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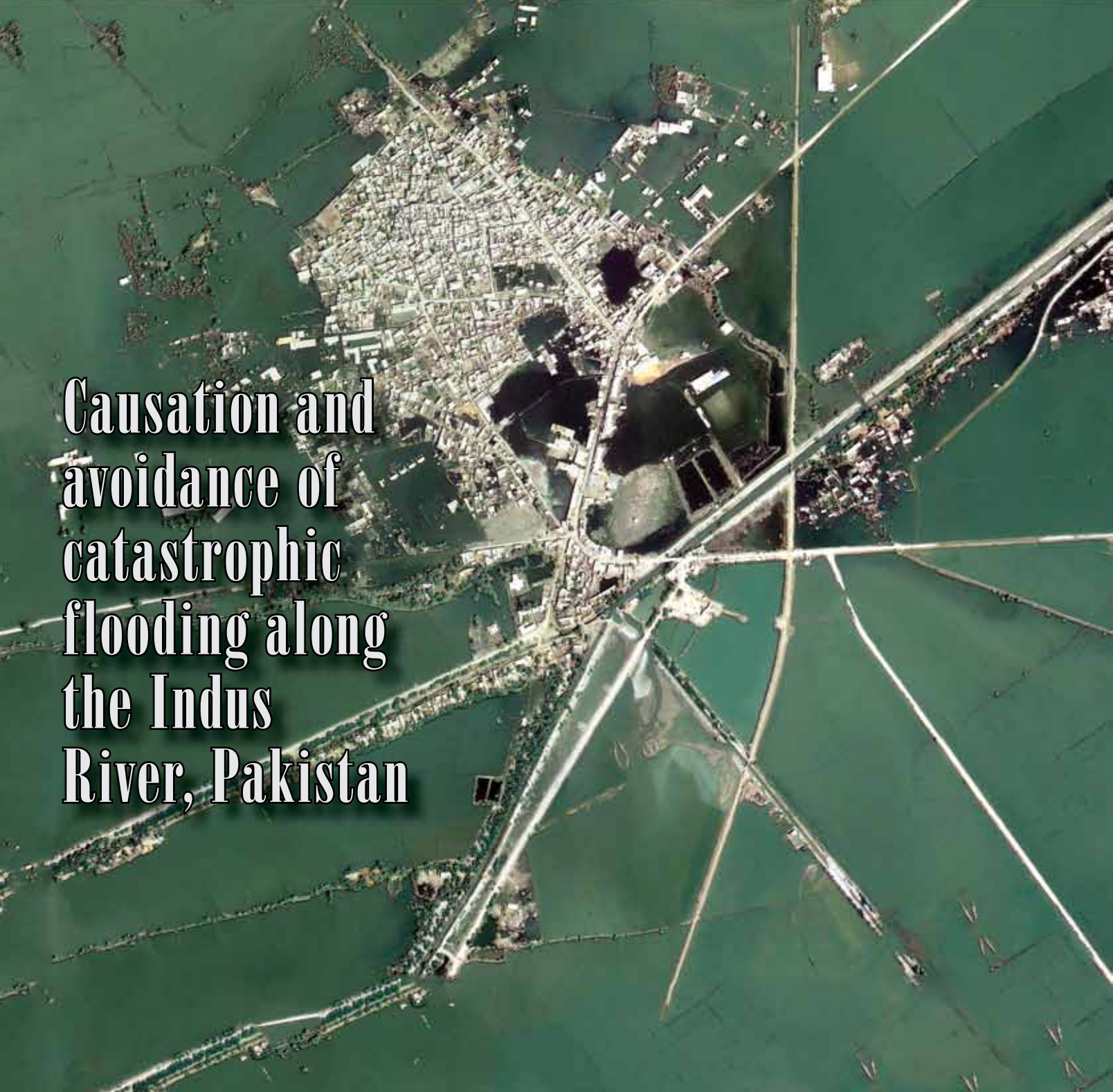
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An aerial photograph showing a city grid partially submerged in floodwater. The water is a dark, murky green. The city buildings and streets are visible in the center, surrounded by the flood. A large, dark, irregular shape, possibly a reservoir or a large building, is visible in the middle of the city. The river is visible on the right side of the image.

Causation and avoidance of catastrophic flooding along the Indus River, Pakistan

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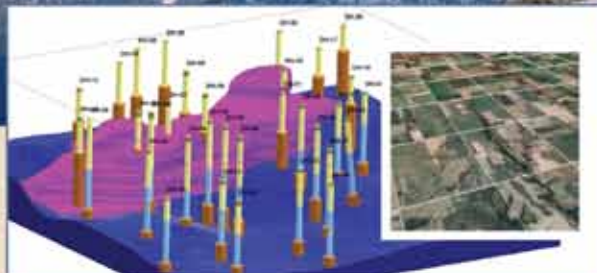


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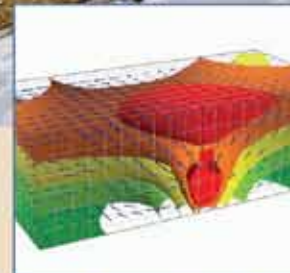
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GSA TODAY STAFF

Executive Director and Publisher: John W. Hess

Science Editors: Bernie Housen, Western Washington Univ. Geology Dept. (ES 425) and Advanced Materials Science and Engineering Center (AMSEC), 516 High Street, Bellingham, WA 98225-9080, USA, bernieh@www.edu; R. Damian Nance, Ohio University Dept. of Geological Sciences, 316 Clippinger Laboratories, Athens, OH 45701, USA, nance@ohio.edu

Managing Editor: K.E.A. "Kea" Giles, kgiles@geosociety.org, gsatoday@geosociety.org

Graphics Production: Margo McGrew

Advertising (classifieds & display): Ann Crawford, +1-800-472-1988 ext. 1053; +1-303-357-1053; Fax: +1-303-357-1070; advertising@geosociety.org; acrawford@geosociety.org

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James P.M. Syvitski and G. Robert Brakenridge

Cover: GeoEye image of the town of Gharhi Khairo with peripheral drowning of buildings, canals, and roads by the northern avulsion of the Indus River, Pakistan, 2010. See related article, p. 4–10.

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Causation and avoidance of catastrophic flooding along the Indus River, Pakistan

James P.M. Syvitski and G. Robert Brakenridge*, *Community Surface Dynamics Modeling System, INSTAAR, University of Colorado, Boulder, Colorado 90309-0545, USA*

ABSTRACT

The catastrophic flood of 2010 along the Indus River began in July with unusually intense but not unprecedented rainfall in the upland catchment. During four months, close to 2,000 fatalities occurred and ~20,000,000 inhabitants were displaced. The meteorological events triggered but did not cause this “natural” disaster. Analysis of multi-temporal remote sensing and topography instead indicates that most damage was caused by dam and barrage-related backwater effects, reduced water and sediment conveyance capacity, and multiple failures of irrigation system levees. The numerous failures extended from upstream areas, where some record discharges occurred, to downstream reaches and the delta, where peak discharges were not extreme. In Sindh, Pakistan, two major river avulsions (sudden changes in flow location) occurred. At one of these (the northern avulsion), Indus water flooded ~8,000 km² of agricultural land to depths of 1–3 m; part of the river flowed 50–100 km west of its pre-flood location. The avulsion was caused by breaching of the Tori Bund, an artificial levee upstream of Sukkur Barrage, on 6–7 August, two days before arrival of the first flood crest and long before attainment of peak river flow at Chacharan, 100 km upstream, on 24 August. The early breach, during the rising stages of the flood, permitted much of the incoming flood wave to feed the avulsion over a sustained period.

As was the case for the dramatic and temporary avulsion of the Kosi River, India, in 2008, the lack of planned accommodation to the river’s high sediment load and its super-elevation above the surrounding terrain set the stage for exceptionally dangerous levee failures and channel avulsions. Major translocations of river flow will continue to occur during large flood events whether flood warning is improved or not. The observed dynamics indicate that reinforcing the existing engineering structures is not a sustainable strategy for avoiding future flood catastrophes. Instead, planning for major water and sediment flow diversions is required for effective flood control along the Indus and other sediment-rich and avulsion-prone rivers.

INTRODUCTION

Following the Great Flood of 1993 along the Upper Mississippi River, USA, orbital remote sensing has been increasingly employed to investigate inundation dynamics (Brakenridge et al., 1994, 1998;

O’Grady et al., 2011). Here, we analyze data from a suite of orbital sensors to track the 2010 Indus River flooding at high spatial resolution and frequent temporal sampling. The Shuttle Radar Topography Mission (SRTM) provides topography at 90 m spatial and ~1.3 m vertical resolution; the data were collected in February 2000, during the dry season when the Indus River was at an extreme low stage (Digital Elevation Model [DEM]; see GSA Supplemental Data¹). GeoEye data show surface water changes finer than 1 m; the MODIS sensor revisits twice daily at much coarser spatial resolution and AMSR-E provides independent monitoring of river discharge changes. The analysis demonstrates why the 2010 Indus River flood was catastrophic and what approach must be taken to avoid future flood disasters along this and other rivers in similar geological settings.

HYDROMETEOROLOGICAL CONTEXT OF THE 2010 FLOOD

The Pakistan flooding, July–November 2010 (DFO event 3696) caused close to 2000 fatalities, displaced 20,000,000 inhabitants for weeks to many months, and was 7.5 on a duration–area affected–intensity scale that compares flood magnitudes on a global basis (Chorynski et al., 2012; Brakenridge, 2012). Flooding along the Indus River began in mid- to late July following unusually heavy monsoonal rain in northern Pakistan and was sustained in downstream areas through the end of 2010 (Fig. 1). Exceptional damage was inflicted on crops and cropland and on agriculture support systems such as canals and levees; 4,500,000 mainly agricultural workers lost their employment for 2010–2011 (Khan, 2011).

The Indus is monsoon-driven and Himalayan snow-fed, and drains an area of 970,000 km². Historically, its average coastal discharge was ~3000 m³/s; with diversions and agricultural use, this discharge has fallen to 300 to 800 m³/s with long periods of no flow (Asif et al., 2007). Until recently, the river carried very high sediment loads to the sea, but dams and diversions have reduced coastal delivery by 10 times (Milliman and Syvitski, 1992). Entering Sindh Province from the north, a meandering channel is constrained within the 15- to 20-km-wide floodplain by engineered artificial levees or “bunds” (Fig. 1). Bordering both sides of this modern floodplain lie the >200-km-wide “historical floodplain” lands that have experienced prior changes in the location of the channel and meander belt. Thus, except far upstream, the Indus River flows through a 5 Ma alluvial landscape of its own making (Clift and Blusztajn, 2005; Giosan et al., 2012). The ongoing sedimentary and erosional processes are mediated by the basin’s monsoon- and

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*Corresponding author e-mail: g.robert.brakenridge@colorado.edu

¹GSA Supplemental Data Item 2013073, precipitation data, flood inundation chronology, river discharge, and digital elevation model, is online at www.geosociety.org/pubs/ft2013.htm. You can also request a copy from GSA Today, P.O. Box 9140, Boulder, CO 80301-9140, USA; gsatoday@geosociety.org.

snowmelt-driven hydrometeorology and by continuing uplift of the Himalayan orogen, forming its highest topography to the north, and by sediment compaction and subsidence downstream and in the delta.

Some aspects of the 2010 monsoonal rains were unusual (Houze et al., 2011). July–August precipitation totals were above average but not exceptional for Pakistan as a whole (Precipitation; see GSA Supplemental Data [footnote 1]). However, northern Pakistan rainfall rates during monsoon storms were extreme compared to 1998–2010, and there were unusually frequent downpours (Webster et al., 2011). The Supreme Court Inquiry

Commission report notes: “Beginning 27th July, an unusual convergence of easterly NW system was noted over north western Pakistan ... with westerly Arabian sub-tropical winds forming a static jet for almost 48 hours. ... By 30th July rains had generated raging floods” (Khan, 2011, p. 85). The Khyber-Pakhtunkhwa region, far upstream along the Indus, experienced unusually high rainfall totals: >300 mm for 27–30 July (Supplemental Data Fig. S1). The Punjab, Gilgit Baltistan, and Azad Kashmir provinces that commonly receive monsoon deluges include stations with July 2010 rainfall totals of >500 mm. Pakistan-wide August rainfall totals were 75% of July totals. The flood wave then moved downstream into drier areas during the months-long catastrophe: Sindh Province suffered the worst of the flooding but received relatively little rainfall throughout the monsoon. The downstream regions had weeks of advance notice of the expected high Indus discharges, yet exceptionally high damage still occurred.

The flood involved the Indus River and its tributaries Jhelum and Chenab. At four sites along the lower portions of the river, in Sindh, Punjab, and Balochistan, we use passive microwave remote sensing calibrated by hydrological modeling to estimate peak discharges and measure their times of arrival (Supplemental Data Figs. S5 and S6). The peak flows were larger than other, similarly measured twenty-first-century floods (period of record 2002–2010) but not exceptional compared to late twentieth-century events. Thus, upstream at Guddu Barrage, estimated peak flows of 33,970 m³/s occurred on 15 August 1976; 33,200 m³/s on 13 August 1986; and 32,920 m³/s on 31 July 1988. At Sukkur Barrage, downstream, estimated peak flows of 33,030 m³/s are recorded for 15 August 1986; 32,880 m³/s in 1976; and 31,680 m³/s for 31 July 1988 (Akhtar, 2011). These compare with the ground-based estimates for 2010 at Guddu of 32,530 m³/s on 8–9 August, and at Sukkur of ~32,000 m³/s on 9–11 August for peak flow (Government of Pakistan, 2011, p. 28). Flow lost at upstream breaches is, in both cases, not included.

According to our independent estimates, the flood wave crested ~100 km upstream at Chacharan (site 2009; Supplemental Data Fig. S6B) at 35,000 m³/s on 24 August. Meanwhile, the discharge at Ghauspur (site 2008; Fig. S6a) never

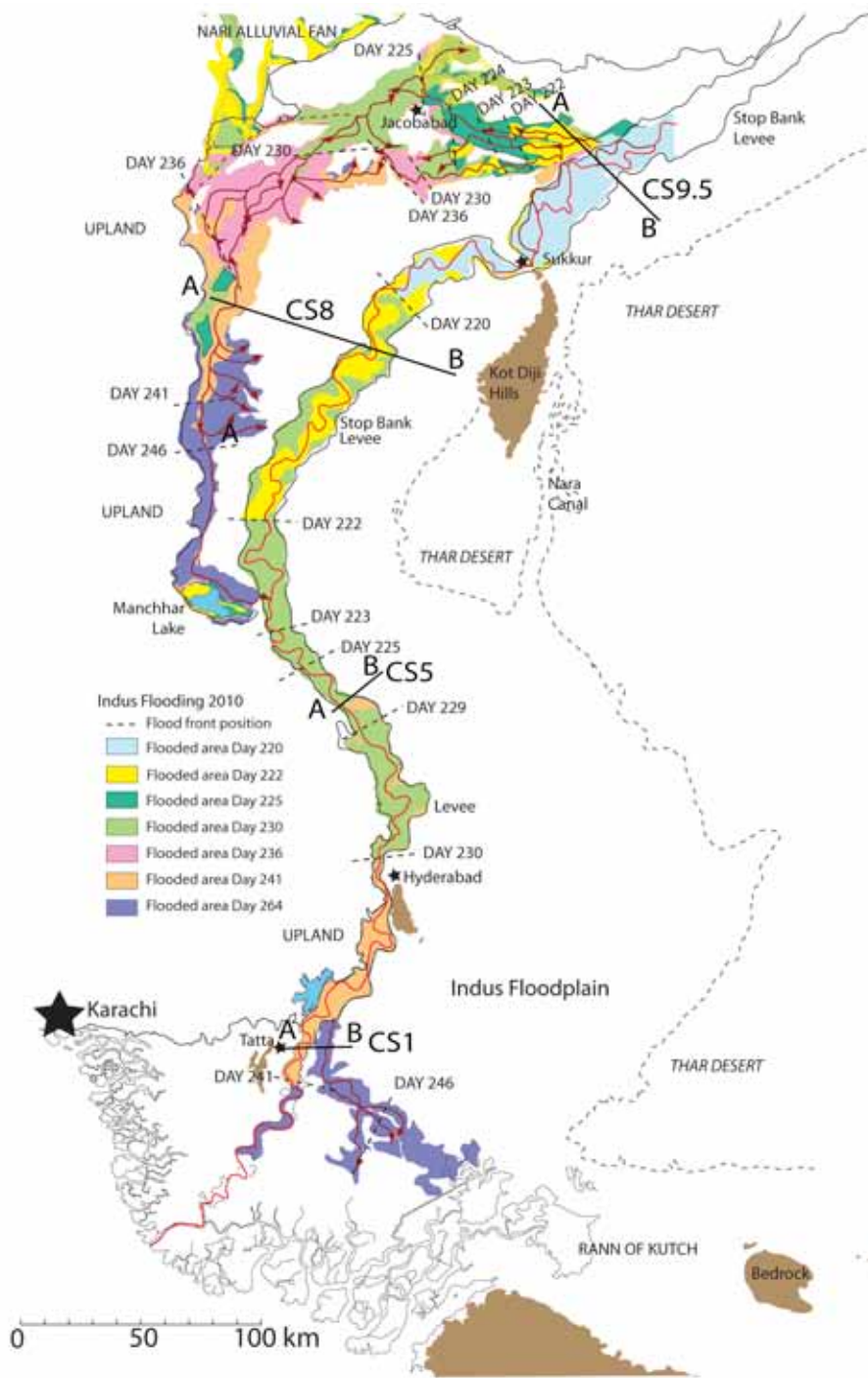


Figure 1. Summary map showing the progress of the 2010 Indus flood wave and its two main avulsions, key features, and towns. Arrows show the direction of overbank floodwater as determined by progressive inundation from the remote sensing data (see Flood Inundation and Chronology, GSA Supplemental Data [text footnote 1]). Day 222 is 10 August 2010. See Figure 3 for data on profiles CS1, CS5, CS8, and CS9.5.

