also contact Grants, Awards, and Recognition, P.O. Box 9140, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.

**Award details are in the January 2007 issue of GSA Today and at www.geosociety.org/aboutus/awards/.

FREE K–12 LESSON PLANS!

Need a lesson plan or resource for that earth science project? GSA has loads of free teacher resources. Go to www.geosociety.org/educate/ to view and download quality lesson plans, developed and classroom-tested by your fellow teachers.

Have a lesson plan you want to share? Go to www.geosociety.org/educate/, complete our lesson plan template (Microsoft Word format), then send it via e-mail to Chris McLelland, GSA’s Distinguished Earth Science Educator, educator@geosociety.org. GSA will extend the reach of your work by including it in the DLESE (Digital Library for Earth System Education; www.dlese.org) library.

George P. Woollard Award

GSA Geophysics Division

Seeking Earth Science Fair Judges

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To Be A Judge

GSA provides three special awards for earth science project excellence at the Intel International Science and Engineering Fair. We are seeking judges for this prestigious event, to be held in Albuquerque, New Mexico, 15–16 May 2007. If you are interested in this fascinating and rewarding volunteer activity, please contact Chris McLelland at educator@geosociety.org, +1-303-357-1082.

The Geological Society of America
ROCKY MOUNTAIN

Section Notice

59th Annual Meeting
Rocky Mountain Section, GSA
Dixie Center, St. George, Utah, USA

7–9 May 2007

CALL FOR PAPERS

Abstracts Deadline: 13 February 2007

Papers are invited from students and professionals for oral and poster presentations. Submit your abstracts via www.geosociety.org. An abstract submission fee of US$15 will be charged. An individual may present only one volunteered paper but may be co-author on other papers. Individuals invited to participate in symposia may present an additional volunteered paper. Depending on time constraints in oral sessions, some submitters may be requested to switch to a poster presentation and vice-versa. Please check the March GSA Today for complete meeting information, and go to www.geosociety.org/sectdiv/rockymtn/07rmmtg.htm for symposia and field trip listings.

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The Roy J. Shlemon Mentor Programs in Applied Geoscience are designed to acquaint advanced undergraduate and beginning graduate students with careers in applied geoscience. Volunteer mentors provide real-world information and insight based on their career experience—wisdom students may not glean from their regular academic training.

The John Mann Mentor Programs in Applied Hydrogeology provide a forum for undergraduate and graduate students interested in hydrogeology or hydrology as a career to participate in informal conversations with professionals currently practicing in these fields. These programs are relaxed, small-scale, focused events.

If you are interested in serving as a mentor at one of the GSA Section Meetings, please contact Jennifer Nocerino, jnocerino@geosociety.org. See the program schedule at www.geosociety.org/science/mentors/07programs.htm.

GSA Section Meetings 2007

Northeastern Section
12–14 March 2007
University of New Hampshire
Durham, New Hampshire
Information: Wally Bothner, University of New Hampshire, Dept. of Earth Sciences, James Hall, 56 College Rd., Durham, NH 03824-3578, USA, +1-603-862-3143, wally.bothner@unh.edu.

Southeastern Section
29–30 March 2007
Hyatt Regency Savannah on the Historic Riverfront
Savannah, Georgia
Information: Pranoti Asher, Georgia Southern University, Dept. of Geology and Geography, Statesboro, GA 30460-8149, USA, +1-912-681-0338, pasher@georgiasouthern.edu.

Joint Meeting
South-Central and North-Central Sections
11–13 April 2007
Kansas Memorial Union, University of Kansas
Lawrence, Kansas
Information: Greg Ludvigson, +1-785-864-2734, gludvigson@kgs.ku.edu—or—Greg Ohlmacher, +1-785-749-4502, ohlmac@kgs.ku.edu; both at Kansas Geological Survey, University of Kansas, 1930 Constant Ave., Lawrence, Kansas 66047-5317, USA.

Cordilleran Section
4–6 May 2007
Western Washington University
Bellingham, Washington
Abstract Deadline: 6 February 2007
Information: Bernie Housen, Western Washington University, Dept. of Geology, MS 9080, 516 High St., Bellingham, WA 98225-5946, USA, +1-360-650-6573, bernieh@cc.wwu.edu.

Rocky Mountain Section
7–9 May 2007
Dixie Center
St. George, Utah
Abstract Deadline: 13 February 2007
Information: Jerry Harris, Dixie State College, Science Building, 225 South 700 East, St. George, UT 84770-3875, USA, +1-435-652-7758, jharris@dixie.edu.
2006 OEST AWARD RECIPIENTS NAMED

GSA Congratulates These Outstanding Earth Science Teachers

The National Association of Geoscience Teachers (NAGT) announced the 2006 Outstanding Earth Science Teacher (OEST) Award recipients in December 2006.

OEST awards are earned by outstanding pre-college teachers through their exceptional contributions to the stimulation of interest in the earth sciences. Each NAGT section selects a section winner; sections may also have state winners. For more information about this award and the NAGT, go to www.nagt.org/nagt/programs/oest.html.

The OEST award is administered by the Geological Society of America; GSA awards section recipients US$500 travel money to attend a GSA meeting, and awardees can also apply for up to $500 for classroom supplies. The award includes a certificate and a complimentary membership to GSA for three years for section recipients and one year for state recipients.

2006 OEST SECTION Awardees
(No awardees were selected for the North-Central, Southwest, and Midcontinent Sections.)

Aaron Spurr
Central Section
Northern University High School
Cedar Falls, Iowa

Walter “Len” Sharp
Eastern Section
Liverpool High School
Liverpool, N.Y.

David Meade
FarWest Section
New Jerusalem Charter School
Tracy, Calif.

Marguerite (Margo) Murphy
New England Section
Georges Valley High School
Thomaston, Maine

Jodie Harnden
Pacific Northwest Section
Sunridge Middle School
Pendleton, Oreg.

Bryan P. Byrne
Southeast Section
E.A. Cox Middle School
Columbia, Tenn.

Cristopher D. Marshall
Texas Section
The Colony High School
The Colony, Tex.

2006 OEST STATE Awardees

Tim Ashley
OEST Alabama
John L. LeFlore Prep
Mobile, Ala.

William Waggener
OEST Georgia
Paulding County High School
Dallas, Ga.

Aaron Spurr
OEST Iowa
Northern University High School
Cedar Falls, Iowa

Janelle Albarez
OEST Louisiana
Brusly Middle School
Brusly, La.

Christa Bowser
OEST Maryland
Southern Barrett High School
Oakland, Md.

Kirk Enzenauer
OEST Minnesota
Coon Rapids Middle School
Coon Rapids, Minn.

Walter Patelunas
OEST New Jersey
Toms River High School East
Toms River, N.J.

Walter “Len” Sharp
OEST New York
Liverpool High School
Liverpool, N.Y.

Carrie A. Jones
OEST North Carolina
Middle Creek High School
Apex, N.C.

Jason Petula
OEST Pennsylvania
Tunkhannock Area High School
Tunkhannock, Penn.

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Because the best geologists have seen the most rocks!
When I accepted the GSA–USGS Congressional Science Fellowship, my colleagues had a wide array of responses: some were very supportive of my decision, while others made comments like “you’re going to become one of those people.” I’m not sure what that meant, but I did understand why some people were confused about my choice. I have always bemoaned the lack of women in science, and while I had opportunities that year to continue in more traditional research positions, I chose the Congressional Fellowship, which led me away from a lab bench or, in my case, from rivers. Apparently, it seemed to some that I wasn’t going to be the role model of a woman scientist that I had often longed for during my training.

I hope that is far from the truth. I have always loved science, and I never planned to leave research forever, even though I knew the Fellowship could lead me in that direction. As a student, I sometimes found it frustrating that few of my advisors had experience outside of academia. Even though I aspire to a job similar to that of my academic advisors, I know that there are not enough faculty positions for every Ph.D. student. I felt that in order for me to be a good teacher and role model, I needed to have a few more experiences under my belt. As a bit of a politics junky, it seemed to me that the Congressional Fellowship would be an ideal way to broaden my horizons. When GSA selected me as the 2005–2006 Fellow, I jumped at the opportunity.

I’d never had a formal civics class before I arrived in Washington, D.C., but jumping into the fire is often the best way to learn. As a Congressional Fellow, I was given all the responsibilities of a legislative assistant. My portfolio of policy issues included science research and development, climate change, water infrastructure, disaster preparedness, nuclear waste, nuclear nonproliferation, and human rights. Congress members often get information from their staff through memos, and I had never written a memo before last year. I wasn’t worried though; I write C++ code, so how hard could it be to write a memo? It turns out that writing computer code was much easier for me than those first few memos. Writing speeches and talking points was also challenging, because I had never written in anyone else’s voice but my own. The learning curve on the Hill is steep, but I quickly found my rhythm. I got used to hearing the phrase “that needed to be done ten minutes ago,” and I figured out that Congress members do not use the term “order-of-magnitude.”

My day-to-day tasks in the office varied widely. When Congress was in session, many of my days were spent frantically finding the last-minute facts that my boss needed for committee hearings, votes, or speeches on the House floor. There are schedules in Congress, but they are often not followed, and last-minute changes always come up. Although the House floor is for members only, I did get to join my boss on the floor when he was debating an amendment I had helped to write. It was a bit nerve-wracking for me, but I also found it fascinating to watch the last-minute politicking and arm-twisting that invariably happens before votes.

As much as I loved the chaos while Congress was in session, I had more time to pursue my own policy interests when Congress was in recess. Learning the ins-and-outs of the legislative process and writing talking points and press releases were very important parts of my Fellowship experience, but most enlightening for me was seeing how science is viewed and used in the policy arena. Before the fellowship, I had been entrenched in academia, and I had forgotten that most people do not understand how scientific funding works and how difficult it is to actually receive grant money. Peer review, of both grants and journal articles, is a black-box process to many outside of research. It was disheartening at times to see that some Congressional staff, who will ultimately advise their bosses on how to fund agencies like the National Science Foundation and the National Institutes of Health, have only minimal understanding of how these agencies actually distribute research funds.

Scientific agencies and scientists themselves are partially to blame for the mystery surrounding how peer review and funding work. Congressional staffers are generally overworked and underpaid, and there is little spare time for reading on federal agencies. However, to my knowledge, the office I worked in never turned away a visit from a constituent, regardless of what he or she wanted to talk about. In my office, I was the person who met with nearly every scientist who walked through the door. I was surprised by how few scientists or representatives of scientific groups actually visited the office. Science will never be integrated into policy if the scientific community does not participate in the policy process.