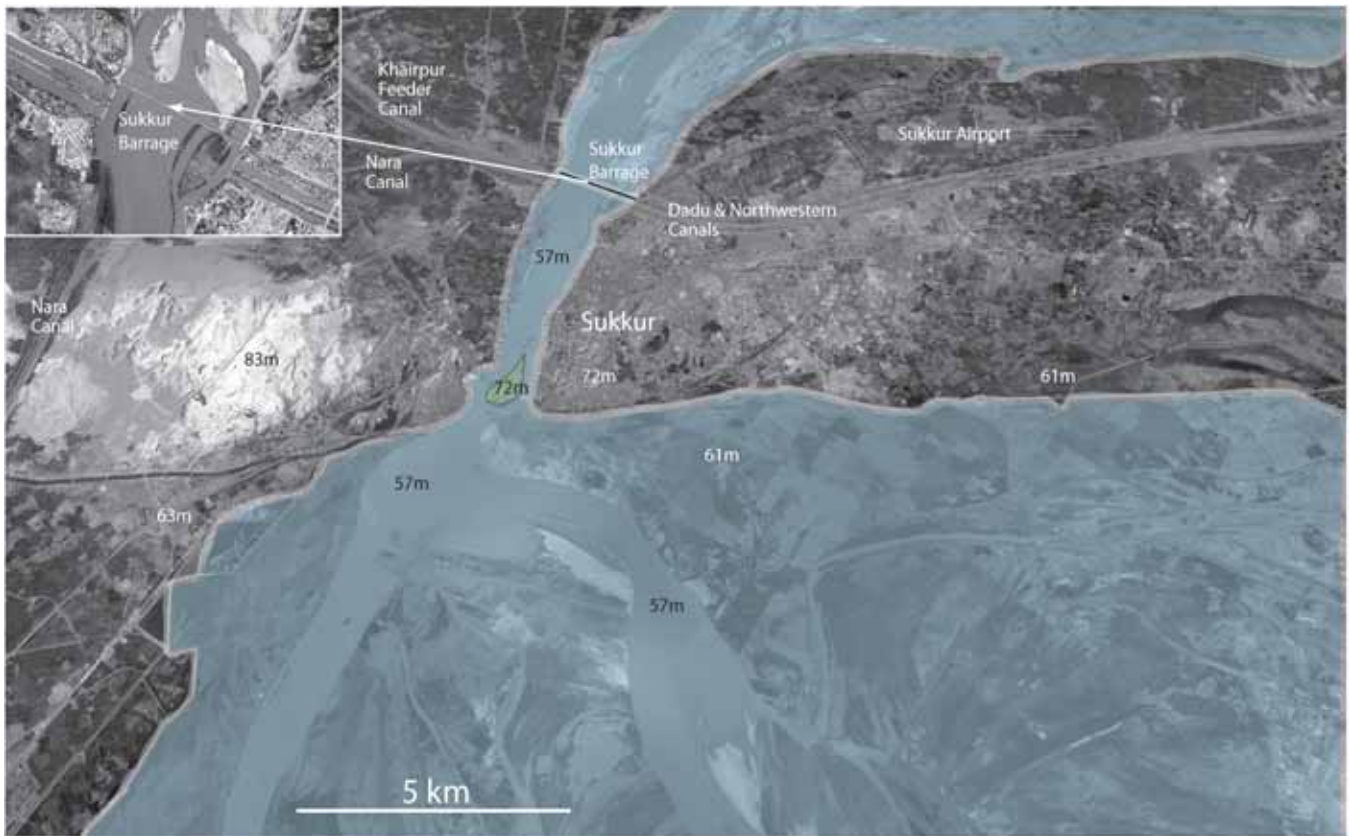


Figure 2. The modern Indus floodplain (south is top; west is right) facing the town of Sukkur, which is situated on a bedrock surface 10 to 15 m above the locally confined river channel. The Sukkur Barrage diverts up to 50% of the Indus discharge via a series of feeder canals (Nara, Khaipur, Dadu, Northwestern). On this ASTER image, the 2010 floodwaters are shown in transparent gray, contained by stop banks outlining the modern Indus floodplain. The narrow constraint of the natural mini-gorge together with the barrage causes advancing floodwaters to slow and rise upstream (bottom of image), thus increasing local sediment aggradation.

exceeded 25,000 m³/s, due to the breaching of nearby levees, including the Tori Bund on 6–7 August, and the diversion of ~7000 m³/s onto the surrounding agricultural lands (Fig. 1). Levee breaching began at only ~20,000 m³/s, a level reached every few years; levee overtopping was not the primary cause (Khan, 2011, p. 16). This “northern avulsion” (described in the following section) near the city of Sukkur occurred 17 days before peak of flooding upstream at site 2009. By the time of arrival of the flood crest, the northern avulsion breach had already been scoured to a depth allowing direct access to the river (Flood Inundation Chronology, Supplemental Data).

Our remote sensing findings agree with depositions to the Pakistan Supreme Court during its investigation of the flood: “In essence, he deposed that in record high 1976 floods, 1.2 million cusecs (33,980 m³/s) of water passed Indus at Guddu Barrage without breaching Tori Bund; in 1996, only 500,000–600,000 cusecs (14,158 m³/s–16,990 m³/s) caused it to breach, that was repeated during 2010” (Khan, 2011, p. 34). Also, the Annual Report of Pakistan’s Federal Flood Commission states that exceptionally high flows began entering Guddu Barrage, upstream of the Tori Bund, on 5 August, that the first high peak of this flood event occurred at Guddu on 8–9 August, and that it arrived at Sukkur Barrage on 9–11 August (Government of Pakistan, 2011, p. 34–35).

It is also clear that the relevant government ministries did not have adequate information as they attempted to respond:

“Actual arrivals on 7/8th August of 1,148,700 cusecs (32,528 m³/s) at Guddu Barrage far exceeded the formulae-based departmental projections of 850,000 cusecs (24,070 m³/s). By then, the Tori Bund breach was already allowing a new course for the flooding Indus far to the west. This avulsion was afterward fed by continuing rising floodwater, including a new peak traversing between Guddu and Sukkur 14–17 August” (Government of Pakistan, 2011, p. 36). Breaching of the downstream Aliwahan levee, on the east bank, did not occur (this levee had been purposefully breached during the 1976 flooding); pressure on the Aliwahan levee must have been reduced by the Tori breach. In the course of this large flood event, the only downstream damage mitigation possible was spilling of excess floodwater upstream.

NON-METEOROLOGICAL CAUSES OF THE DISASTER

We offer here a geomorphological perspective on this flood catastrophe. The remote sensing data (Flood Inundation Chronology, GSA Supplemental Data [footnote 1]) agree with many of the findings reached by in-country water ministries (Khan, 2011), and this information does not support exceptional weather phenomena as the principal cause of the catastrophe. Levee failures led to the northern avulsion (Figs. 1–3), including in particular the 2.7 km break at the Tori Bund. The bund was in poor repair, had failed repeatedly in prior floods, by 2010 had lost 1.7 m from its design height due to erosion and poor maintenance,

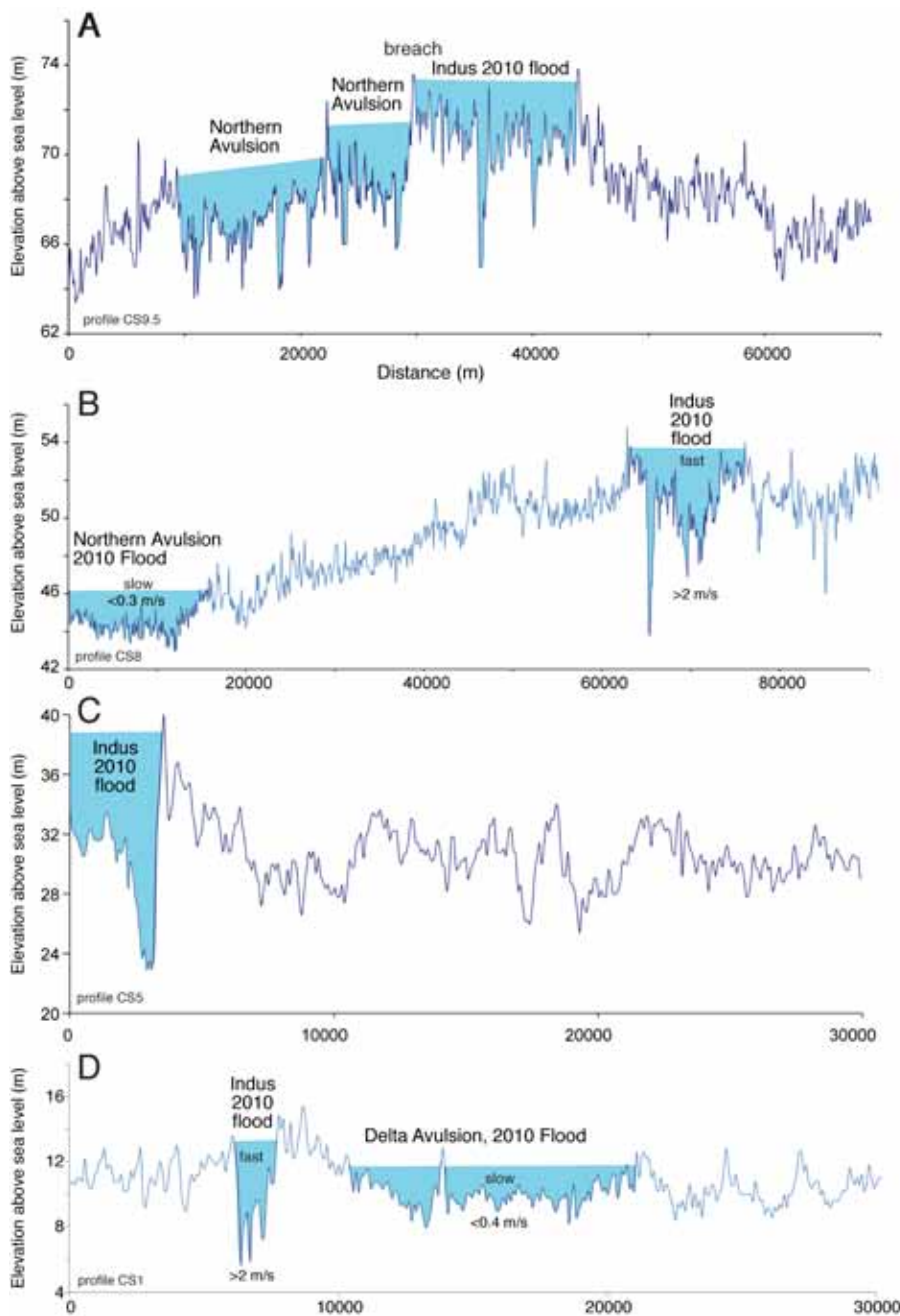


Figure 3. Four SRTM-based topographic sections across the Sindh portion of the Indus floodplain (see Fig. 1 for their locations) showing the maximum 2010 flood heights in blue. Note the different scales for each profile. (A) The backwater-elevated flood waters of the Indus and the northern avulsion breach location. (B) The super-elevated Indus floodplain, above the slower moving northern avulsion floodwaters. (C) Indus floodwaters contained by the levee stop banks. (D) The river flowing quickly beside the slower moving southern (delta) avulsion.

and was breached in advance of flood crest arrival. Attempts to repair the failures during the flood involved local removal of more levee height to fill pits developed in the riverward side of the levee (6–7 August). As the flood wave reached this location, its failure, and river avulsion to the west (Figs. 1, 4A, and 4C; Supplemental Data Figs. S2, S3, and S4) captured a significant portion of the Indus flow, causing “extensive damage ... and further breaches to the Shahi and Begari canal systems ... many lives were lost and extensive property was destroyed or sub-merged in Naseerabad Division. Jaffarabad District was completely inundated ... floods swept away vast cropped areas leading to declaration of emergency on 14–15 August.” In all, 1,315,342 people in four districts,

including those from Sindh, were directly exposed to the Tori breach, and 97 deaths were reported (Khan, 2011).

Although it directly caused much of the extreme damage, the northern avulsion was not itself a rare event. All major floods along this river have been accompanied by breaches of the levee system and spilling of flood water (Asif et al., 2007; Mustafa and Rathall, 2011). Many breaches have been intentional: The diversion of excess discharge onto agricultural lands in order to protect cities and engineering structures was a standard flood control approach when the area was under British colonial rule (Mustafa and Rathall, 2011). The Tori Bund failed in 1904, 1930, 1932, 1942, 1975, 1976, and 1995 (Khan, 2011); each time, it was rebuilt. The vulnerability of the control structure at this location was known, and its upgrade and repair had been urgently recommended but was not accomplished (Khan, 2011). Its breaching before arrival of the 2010 flood crest is testimony to the critical geomorphological context of flood catastrophes along this river. Tori Bund is an example of a systemic problem. The proximate cause for this flood disaster was the intersection of (1) a suite of ongoing, non-stochastic, and relatively predictable depositional mechanisms exhibited by a confined, sediment-rich river flowing on an alluvial ridge; and (2) the lack of explicit engineering and societal accommodation to these natural geomorphological processes.

IMPORTANCE OF RIVER AVULSION

Of these processes, the potential for avulsion is of most concern. Avulsion (Slingerland and Smith, 2003) is not limited to very restricted reaches of the river, but structural modifications and valley geomorphology may help locate where it occurs and how it affects flood hydrology. For example, downstream of the northern avulsion breach, Indus floodwaters pass through a natural mini-gorge where the Sukkur Barrage, controlling one of the largest irrigation projects in the world, diverts Indus water into feeder canals (Fig. 1). This narrow constraint slowed the floodwaters, caused backwater stage increases upstream (an area of local sediment aggradation; Fig. S3, GSA Supplemental Data [footnote 1]), and helped to localize this breach. The next downstream

monitoring station (Hala; site 2010: Fig. 4C; Supplemental Data Fig. S5B) shows the flood-wave cresting at $\sim 24,000$ m³/s on 24 August and again on 9 September at $\sim 24,500$ m³/s, after northern avulsion floodwaters rejoined the Indus (Fig. 4).

On 27 August, a second major levee breach occurred along the southeast bank of the Indus, far downstream in southern Pakistan near Daro. It occurred at a location that had previously experienced similar changes through recent history and prehistory (Holmes, 1968; Wilhelmy, 1969). Approximately 10,000 m³/s were diverted into a “delta avulsion” (Figs. 1–3) such that at site 2011 (Kotri Allahrakhio), south of that breach, discharge never exceeded $\sim 15,000$ m³/s (Fig. 4D; Supplemental Data Fig. S5A). By 1 September, the delta avulsion had advanced 45 km, flooding the town of Sujawal; however, it lessened the severity of flooding further south in Thatta (see also Erosion and Other Impacts, Supplemental Data).

Similar changes are documented along other sediment-rich rivers (Kale, 2008) and are an inherent feature of such fluvial systems. Avulsion is distinct from crevassing (Slingerland and Smith, 1998), in which levees may be breached or overtopped, floodplains are temporarily occupied by flood water, and coarser overbank deposits are superimposed over finer sediment. Instead, river avulsion may be permanent without human intervention, and the translocation is not confined to the existing meander belt. It is at least a two-step process: (1) sedimentation along a relatively fixed channel bed, over many years of time, elevates such above surrounding terrain (for the Indus, see Supplemental Data Fig. S8); and (2) during floods, breaches in banks and levees allow major shifts of the position of the channel and its meander belt to a new, lower, location, perhaps hundreds of kilometers distant (Figs. 1 and 2). Decades may be required to accomplish a complete avulsion, with repeated floods scouring deeply enough to create a persisting new river channel. Alternatively, the new location may be immediately occupied.

Studies of other river avulsions indicate the importance of local conditions, including floodplain sedimentology and previously occupied channels, in determining the change (Aslan et al., 2005; Jones et al., 1999; Slingerland and Smith,

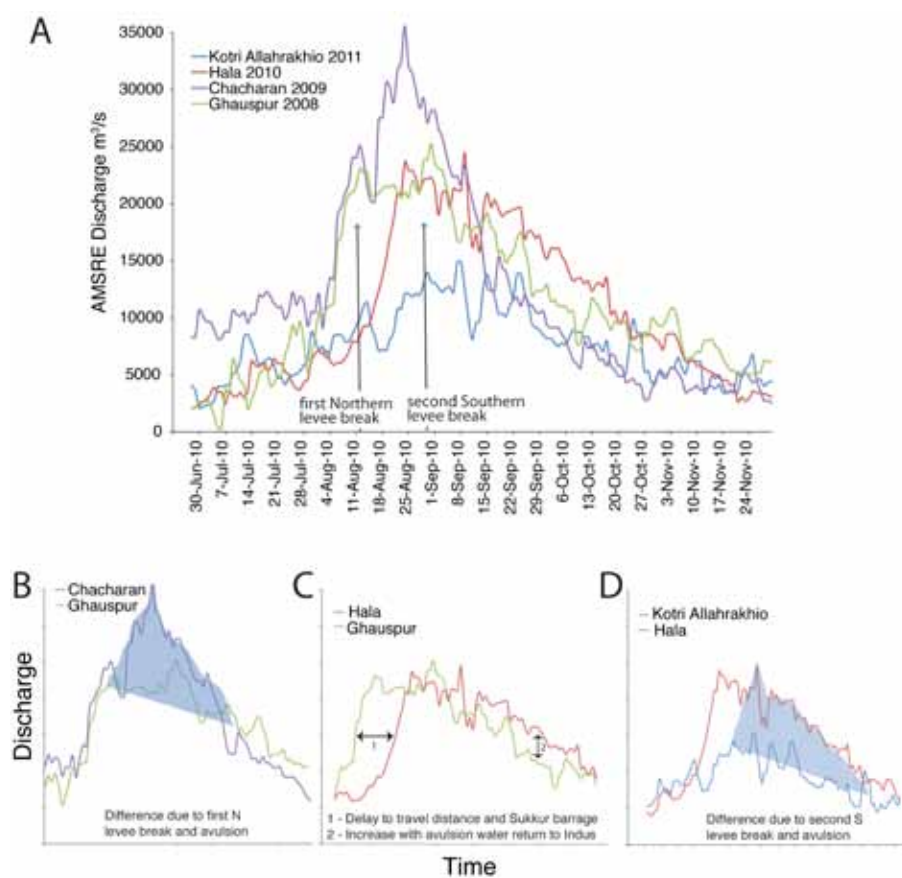


Figure 4. Analysis of the timing and magnitude of the 2010 Indus flood wave at the river measurement sites (see Fig. 1 for locations). (A) Satellite microwave river discharge estimates (see also GSA Supplemental Data Figs. S5 and S6 [text footnote 1]) of the 2010 flood and the northern and delta avulsion levee breaks. The lower figures show detail: (B) Indus flood wave at Chacharan and at Ghauspur just downstream of the northern avulsion point; the magnitude difference is from missing avulsion discharge (see Supplemental Data Fig. S7); (C) between Ghauspur and downstream Hala, located seaward of Lake Manchar; and (D) between Hala and Kotri Allahrakhio, located downstream of the delta avulsion.