Even when policy makers intend to meld science into legislation, the results can be tenuous. Last year, a case came before the Supreme Court involving a Michigan landowner who was charged with violating the Clean Water Act (CWA) when he filled wetlands on his property without obtaining a permit. The CWA requires a permit for discharging fill material into “navigable waters.” The Court had defined “navigable waters” as “waters of the United States, including the territorial seas.” The Army Corps of Engineers includes wetlands “adjacent” to other waters of the United States in “waters of the United States.” A lower court ruled that because the landowner’s wetlands have “surface connections” to tributaries of waterways that are tradi-
tionally deemed “navigable,” the wetlands were thus “adjacent” to navigable waters. The Supreme Court was split on the case with a 4–1–4 vote; ultimately, the Court did not clearly address what waters are and are not protected by the CWA. Justice Antonin Scalia’s position, written for himself, Chief Justice John Roberts, and Justices Clarence Thomas and Samuel Alito, states that “the waters” in the CWA refers to water “found in streams and bodies forming geographical features such as oceans, rivers, and lakes,” as defined by Webster’s New International Dictionary (1954). While in a briefing on the details of this case, I thought about my training in hydrology and how I might define “connections” between waterways. Although you don’t need a Ph.D. to understand the water cycle, it seems to me that a 1954 definition of water might not fully capture the complexity of connections between waterways. I’m sure that scientists are weighing in at every point of this case as it makes its way through the courts (where it still remains), but I was left wondering if this was the best way to integrate science into policy.

At times during my year on the Hill, I was inspired, yet at other times, I was very frustrated. These feelings led me to contemplate staying in Washington to “make a difference.” In the end, however, I decided that the biggest difference I could make was to go back to research and teaching and try to educate the next generation of scientists to be more aware of the science-policy nexus. At some point, I hope to get more involved in policy at the local level, maybe by attending town meetings or even running for a position on the school board. For now, though, I am enjoying my life as a geomorphologist again; I definitely prefer writing manuscripts to writing memos.

This manuscript is submitted for publication by Nicole Gasparini, 2005–2006 GSA–U.S. Geological Survey Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and by the U.S. Geological Survey. Department of the Interior, under Assistance Award No. 05HQGR0141. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government. Gasparini can be reached at nicgaspar@gmail.com.

About People

GSA Fellow and past president (2000) Mary Lou Zoback has been appointed vice president of Earthquake Risk Applications at Risk Management Solutions, a private, worldwide corporation founded at Stanford University in 1988. Zoback leaves the U.S. Geological Survey (USGS) after 28 years of service, most recently as a senior research scientist with the USGS Earthquake Hazards Team in Menlo Park, California, and regional coordinator for the USGS Northern California Earthquake Hazard Program.

Zoback is a woman of accomplishment. She served as chair of the steering committee for the 1906 Earthquake Centennial Alliance, which helped coordinate the 100th Anniversary Earthquake Conference commemorating the 1906 San Francisco earthquake. She was awarded the American Geophysical Union’s Macelwane Award in 1987 for “significant contributions to the geophysical sciences by a young scientist of outstanding ability” and currently serves on the Council of the National Academy of Sciences. Most recently, Zoback was named co-recipient of the Earthquake Engineering Research Institute’s Northern California Chapter’s 2006 Award for Innovation and Exemplary Practice in Earthquake Risk Reduction.
Including the GSA Foundation in Your Estate Planning

A number of common planned giving instruments are outlined here to guide GSA Members in their estate planning. In all cases, consult your tax accountant and/or attorney in developing any instrument. For details, contact Donna Russell, Director of Operations, GSA Foundation, P.O. Box 9140, Boulder, CO 80301-9140, USA, +1-303-357-1054, drussell@geosociety.org.

- A simple, inexpensive codicil (modification) to your will can create a bequest to the Geological Society of America Foundation (GSAF). You set the amount or percentage of your estate using wording such as “I hereby give, devise, and bequeath to the Geological Society of America Foundation Inc. the sum of $_____."
- If you wish, you can specify a purpose for your bequest by adding “It is my desire that this bequest be used for the following purposes: (specify a Foundation Fund).”
- Add GSAF as an additional beneficiary or contingent beneficiary to your existing life insurance policy. Other insurance instruments include (1) purchasing a new insurance policy in the name of GSAF, with tax-deductible premiums; or (2) including GSAF as one of the beneficiaries on your company insurance policy.
- Make GSAF the beneficiary of all or part of your retirement plan assets; this would be a tax-free testamentary charitable gift.
- Establish a charitable remainder trust with a minimum of $100,000 in cash, property, or real estate. This provides a lifetime income stream to you or other individuals, followed by a distribution of the principal at the end of the trust period. In addition, there are immediate charitable income tax deductions, capital gains avoidance, and federal estate tax deductions.
- Enter into a charitable gift annuity agreement with the GSAF for as little as $10,000 in cash or securities. This provides a fixed income for life.
- Deed your house to the GSAF and continue to live in it for life. There are current income tax savings.
- Have your surviving spouse include GSAF in her or his estate planning.