1998; Törnqvist and Bridge, 2006). Previous major avulsions of the Indus are documented in history and prehistory, including a river position at B.C. 300 closely similar to that temporarily occupied after the northern avulsion in 2010 (Holmes, 1968; Wilhelmy, 1969). The recent avulsion of the Kosi River in Bihar, India (Kale, 2008), is also a useful comparison. On 18 August 2008, 80%–85% of the Kosi water discharge shifted by ~ 120 km after a levee failed at Kusaha, Nepal, 12 km upstream of the Kosi barrage (Sinha, 2009). The event was the latest of a series along this river (Wells and Dorr, 1987), where even a small flood can trigger an avulsion at sensitive locations (Jones et al., 1999; Sinha, 2009). Long-abandoned Kosi channels may be reoccupied, or new ones carved. As can be the case for the Indus, the 2008 Kosi avulsion occurred during a common high discharge that was less than the design capacity of the engineered levee system (Sinha, 2009). Avulsion to the east occurred even though twentieth- and twenty-first-century aggradation was preferentially on the east: The overall channel is raised compared to adjoining land on both sides, and the structures designed to protect from flooding set the stage for a disastrous event by confining channel and channel-marginal sedimentation to one location over long periods of time (Sinha, 2009). The Kosi avulsion in 2008 caused >400 fatalities and displaced 10,000,000 people (Brakenridge, 2012).

Events somewhat similar to this occurred along the Sindh portion of the Indus in 2010, where the Indus flows along the crest of a convex-upward, ~ 10 – 15 -m-high, ~ 100 -km-wide alluvial “mega-ridge” (Giosan et al., 2012; also see Fig. 3 and Digital Elevation Model, Supplemental Data). After the breach at the Tori Bund, 22% of the river flow was diverted

from the main channel for 37 days. During its occurrence, the avulsion path widened and developed with many merges and splits (Fig. 1). The avulsion progressed down-valley at an average speed of 10 km/d (0.1–0.3 m/s), occasionally becoming delayed at irrigation canal levees and roads. In contrast, the flood wave within the preexisting channel and stop banks traveled at three times this rate. Even after the Indus River no longer fed the northern avulsion (post–1 Oct.), the southerly parts of the avulsion continued to expand, as driven by the topographic gradient and without being confined or channelized by any planned spillway. Indus River water flooded ~8000 km² of agricultural land 50 to 100 km west of the pre-flood river, typically to depths of 1 to 3 m (Fig. 3), along a 354 km travel route (Flood Inundation and Chronology, Supplemental Data). Thus, the extensive damage caused by the avulsions was associated not only with the incoming flood wave and insufficiently strong and maintained levees, but also with the lack of planned spillways—even at sites where breaches were artificially created in the past. Along both the Indus and the Kosi, engineered spillways could have channeled the escaping floodwater, greatly restricted the geographic extent of inundation, and facilitated early warning of the population in danger.

CONCLUSION

The 2010 Indus flood inundated nearly 40,000 km², was exceptionally lethal, caused massive displacement of the population, severely damaged Pakistan's national economy, and nearly depleted the resources of international disaster responders. Remote sensing of this catastrophic flood demonstrates that much damage was directly caused by two river avulsions—the first of which occurred before the flood crest reached the avulsion site. Given the tendency for avulsion, individual levee reconstruction is unlikely to enhance overall flood protection and instead may worsen the risk (any failure of higher levees will be even more catastrophic, and if upstream levees do hold, downstream discharges are increased). Reconstruction of past channel location and the detailed sequence of events in 2010 together indicate a different need for improving flood protection. There is no single stable or equilibrium location for high-sediment load, actively aggrading rivers such as the Indus and the Kosi. Unless the engineering response changes, even modest flood events in the future will continue to pose an increasing risk of exceptional damage.

The lesson of the 2010 Indus floods is that large populations are presently at grave risk, and that it will not be long before future flooding causes similar damage. Other workers have focused on the storm events that led to the Indus flooding and on the need for better prediction of such events and modeling of the resulting flood water (Webster et al., 2011). However, improvements in this area alone will not address the continuing increase in flood risk along sediment-rich rivers such as the Indus. Instead of attempting to permanently fix the channel in its present location during large discharges, planning for temporary channel diversions to spill both water and sediment during floods is necessary. In southern Pakistan, intermittent transmission of Indus floodwater and sediment to the sea, along pathways and spillways designed to protect local populations (Kale, 2008), could also mitigate subsidence and other geological processes that are

increasing vulnerability to coastal flooding caused by ongoing sediment starvation of the delta areas (Syvitski et al., 2009).

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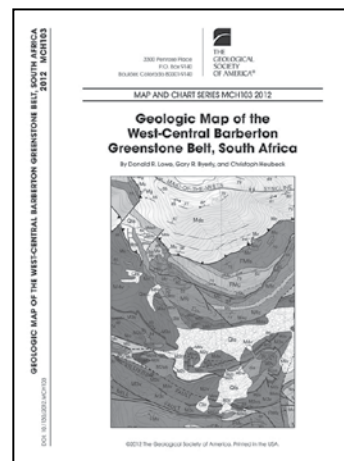
Geologic Map of the West-Central Barberton Greenstone Belt, South Africa

Compiled by Donald R. Lowe, Gary R. Byerly, and Christoph Heubeck

This 1:25,000 map covers 500 km² of Archean rocks in the Barberton Greenstone Belt (BGB), South Africa—the oldest, best-preserved sedimentary and volcanic sequence on Earth. Five major tectonic cycles are represented in the BGB's 3.55–3.22 Ga history—komatiitic volcanism, forming lava plains, begins each cycle, and dacitic volcanism, likely related to an early style of subduction, ends each cycle. These cycles produce small yet stable protocontinental blocks that coalesce by magmatic and tectonic accretion. The BGB rocks provide direct information about the nature and evolution of early Earth and its biota. Carbonaceous cherts occur throughout the sequence, containing microfossils, microbial mats, and stromatolites. Evaporites represent shallow marine environments, whereas ferruginous chert and banded iron formation are indicators of deeper water settings. The BGB also contains a remarkable record of large asteroidal impacts, in eight distal impact layers, each more energetic than the K-T boundary event.

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Northeastern Section Meeting

Bretton Woods, New Hampshire, USA

Shlemon Program in Applied Geoscience: Monday, 18 March
Mann Mentors in Applied Hydrogeology: Tuesday, 19 March



Southeastern Section Meeting

San Juan, Puerto Rico

Shlemon Program in Applied Geoscience:
Wednesday, 20 March
Mann Mentors in Applied Hydrogeology: Thursday, 21 March
Palominito Islet, Puerto Rico. Image courtesy seepuertorico.com.

South-Central Section Meeting

Austin, Texas, USA

Shlemon Program in Applied Geoscience: Thursday, 4 April
Mann Mentors in Applied Hydrogeology: Friday, 5 April
Loop 360 Bridge at Sunset, Austin, Texas, USA. Photo by Dan Herron, HerronStock.com.
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North-Central Section Meeting

Kalamazoo, Michigan, USA

Shlemon Program in Applied Geoscience: Thursday, 2 May
Mann Mentors in Applied Hydrogeology: Friday, 3 May
Looking southwest from N. Edwards Street in downtown Kalamazoo, Michigan.
Round-topped towers are the Radisson Plaza hotel.



Rocky Mountain Section Meeting

Gunnison, Colorado, USA

Shlemon Program in Applied Geoscience: Wednesday, 15 May
Mann Mentors in Applied Hydrogeology: Thursday, 16 May
Curecanti National Recreation Area west of Gunnison, which includes Blue Mesa Lake, Colorado's largest body of water. Photo courtesy U.S. National Park Service.



Cordilleran Section Meeting

Fresno, California, USA

Shlemon Program in Applied Geoscience: Monday, 20 May
Mann Mentors in Applied Hydrogeology: Tuesday, 21 May
The U.S. Sierra Nevada. Photo by Jeffrey Pang, 2008, used with permission via Wikimedia Commons, http://commons.wikimedia.org/wiki/File:Sierra_Nevada_aerial.jpg.

2012 GSA Annual Meeting & Exposition

WRAP-UP

TOTAL ATTENDANCE: 5,701

- Number of countries represented: 48
- Abstracts presented: 3,389
- Oral sessions: 173
- Poster sessions: 96
- Digital poster sessions: 3
- Exhibiting booths: 213
- Graduate School Information Forum: 68
- Short Courses: 29
- Short Course participants: 568
- Field trips: 12
- Field trip participants: 250
- Student volunteers: 256

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www.geosociety.org/meetings/2012/media.htm

- GSA put together seven special e-newsletters for meeting attendees;
- More than 70 news and blog articles were written about annual meeting science; and
- Quite a few press releases were also generated about the meeting by GSA and other organizations.

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GSA would like to acknowledge and give a special thank you to the GSA Foundation for their continued support.

* In-kind donation.

2012 GSA PRESIDENTIAL ADDRESS

Where our deepest passions intersect the world's compelling needs

George H. Davis, Dept. of Geosciences, The University of Arizona,
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PERSONAL REFLECTIONS

GSA has made a huge difference in my professional and personal life. My mind carries meaningful specifics of GSA experiences that helped shape me. As a college senior I attended my first GSA Annual Meeting and gained a glimpse of the scope of what it means to be a geologist. At the GSA Annual Meeting held during my final year of graduate studies, Jim Zumberge, Dean of Earth Sciences at The University of Arizona, encouraged me to apply for the structural geology opening just being advertised there. After my first talk at a GSA Annual Meeting, Clark Burchfiel and Greg Davis motioned to me to join them for a beer and chat about the paper I had presented. At the Penrose Conference on the *Geophysics and Structure of Folded Belts in Switzerland*, I met my structural geology hero, John Ramsay. On a 1974 GSA Field Trip led by David Love through the eastern Idaho/western Wyoming thrust, I met Peter Coney for the first time. It was there that our conversations began in earnest about the Rincon Mountains and the Snake Range being part of a regionally coherent belt of metamorphic core complexes. Moreover, within the annual rhythm of GSA meetings, I treasure reconnecting with old friends and making new friends and colleagues.

I was drawn into geosciences by the three factors that Suzanne O'Connell and Mary Anne Holmes (2011) report as the main attractors for all who enter our discipline: positive undergraduate experiences in geology, love of the outdoors, and family influences. Had I been a woman or an unrepresented minority, I likely never would have found geosciences. More to the point, geosciences would have never found me. Mary Anne and Suzanne framed a goal in relation to attracting women and underrepresented minorities to the geosciences: having sufficient role models such that each undergraduate who might aspire to a career in geosciences will have an inspiration, a person whom they wish to emulate (Holmes and O'Connell, 2005, p. 14).

For the broadest ranges of individuals and communities, I want GSA to be a source of collective inspiration, enabling *individual geoscientists* and *communities of geoscientists* to do their best work,

thereby advancing the science and its practice. Moreover, I want GSA to help leverage individual and collective accomplishments in ways that advance civilization and improve the human condition.

SUPPORTING INDIVIDUALS AND COHORTS TO DO THEIR BEST WORK

A good place to be in our individual professional lives is where our deepest passions and keenest skill-sets intersect the world's most compelling needs. We recognize passion when we see it in ourselves and in others. It takes the form of unusually high enthusiasm toward what we do and how we do it. At our best, and when life's circumstances permit, we have it in our elevated engagement in learning, discovering, communicating, and in solving "hairy" problems, whether working in academia, government, or private practice.

By and large, we seem to like what we do. I think there is a lot of geoscience career envy out there. We see this in the names of cars people buy: e.g., *Expedition*, *Explorer*, *Geo Tracker*, *Pathfinder*, *Compass*, *Mountaineer*. Consider how many models have names that conjure the images of geological exploration and discovery! Even journalists and politicians adopt our language. In September 2008, a *New York Times* reporter wrote that "tectonic shifts" in the U.S. financial industry shook the world's markets. The Associated Press exclaimed that Alan Greenspan told Congress that the international credit crunch was a "once in a century credit tsunami."

GSA supports the professional passion of individual geoscientists. GSA meetings, conferences, and field trips bring us together, creating both formal and informal venues for connecting with one another. We describe to others what we are doing *and why*. We discuss, in person, geo-relevant current events, such as the trial verdicts (LAquila earthquake) and Hurricane Sandy. We prepare diligently to present our best thoughts at GSA meetings. At annual meetings, the narratives of, and narrations by, our medalists inspire us.

Passion and drive is one thing. Incorporating just the right skill sets is quite another. Especially in this age of new and emerging technologies, we recognize that skill-sets are transient—they wear out and need to be updated. New tools come along with increasing frequency.

When I was an undergraduate taking structural geology, one of the “right-of-passage” skill sets was using orthographic projection to determine net slip on a fault. I was so enthusiastic about this form of “sick fun” that I devoted much of my senior thesis research to orthographic projection solutions, the Holy Grail being rotational fault kinematics. Now, 50 years later, one of my undergraduate advisees explores a 3-D seismic volume of faulted strata, digitizes discrete stratigraphic horizons, maps the tip lines of tens of individual normal faults, and evaluates the gradient of slip for each of the faults.

Outside of school settings, GSA helps us with the “skill-sets” part of our individual lives. GSA Short Courses have been a vital means for staying abreast of new methods, approaches, and technologies. Since 1982, more than 300 short courses have been taught at annual meetings alone!

A second central mission embraced by GSA is doing all we can to support cohorts of geoscientists in common subdisciplines or specialty fields. We all understand the practical power of specialization, which is so clearly expressed in what we choose to work on and how we choose to work. The list of GSA’s 17 Divisions reflects one way in which we arrange ourselves in subdisciplinary clusters. The programs of GSA annual and regional meetings are framed dominantly through lenses of Divisions, subdisciplines, and specialty fields. Every year at meetings I am overawed by the tenaciousness of specialized geoscience communities taking on seemingly intractable problems and bringing those problems to their knees.

Of course there is another side of this coin. It is not just the skill-sets that wear out. John Suppe (2008) once reminded us that even specialty fields wear down, typically lasting less than a scientific career. A given subdiscipline may become a “ghost town” or may just seem to disappear as the number of new specialties appear. Knowledge fragmentation is what results, driven partly by “scientists unable to stay abreast of all the research within their own discipline.” Beth Fratesi and Len Vacher (2008) captured this by grouping journals into subdiscipline categories and mapping journal proliferation from 1945 to 2000. The emergence of new lines of research tends to be accompanied by the emergence of more and more specialized journals. No wonder that we feel, at times, like we are swimming upstream.

GSA concluded a long time ago that disciplinary cohorts are essential, but not sufficient, to sustaining healthy geosciences. We began to organize ourselves into regional sections way back in 1901. Furthermore, our primary publications always have been cross-disciplinary. Increasingly in the past five decades we see and attend cross-disciplinary sessions at our annual and regional section meetings. Of course, GSA’s Penrose Conferences are designed to pull geoscientists together from different disciplines and from different career paths (academia, government, private practice). One hundred and fifty Penrose Conferences have been held since 1969, and we need to keep them coming.

ADDRESSING THE WORLD’S COMPELLING NEEDS THROUGH SPECIALTY EXPERTISE

Just like basic and applied science, the world’s compelling needs that must be addressed through geosciences are ones requiring both specialty and unifying cross-disciplinary action. If we wish to be reminded of the most pressing of the world’s needs, we can turn to

the most stressed conditions on our globe. At the 34th International Geological Congress held in August 2012 in Brisbane, Australia, there was a theme session on “Geoscience Benefiting Low Income Countries.” The theme statement related to “benefiting low-income countries” applies universally: groundwater management and rural health; geohazards; climate change; medical geology for human survival and welfare; geoplanning for urban development and infrastructure; the role of geosciences in protecting ecosystems; geothermics; the role of women geoscientists in resource development; construction and industrial minerals; and production of mineral and energy resources.

Similarly, AGI has identified *21st Century Challenges* that underscore the interplay of natural resources, environmental quality, and resiliency. NSF’s *GEOVISION Report* (2009) has a comparable emphasis, addressing atmospheric, earth, and ocean sciences.

I believe the world’s needs can be framed productively in everyday terms underscoring the threats our world faces—ignorance, thirst, hunger, environmental degradations, shortages, excesses, hazards, sustainability. These are clarion calls for the best we have to offer, **and at this moment in time**. Back in 1990, a friend and author, Robert Grudin, did not mince words: “A world population growing by a billion every decade, and increasingly demanding of technological conveniences, will make short work of existing energy sources and tear the environment to shreds” (Grudin, 1990, p. 130). Similarly, this year’s GSA President’s Medalist, Bill McKibben, puts things starkly. In his book, *Eaarth*, McKibben writes (2011, p. 23): “We’ve turned our cars and factories into junior volcanoes, and so we’re not just producing carbon faster than the plant world can absorb it; we’re also making it so hot that the plants absorb less carbon than they used to.” He goes on to say (2011, p. 86):

Suddenly you felt a little less confident that you were an ‘Explorer,’ a ‘Navigator,’ a ‘Forester,’ a ‘Mountaineer,’ a ‘Scout,’ a ‘Tracker,’ a ‘Trooper,’ a ‘Wrangler,’ a ‘Pathfinder,’ a ‘Trailblazer.’ You all of a sudden were in Kansas... not ‘Durango,’ or ‘Tahoe,’ or ‘Denali,’ or the ‘Yukon.’ ‘Discovery’ and ‘Escape’ and ‘Excursion’ suddenly seemed less important than the buzz-killing fact that it took a hundred bucks to fill the tank.

Our specialty field expertise has been serving us well in any number of the global arenas of need, especially when intertwined with other specialty fields. James Dolan’s current research in active tectonics illustrates the power of connecting specialty fields—in ways that inform probabilistic seismic hazard analysis and the goal of mitigating loss of life and property due to earthquakes. Dolan, like others, has been wrestling with the troubling fact that inferred fault slip rates based on geodesy sometimes outpace those inferred on the basis of geology. James and one of his students, Ben Haravitch, have been evaluating slip-rates on *big* faults, such as the northern Death Valley fault (Snow and Wernicke, 1989), on the basis of geologic mapping and LiDAR-based restorations of faulted geomorphic surfaces. Ages of faulted geomorphic surfaces are determined through cosmogenic surface exposure dating (Frankel et al., 2011). Dolan and Haravitch have concluded that the degree to which geologically based fault slip rates record the *actual* rate at seismogenic depths is strongly dependent on the structural maturity of the fault zone. When they compared the ratios of surface slip rate in large

earthquakes with slip at depth and plotted these as a function of fault-zone complexity, they discovered a way to “correct” the near-surface slip estimates using as a basis the overall maturity of the fault zone. Before a fault zone becomes “straight” and through-going, a considerable amount of the slip budget is diffused through distributed deformation away from the fault itself. To model seismogenic hazards, it is essential to know the *true* seismogenic slip rate.

STRATEGIC OUTLIERS

In spite of such sophisticated core science, we still struggle mightily in addressing particular strategic outliers that if not tightly connected to the core will threaten the capacity of the geosciences to make a difference in the manner to which we aspire. Among these strategic outliers are geosciences and public policy, geosciences and K–12 education, geosciences and the media, geosciences and the general public, and geosciences and its future workforce.

There is a sharp contrast between the ways in which we are excelling as individual geoscientists and cohorts of scientists in fundamental and applied research, versus our impact with respect to these strategic outliers. Why is this?