New Fund for the QG&G Division

The Quaternary Geology and Geomorphology Division is pleased to announce the establishment of a new scholarship fund named in honor of Marie Morisawa, one of the first women to maintain a high profile in Quaternary geology and geomorphology throughout her career. Marie entered the discipline in 1960, a period when relatively few women engaged in research and in university-level science teaching. She went on to help establish the annual Binghamton Geomorphology Symposium and the journal *Geomorphology*, both of which are thriving today. She was also the first female chair of the QG&G Division. Given that Marie was well known for mentoring younger scientists throughout her career and that she was an active participant of the QG&G Division of GSA, it seems particularly appropriate to establish an award for graduate students in her name through the Division. This award will go to women M.S. or Ph.D. students.

We are working to establish a $25,000 base, which would allow an annual scholarship award of $1,250. You can donate to this fund by sending a check to the GSA Foundation with a brief note earmarking the funds for the Morisawa scholarship or by credit card via the Foundation’s Web site, www.gsafweb.org/makeadonation.html.

Enclosed is my contribution in the amount of $_____________.
Please credit my contribution for the:

☐ Morisawa Fund
☐ Greatest need ☐ Other: ____________________________ Fund
☐ I have named GSA Foundation in my will.

PLEASE PRINT

Name
Address
City/State/ZIP
Phone
Most memorable early geologic experience:

My first days in the field in Northern Alaska, with my party chief and mentor, Art Bowsher, looking at the limestone ridge from about one-half mile away (no geologist had ever been in this valley before)—Art says “See that bench about one-third of the way up the cliff? We will find fossils there—Mississippi crinoids.” And we did!

—John T. Dutro

Remember receiving your research grant from GSA?
Remember the feeling of pride and accomplishment?
Don’t you wish others could enjoy this experience?

MAKE IT HAPPEN!

Contribute to GEOSTAR—Supporting The Advancement of Research.

GEOSTAR
Supporting The Advancement of Research

Geological Society of America Foundation
P.O. Box 9140, Boulder, CO 80301-9140
+1-303-357-1054 or www.gsaweb.org

Apply to Host a Speaker!

JOI/USSSP Distinguished Lecturer Series

The Joint Oceanographic Institutions/U.S. Science Support Program (JOI/USSSP) offers the Distinguished Lecturer Series to bring exciting scientific results and discoveries of the Integrated Ocean Drilling Program to students at the undergraduate and graduate levels and to the geosciences community in general. JOI is currently accepting applications from U.S. colleges, universities, and nonprofit organizations to host talks given by the speakers listed below during the 2007-2008 academic year. Applications are available online at www.uussp-iodp.org/DLS or from: JOI, Inc., 1201 New York Avenue, NW, Suite 400, Washington, DC 20005; tel: 202-232-3900; email: dls_coordinator@joiscience.org. The application deadline is April 6, 2007.

Pore Pressure, Sedimentation, and Submarine Landslides
Peter Flemings, Pennsylvania State University

One Rock to Change the World: The Story of the Chicxulub Impact Crater
Sean P.S. Gulick, University of Texas at Austin

The Earth’s Turmoil of the Last Deglacial Period
James Kennett, University of California Santa Barbara

Tales of Deep Ocean Circulation Told by Tiny Fish Teeth
Ellen Martin, University of Florida

Cretaceous Black Shales, Mediterranean Sapropels, and Greenhouse Climate
Philip Meyers, The University of Michigan

Unlocking the Secrets of the Deep Subsurface Biosphere
Andreas Teske, University of North Carolina, Chapel Hill

An integrated geologic framework for EarthScope’s USArray:
WESTERN GEOSWATH WORKSHOP

The GeoSwath initiative, a geologic activity under EarthScope’s USArray, involves integration of geology and geophysical imaging toward understanding the 4-D construction, stabilization and modification of the North American continent. GeoSwath uses a continuous coast-to-coast perspective that examines fundamental tectonic processes, the continent’s major geologic provinces and their boundaries.

This workshop examines a continuous swath from the northwest coast to the Great Plains (‘Lewis and Clark’ or Western GeoSwath), focusing on Cascadia, Northern Rockies and Black Hills/Great Plains. The workshop, co-sponsored by IRIS, will bring together complementary segments of the U.S. geosciences community, including geologists, geophysicists and geochronologists. Held on April 27-29 in a northern Rockies location; information on website: www.globalchange.umich.edu/ben/geoswath.

Application deadline: March 1, 2007.
NSF’s GeoSwath funding will support the costs of housing, food and a contribution toward your travel. For more information, contact: R. Keller (grkeller@ou.edu), B. Tikoff (basi@wisc.edu), or B. van der Pluijm (vdpluijm@umich.edu).
GeoHostel: Geology of the Sierra Nevada and White-Inyo Range, California, USA

4–11 August 2007 (8 days); Location: Mammoth Lakes and Crooked Creek Research Station, California, USA

Scientific Leaders: Steve Lipshie and Gary Ernst

Who Should Attend? Professional and amateur geologists interested in geology. A basic background in geology is required. Min.: 10; max.: 25.


Included: All hotels, transportation, all entrance fees, most meals, and guidebook. Not Included: Airfare to and from Reno, Nevada, and some meals. Find flight info and our cancellation and refund policy at www.geoventures.org.

Trip Overview: We will start and end our tour in Reno, Nevada, USA. For the first three-and-a-half days, we will explore the Quaternary geology of the east-central Sierra Nevada region of California. This region is surrounded by spectacular scenery at the boundary between the Sierra Nevada and the Great Basin. We will see Pleistocene glacial moraines and lakes and volcanic deposits that erupted during and between glaciations. At Mono Lake, we will walk amongst the tufa deposits that are still being formed today. Farther south, we will walk on lava domes and craters that are less than 700 years old and visit the classic columnar jointing at Devils Postpile National Monument. The trip includes stops to view the air-fall ash and ash-flow units within the Bishop Tuff, the product of a catastrophic eruption 760,000 years ago that produced the Long Valley caldera and spread ash as far east as Nebraska. Within the caldera, we will visit hot springs and look at the resurgent rhyolite dome that formed after its collapse.

The last two-and-a-half days of the trip will focus on the structural, stratigraphic, igneous, and metamorphic geology of the White-Inyo Range, across the Owens Valley from the Sierra Nevada. We will explore the uppermost Proterozoic and lowermost Paleozoic sedimentary rocks and late Mesozoic plutonic rocks of the region and enjoy some magnificent views of the east-facing Sierra Nevada escarpment. At Devils Gate, we will see disharmonic folding and local faulting on an impressive scale. We can also expect to find abundant Cambrian trace fossils, especially abundant worm tracks, and possibly even the ever-elusive, shy, and retiring trilobite. In the White Mountains, we will walk among stands of ancient...
Scientific Program and Itinerary: The first half of the trip emphasizes the Quaternary volcanic history of the Long Valley caldera and surrounding areas and addresses the glacial history and geomorphology of the region, including (1) the relationship between the silicic volcanism of the Long Valley magma chamber and the mafic volcanism of the region; (2) the presence of other, younger sources of silicic magma in the region, with visits to examples of these younger silicic lavas, some of them younger than the Magna Carta; (3) we will also visit geothermal features, both ancient and active, including hot springs, fumaroles, and zones of hydrothermal alteration (including a stop at a kaolinite mine—bring your sunglasses!). The second half of the trip emphasizes the pre-Cenozoic structure and stratigraphy of the White-Inyo Range, with observations, study, and review of (1) a number of the upper Proterozoic and Lower Cambrian formations in the range; (2) contact relationships between some of the sedimentary formations on the outcrop; (3) intrusive bodies of late Mesozoic granitic magma; (4) the broad structure of the White-Inyo Range along with some of the smaller folds and faults along the way; and (5) geologic and topographic control on the distribution of ancient bristlecone pine groves and other characteristic botanical associations in the White-Inyo Range. More information and a detailed daily itinerary are posted on the GeoVentures Web site, www.geoventures.org.

Scientific Leader: Steve Lipshie. Steve, who has a B.S. degree in geophysics from Caltech and M.S. and Ph.D. degrees in geology from the University of California at Los Angeles, has worked off and on in the eastern Sierra region between Bishop and Mono Lake since 1972. He has taught or co-taught summer field geology camps in California and New Mexico and has done field mapping in California and Alaska. For the past 17 years, he has worked as an engineering geologist with the Los Angeles County Department of Public Works, and he periodically teaches engineering geology at California State University–Northridge. He has also taught geology and geophysics courses at North Carolina State University and Iowa State University. In 1976, he wrote a guidebook to the Long Valley–Mono Craters region; this guidebook, revised in 2001, will be used for the first half of this GeoVentures trip.


Questions about the agenda? Concerns about accessibility? Contact Wesley Hill, whill@geosociety.org, +1-303-357-1005. GSA is committed to making this program accessible to all people interested in attending.

Questions about the science? Contact Steve Lipshie at slipshie@ladpw.org.

Check the January issue of GSA Today to learn about four other exciting GeoVentures trips (to Alaska, Arizona, China, and Montana), or go to www.geoventures.org to read more.

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Signature (print name)

MAIL OR FAX REGISTRATION FORM AND CHECK OR CREDIT CARD INFORMATION TO:

2007 GSA GeoVentures, GSA Sales and Service
P.O. Box 9140, Boulder, CO 80301
Fax: +1-303-357-1071

MAKE CHECKS PAYABLE TO: GSA GeoVentures
The Department of Earth and Environmental Sciences (EES) at the University of New Orleans invites applicants to fill a tenure-track position as an Assistant Professor in the field of Petroleum Geology anticipating starting in the 2007 calendar year. EES is particularly interested in an individual whose work focuses on coastal wetland and environmental sciences in the heartland of America’s energy coast, Louisiana’s Mississippi River delta.

For an expanded description of the position, contact Victor Mossotti at mossotti@usgs.gov, or learn on how to apply on www.usgs.gov/ohr/oars/, or contact Rob Hosinski at rhosinski@usgs.gov. The USGS is an Equal Opportunity Employer.

DEPT. OF EARTH AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF NEW ORLEANS

TENURE-TRACK FACULTY POSITION
PETROLEUM GEOLOGIST

The Department of Earth and Environmental Sciences (EES) at the University of New Orleans invites applicants to fill a tenure-track position as an Assistant Professor in the field of Petroleum Geology anticipating starting in the 2007 calendar year. EES is particularly interested in an individual whose work focuses on coastal wetland and environmental sciences in the heartland of America’s energy coast, Louisiana’s Mississippi River delta.

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Briar, VA 24595, USA, ralexander@sbc.edu. Application review begins February 16, 2007. EOE.