Part relates to internal dynamics and barriers within our own scientific culture. Our personal specialty goals and responsibilities tend to be all consuming. Furthermore, the work environments within which we operate tend to reward us most when we stick to our specialty areas. Thus it is natural for each of us to defer to our specialists in earth science education, public policy, the geoscience workforce, and in reaching the media and general public. However, part relates to persistent barriers presented by leaders ignorant of how Earth behaves and a public ignorant of how understanding the earth system is critical to our survival.

Given what is at stake in terms of the world’s pressing needs, I believe that GSA is right to be distinguished by a broad and encompassing mission scope. Strong platforms have already been built within GSA for addressing strategic outliers. For example, way back in 1972, GSA established its Geology and Public Policy Committee (GPPC), whose products are position statements. Currently, we have 18 active statements (www.geosociety.org/positions/), covering “Geoscience Issues,” “Education Issues,” “Data Issues,” and “Professional Issues.” The framing of some position statements is straightforward. Others have a complexity that can be underscored through my uttering just one word: “Hydrofracking.” The GPPC has initiated the development of a white paper on hydrofracking, with the goal of sorting facts from fictions. Part of my homework on this effort was attending the special session on “Shale Gas and Fracking” at the North-Central Section Meeting last spring. Jeffrey Daniels of Ohio State University presented. I heard Jeff say something powerful that applies at every turn within the outlier of geosciences and public policy: “geoscientists represent the only profession *anywhere* that knows how to picture the subsurface.” Voters, communities, and public officials simply have no idea how to visualize what’s down below, let alone discriminate what is factual from what is not, let alone evaluate proposed solutions.

***Editor’s note:** Richard Alexander Fullerton (R.A.F.) Penrose Jr. joined GSA in 1889, served on GSA Council from 1914 to 1916, was GSA vice president in 1919, a member of the Finance Committee from 1924 to 1929, established the GSA’s Penrose Medal in 1927, and was GSA president in 1930. Upon his death in 1931, he left a generous bequest to GSA (more than \$3 million dollars).

I want to expand on Jeff’s point. Geosciences *is* the only scientific community that can actually picture what happens right at, beneath, and deep beneath Earth’s surface today, at any spot on the globe AND can picture past subsurfaces in relation to past oceans and past atmospheres over the spans of vast time and ever-changing circumstances AND can picture all of this dynamically, not simply statically. The pictures we all create of Earth’s surface and subsurface, past, present, and future are not constructed through single disciplines or specialty fields. Emphasizing this moves us away from the forces of fragmentation: geology versus geophysics; hard rock versus soft rock; pure versus applied; academic versus professional practice; this specialty or that.

FUTURE INITIATIVES

I look at challenges as glasses half full. Robert Grudin (1990, p. 159) sees things in a starker reality. For example, he commented on the way specialization and fragmentation are exploited in the political process:

Politicians assemble in committees and call in experts to testify. ... Natural scientists appear in force: business scientists, military scientists, government scientists, scientists from the academy. The specialists not only hold conflicting views but speak in different forms of jargon. The individual politician ... must then make a decision. The politician’s staff is consulted. One staffer has been sifting the media for editorial consensus. Another has been lunching with lobbyists. A third, who has hired consultants, summarized their report. A fourth phones in long-distance with word from the constituency. A position is hammered out in conference. A fifth staffer writes an appropriate speech, and the *interdisciplinary function of politics* has been fulfilled again. (emphasis added)

I believe that it is essential to blunt the interdisciplinary function of politics with the interdisciplinary function of geoscience. I want to urge our thinking creatively about potential new interdisciplinary initiatives that can accelerate GSA’s, addressing *all* of the strategic outliers simultaneously and in ways that resist fragmentation and reward alignment. My thinking on this began more than a year ago when Geoff Feiss, president of the Geological Society of America Foundation (GSAF), challenged GSA Council and the GSA Executive Committee with the question: “If Dr. Penrose* walked into my office today and said I am willing to invest considerably into a large idea, what would that idea be?” Now that’s a question worth thinking about.

Permit me for a moment to use this platform as a bully pulpit. GSA excels in managing the programmatic and logistical challenges in bringing geoscientists together, through Annual Meetings, Section Meetings, Penrose Conferences, International Conferences, Field Forums, and the like. We can harness these skill sets and experience in yet new ways. My idea takes the form of “Response Conferences to GEO-Events Impacting Population Centers.” I’ll describe what this means by pretending that we just

held one and that what you are about to hear is my *virtual* report to you on how it came about and what was accomplished:

MOCK REPORT

Good afternoon! GSA's most recent "Response Conference" was triggered by the M_w 5.8 earthquake that took place at 1:51 p.m. (local time) in northern Virginia on 23 August 2011. The epicenter was located ~130 km south-southwest of the nation's capital. Ground shaking lasted about 45 seconds.

Receiving most of media attention was the shaking of and damage to the Washington Monument. The monument suddenly began to sway, and those visitors inside, many of whom were school children, needed to make a quick escape down the stairs. The scene was captured on a surveillance camera inside the monument, 150 m above ground level. The Washington Monument experienced permanent damage expressed by fracturing and spalling, especially in the height interval between 140 and 160 m.

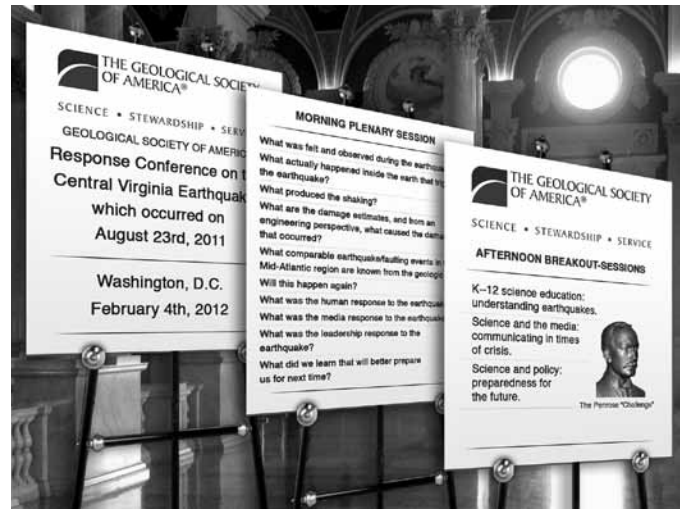
The White House and the Capitol were evacuated. Metro system trains ran at reduced speed while tunnels were inspected. Staff at the National Zoo reported that the apes were feeding normally up until 10 seconds before the quake, but then they abandoned their food and scrambled to the top of their habitat.

Vice President Joe Biden was at a campaign stop in Virginia touting the administration's energy policy. He blamed the earthquakes on the extraction of natural gas by hydrofracking. As reported in the *Washington Times*, things got political in a hurry when Benjamin Cole, communications director at the Institute for Energy Research, was quoted as saying: "The worst-kept secret in Washington is Vice President Biden's penchant for exaggeration ... now he's pretending to be a seismologist."

Circulating on the Internet was the view that this was not a natural earthquake but was an earthquake created as a result of an underground nuclear detonation.

Six months following this earthquake, on Saturday, 4 February 2012, The Geological Society of America, in partnership with its Associated Societies and the United States Geological Survey, held a "Central Virginia Earthquake Response Conference" in Washington D.C. The purpose was to host a public retrospective on science and society dimensions of the earthquake event.

GSA was able to work swiftly because five years ago a structure of working committees had been established to forecast possible to probable geo-incident events in North America, and to populate working teams of experts. The critical planning window after the earthquake was on the order of eight weeks. During that time, GSA reserved a venue in the D.C. area; established a Saturday calendar date; notified the Executive Branch, the Hill, the Pentagon, and emergency responder



Virtual foyer at response conference.

MORNING PLENARY SESSION

What was felt and observed during the earthquake?
What actually happened inside the earth that triggered the earthquake?
What produced the shaking?
What are the damage estimates, and from an engineering perspective, what caused the damage that occurred?
What comparable earthquake/faulting events in the Mid-Atlantic region are known from the geologic record?
Will this happen again?
What was the human response to the earthquake?
What was the media response to the earthquake?
What was the leadership response to the earthquake?
What did we learn that will better prepare us for next time?

Middle poster.

agencies; alerted teachers and professors in the region, urging them to consider incorporating the conference into the curriculum; communicated the planned event to the media and the general public; and invited the membership of GSA to turn out in force. GSA accomplished this through close cooperation between its Boulder, Colorado, headquarters and its Northeastern and Southeastern Sections.

The program followed the standard blueprint for Response Conferences, with two main rules for engagement: 1—no "geospeak" is permitted; 2—admission for students, teachers, media, and elected officials is free-of-charge. The morning session was plenary and addressed critical questions. Workshops were held in the afternoon.

At the upcoming GSA Annual Meeting in Charlotte, the plenary speakers and workshop facilitators from the

Northern Virginia Earthquake Response Conference will hold debriefings on what they presented and will report on the responses from students, teachers, media, public officials, and the scientific community. A number of GSA members noted that we commonly lament how difficult it is to connect with members of the media, and yet, because of the Response Conference, the media came to us.

CONCLUDING THOUGHTS

I thank Geoff Feiss for demonstrating that when the right question is asked, we elevate our science and our imagination generally. Let each of us think hard about how *we* would respond to a Dr. Penrose. And let us elevate our collective thinking the way R.A.F. Penrose did and envision what the world’s needs will require of us.

In conclusion, what guides my value system as your GSA President is to have GSA continue to function in ways that help individual geoscientists and communities of geoscientists do their best work, thus advancing the science and its practice, and thus leveraging individual and collective accomplishments to advance civilization and to improve the human condition.

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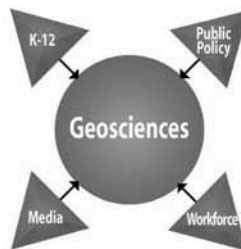
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Video of Davis’ Presidential Address and his PowerPoint presentation are online at www.geosociety.org/gsatoday/PresAddress.htm.



George H. Davis, GSA “Lifer”



Kelly A. Kryc

What's up with helium?

It's hard to believe, but this is my last report as a Congressional Science Fellow. I'm passing the Hill credential off to Todd Bianco and will be looking forward to reading his reports in the future. For my last report, I'm taking a deep dive into a subject that landed on my desk this past April: the Helium Stewardship Act of 2012.

So, what's up with helium? In 2010, the National Research Council published a report titled "Selling the Nation's Helium Reserve" that caught the attention of Senate Energy and Natural Resources Committee Chairman Jeff Bingaman and his staff. That set into motion the process of introducing legislation to prevent a catastrophic global helium shortage.

First things first. Helium is the second lightest element on the periodic table, and it is also the second most abundant element in the universe. It is inert, has high thermal conductivity, low viscosity, and high ionization potential, which makes it highly valued for many applications, including high-tech manufacturing (e.g., semiconductors, optical fibers, and LED lights); cryogenics (e.g., magnetic resonance imaging and fundamental science); pressurization and purging (e.g., space and defense rocket launches); lifting (e.g., weather and party balloons); and welding, leak detection, and commercial diving, among others. It is the product of radioactive decay of heavy elements in Earth's crust, and it is effectively trapped in the same geologic reservoirs that trap natural gas. Separation of helium from natural gas becomes economically feasible at concentrations of greater than 0.3% helium.

In 1925, the United States created the Federal Helium Reserve (FHR) near Amarillo, Texas, USA, to ensure a stable supply of helium for airships and dirigibles that were critical for national security. Helium played an important role in the United States' security interests for the remainder of the century, and Cold War policies ensured that the element continued to be stockpiled at the FHR while simultaneously accruing a US\$1.3 billion debt to the Federal Treasury. In the mid-nineties, the federal government decided to get out of the helium business and passed the Helium Privatization Act of 1996, which directed the Bureau of Land Management (BLM) to sell the helium in the reserve to repay the federal government for the debt associated with the helium program. Rather than sell the helium at market prices, the 1996 legislation used a formula to determine the price at which the

helium would be sold that was based on the amount of debt to be paid, the volume of helium stored in the reserve, and the number of years that the reserve was authorized (through 2015). At the time the legislation was passed, the price of helium sold from the reserve was nearly twice the price of private crude helium. The BLM price for helium is the only published price and so, over the next decade, the price of private crude helium steadily rose until it equaled the price of federally owned helium.

Several unintended consequences resulted from the 1996 helium legislation. First, the global helium market became coupled to the published BLM price of helium, which artificially depressed the global market price. Consequently, the low federal price of helium meant that the FHR became the source of choice for 50% of domestic and 30% of global helium demand. Furthermore, because the federal government sells helium so cheaply, private industry has not been incentivized to develop new helium sources (aside from the United States, Qatar, Algeria, and Russia are also major suppliers of helium). Finally, any disruption in the supply from the FHR could have a debilitating impact on American industries and businesses because of the lack of a diverse supply chain.

While the 1996 legislation authorized the helium sell-off through 2015, it didn't anticipate that the US\$1.3 billion debt to the treasury would be paid off two years early. Once the debt is paid in full, which is anticipated to happen sometime in 2013, the funding mechanism for the FHR ceases to exist. Without funding, the reserve is unable to continue operating. This brings us to the precipice—a cliff requiring a legislative solution before American manufacturing, patient health care, and discovery-driven research suffer the consequences of a potential global helium shortage.

In April 2012, Senators Bingaman, Barrasso, Wyden, and Enzi introduced bipartisan legislation (S.2374) that would authorize the FHR to continue selling helium, but at market prices. S.2374 aims to promote the responsible management of federally held crude helium assets and to stimulate development of private sources of helium. This will secure helium supplies for federal agencies, such as NASA, DOD, DOE, and NIH, as well as for medical, scientific, and commercial users over the long term. Selling the helium at market price will ensure that sales of this scarce, critical, and non-renewable resource recover fair value for U.S. taxpayers. Finally, the Act would authorize the Secretary of Energy to support research and development of technologies that aid the natural gas industry and helium users in capturing, gathering, producing, recycling, and conserving helium.

In April 2012, I was given responsibility for this issue on the committee. There was a hearing in May shortly after S.2374 was introduced and then a steep learning curve for me as I spoke with the stakeholder community and learned more about their concerns should the FHR go offline in 2013. Because helium touches so many facets of American well-being, we were successful in getting 23 bipartisan cosponsors for the bill (12 Democrats, 10 Republicans, and 1 Independent). Normally, at this stage in the process, the bill would be marked-up and reported out of the committee. However, the Senate Committee on Energy and Natural Resources has not

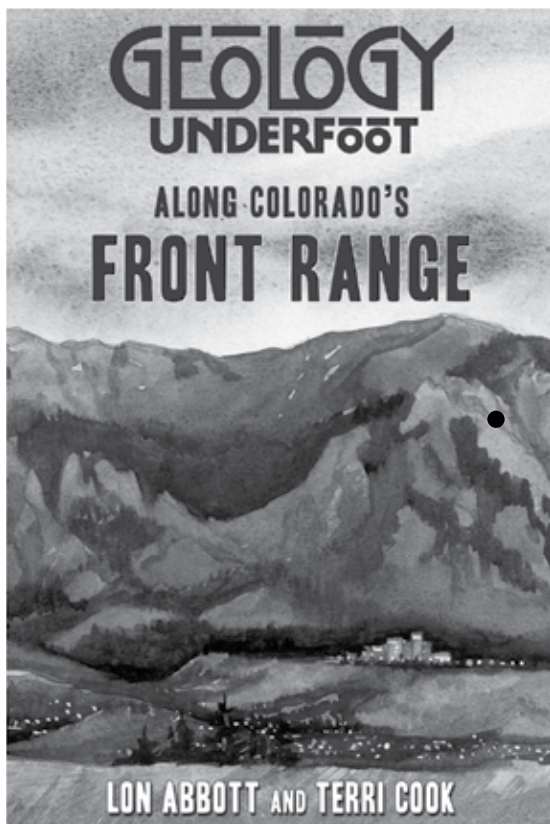
had a mark-up since March 2012, so, given the time-sensitive nature of the legislation, an alternative option was identified to discharge the bill from the committee. Ultimately, S.2374 was packaged with other issues under the committee's jurisdiction and offered as a substitute amendment to a critical minerals bill that the House passed (H.R. 4402) earlier in the year and that was subsequently referred to the Senate Energy Committee.

On 13 September, the package was "hotlined," a process that seeks to expedite passage of a measure by having all Senators unanimously agree to approve the bill. If there are any objections, a Senator can hold up the entire package. A "hold" can be placed for any reason and can also be lifted at any time. In the case of this hotline, several holds were placed on the measure so, at the time of writing, it has not yet cleared the Senate.

The end of this story is yet to be written, but it certainly will be satisfying to have played a role in passing a public law during my fellowship. It will be even more satisfying knowing that this

particular legislation has a direct impact on the research enterprise in the United States, among many other important end-user applications of helium in this country. Thanks to GSA and USGS for selecting me as their fellow this past year, and thanks to the Committee and the helium stakeholders for entrusting me with this issue.

This manuscript is submitted for publication by Kelly A. Kryc, 2011–2012 GSA-USGS 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. G11AP20221. 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. Kryc served on the staff of the Senate Committee on Energy and Natural Resources and can be reached at kakryc@gmail.com.



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2012 OEST Awards

The National Association of Geoscience Teachers (NAGT) has announced the 2012 Outstanding Earth Science Teacher (OEST) Awards. This is a yearly award that recognizes excellence in earth-science teaching at the pre-college level. The Geological Society of America awards the section recipients US\$500 in travel money to attend a GSA meeting, US\$500 for classroom supplies, and complimentary membership in GSA for three years. State winners receive a one-year GSA complimentary membership.

SECTION WINNERS

Eastern Section (and New Jersey State)

Edward Cohen

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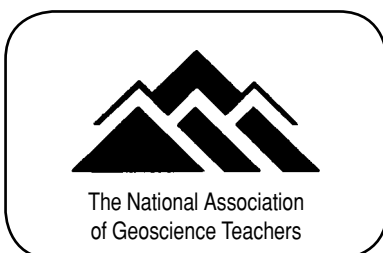
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LOCATION

The Department of Geology at the University of Puerto Rico–Mayagüez is pleased to host this meeting at the Caribe Hilton Hotel, which is located between historic Old San Juan and the Condado area. Puerto Rico is not only an idyllic tropical setting—it also features stunning geology and thousands of years of history and culture. The wide variety of geologic and geographic settings on the island include a world-class karst province, a central mountain range with igneous and metamorphic terrane, serpentinites, economic mineral deposits, a classic rudist outcrop, the only tropical rain forest in the U.S. National Forest system, limestone cliffs, and active tectonics.



View of El Morro castle in San Juan.

REGISTRATION

Early registration deadline: 19 February 2013

Cancellation deadline: 25 February 2013

REGISTRATION FEES (all fees are in U.S. dollars)

	EARLY		STANDARD	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	\$190	\$110	\$220	\$120
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Student Member	\$75	\$55	\$80	\$60
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K–12 Teacher	\$40	\$30	\$45	\$35
Guest	\$55	n/a	\$65	n/a
Short Course/Field Trip only	\$45	n/a	\$55	n/a

ACCOMMODATIONS

Hotel reservation deadline: 27 February 2013

A block of rooms has been set aside for meeting attendees at the Caribe Hilton Hotel, 1 San Geronimo St., San Juan, Puerto Rico 00901, USA, +1-787-721-0303. Rate: US\$189 per night, plus tax. To qualify for this rate, please use group code “GSA13” when making your hotel reservations via the link at www.geosociety.org/Sections/se/2013mtg/lodging.htm.

TECHNICAL PROGRAM

Theme Sessions

- T1. Gondwanan Crust and Lithosphere along the Gulf of Mexico Margin: The Record of Pangea Accretion and Dispersal.** David A. Foster, Univ. of Florida, dafoster@ufl.edu; Paul A. Mueller, Univ. of Florida, pamueller@ufl.edu; Craig B. Grimes, Ohio Univ., cgrimes@geosci.msstate.edu.
- T2. Assessing Coastal Vulnerability: Technical and Management Considerations.** Chester Jackson, Georgia Southern, cjackson@georgiasouthern.edu; Clark Alexander, Skidaway Ocean Institute, clark.alexander@skio.usg.edu.
- T3. Multidisciplinary Approaches to Caribbean Stratigraphy and Paleontology.** Jorge Vélez-Juarbe, Howard Univ., velezjuarbe@gmail.com; Alvin J. Bonilla-Rodríguez, Univ. of Kansas, alvin12@ku.edu.
- T4. Science Dissemination through Informal Geoscience Education: Current Approaches and Future Directions.** Pablo A. Llerandi-Román, Grand Valley State Univ., llrandp@gvsu.edu.
- T5. Caribbean Earthquakes and Tsunamis.** Alberto López, Univ. of Puerto Rico–Mayagüez, alberto.lopez3@upr.edu; Brian Atwater, USGS, atwater@usgs.gov; Christa G. von Hillebrandt, NOAA, christa.vonh@noaa.gov.
- T6. The Present is the Key to the Future: Experiences and Initiatives in Undergraduate Research.** Michael Martínez-Colón, Univ. of South Florida, mmartin8@mail.usf.edu.

- T7. **From Provenance to Sequestration: A Heavy Metal Journey.** Michael Martínez-Colón, Univ. of South Florida, mmartin8@mail.usf.edu; Warner Ithier-Guzmán, Universidad de Puerto Rico—Río Piedras, warner.ithier1@upr.edu.
- T8. **Using Interactive Video and Other Visualizations to Support Teaching and Enhance Learning in Geoscience Courses.** David McConnell, North Carolina State Univ., david_mcconnell@ncsu.edu; Katherine Ryker, North Carolina State Univ., kdalmqui@ncsu.edu.
- T9. **Karst Processes, Development, and Paleoclimate Studies in the Neotropics, Caribbean, and Gulf of Mexico.** Thomas Miller, Univ. of Puerto Rico—Mayagüez, thomase.miller@upr.edu.
- T10. **Characterization and Utilization of Carbonate Reservoirs.** Tina Roberts-Ashby, USGS, troberts-ashby@usgs.gov; Jessica Pierson Moore, West Virginia Geological & Economic Survey, jmoore@geosrv.wvnet.edu.
- T11. **Critical Zone Processes and the Geology of Puerto Rico.** F.N. Scatena, Univ. of Pennsylvania, fns@sas.upenn.edu.
- T12. **Quaternary Caribbean Reef Systems.** Clark Sherman, Univ. of Puerto Rico—Mayagüez, clark.sherman@upr.edu; Wilson Ramírez, Univ. of Puerto Rico—Mayagüez, wilson.ramirez1@upr.edu; David Cuevas, U.S. EPA Caribbean Environmental Protection Division, cuevas.david@epa.gov.
- T13. **Lesser Antilles: Volcanology, Petrology, and Monitoring.** Alan L. Smith, California State Univ., alsmith@csusb.edu; Lizzette A. Rodríguez, Univ. of Puerto Rico—Mayagüez, lizzette.rodriguez1@upr.edu.
- T14. **Oceanic Trench Research in the 21st Century.** Wilford Schmidt, Univ. of Puerto Rico—Mayagüez, wilford.schmidt@upr.edu; Alberto López, Univ. of Puerto Rico—Mayagüez, alberto.lopez3@upr.edu; Manuel Jiménez, Univ. of Puerto Rico—Mayagüez, mjimenez@ece.uprm.edu; Hirohishi Kitazato, kitazato@jamstec.go.jp.
- T15. **Sustainable Water Resources and Water Treatment in Haiti.** Peter J. Wampler, Grand Valley State Univ., wamplerp@gvsu.edu; Richard R. Rediske, Grand Valley State Univ., redisker@gvsu.edu; Azizur R. Molla, Grand Valley State Univ., mollaziz@gvsu.edu.
- T16. **Extreme Interglacial Events: The Late Neogene—Quaternary Record of Climate Instability from North American and Caribbean Coasts.** Blair R. Tormey, Western Carolina Univ., btormey@wcu.edu; Paul J. Hearty, Univ. of North Carolina at Wilmington, kaisdad04@gmail.com.
- T17. **Collaborative Seismology in the Caribbean and Central America.** Jay Pulliam, Baylor Univ., jay_pulliam@baylor.edu; Víctor Huérfano Moreno, Puerto Rico Seismic Network, victor@prsn.uprm.edu; Olga Cabello, IRIS Consortium, olga.cabello@iris.edu.
- T18. **Dolomitization in the Caribbean.** Luis González, Univ. of Kansas, lgonzlez@ku.edu; Wilson Ramírez, Univ. of Puerto Rico—Mayagüez, wilson.ramirez1@upr.edu.
- T19. **New Insights into Old Arcs: Petrology, Geochemistry, and Tectonics of Caribbean Island Arcs.** Aaron J. Cavosie, Univ. of Puerto Rico—Mayagüez, aaron.cavosie@upr.edu.
- T20. **The Shoreline of Puerto Rico: Session in Honor of Jack Morelock.** David M. Bush, Univ. of West Georgia, dbush@westga.edu; Maritza Barreto, Univ. of Puerto Rico—Río Piedras, maritzabarretoorta@gmail.com; Wilson Ramírez, Univ. of Puerto Rico—Mayagüez, wilson.ramirez1@upr.edu.
- T21. **Volcanic Hazards and Risk in Latin America and the Caribbean.** Lizzette A. Rodríguez, Univ. of Puerto Rico—Mayagüez, lizzette.rodriguez1@upr.edu; Carlos J. Ramírez Umaña, Universidad de Costa Rica, carlosjru@yahoo.com; Raúl Mora Amador, Universidad de Costa Rica, raulvolcanes@yahoo.com.mx; Gino S. González Ilama, Universidad de Costa Rica, ginovolcanico@gmail.com.
- T22. **Mapping Puerto Rico and Beyond in the Digital Age and in the Past: From the Mountains to the Sea, Exploring Historical and New Geospatial and Visualization Techniques for Crafting Modern Maps.** Chester W. Jackson, Jr., Georgia Southern Univ., cjackson@georgiasouthern.edu.
- T23. **Applications of Tracers in Geology, Hydrology, and Environmental Sciences.** Sam Mutiti, Georgia College, samuel.mutiti@gcsu.edu.

FIELD TRIPS

1. **Geology of Mona Island.** Sat.–Tues., 16–19 March. Max: 10. US\$670—includes transportation to and back from Mona Island, all meals, camping fees, and transportation to the Caribe Hilton after the trip; does not include camping equipment (tent, sleeping bags, etc.)—there is no camping equipment available in Mona Island. Luis González, Univ. of Kansas, lgonzlez@ku.edu; Wilson R. Ramírez, Univ. of Puerto Rico—Mayagüez, wilson.ramirez1@upr.edu.
2. **Karst Terranes of Puerto Rico: A Mix of Lithology, Hydrology, and Climate.** Tues., 19 March. Max: 32. US\$85—includes transportation, field guide, entry to the Camuy Caverns, beverages, a snack, and a box lunch. Thomas Miller, Univ. of Puerto Rico—Mayagüez, thomase.miller@upr.edu.
3. **Volcanic Evolution of Montserrat: From the Silver Hills to the Soufriere Hills Current Eruption.** Fri.–Tues., 22–26 March. Max: 19. US\$1,350—Includes field guide, transportation, lodging (double/triple occupancy), car rental/gas, departure tax, and some meals (two breakfasts, one packed lunch, and three dinners). Does not include snacks, other meals (two breakfasts, two lunches, one dinner), and boat tour (~\$60). Lizzette A. Rodríguez, Univ. of Puerto Rico—Mayagüez, lizzette.rodriguez1@upr.edu; Alan L. Smith, California State Univ.—San Bernardino, alsmith@csusb.edu; Paul Cole, Montserrat Volcano Observatory, paul@mvo.ms. **Registration for this trip closes on 15 January 2013. Valid passport required.**
4. **Geology and Landslides of Puerto Rico Day 1: El Yunque Rainforest and Landslide and NE Coastal Geology.** Fri., 22 March. Max: 30. US\$105—includes field guide, transportation, drinks, a snack, a full Puerto Rican lunch with beverage, and entrance fees to the National Forest and Seven Seas Beach. James Joyce, Univ. of Puerto Rico—Mayagüez, james.joyce@upr.edu.
5. **Geology and Landslides of Puerto Rico Day 2: Geology and Landslides of the Central Mountainous Interior and Great Southern Fault Zone.** Sat., 23 March. Max: 30. US\$80—includes field guide, transportation, drinks, a snack, and a full Puerto Rican lunch with beverage. James Joyce, Univ. of Puerto Rico—Mayagüez, james.joyce@upr.edu.


6. **Geology and Landslides of Puerto Rico Day 3: Geology and Landslides along the Margin of the Northern Karst Plateau and the Utuado Batholith.** Sun., 24 March. Max: 30. US\$80—includes field guide, transportation, drinks, a snack, and a full Puerto Rican lunch with beverage. James Joyce, Univ. of Puerto Rico—Mayagüez, james.joyce@upr.edu.

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John Mann Mentors in Applied Hydrogeology Program. Thurs., 21 March. Students interested in applied hydrogeology or hydrology as a career will have the opportunity to network with professionals in these fields over a FREE lunch.



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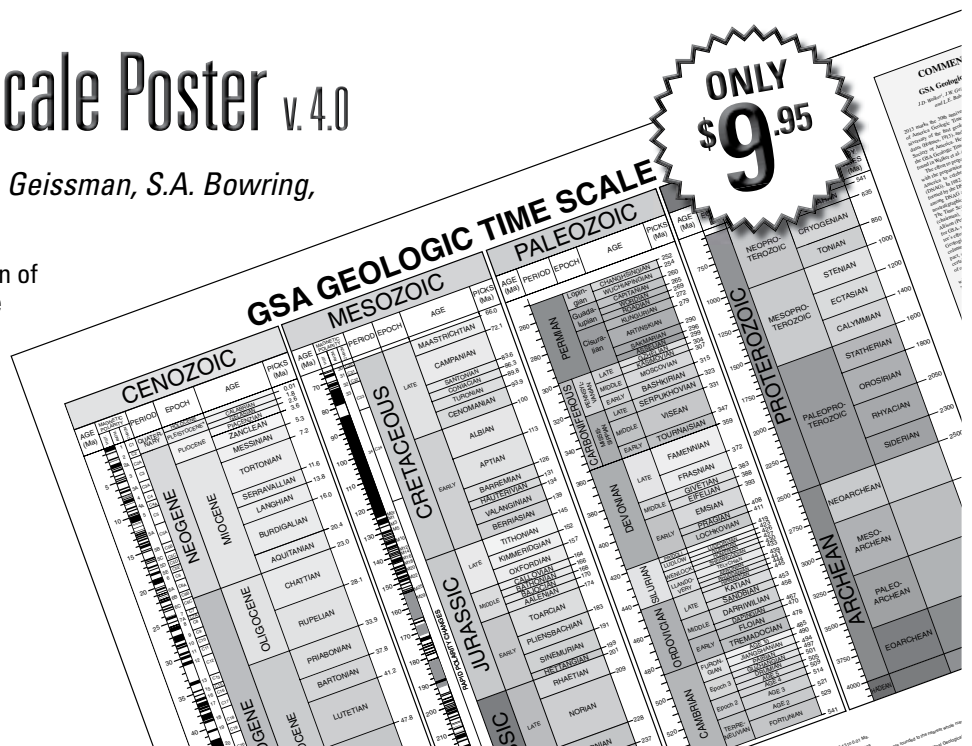
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THE
GEOLOGICAL
SOCIETY
OF AMERICA®

Call for Nominations and Applications

Awards, Grants & Recognition

1 February 2013



Questions? See www.geosociety.org/awards/ or contact GSA Grants, Awards & Recognition, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.



GSA MEDALS & AWARDS

Nomination deadline: 1 February

- Penrose Medal
- Day Medal
- Young Scientist Award (Donath Medal)
- GSA Public Service Award
- The Bromery Award for the Minorities
- GSA Distinguished Service Award
- Subaru Outstanding Woman in Science Award

GSA FELLOWSHIP

Nomination deadline: 1 February

A GSA member can be elected to Fellowship in recognition of distinguished contributions to the geosciences. Current GSA Fellows may support two nominees each year (only one as a primary nominator), and GSA members who are not Fellows may be secondary nominators for up to two nominees.

2013 POST-DOCTORAL RESEARCH AWARDS

Nomination deadline: 1 February

The following post-doc research awards are managed by the GSA Foundation. Learn more at www.geosociety.org/grants/postdoc.htm.

- The **Gladys W. Cole Memorial Research Award** for research on the geomorphology of semiarid and arid terrains in the United States and Mexico is awarded to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology.
- The **W. Storrs Cole Memorial Research Award** for research on invertebrate micropaleontology is awarded to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

AGI MEDAL IN MEMORY OF IAN CAMPBELL

Nomination deadline: 1 February

The AGI Medal in Memory of Ian Campbell recognizes singular performance in and contribution to the profession of geology. Submit your nomination at www.agiweb.org/direct/awards.html.

AGI MARCUS MILLING LEGENDARY GEOSCIENTIST MEDAL

Nomination deadline: 1 February

The Marcus Milling Legendary Geoscientist Medal is awarded for consistent contributions of high-quality scientific achievements and service to the earth sciences that are of lasting historic value. Submit your nomination at www.agiweb.org/direct/awards.html.

2013 NATIONAL AWARDS

Check each site for nomination deadlines.

- **William T. Pecora Award:** <http://remotesensing.usgs.gov/pecora.php>.
- **National Medal of Science:** www.nsf.gov/od/nms/medal.jsp.
- **Vannevar Bush Award:** www.nsf.gov/nsb/awards/bush.jsp.
- **Alan T. Waterman Award:** www.nsf.gov/od/waterman/waterman.jsp.
- **G.K. Warren Prize:** www.nasonline.org/site/PageServer?pagename=AWARDS_warren.

JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

Nomination deadline: 31 March

In cooperation with the Association of American State Geologists and supported by endowment income from the GSA Foundation's John C. Frye Memorial Fund, GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey. To nominate a report, please send a letter describing its importance, up to three letters from users of the publication, and three copies of the publication to GSA Grants, Awards & Recognition, P.O. Box 9140, Boulder, CO 80301-9140, USA; awards@geosociety.org.

ENVIRONMENTAL AND ENGINEERING GEOLOGY DIVISION

E.B. Burwell, Jr., Award

Nominations due 1 February

Send nominations to James McCalpin, GEO-HAZ Consulting, Inc., PO Box 837, 600 E. Galena Ave., Crestone, CO 81131, USA; mccalpin@geohaz.com. This award is made to the author or authors of a published paper of distinction that advances knowledge concerning principles or practice of engineering geology, or of related fields of applied soil or rock mechanics where the role of geology is emphasized. The

Call for Nominations and Applications

paper that receives the award must: (1) deal with engineering geology or a closely related field, and (2) have been published no more than 5 years prior to its selection. There are no restrictions on the publisher or publishing agency of the paper.

GEOSCIENCE EDUCATION DIVISION

Biggs Award for Excellence in Earth Science Teaching

Nominations due 1 February

Submit nominations to <http://gsaged.org/biggsaward/award2010.htm>. Send supplemental materials to Julie C. Libarkin, libarkin@msu.edu. This award recognizes innovative and effective teaching in college-level earth science. Instructors and faculty members from any academic institution engaged in undergraduate education who have been teaching full-time for 10 years or fewer are eligible (part-time teaching is not counted). Both peer- and self-nominations will be accepted. This award, administered by the GSA Foundation, is made possible by support from the Donald and Carolyn Biggs Fund, the GSA Geoscience Education Division, and GSA's Education and Outreach Program. A travel reimbursement is also available to enable the recipient to attend the award presentation at the GSA Annual Meeting.

HISTORY AND PHILOSOPHY OF GEOLOGY DIVISION

Mary C. Rabbitt History and Philosophy of Geology Award

Nominations due 1 February

Send nominations to Jane P. Davidson, University of Nevada, Reno, NV 89557-0001, USA; +1-775-747-2252; jdhexen@unr.edu. The Mary C. Rabbitt History and Philosophy of Geology Award is presented to an individual for exceptional scholarly contributions of fundamental importance to our understanding of the history of the geological sciences. Achievements deserving of the award include publication of papers or books that contribute new and profound insights into the history of geology based on original research or a synthesis of existing knowledge. For more information, go to <http://gsahist.org/HoGaward/awards.htm>. Monies for the award are administered by the GSA Foundation.

GEOPHYSICS DIVISION

George P. Woollard Award

Nominations due 15 February

Submit nominations online at <http://bit.ly/THlifK> and include a description of the nominee's contributions and their scientific impact. This award recognizes outstanding contributions to geology through the application of the principles and techniques of geophysics. A highlight of the presentation is the honorary George P. Woollard Technical Lecture by the recipient. Award funds are administered by the GSA Foundation.

SEDIMENTARY GEOLOGY DIVISION

Laurence L. Sloss Award for Sedimentary Geology

Nominations due 20 February

Submit (1) a cover letter describing the nominee's accomplishments in sedimentary geology and contributions to GSA and

(2) a curriculum vitae electronically to Linda Kah, secretary, Sedimentary Geology Division, lckah@utk.edu. This award recognizes a sedimentary geologist whose lifetime achievements best exemplify those of Larry Sloss (i.e., contributions to the field of sedimentary geology and service to GSA). Monies for the award are derived from the annual interest income of the Laurence L. Sloss Award for Sedimentary Geology Fund, administered by the GSA Foundation.