**POSTDOCTORAL RESEARCH ASSOCIATE**

CUIAR/UNIVERSITY OF ARIZONA/PENN STATE

We are seeking a Postdoctoral Research Associate for an interdisciplinary study of wildfire in the geologic record using thermochronology, organic geochemistry, mineralogical, and petrographic approaches to understanding the timing and climatic correlates of fire. PhD in Earth Sciences, Geology, Geography, or related field required. Applicants please apply online through the University of Arizona Human Resources Web page at https://www.uacareertrack.com/ for job number 36884. In addition to the electronic submission of the letter of interest and CV, please send a statement of research and contact information for at least three references to reinersr@email.arizona.edu. Please refer to Job Number 36884. Review of applications will begin January 2007 and continue until the position is filled. The University of Arizona is an EEO/AA Employer-M/W/D/V.

**KEAN UNIVERSITY**

DEPARTMENT OF GEOLOGY AND METEOROLOGY

Department of Geology and Meteorology—to teach introductory and advanced courses in geography and earth sciences, participate in interdisciplinary programs for the Urban Ecosystem Study initiative. Ph.D. in Physical Geography required, with an interest in urbanization, water or natural resources. The Department offers degrees in Geography, Meteorology, Earth Systems Science, and General Earth Science with Teacher Certification. Knowledge and teaching expertise in geovisualization/spatial decision support for the spatial, social and environmental sciences desirable. Position begins 1 September 2007. Send letter of interest, CV, & 3 letters of reference to Dr. Robert Metallo, Chair, Department of Geology and Meteorology at Keaton Building, Kean University, 1000 Morris Ave, Union, NJ 07083, USA.

**VISITING YOUNG SCIENTIST**

DARTMOUTH COLLEGE

Visiting Young Scientist: A visiting appointment for a young scientist, recent Ph.D., is available at Dartmouth College. The appointment would be for 3 months during late academic 2006-2007 or academic ’07-’08. The position would include teaching in one of the following Departments: Physics and Astronomy, Engineering, or Earth Sciences. The appointment is possible for sponsored research projects. To qualify, candidates must be engaged in research related to space science, planetology, exobiology, planetary geology, remote sensing, space technology, or space technology dependent on space-based platforms. To apply, send a 1-2 page summary of teaching and research goals, curriculum vita, and a statement of your professional training. Send an electronic copy of your application to: Dr. Daniel Altschuler, Dartmouth College, 6105 Firehouse Hall, Hanover, NH 03755-3571, USA.

**VISITING ASSISTANT PROFESSOR OF GEOLOGY**

CENTENARY COLLEGE OF LOUISIANA

Centenary College of Louisiana invites applications for a two-year visiting assistant professor or instructor level in the Department of Geology, beginning August 2007. We are seeking candidates who are interested in teaching physical and historical geology in a liberal arts environment and involving undergraduate students in research experiences. Recent Ph.D.’s and ABD’s are encouraged to apply. Teaching responsibilities will depend on the background of the successful candidate but should include at least one course in Physical Geology, Environmental Geology, Historical Geology, and Sedimentary Geology; a special topics course in the successful candidate’s field of expertise; and one or more introductory courses. Applications should include a letter of introduction, curriculum vitae, three letters of recommendation, teaching and research statement, and a statement of teaching philosophy. Send all materials to: Dr. Scott Vetter, Chair, Department of Geology and Geography, Centenary College of Louisiana, P.O. Box 41185, Shreveport, LA 71134-1188, USA. Review of applications will begin 1 March 2007. Centenary College of Louisiana recognizes that diversity is essential to its goal of providing an educational environment where students explore the unfamiliar, invent new approaches to understanding, and connect theory, work, and lives to the world at large. We thus welcome applicants who would add to the college’s diversity of ideas, beliefs, experiences, and cultural background. EOE.

**INTERDISCIPLINARY RESEARCH GEOLOGIST**

(SPACEALYST)

U.S. GEOLOGICAL SURVEY

SPOKANE, WASHINGTON, USA

The U.S. Geological Survey is seeking a full-time, term Research Geologist to work jointly with research-funded faculty in Spokane, Washington. The Spokane office conducts interdisciplinary research that includes spatial analysis of geological, mineral resource, mineral-environmental, lithological, biological, climatic, and other data. We are seeking a highly motivated, intellectually-curious individual willing to adapt to new research questions that may be outside their professional training.

The successful candidate will analyze spatial phenomena and construct spatial and temporal models to develop a process-based understanding of earth systems. The research candidate must have strong design, building, and using spatial and statistical or other mathematical models to analyze spatially-referenced data. A level of experience commensurate with a Ph.D. in earth sciences, spatial analysis, mathematics, physical geography, or other natural sciences is required. Extensive analytical experience in data handling is required.

The position is a four-year term with option to extend to five. Starting salary will range from $63,417 to $80,442, plus benefits. Recruitment incentive may apply. Must be a U.S. citizen. A complete description and application can be found at: www.usgs.gov/oh/oars/ as announcement WR-2007-0148. The opening date for application is 22 Jan. 2007 and closing is 21 Feb. 2007. For information about the position, contact Tom Frost at tfrost@usgs.gov. For information on how to apply, contact Rob Hosinski at rhosinski@usgs.gov. The USGS is an Equal Opportunity Employer.

**U.S. GEOLOGICAL SURVEY**

DISTINGUISHED PROFESSORSHIP IN GEOPHYSICS

The Department of Geology and Geophysics at the University of Wyoming invites applications for a Distinguished Professor of Geophysics. This is an endowed Chair position in the Department and in the newly created School of Energy Resources (SER) at the University of Wyoming, an institute dedicated to energy-related teaching and research in support of state, national, and international energy-related activities. This appointment may be made at any rank, including Associate and Full Professor. The position can begin as soon as July 1, 2007.

We seek an internationally recognized individual who has the potential to develop an externally funded research program in reservoir imaging using 3-D seismic technology and/or reservoir characterization using petrophysical techniques. The successful candidate will be involved in the undergraduate and graduate teaching mission of the Department of Geology and Geophysics, and will complement and expand on departmental strengths not only in geophysics, but also in areas including structural geology/tectonics, sedimentary geology, and environmental geology. We seek a person with the ability to cooperate productively with other SER professors in geology and geophysics, mathematics, chemical and petroleum engineering, economics, and other energy-related fields. The SER is an ambitious, new state-funded institute that requires innovative, forward researchers with the ability to produce benefits tangible to SER stakeholders and supporters. Information about the School of Energy Resources is available at uwyo.edu/SER. Additional information on the Department Geology and Geophysics can be obtained at home.gg.uwyo.edu.

Applications should include a statement of research and teaching interests and accomplishments, curriculum vitae, and the names and contact information for three individuals who can provide letters of evaluation. Preference will be given to candidates applying before March 1st 2007 and review of completed applications will begin immediately upon receipt; however, applications will be accepted until the position is filled. Send an electronic copy of your application to: Ms. Carol Pribyl at cprbyl@uwyo.edu; if you have additional application materials to send, please direct them to the Geophysics Search Committee, Department of Geology and Geophysics, University of Wyoming, 1000 E. University Avenue, Dept. 3006, Laramie, WY 82071-0000.

The University of Wyoming is an equal opportunity/affirmative action employer.
Unimin Corporation is the leading producer of industrial minerals in North America with over 45 mining and processing facilities in the United States and Canada. Our products include high-purity quartz, nepheline syenite, glass sands, frac sands, foundry sands and other silica sands. Our customers can be found in the glass, ceramics, plastics, oil service, semiconductor, quartz lighting, plastic, refractories, paint and coatings, metallurgical and construction-related industries. We currently seek a proactive, detail-oriented Geologist for our Ottawa, IL Regional Office.

Reporting to the Manager of Geology, the successful applicant will conduct and manage field geological projects in support of Unimin’s mining facilities. You will learn to complete geological models using MineSight, write reserve evaluations, conduct quality determinations on deposits and conduct hydrology investigations. Utilizing the Company’s field equipment and computer systems, you will perform quality and physical characteristic analyses and help plan future mine exploration.

This position requires at minimum a BS in Geology (Master’s Degree in Geology preferred), or the equivalent through directly related work experience. Previous professional work as a Geologist is a plus. Prior MineSight software work is also a plus.

We offer a competitive salary/benefits package. Please forward resume and cover letter with salary history to: HR Administrator, Job Code STG10, Unimin Corporation, 258 Elm Street, New Canaan, CT 06840. Fax: 203-966-1557. Email: HR-Recruiter@unimin.com

JOSEPH P. OBERING POSTDOCTORAL FELLOWSHIP DARTMOUTH COLLEGE

The Department of Earth Sciences seeks outstanding candidates for the Joseph P. Obering Postdoctoral Fellowship in Earth Sciences at Dartmouth College. This competitive fellowship provides two years of full-time salary and a research allowance, with a third year contingent upon performance and funding. In concert with Dartmouth’s philosophy that scholarship and teaching are inseparable facets of academic life, this fellowship provides recent Ph.D. recipients the opportunity to pursue independent research as well as develop a teaching portfolio. Candidates will be expected to collaborate with one or more Dartmouth Earth Sciences faculty members, taking advantage of existing resources and facilities, and will teach one course (quarter) per year. The starting date is negotiable, but could be as early as 1 July 2007. Details about our program can be found at www.dartmouth.edu/earthsci.

Candidates should submit a CV, statement of research and teaching interests, and three letters of recommendation by 1 March 2007. Applications should be sent by mail to Obering Postdoctoral Fellowship Committee, Department of Earth Sciences, Dartmouth College, 6105 Fairchild Hall, Hanover, NH 03755, USA, or by e-mail to earth.sciences@dartmouth.edu. In addition, applicants should arrange for three letters of recommendation to be sent directly to the above addresses. Dartmouth College is an EEO/AA Employer.

ECONOMIC GEOLOGIST, ASSESSMENTS (RESEARCH GEOLOGIST) U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey is seeking a full-time, term Economic Geologist, Assessments in Tucson, Ariz., or Mielo Park, Calif.

The main purposes of this position are to conduct mineral resource and geologic investigations that support mineral resource assessments, and to collaborate with other scientists in planning, organizing, conducting, and reporting mineral resource assessments, both domestic and foreign, that range in scope from local to national. The emphasis is in mineral resource and geologic investigations on is improved assessment of concealed mineral resources. A level of experience commensurate with a Ph.D. in earth sciences is desired.