COAL GEOLOGY DIVISION

Gilbert H. Cady Award

Nominations due 28 February

Send three copies of the following to Jack C. Pashin, Energy Investigations Program, Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999, USA; jpashin@gsa.state.al.us: (1) name, title, and affiliation of the nominee; (2) date and place of birth; (3) education, degree(s), honors, and awards; (4) major events in his or her professional career; and (5) a brief bibliography noting outstanding achievements and accomplishments. Monies for the award are derived from the annual interest income of the Gilbert H. Cady Memorial Fund, administered by the GSA Foundation.

ENVIRONMENTAL AND ENGINEERING GEOLOGY DIVISION

Richard H. Jahns Distinguished Lecturer

Nominations due 28 February

Send nominations to Dennis Staley, USGS, Box 25046, MS 966, Denver, CO, 80225, USA; dstaley@usgs.gov. This award is given to an individual who through research or practice has made outstanding contributions to the advancement of environmental and/or engineering geology. The awardee will speak on topics of earth processes and the consequences of human interaction with these processes, or the application of geology to environmental and/or engineering works. Award funds are administered by the GSA Foundation.

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

Farouk El-Baz Award for Desert Research

Nominations due 2 April

Submit nominations, including (1) a statement of the significance of the nominee's research, (2) a curriculum vitae, (3) letters of support, and (4) copies of no more than five of the nominee's most significant publications related to desert research, to Alan R. Nelson, anelson@usgs.gov. Please submit electronically unless hardcopy previously approved. This award rewards excellence in desert geomorphology research worldwide, and any scientist from any country may be nominated. Monies are derived from the annual interest income of the Farouk El-Baz Fund, administered by the GSA Foundation.

Call for Nominations and Applications

ESPECIALLY FOR STUDENTS

2013 Graduate Student Research Grants

GSA is proud to offer research grants to its highly qualified student members.

Application deadline: Friday, 1 February, at noon MST
www.geosociety.org/grants/gradgrants.htm

The primary role of the GSA research grants program is to provide partial support of master's and doctoral thesis research in the geological sciences for graduate students enrolled in universities in the United States, Canada, Mexico and Central America.

NEW: Students may receive a total of two grants during their academic career, regardless of the program in which they are currently enrolled (i.e., master's or Ph.D.). **The maximum award per grant is US\$2,500.** Applications must be completed *online only*; no paper applications or letters of support will be accepted. If you need information on the 2013 Research Grant Program that cannot be found online, please call +1-303-357-1028 or e-mail awards@geosociety.org.

Farouk El-Baz Student Award

Application deadline: 1 February

The GSA Foundation established the Farouk El-Baz Student Award to encourage and promote desert research in the broadest sense. Up to two students will be awarded an honorarium at the 2013 GSA Annual Meeting in Denver, Colorado, USA, based on proposals for arid land research and advisor recommendations. Recipients will be selected by a GSA International Section-appointed Committee.

Guidelines and the application form are online at <http://rock.geosociety.org/forms/el-bazGrant.asp>.

Antoinette Lierman Medlin Scholarship in Coal Geology

Application deadline: 15 March

This GSA Coal Geology Division scholarship provides full-time students who are involved in coal geology research with financial support for their project for one year (~US\$2,000 for 2013–2014). In addition, the recipient may be provided with a stipend to present project results at the 2013 or 2014 GSA Annual Meeting.

For the academic year 2013–2014, the Coal Geology Division is also offering a field study award of ~US\$1,500. The recipient of this award will also be eligible to receive travel funds to present results at the 2013 or 2014 GSA Annual Meeting.

A panel of coal geoscientists will evaluate proposals for the scholarship and the field study award. Students may apply for both; however, only one award will be made to a successful applicant.

Submit five copies of the following to Mark Engle, Dept. of Geological Sciences, The University of Texas at El Paso, El Paso, TX 79968, USA; mercurous@gmail.com: (1) a cover letter indicating which award(s) is(are) sought; (2) a concise statement of objectives and methods and a statement of how the scholarship funds will be used to enhance the project (the proposal should

be no more than five double-spaced pages, including references); and (3) a letter of recommendation from the student's immediate advisor that includes a statement of financial need and the amount and nature of other available funding for the research project.

History and Philosophy of Geology Student Award

Applications deadline: 1 May

The History and Philosophy of Geology Division is offering a US\$1,000 award for proposals for a student paper to be presented at an upcoming GSA Annual Meeting. The topic of the proposed paper may be, but is not limited to, (1) the history of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history of geology we have not thought of before. This award, established in 2004, is made possible by a bequest from the estate of Mary C. Rabbitt. Consideration will be given to both undergraduate and graduate students who are in good standing at the time of application, and the presentation at the GSA Annual Meeting may take place after graduation. Faculty advisor(s) may be listed as second author(s) but not as the lead author of the paper, and while both oral and poster presentations are acceptable, oral presentations are preferred.

Proposal guidelines and the application form are online at <http://gsahist.org/HoGaward/awards.htm>. If you have questions about the award, please contact the Division secretary-treasurer, Jane P. Davidson, jdhexen@unr.edu. Nominees need not be members of the History and Philosophy of Geology Division or of the Geological Society of America.

Stephen E. Dwornik Student Paper Award

Check <http://www.lpi.usra.edu/meetings/lpsc2013/> for nomination deadline.

GSA's Planetary Geology Division encourages applications for the Stephen E. Dwornik Student Paper Award, established in 1991 to provide encouragement, motivation, and recognition to outstanding future planetary scientists. Two awards are given each year—one for the best oral presentation, the other for the best poster presentation. Student applicants must be (1) the senior author of the abstract (the paper may be presented orally or in a poster session); (2) a U.S. citizen; and (3) enrolled in a college or university, at any level of their education, in the field of planetary geoscience. Papers will be judged on the quality of the scientific contributions, including methods and results, clarity of material presented, and method of delivery (oral or display). The program is administered through GSA's Planetary Geology Division; the GSA Foundation manages the award funds.

Please go to <http://www.lpi.usra.edu/meetings/lpsc2013/> for instructions, an application form, and further information. The 2013 award applies to papers presented at the 44th Lunar and Planetary Science Conference on **18–22 March 2013** in The Woodlands, Texas, USA.

Welcome New GSA Members!

The following individuals (about 2,500!) submitted their applications for GSA membership between February and September 2012 and were approved by GSA Council during the 2012 GSA Annual Meeting & Exposition in November.



PROFESSIONALS

Adel M.H. Abdelaziz
Richard L. Adams
Odunyemi Anthony Ademeso
Debra J. Alexander
Harry J. Allen
Jeffrey Joseph Anderson
Mark Edward Angelos
Kazumasa Aoki
Michael Anthony Arauza
Philip B Austin
Timothy E. Aydelott
Prahlad K.N. Ayengar
Laura A. Bagwell
John T. Balczewski
Barbara Balestra
Gregory C. Bank
Kimball Banks
Alli Alfaia Barbosa
Charles Thomas Barker
Ken Barnes
Laura Barnwell
Aymon Olivier Baud
Mona Becker
Dan Beeker
Jeffrey Beirnes
Tom Belanger
Patti L. Bennett
Jeff Benton
James M. Berry
Julio L. Betancourt
Michael Bingle-Davis
Elizabeth Birkos
Richard Rushton Blessing IV
Richard A. Bobigian
Alec M. Bodzin
James Bohanan
Sonja Louise Boorman
Chad Borean
Heather Denise
Bracken-Grissom
Louisa Bradtmiller
Arnaud Brayard
Jen Bright
Dale Andrew Brittliffe
Mark A. Bronston
Lori L. Bryan

Joan Bunbury
Helen Burke
Trina Celeste Burling
Charles Burroughs
James Lane Byrd
Jong-Min Byun
Shawna White Caldwell
David H. Campbell Jr.
Remi Candaele
David Cannon
Ramon Carbonell
Tara Rae Cardenas
Douglas Keith Carlton
Paola Castano
John Chadwick
Thomas Michael Chambers
Michael Leslie Chapman Jr.
Sara Jane Chapman
Donna J. Charlevoix
Vijay Kumar Chaudhry
Dongqing Chen
Frederick Hall Chormann Jr.
Amy Richter Clark
Dennis A. Clark Jr.
Sarah Elizabeth Clark
Stuart R. Clark
Timothy Wyche Clark
Benjamin T. Clement
Samuel G. Cobb
Kristan Cockerill
Mark Wayne Cofflin
Neil Coleman
Amanda Colosimo
Joanna Michie Connolly
Lee Allan Copp
Christopher Lee Corbitt
Lisa Bailey Corbitt
Louis Rene Corrales
Rafael Coyoli
William Louis Crepet
Michael Cronin
Cara L. Crook
John W. Crook
Christopher J. Crosby
Diane P. Crosley
Brent Joseph Cunderla
Dickson Cunningham
J. David Curlis
Patty Currier
Alex G. Czuhanich
Mark Darrach
Stephen Wayne Day
Kenneth Rene De Baets
David Charles Del Marco
Christopher Dennis
Jon M. Dial
Victor Hugo M. Diaz
Robert C. Donovan
Bruce J. Douglas

Lynn Dudley
Todd David Eaby
Jennifer A. Eakins
Harvey S. Eastman
Christina Ebey-Honeycutt
Mary Edleman
Jay B. Edwards
Munir Moh. El-Mahdy Jr.
Johann Pieter Engelbrecht
Larry Ervin Engelhart
Emily M. Engle
William C. Erickson
Jason D. Esselburn
Mateus J. Facatino
Eric James Fair
András Fall
Shane Finegan
William Thomas Fischer
Sean M. Fitzgerald
Christopher P. Foldesi
Adrian Forsyth
Robin D. Franks
Robert Frykman
Matthew L. Fuller
Nathan Gabelman
David Gale
Kevin T. Gallagher
Davy L. Ganga
Ioulia A. Georgiadou
Leslie Sour Gertsch
Andrea Geyer
Jaswinder Ghilotra
Kati Irene Gibler
Rick Gibson III
Ivan P. Gill
Christopher Steven Gilliam
Kenneth A. Gillon
Brian E. Glackin
Maria Angelica Godoi
Jules Goldspiel
Barry Samuel Goldstein
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Andy Goryachev
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 Steven Hunns
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 Lara Hutto
 Ryan Ben Ickert
 Masayuki Ikeda
 Ken Ikehara
 Kristin G. Irish
 Masahiro Ishikawa
 Margarete A. Jadamec
 Abdolreza Jafarian
 Don L. Jenkins
 Gregg Jilson
 Grisel Paola Jiménez Soto
 Zhenmin Jin
 Steve Jirousek
 Wade Johnson
 David Jones
 Miriam C. Jones
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 Francis John Kane
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 Kayla Kilpatrick
 You Jung Kim
 Christopher Kocka
 Ted Koelsch
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 Christopher Krambis
 Meredith Kratzmann
 Loic Labrousse
 Jack R. Lagoni
 Paula J. LaPoint
 Jonathan B. Laronne

S.H. Lau
 Michael F. Leahy
 Cassandra M. Lehmann
 Jon D. LeMessurier
 David L. LePain
 Ruiping Li
 Henri Liauw A Pau
 Charles S. Lindsay
 Chuck Lindsay
 William Craig Lipps
 James P. Llorca
 Christopher Lockwood
 Ann D. Long
 Jose F. Longoria Jr.
 Trevelyn Anne Lough
 David J. Lown
 Juha P. Lunkka
 Rigel L. Lustwerk
 Charles W. Magee Jr.
 Allan Mandanas
 Shibu K. Mani
 W. Andrew Marcus
 Ronald T. Marple
 Michael Marrano
 Linda M. V. Martel
 Rock Martin Jr.
 Jerome G. May
 Carolyn Mazzo
 Colin M. McAvoy
 James G. McDermott
 Matthew H. McDuffie
 Suzanne A. McEnroe
 Jennifer L. McKay
 Steven L. McKeel
 Santa E. McKenna
 Marjorie McKinney
 Maria McNamara
 Andrew W. McThenia III
 Vanessa J. Meades
 Christopher B.T. Melby
 Trina Kay T. Melville
 Jose Antonio M. Mendoza
 Carlos D. Mendoza Espino
 John F. Messa
 Finn B. Michelsen
 Dennis James Mihalek
 Luke Milan
 Roger S. Miller
 Richard Tran Mills
 Alejandro Molina
 Paola Catalina Montano
 Marco Monteiro
 David W. Moore
 John S. Moore
 Serena Eir Moores
 Raphael Morand
 Margo Morell
 Ann Morey
 Chris Morrell

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 Martin Moscosa Gonzalez
 Gregory J. Moss
 Kieran F. Mulchrone
 Andrew C. Murphy
 Bernhard D.A. Naafs
 Kenneth Nelson
 Tenea Nelson
 Thomas W. Neurauter
 Nancy L. Niemann
 Giovanni Nova
 Paul Novak
 Robin Novosad
 Kristin O'Connell
 Karin Olsen
 Donna Olson
 John Ortiz
 Chris Osterman
 José Antonio Otero
 Steven Scott Park
 Dale L. Pate
 J. David Patton
 Dianne Pavlicek
 Mark Ernest Pecha
 Joseph William Piche
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 Thomas J. Plona
 Ali Polat
 Cassandra A. Pollock
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 Martin Ruecklin
 Steven William Ruff
 Joseph Russo
 Cassandra Rutherford
 Albert T. Rutledge
 Edward Frank Rutledge
 Andrew Jeremy Ryan
 Angel F. Nieto Samaniego
 Laura A. Santamaria
 Cara Santelli

Gabriel-Philip F. Santos
 Mariek E. Schmidt
 Jordan Sedlock
 Scott G. Shay
 Bunichiro Shibazaki
 Paul M. Shipp
 James Shoemaker
 Kristine Simonyan
 Eron Shane Singleton
 Christopher N. Smith
 David Lynn Smith
 Gilbert E. Smith
 Jason Todd Smith
 Sarah Clemens Smith
 Sean Michael Smith
 Mariam Sowe
 Sean Spaeth
 Wayne T. Spence
 Robert G. Sproule Jr.
 Stephen O. Starke
 Thomas A. Stemann
 Bob Stewart
 Christine Marie Edwards
 Stewart
 Debra R. P. Stiffel
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 Raymond L. Straub
 Adrienne Stroup
 Michael J. Styzen
 Shu-Chun Su
 Emmanuel C. Suh
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 Hans Thybo
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Lawrence E. Young
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Junfeng Zhang
Fangchen Zhao
Brian Zimmer

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Snir Attia
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Quintin D. Bendixen
Andrew J. Bisbee
Samantha Nicole Blair
Alexandra Cristine Blel
Adrian Bouknight
Logan Clay Bridges
Vanessa May D. Brillo
Agung Budiman
Michael Cardiff
Charlie Carlisle
Laura Carmody
Leah R. Carrigan
Matthieu J.B. Cartigny
Abdulrahman Chalabi
Elizabeth Cheney
Tristan Morgan Childress
Lyle J. Cobb
Alexandria Lynn Cochrane
Camille M. Collett
Daniel T. Copper
Steven Frank Cornia
Ashlee Marie Cowles
Kathleen M. Coyle
James Michael Crowell-Davis

Sarah E. Crump
Eric John Cutler
Matthew Scott Daigneault
James M. David
Christina Davis
Spencer Davis
John Wesley Dawson
Nathan M. Deliman
Alison R. Denn
Nicole Dickerman
AnneMarie Elizabeth Dickey
Aundrea Dolan
Evan Draper
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Hannah Katie Foster
Gregory Clark Friedman
Jennifer Leigh Fruzzetti
Bonnie Fryer
Christopher Ryan Gallagher
Lucas Alan Garcia
Benjamin D. Gardner
Ruth Gbadeyan
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Timothy Mark Gibson
Conan Ray Godfrey
Leonardo Gruber
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Casey R. Halton
Nicola Jane Hanna
Daniel Ryan Harrison
Evelyn Anna Hay
William Henke
Blaine Edward Higbee
Ross A. Hintz
Tyler Hischke
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Caleb Hilliard James
Katherine James
Megan Javonovich
Kelly Jemison
Matthew Eric Jergenson
Emily Page Johnson
Evan Michael Johnson
Jason Lynn Jones
Matthew Adam Kaufman
Julia Kelson
David S. Kendall

Matthew Kendall
Nina Kilham
Kathryn L. Ladig
Jacob Garnett Laffoon
Samantha Langton
Ann Marie Larquier
Robert Hunter Lee
Blaine Alexander Limpus
Chelsea Locke Lindgren
Jennifer Loeffler
Emily Long
Evan Michael Maldonado
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Ashley Jordan Matrisciano
Naomi Elizabeth Matthews
Sean McCartney
Suzanne McCormick
Mark D. McHugh
Timothy Garrison McNally
Colin Joseph McNeece
Julia Michelle Mechler
Marques Sidney Miller
Tim Miller
Tyler Miller
Vikesh Mistry
Angel Mojarro
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Kyle Dennis Murray
Muhammad Mushtaq Arain
Adrian Nelson
Elizabeth Newbern
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Danny Nursasono Jr.
Heather Offord
Nazik Ogretmen
Oluyemi T. Olubodun
Mary Dillon O'Neil
Agustín Ortiz Yañez
Kent Ostman
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William Edward Philipps
Zachary R. Phillips
Hugo Pouderoux
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Erica Lindsey Ragland
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Justin Nash Rodgers
Lindsay Rodgers
Fee-Alexandra Rodler
Alicia Isabelle Rolin
Daniel Rothberg
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Gene Walter Schmidt

Allen James Schneider
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Madhumita Sengupta
Inga Sevastjanova
Greg Shagam
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Amanda Coral Sherman
Ethan Shirley
Chris Jordan Smith
Megan Frances Smith
Phillip Spake
Josiah Strauss
Manique Talaia-Murray
Kavita Nicole Thakkar
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Nicole Thomas
Dylan E. Tougas
Devin Robert Triantos
Goichiro Uramoto
Krista Ventura
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Roger Ward
Shemelis Fikre Weldesenbet
Oivia Lorraine Wells
David Henry Wessell
Henry Marshall White
Joshua Whitehurst
Shannon Whitmore
Shannon Williams
Amelia Willits
Scott Campbell Worland
Intan Nurmaya Yokelson
Suzanne Young
Rozalli Yusuf Jr.

STUDENTS

Alyssa Abbey
Abraham Abduslam
Kelly F. Ables
Kyle Abraham
Joel Abrahams
Cody J. Absher
Tobias R. Ackerman
Kathryn Adamson
Jennifer R. Adkins
Patrick Adu-Gyamfi
Eldert L. Advokaat
Alison Agather
Aisha E. Agbali
Daniel J. Agner
Priyanka Agrawal
Dalia Ahmed
Faizan Ahmed
Yousef A. Aimubarak
Sunday S. Ajayi
Alero Hilda Ajogri
Alliya Akhtar



- Lailah G. Akita
 Alican Aktag
 Ann Alampi
 Felipe A. Alarcon-Canto
 Alejandro R. Aldana
 Christiane Alepuz
 Jacqueline M. Alexander
 Michael R. Alexander
 Jonathan T. Algeo
 Talal Ghazi Alharbi
 Fayard Roman Ali
 Jennifer LeeAnn All
 Ruksana Alladeen
 Austin B. Allen
 Elif Altikulac
 Angelica Alvarez Naranjo
 Nathan T. Andachter
 Jacob S. Anderson
 Noel E. Anderson
 Ryan R. Anderson
 Ian E. Andree
 Joel J. Angen
 Miles S. Anson
 Ashlyann Arana Morales
 James H. Argyle
 Cedric Aria
 Eric M. Arney
 Victoria Arreola
 Jason Arrow
 Kimberly Artita
 Abigail E. Asangba
 Amy Asanuma
 Thomas C. Ashley
 Michael A. Aughenbaugh
 Kathryn Aukerman
 Kate Aulenbach
 Michelle D. Avent
 Michael Ayers
 David Azinheira
 Christine Baba
 Ethan Lee Backus
 Allison A. Baczynski
 Brooks John Bailey
 Bryan Earl Bailey II
 Claire H. Bailey
 Leif Anthony Bailey
 John Edward Baird
 Dudley Duggan Baker V
 Luke Austin Baker
 Divya Balaji
 Stephanie Balbuena
 William Ballow
 Philip W. Bambach
 Nicholas E. Bandy
 Sagarika Banerjee
 Roxanne Banker
 Robin Lydia Banner
 Azzeddine Barakat
 Jennifer L. Barckhoff
 Audra I. Bardsley
 Alan Barraza
 Mabely Barrera
 William Barron
 Bryan T. Barry
 Colin H. Barry
 Sheila Bart
 Sarah M. Bartholomew
 Daniel A. Bassett
 Chase E. Batchelor
 Janelle Bauer
 Jennifer Bauer
 Jason Baugh
 Jennifer Bautista
 Jacob B. Bayer
 Emily Beahm
 Lindsey C. Beard
 Díaz Beatriz Adriana
 Kacy Amber Beck
 Anita L. Behari
 Brandon Belcher
 Colin Bell
 Lauren E. Bell
 Richard Lee Bell
 Rachel A. Benaway
 Austin Bennett
 Jonathan T. Bennett
 Timothy Carl Bents
 Kristopher M. Benusa
 Patrick Bergin
 Jeffry C. Bernard
 John Bertalott
 Laura Best
 Ian Robert Beyerle
 Anmole Bhandari
 Soumendra N. Bhanja
 Alicia M. Bierstedt
 Carol Lynn Bigalke
 Anne Billingsley
 Nina Bingham
 Caleb Evans Birchard
 Kristi Birchfield
 Daniel Birmingham
 Mary Sheela Biswal
 Kenneth E. Bitzer
 Heather Black
 Nathaniel C. Blackburn
 Sean Blackwell
 Michael George Blair
 Luis F. Blanco Orozco
 Lukas J. Blom
 Katie Blood
 Cody W. Bodman
 Patrick Boehnke
 Isaiah W. Bolden
 Michael E. Bond
 Ryan Bond
 Thomas Paul Bond
 Robert Booth
 Ethan W. Boothe
 Erik Boots
 Steven Booty
 Marisa L. Boraas
 Jackson S. Borchardt
 Alex Borchert
 Alexander M. Borell
 Taylor M. Borgfeldt
 Palma J. Botterell
 Jennifer A. Bower
 Anthony Boxleiter
 Ariana Boyd
 Cullen H. Boyd
 Brian K. Bradley
 Christine M. Brandon
 Katelynn Braunschneider
 Benjamin S. Brechtel
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 Benjamin Breland
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 Alec Brenner
 Stacy Brent
 Alison S. Bressler
 Peter John Bridges
 John M. Bright
 Kyle A. Brill
 Amanda S. Brioche
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 David J.H. Brooks
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 Alan Brown
 Elizabeth A. Brown
 Jessica M. Brown
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 Megan A. Brown
 Micah Brown
 Andrew T. Brownell
 Megan Bruck Syal
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 Chad W. Bryant
 Sarah Buckerfield
 Karen Buckland
 Nicollette Buckle
 Kourtney Jo Buckley
 Jacob E. Buettner
 Chelsea Bulen
 Garret Bullard
 Emily Grace Bunse
 Nicole Burdakin
 Jeri J. Burke
 Nicholas R. Burke
 Laura K. Burkemper
 Sarah R. Burket
 James Eric Burns
 Oliver Eagan Burns

Aaron C. Carino Burr
Jill E. Burrows
Josh Burrus
Connor Burt
Alexandra C. Busk
Jacqueline M. Bussey
Francis M. Bustard V
Meredith E.M. Butler
Morgan M. Butterfield
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Logan C. Byers
José Francisco V. Cabrera
Stephanie Caffee
Carson Cain
Rebecca L. Caldwell
Erika Blanca R. Callagon
Fredy M. Calle Ojeda
Christopher Cameron
Rafael Campanha
Alicia A. Campbell
Claire Campbell
Trevor John Campbell
Roxanne I. Candelaria-Ley
Joseph Maxwell Cange
Irma Caraballo Álvarez
Benjamin T. Cardenas
Rolando Cardenas
Randy W. Cardon
Benjamin M. Carlson
Gloria Carpenter
Adam Ryan Carr
Hunter Carr
Vanna Lynn Carr
Andres Carranco
Taylor L. Carrasco
Juan David Carrillo
Corbin Tyler Carsrud
Caitlin Stella Carter
Joseph M. Carter
William A. Cary
Brendan A. Cassidy
Amanda M. Casteel
Jessica Castleton
Benjamin Caswell
Genevieve Cavalier
Danielle N. Cedillo
Keren Cepero-Perez
Calum Chamberlain
Bryce Chambers
Kevin Scott Chambers
William M. Chamlee
Thomas E. Chapman
Daniel Chavez
Semiiar Chavez
Terry M. Cheiffetz
Ruiqian Chen
Michael D. Cherney
Robin M. Chernow
Aaron J. Chesler

Robert Chester
Miranda Chien-Hale
Shamar Chin
Suzanne S. Ching
Dariusz Chlebica
Na Hyung Choi
Shreyasi Choudhury
John M. Christenson
Kayla Christian
Cole M. Christiansen
Adam R. Christianson
Cidney Christie
Byong-suk Chun
Peter M. Chutcharavan
Burcu Ciner
Elyse Clark
Joanna V. Clark
John Patrick Clark
John R. Clark
Richard Ray Clark
Robert Clark
Chad L. Clendenin
Christopher J. Cline II
David T. Clippinger
Trisha Ruth Cockey
Adam B. Coderre
Jason James Coenen
Kevin Thomas Coffey
Michael J. Cohen
Shaina Cohen
Parker James Coit
Devon Cole
Hank M. Cole
Selina R. Cole
Preston D. Colledge
Tyler Lee Collier
Zack Collins
Alice Colman
Jack Colpitt
William T. Colson
Laura Condon
Shane G. Cone
Byron Conley
Angelica J. Connelly
John Daniel Cook
Sarah Cooley
Hayley N. Cooney
Michele L. Cooney
Jassy Cooper
Melissa Corbett
MaryKate F. Core
Casey S. Corkery
Miles Tyler Costello
Justin R. Coughlin
Samantha Couper
Pierre Couture
Kathleen Deanna Cox
Patrick Carroll Cox
Terry Lawrence Cox

Neala M. Creasy
Andrea Creighton
Ryan Creitz
Kevin P. Crews
Alejandro Cristin
Katharine Criswell
Isabella Cross-Najafi
Lauren P. Crow
Dawn Faye Crowell
Chadwick R. Crumbley
Horace R. Crump III
Jessica L. Crysler
Yanet Cuddus
Caitlin Cunningham
Jessica M. Cunningham
Maxwell Cunningham
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Ivy S. Curren
Brittany A. Cymes
Jennifer Dabbs
Hiba Dagash
Zhen Dai
Kelsey Dailey
Adrian N. Dancer
Susan E. Daniel
Brian Danielson
Peter Danner
Ravi M. Darji
Oindrila Das
Charles Davidshofer
Max Davidson
Melissa E. Davidson
Jubril A. Davies
Jasmine L. Davis
Jennifer R. Davis
Kelly Davis
Kyle Lee Day
Luciana de la Rocha
Luiraima S. De Langer
Danielle M. de Montigny
Luiz H.S. De Oliveira
Joey Ellis Dean
John P. DeDecker
Mike Dellea
Tatiana D. Delledera
Erin M. Delman
Timothy Deloria
Jonathan Delph
Michaelann DeMille
Barbaros Demircan
Christopher Dempsey
Hang Deng
Trina May Dennison
Richard DePolo
Erin Rebecca Derrick
Elizabeth DeRubeis
Steven M. Devine
Pedro Di Liscia
Emanuela Di Martino

Albert V. Dias III
Ariel Ramirez Diaz
Jacqueline Diehl
Benjamin DiFrancesco
Rio Sophia Diniakos
Scott L. Dinsmore
Sebastian Dirringer
Nilesh C. Dixit
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Shadae Dixon
Issoufou Djibo
Stephen Cole Dobbs
Alanna Dolen
Katherine Dominguez
Rene Dommmain
Stefanie Domrois
Kevin Patrick Donovan
Toby Dossett
Ikumi Dori Doucette
Samantha Doupnik
Abraham W. Downer
Aaron G. Doyka
Michelle Kim Drake
Jessica M. Driscoll
Michael Dubnansky
David Nicolas Dudics
Anna L. Duewiger
Daniel Patrick Dunham
Alexander Mark Dunhill
Ashley Dupont
Andrew Charles Eagar
Marc A. Eaton
Elizabeth Eberle
Wilson Ray Echols
Heidi L. Edwards
William K. Edwards
Lauren Eggleston
Mary A. Eibl
Chuka Eko
Adam Elabd
Mostafa Galal Elbasal
Rania Eldam
Jake Austin Elder
Graham Eldridge
Benjamin Reilly Elliott
Kristin Renee Elliott
Imogene Aitken Ellis
William Anthony Ellison
Shawn Curtis Elswick
Jacqueline Engel
Hunter England
Hersy Joy Enriquez
Emma Rose Ervolina
Raphael Esedo
Ernest L. Espinosa Jr.
David Nava Espinoza
Caleb Essex
Alicia Kelly Estabrook
Biniam Haileab Estifanos

Emilie D.G. Ethridge
 Edward Etienne
 Andrew Eull
 Alyssa Evans
 Benjamin Evans
 Tyler B. Evans
 Timothy J. Eyerdom
 Ethan James Faber
 Nicole Fahrenfeld
 Lauren W. Falvey
 Ziqian Fan
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 Lian Feng
 Yao Feng
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 Katie Foster
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 Mattie E. Friday
 Corey Justin Friedman

Ryan James Fries
 Kasey Fritz
 Drew Fuchs
 Alayna Jenne Fuess
 Conan Yale Fugit
 Chika Fujimitsu
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 Diana B. Fulmer
 Nate W. Fulmer
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 Tyler Clayton Furr
 Ibrahim A. Gabr
 Geoffrey Gadd
 Kelli E. Gagnon
 Letitia E. Gaillard
 Elisabeth Gallant
 Martha I. Gallegos
 Laurel Marie Galm
 Colin Scott Gannon
 Michelle E. Gannon
 Lingrui Gao
 Emmanuel Garcia
 Jessica Lee Gardellini
 Dominique I. Garello
 Matthew Lee Garnett
 Joanna C. Gaset
 Daniel Peter Gaspari
 Hannah Sarah Gatz-Miller
 Mark A. Gayeski
 Alay G. Gebregiorgis
 Phillip S. Geer
 Brenda Marie Geis
 Jennifer Geoghegan
 Sarabeth E. George
 Sarah George
 Cassie Geraghty
 Laci M. Gerhart
 Brandt M. Gibson
 Amanda K. Giesler
 Katherine Gigandet
 Ian Ross Gilbert
 Patrick Daniel Gilbride
 Sam Giles
 Alden Jane Gilliom
 Anastasia Gloria Gilmer
 Lars A. Gilmour
 Carrie Lynn Glauner
 Christopher R. Goeddeke
 Steven A. Gohlke
 Jonathan Goldman
 Aaron Paul Goldner
 Kiara J. Gomez
 Charlene N. Gonsalves
 Noah Gordon
 Suzanne Gordon
 Eric Gorscak
 Timothy A. Goudge
 Andrew Goulet
 Kaitlyn Grace

Jason Graessle
 Joshua Graham
 Lauren N. Graham
 Will Graham
 Nicholas K. Grapsas
 Shawna Graves
 Leah R. Gravitz
 Jeffrey J. Gray
 Daniel Green
 Jeremy W. Greene
 Cole Green-Smith
 Andrea C. Gregg
 Caroline Gregory
 Andrew R. Gregovich
 Ryan Griffin
 Ira Lee Griffith
 Theodore Grimm
 Timothy M. Grip
 Jordan M. Gross
 Pamela Ruth Grothe
 Matthew A. Grundy
 Lauren N. Guidry
 Paul A. Gully
 Erkan Gun
 Melissa Gundersen
 Sydney R. Gunnarson
 Kun Guo
 Raymond Gurnick
 Paul Joseph Gutierrez
 Derek Guzman
 Casimir M. Guzowski
 Shellie Linn Habel
 Mary Helen Habicht
 Kristiana Haehnle
 William Jesse Hahm
 Timothy Hainley
 Ketan D. Hakay
 Chandler T. Hale
 Richard P. Hale
 Billy U. Hales Jr.
 Christopher J. Hall
 Jeffrey Charles Hall
 Drew Hamilton
 Katherine R. Hamilton
 Jennier Hamon
 Tyler Barbee Hampton
 Liang Han
 Charles T. Hancock
 Zac S. Hancock
 Patricia Hanks
 Caitlin Marie Hanley
 Emma G. Hansen
 Joshua Hansen
 Steven Hansen
 Ezazul Haque
 Md. Aminul Haque
 Tate Hardesty
 Eric Jon Hardin
 Sarah E. Hardison

James D. Hardy
 Jennifer Harkness
 Dalia R. Harmon
 Patrick A. Harms
 Patrick P. Harold
 Christopher Harper
 Danielle R. Harper
 John Ross Harper
 Jake Harrington
 Ryan T. Harrington
 Jeffrey S. Harris
 Joseph Blake Harris
 Matthew C. Harris
 Anthony A. Harrison
 Emma J. Harrison
 Logan Hartle
 Erik Hascall
 Megan J. Haserodt
 Cheyenne B. Hassan
 Muatasam Hassan
 Kelly E. Hattori
 Jacob Hauser
 Jeffrey Haworth
 Charles Hayes
 Emily Blythe Hayes
 Keith A. Hayes
 John Daniel Haynes
 Laura Haynes
 Griffin M. Heard
 Nicholas Heaverlo
 Christina Hefron
 Erik Sidney Heider
 Samuel Hellman
 Cora Hemmila
 Bonnie J. Henderson
 Nathaniel P. Hendler
 Rachel L. Hendricks
 Clayton Hengst
 Tyler Henning
 Stephen J. Henry
 Guadalupe L.A. Hernandez
 Caitlin Marie Herrera
 Chelsy Anne Herring
 Jason A. Hightower
 Joshua N. Hilderbrand
 Jenny Charlotte Hill
 Jonathan W. Hill
 Michael Hunter Hill
 Michael John Hill
 Paul Hill III
 Tyler J. Hill
 Trevor Ray Hillebrand
 Leanne Hillegas
 Dorothy M. Hinds
 Johnny Ray Hinojosa
 Jessica J. Hirsch
 Zachary S. Hitchner
 Kelly Ho
 Catherine Hodierne

Alexandria M. Hoffman
Nicholas J. Hogancamp
Jessica R. Hoglen
Rachel Hohn
Robert M. Holder
Natalie A. Hollis
Sarah E. Holmes
Christopher J. Honess
Ian Wiley Honsberger
Taylor Van Hoorebeke
Xavier Hope
Benjamin D. Hornsby
Kelsey Hornung
Jennifer Marie Horton
Jun Hosoi
Addison Hostetler
Terrance Hourihan
Sally M. Houseman
Jason B. Howard
Rebecca Howe
Jason M. Howell
Kyle Howell
D. Anderson Howington II
Danielle Marie Howlett
Shih-Yi Hsiung
Ningjie Hu
Erika Hubbard
Jared Hudson
Reece D. Hudspeth
Wilfer Yadir Huertas Sr.
Ashley S. Hughes
Matthew Hughes
Sam R.W. Hulett
Brad Hull
Neil Hulland
Cody Fox Hume
K Ann Hume
Phillip Hummer
Jeffrey B. Hundley Jr.
Ryan William Hupfer
Elizabeth Grace Huss
Donald C. Hutchinson
James Cliff Hutto
Yinal Neses Huvaj
Takashi Ichiki
Erin E. Idleman
Fidelis E. Idoko Jr.
Tasnuva Islam
Carrolyn Izzo
Shirley Jackson
Jaison Jacob
Leslie Jacobs
Leandra Jacobsen-Guy
William Jahraus
Anna M. Jalowska
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Sarah C. Jantzi

Ian Jaqua
Christina Meg Jasion
Cassidy Jay
Angelina Jelks
Casey Jennings
George R. Jennings III
Randy S. Jennings
Tyler M. Jennings
Dustin Jensen
Owen Jensen
Zachary A. Jensen
Andy Steven Jerrett
Vandana Jha
Anthony P. Jijina
Juan A. Jimenez
Ligia Jimenez
Jacob A. Johns
Blake S. Johnson
Calvin E. Johnson Jr.
Cassandra L. Johnson
Craig Johnson
Stephanie Johnston
AnnMarie Jones
Aubrey S. Jones
Catherine Jones
Crystal Ann Jones
Daniel C. Jones
Douglas J. Jones
Kaitlyn L. Jones
Margaret Jones
Rebecca H. Jones
Rebecca L. Jordan
Billyjack P. Jory
Lauren Jozwiak
Marisol Juarez Rivera
Sean Julander
Jikhan Jung
Carl V. Jurkowski
Robert L. Justice III
Kate M. Kaminski
Haunani Kane
Patrick Kane
Elizabeth Kang
Cynthia Mai Kanno
Hannah Kaplan
Salih Burak Karabel Alyssa M.
Karis
Jennifer J. Kasbohm
Scott D. Kasten
Chris Katz
Ersin Kaya
Amy K. Kearney
Jessica Kegel
Carolyn L. Kegler
William E. Kellam
Alexandria V. Kellenberger
Chad Edward Kelley
Lawrence T. Kellum
Corey Kelly