The position is a four-year term with option to extend to five. Starting salary will range from $62,291 to $84,713 plus benefits, depending on experience and location. No relocation expenses will be available. Candidates must be U.S. citizens. The job will be listed on the USGS Online Announcement System (OAQS) Website as a Research Geologist GS-1350-12/13 under announcement number WR-2007-0141. The opening date for applications is 15 Jan. 2007 and the closing date is 14 Feb. 2007. For additional information about the position, contact Bob Kamilli at bkamilli@usgs.gov. For information on how to apply, contact Rob Hosinski at rhosinski@usgs.gov. The USGS is an Equal Opportunity Employer.

HYDROLOGY FACULTY AT NM TECH

Assistant Professor of Hydrology
New Mexico Institute of Mining and Technology invites applications for a tenure-track position in the Hydrology Program. The position is a joint appointment between the Department of Earth and Environmental Science and the Geophysical Research Center, a state-funded research agency.

Applicants should have a Ph.D. in Earth Sciences, Civil or Environmental Engineering, or a related field at the time of appointment. We seek candidates with interest in combining hydrological modeling and field studies. Areas of particular interest include, but are not limited to, hydrogeology, karst hydrology, sedimentary basin hydrology, and hydrological remote sensing/GIS. Potential for excellence in teaching and research are the most important qualifications. Women and underrepresented minorities are encouraged to respond. Responsibilities include developing an active program of extramurally funded research, supervising and supporting graduate students, and teaching graduate and undergraduate courses. Salary is competitive.

The successful candidate will join a program of six full-time Hydrology faculty, eight adjunct faculty, and 30 graduate and undergraduate students. Additional geoscience professionals on campus include over 30 staff members of the Bureau of Geology and Mineral Resources, New Mexico’s geological survey. For more information on the position and on New Mexico Tech see www.ees.nmt.edu/professional_ops.html

For detailed inquiries, contact search committee co-chairs, Fred Phillips (philipps@nmt.edu) and/or Enrique Vivoni (vivoni@nmt.edu).

Applicants should submit a letter of interest, resume, a statement of teaching and research interests, and names of three references to Hydrology Search, Human Resources, Box 586, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801, USA. College transcripts will be required if selected to interview. Applications will be reviewed as received. Email applications are not accepted. New Mexico Tech is an equal opportunity/affirmative action employer.

TENURE-TRACK PROFESSOR, UNION COLLEGE

The Geology Department at Union College seeks to fill a tenure track line at the Assistant or Senior Assistant Professor level in Petrology/Structure with an anticipated start date of September 2007. We seek a dynamic teacher and scholar capable of teaching introductory geology courses as well as two or three of the following areas: Petrology, Mineralogy, Geochronology, Structure, Geophysics, Tectonics, and Economic geology. Candidates should have a Ph.D. or Joint Ph.D. in the area of research and will be expected to develop a research agenda that builds on the established programs of extramurally funded research, supervising and supporting graduate students, and teaching graduate and undergraduate courses. Salary is competitive.

The Department of Earth and Environmental Science is a member of the Keck Geology Consortium, and is very well equipped with geological and geophysical instrumentation that includes an ICP-MS, two ion chromatographs, fission track lab, a wide variety of sample prep and geophysical equipment, core analysis lab, and a new SEM system (Hitachi and CL). The Geology Department has a strong record of student-faculty research. More information about Union College is available on the Web at www.union.edu.

We will begin reviewing applications starting on 1 March 2007. To apply, please send a cover letter along with resume, list of publications, teaching, and research statements, and a list of contact details for three references. Send application material to: John I. Garver, Chair, Department of Geology, Union College, 807 Union St., Schenectady NY 12308-2311, USA.

Union College is an equal opportunity employer and strongly committed to student and faculty diversity.

BELOIT COLLEGE

VISITING ASSISTANT PROFESSOR OF GEOLOGY GEOMORPHOLOGY/PALEOClimatology

Beloit College invites applications from candidates to fill a one-year, full-time, one-year sabbatical replacement, beginning August 2007. The position will have a 2-course teaching load and be available for teaching during both semesters with two offerings of an introductory course in environmental geology, and two courses from the following: geomorphology, paleoclimatology, and interdisciplinary applications of GIS. The successful candidate will also be expected to supervise undergraduate research projects. The Geology Department is a member of the Keck Geology Consortium.

Applicants should have a Ph.D. by the time of appointment. Send a letter of application, a statement of teaching and research interests, vita, college-level transcripts, and 3 letters of reference to Carl Mendelson, Geology Search Committee, Beloit College, 700 College St., Beloit, WI 53511, USA. This position will be advertised until filled. Candidates should submit materials by 1 March 2007. Inquiries may be directed to Prof. Mendelson (+1-608-363-2223 or mendelson@beloit.edu). More information about the department may be found at geology.beloit.edu.

Beloit College is committed to the educational benefits of diversity and urges all interested individuals to apply. AA/EOE Employer.

FEBRUARY 2007, USA TODAY
This volume presents current understanding of the mechanisms and environments of the formation of calcretes and palustrine carbonates. Through a series of specific field examples, papers in this volume illustrate the wide variety of potential applications of these types of deposits. The papers presented here cover a wide array of ages and environmental settings of calcrete and palustrine deposition and include many interesting applications, such as the climatic and geomorphic controls on calcrete formation, possible modern analogues for palustrine carbonates, the interplay between palustrine, pedogenic, and diagenetic processes, the utility of radio-isotopic methods for dating pedogenic carbonates, applications to understanding landscape evolution, and reconstruction of diagenetic sequences. The result is a state-of-the-art book on these deposits so common in the geological record and in recent environments.


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