Michael Patrick Kelly
Thomas Kelly
Joshua Gerard Kempf
Celia Cassis Kennedy
Jeffrey R. Kennedy
Dayna Kent
Lauren E. Kerber
Kellie Rae Kerner
Subhasis Kesh
Amber Keske
Brenda Kessenich
Ren N. Keyport
Marina Khakhulina
Ahmed Khydor
Billie Jo Kibler
Md. Golam Kibria
Kebede Gezahegn Kidane
Joy Julianna Kiefer
Alex E. Kiewit
Henok Gidey Kiflu
Courtney Killian
Mi Yen Kim
Michaela Kim
Amanda G. Kimbley
Brianna M. King
Arata Kioka
Mackenzie E. Kirchner-Smith
Fraser A. Kirk
Yael Kiro
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John Kyle Kissock
Julia F. Klath
James W. Klein
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Joe F. Klumpstra
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Dante Lee Knapp
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Friedrich Alexander Knuth
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Daisuke Kobayashi
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Laurel Kohl
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Rebecca Koll
Hellen G. Kollar
Miela Kolomaznik
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Thomas J. Kosciuch
Ian J. Kosciusko
Alisa Kotash
Sara Kozmor
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Austin William Krehel

Chelsea Krieg
Thaddeus C. Krueger
Robert Norman Kryzer
Krystal Vanessa Kuehl
Michelle M. Kuehlhorn
Abhash Kumar
Amishi Kumar
Dervla Kumar
Calvin Cox Kuntze
Kristopher M. Kusnerik
Harry Max Kuttner
Jeffrey Stephen Kwang
Aji Kyari
Andrew John Lade
Natasha M. Laflin
Judy Lam
James Lambert-Smith
James C. Lamsdell
Heather N. Lancaster
Tisha Lance
Amanda Lanik
Mario E. Lara Ocampo Sr.
Hernan J. Lara-Saavedra Jr.
Justin M. Lashley
Aaron Last
Nicole Marie Latham
Pok Him Ron Lau
Nancy Lauer
Zachary H. Lauffenburger
Stephan Lautenschlager
Lance Lawson
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Kaitlyn L. Le Baudour
Alyssa G. Le Mar
Richard D. Le Mon
Shannon Noelle Ledger
Carver Elliott Lee
Kelly Michelle Lee
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Andrea Leonard
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Lindsey Ann Lepak
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Alia Lesnek
Emily Ann Lestingi
Alexander Turner LeSueur
Tania Leung
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Gabriel Lewis
Ira Charles Lewis
Scott A. Lewis



Khalil A. Lezzaik
 John Zihong Li
 Zhixin Li
 Stephen Liberatore
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 Meimei Lin
 Qianying Lin
 Keith B. Lindabury
 Abbie R. Lindeberg
 Xafira Ling
 Chris Linkletter
 Michael V. Little
 Demin Liu
 Michael Liu
 Yu-Ting Liu
 Teresa K. Lloro-Bidart
 Edward Lo
 Stewart M. Long
 Peter Lordan
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 Jennifer Lovell
 Lindsey R. Lowery
 Emily J. Lubicich
 Jason Lubniewski
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 Thomas W. Luckie
 Ingrid Luffman
 Eric Connor Luken
 David Azaria Lukudu
 Dylan Lundgren
 Scott Lyons
 John W. Lyons-Baral
 Blake A. Lytle
 Chong Ma
 Yuteng Ma
 Jenny Maccali
 Peter J. MacDonald
 Esteban R. Macias
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 Matthew Magdic
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 Rhiannon Helen Carene Maio
 Harry M. Maisch IV
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 Jillian Mallis
 Jordan Robert Malloy
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 Reinbill P. Maniquez
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Joselyn Marquinez
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 Jeff Marsh
 Donna P. Marshall-Knowles
 Christopher Martin
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 Emily S. Martin
 James Dylan Martin
 Jocelyn L. Martin
 Wesley Martin
 Jesse G. Martinez
 Maria C. Martinez
 Breno S. Martins
 Larisa U. Masalimova
 Carlos Mascote
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 Iain Paul Mason
 Michael Stuart Mason
 Samaneh Masoumi
 Tayyaba Mateen
 Frank Mathias Jr.
 Jacob Shane Mathis
 Gabriel O. Matson
 Aya Matsunaga
 Steven J. Mattern
 Mark Matyi
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 Mitchell A. May
 Edward C. Mayes
 Meghan Maylone
 Whitney T. Maynard
 Kevin McAndrews
 Jennifer L. McAuley
 Jessica McBeck
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 Ashley McCann
 Ian A. McCary
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 Kegan N. McClanahan
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 Christopher McConaghy
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 Julianna McDonnell
 Chris McGibbon
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 Richard A. McGuire Jr.
 Duncan McIntosh
 David Brett McKee
 Paul D. McKenna
 Dylan James McKeivitt
 Rufus C. McLean Jr.

Claire Louise McLeod
 Matthew C. McMahan
 Andrew R. McMahan
 Evan C. McMullen
 Nancy Means
 Lindsey D. Medina
 Tyler N. Meek
 Matthew T. Meeks
 Vernon Meidlinger-Chin
 Scott D. Meier
 Julie Ann Meleski
 Thomas Augustus Meloy
 Fabio Mendoza Villero
 Garrett T. Menichino
 Heather M. Merchant
 Juan S. Mesa Sr.
 Jake Matthew Meyer
 William Middlebrook
 Miranda Mikesch
 Kimberly A. Miles
 Laura C. Millan
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 Elizabeth Miller
 Hollis Miller
 Jon L. Miller
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 Shane M. Miller
 Summer A. Miller
 Zachary Miller
 Jacqueline A. Mills
 Sara E. Miltenberger
 Hannah Miltier
 Thomas J. Minier
 Jeffrey J. Minnehan
 Joseph W. Minnetto III
 Dustin Brady Minter
 Iris Nicole Miranda
 Cameron Mitchel
 Emily Elizabeth Mitchell
 Ronald Grant Mitchell
 Toshio Miyazaki
 Kris Mo
 Gary E. Mobbs Jr.
 Brian Robert Mocchi
 Mitchell Modlich
 Lamees Mohamed
 Farah Mohammad
 Abdel Mawgoud Mohammed
 Renas I. Mohammed
 Michael T. Mohr
 Danielle Dawn Molisee
 Hannah Mondrach
 Dewany Monsels
 Ashton Montrone
 Morgan E. Monz
 Jeremiah D. Moody
 Marcus Shay Moon
 Angus K. Moore
 Dean Moore

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Katie Moore	Nick M. Novotny	Dale Patrick Jr.	Steven Hardy Powell
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Veronica Moreno Rodriguez	Tess Nugent	Megan H. Patterson	Seth N. Pratt
Camille E. Morgan	Yarelys E. Nunez	Nicholas R. Patton	Kathleen Presley
Jack Edward Morris	Chijioke S. Nwankwor	Dominique Paxton	Aaron Matthew Price
Jenny Morris	Brian O'Neill	Kelly A. Pearson	Katherine W. Price
Katherine A. Morrow	Carina D. OBara	Tyler B. Pearson	Patrick F. Price
Emily A. Morton	Margaret R. Obear	Eric J. Peavey	Rachel Nicole Price
Matthew M. Morton	Brennan O'Connell	Jeff D. Peck	Tom Jay Price
Joel Mosebach	Steven R. O'Connell	Chelsea L. Pederson	Michael S. Priddy
Jonathan Lee Moskal	Alexander O'Farrill	Justin B. Peers	Jonathan W. Primm
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Danielle Kimiko Moyer	Olawale E. Olabisi	Magaly Perez	Laura Pullum
Anna Mudd	Sarah Jane Olivas	Brett Perry	Alanna Punch
Robert P. Muehlbauer	Joshua E.S. Olsen	Matthew R. Perry	Yogendra Pundir
Stephen A. Muela	Christopher A. Olson	Dana L. Pertermann	Christopher A. Puoplo
David Mueller	Nathan Olson	Ann-Mari Peters	Jamie W. Purcell
Megan Anne Mueller	Katherine O'Malley	Carl Edward Peters	Christopher Pyle
Arindam Mukherjee	Bridget O'Neill	Joseph Paul Peters	Kimbra Quezergue
Tatjana Mulligan	Kehinde Ba. Opatola	Layne Peterson	Lynnae C. Quick
Eric Mumper	Sarah K. O'Reilly	Swardhuni Pethe	Danielle R. Quigley
Kelsey M. Murdaugh	Rafael S. Orozco II	Nathan Pettingill	Justin E. Quinlan
Michele M. Murday	Priscila M. Ortega	John B. Peurifoy	Chad Carson Quinn
Benjamin Scott Murphy	Colby Osborn	Eric M. Pezzi	Stephanie Quintana
Eleanor Murtagh	Tashiana Osborne	Karl Philippoff	Robert Miles Rader
Anthony D. Muscente	Anna Ose	Danyelle E. Phillips	Mohammed H. Rahman
Brittany E. Musser	Johnathon Osmond	Judy Phillips	Diego A. Ramirez
Jeremy Robert Myers	Laura L. Osterhoudt	Katie Lynn Phillips	Carlos Adrian Ramirez
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Thomas A. Nash Jr.	Nicholas Owojori	Stephen M. Picek	Juan Rangel
Samuel Nath	Matthew Oxman	Angel L. Pichla	Ryan Ransavage
Daniel Natter	Mark C. Padgett	Michael J. Pickens	Michael Rasbury
Jason Neal	Kelsey Padilla	Rebecca A. Pickering	Michael Ray Rash
Raymond Nechvatal	Nathan J. Page	Patrick R. Pierce	Nazhat S. Rashid
Daniel C. Nedvidek	Sarinya Paisarnsombat	Tom Piergiovanni	Rebecca A. Ratchford
Brock R. Nelson	Norma B. Palacios Garcia	William Pierskalla	Oliver Ray
Stefano Nerozzi	Jennifer Ann Palermo	Clayton Dean Pilbro	Zach Razor
Jessica H. Nester	Almanet Palm	Sherry E. Pinnell	David Real
Ryan M. Neumann	Li Pan	Mary M. Pipher	Stephanie N. Reavis
Shane I. Neuser	Atul Kumar Pandey	Alexander Piskin	Isaiah Levi Reed
Derrick R. Newkirk	Lauren Pandolfi	Anthony Pivarunas	Jack V. Reeder
Raymond Ng	Chongjin Pang	María F. Podesta	Tabor Reedy
Luan Hai Nguyen	Paul Paris	Kairi Poldsaar	Ashleigh Ka. Reeves
Mallory Gwyn Nickel	Sulgiye Park	Sara Lindsay Poluga	Kimberly C. Reggish
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Brady Morrill Nielson	Eric Parker	Cyle David Pool	Melissa Reusche
Adrienne V. Noftall	Mercer Parker	Gina Ginevra Pope	Brandi Revels
Jason Nolan	Molly Louisa Parks	Jamie R. Popejoy	Andrea Rhode
Cameron R. Noon	Martha Mary Parsons	Robert Porritt	Daniel Luke Rhodes
Francis Noone	Jackson Phelps Partlow	Daniel Portner	Rebecca A. Rhodes
Michael S. Norton	Stephen Paskvich	Richard Allen Potter	J. Robert Rice
Rebecca Norton	Aaron Benjamin Passer	Lauryn Anne Pounder	Joshua S. Rice

Samuel L. Rice
 Matthew C. Richardson
 Faye N. Ricker
 Hannah Beth Riegel
 Steven Michael Rife
 Caitlin Riggs
 Keith Philip Rikli
 Morgan Scott Rinehart
 Cristina Rivas
 Junior Roberts
 Amy Jo Robertson
 Jesse Robertson
 Amanda M. Robinson
 Amber C. Robinson
 Brandon M. Robinson
 James M. Robinson
 Darin Riley Rockwell
 Haley E. Rodack
 Lauren M. Roddy
 Michael J. Rodriguez
 Anastasia Rodzianko
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 Alexis Rojas
 Angela Roman
 Loveinia J. Romero
 Andrew Romero
 Ryan Oliver Roney
 Nelson K. Rono
 Jonathan Casey Root
 John Lewis Ropp
 Hannah J.P. Rosenberg
 Daniel Rosenstein
 Joel Roskin
 Benjamin J. Ross
 Karen Roth
 Eric Rothermel
 Joseph Rotstein
 Rachel Rose Rotz
 Remy C. Rovelli
 Jacqueline M. Rowley
 Jillian Leigh Rowley
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 Cynthia Royce
 Abhishek RoyChowdhury
 Allison Rubin
 Jacob Colin Rudolph
 Alexandra Ruiz
 Kellie Lauren Rulong
 Yuri Konrad Rupert
 Rael R. Rupnaraine
 Catrina Elen Russell
 Evan T. Russell
 Jennifer Lorraine Ryan
 Juliet R. Ryan-Davis
 Uri Ryb
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 Seren Sert
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 Erin Kathleen Shea
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 Kelsey Shields
 Graham Shockley
 Larry W. Shonk
 Timothy G. Shortley Jr.
 Morgan L. Shuman

Philip Shute
 Weimin Si
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 Yanyan Song
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 Joseph G. Spaulding
 Kyle B. Spaulding
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 John Erik Strom
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 Zachary S. Sullivan
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Jillian Votava
Alex Vukmer
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Benjamin M. Wagman
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Erin E. Wagner
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Jennifer Sue Walker
Travis Walker
John Wall
Danny Wallace
Nicole K. Wallace
Kaitlyn Natalia Walleth
Dana Lynn Walters
Yaojie Wang
Yulun Wang
Rachel Warnock
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Jeffrey A. Watford II
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Jean-Charles Weaver
Jixin Wei
Angus Welch

Arden Alana Wells
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Kyle Shane West
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Claire Westervelt
Joshua D. Weyandt
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Sascha Zertani
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Xiaodong Zhang
Xinwei Zhang
YaoQuan Zhou
Adam Zurn

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Olga Blinova
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Carmela Marisa Castellano
Carolina Elizabeth Castro
Timothy Clare
Sean Phillip Clingan
Mary Christine Crusemire
Christine L. Day
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Richard P. Faucett

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 Timothy Grant Hurst
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 Patricia Joyce Judd
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 Kimberly Miller
 Annice Milliner
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 Barry J. Smith
 Jay M. Smith

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 Kristen J. VanVarick
 Nancy Windus
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 M Denise Wartes
 Hudson A. Washburn
 Deborah Faith White
 Toni L. White-Subia
 John Steven Wrobleki
 Wen Xue
 Kenneth Yamamoto
 Lu Zhang
 Lea Zimmerman



GSA ELECTIONS

Elections begin 8 March 2013

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council.

In early March, you will receive a postcard with instructions for accessing your electronic ballot via our secure website, and

biographical information on the nominees will be online for you to review at that time. Paper versions of both the ballot and candidate information will also be available.

Please help continue to shape GSA's future by voting on the nominees listed here.

2013 OFFICER AND COUNCIL NOMINEES

PRESIDENT

(July 2013–June 2014)
Suzanne Mahlburg Kay
 Cornell University
 Ithaca, New York, USA

VICE PRESIDENT/PRESIDENT ELECT

(July 2013–June 2014)
Harry (Hap) McSween
 University of Tennessee–Knoxville
 Knoxville, Tennessee, USA

TREASURER

(July 2013–June 2014)
Jon Price
 Jonathan G. Price LLC
 Reno, Nevada, USA

COUNCILOR POSITION 1

(July 2013–June 2017)

Elizabeth J. Catlos
 The University of Texas at Austin
 Austin, Texas, USA

Carmala N. Garzione
 University of Rochester
 Rochester, New York, USA

COUNCILOR POSITION 2

(July 2013–June 2017)

Neil Fishman
 Hess Corporation
 Houston, Texas, USA

H. Tom Kuper
 Kuper Consulting LLC
 Helena, Montana, USA

COUNCILOR POSITION 3

(July 2013–June 2017)

John J. Clague
 Simon Fraser University
 Burnaby, British Columbia, Canada

Brenden Murphy
 Saint Francis Xavier University
 Antigonish, Nova Scotia, Canada

Ballots must be submitted electronically or postmarked by 6 April 2013.

In Memoriam



The Society notes with regret the deaths of the following members (notifications were received between 1 August and 31 October 2012).

Allen F. Agnew
Corvallis, Oregon, USA
12 September 2012

Wallace De Witt Jr.
Glenwood, Maryland, USA
Notified 31 Aug. 2012

F. Beach Leighton
Indio, California, USA
3 October 2012

George T. Schmitt
Hamilton, Ohio, USA
15 October 2012

Neil Armstrong
Lebanon, Ohio, USA
25 August 2012

Peter R. Hooper
Whitchurch-on-Thames,
Reading, UK
1 April 2012

Glenn B. Morey
Roseville, Minnesota, USA
2 August 2012

Elisabeth C. Schwarzman
Falmouth, Massachusetts, USA
Notified 11 September 2012

Harold K. Brooks
Patillas, Puerto Rico
24 September 2011
Notified 25 Oct. 2012

Richard K. Hose
Cupertino, California, USA
28 July 2012

Lewis G. Nichols
Spring, Texas, USA
Notified 25 October 2012

Charles M. Shaw
La Conner, Washington, USA
24 September 2012

James H. Butler III
Houston, Texas, USA
1 April 2012

James C. Knox
Madison, Wisconsin, USA
6 October 2012

Robert M. Norris
Santa Barbara, California, USA
29 August 2012

Russell B. Travis
Pensacola, Florida, USA
1 September 2012

Wilbert R. Danner
Vancouver, British Columbia,
Canada
1 May 2012

Geoffrey B. Leech
Ottawa, Ontario, Canada
22 April 2012

Richard A. Paull
Littleton, Colorado, USA
13 October 2012

LeRoy E. Warren
Lindstrom, Minnesota, USA
20 March 2012

Dale F. Ritter
Sparks, Nevada, USA
1 June 2012

To honor a friend or colleague with a GSA Memorial, please go to www.geosociety.org/pubs/memorials/mmlGuid.htm to learn how. Contact the GSA Foundation, www.gsafweb.org, if you would like to contribute to the Memorial Fund.



GeoCorps™ America Summer 2013

Deadline: **4 February 2013**

GSA is now accepting applications for paid geoscience opportunities on public lands managed by the U.S. National Park Service, the U.S. Forest Service, and the Bureau of Land Management. All levels of geologists—students, educators, professionals, retirees, and others—are encouraged to apply. Summer 2013 positions include Guest Scientist positions, GeoCorps Diversity Internships, and GeoCorps American Indian Internships.

Learn more:

www.geosociety.org/geocorps/

www.facebook.com/GeoCorps

If you have questions or need application assistance, contact Matt Dawson at mdawson@geosociety.org.

What **GSA GeoVenture** Awaits You?

The best way to learn geology is to study it in the field. GeoVentures are special geoscience field trips created for the members and friends of The Geological Society of America. Join GSA on one of these trips to experience some of the most spectacular geoscience on the planet!

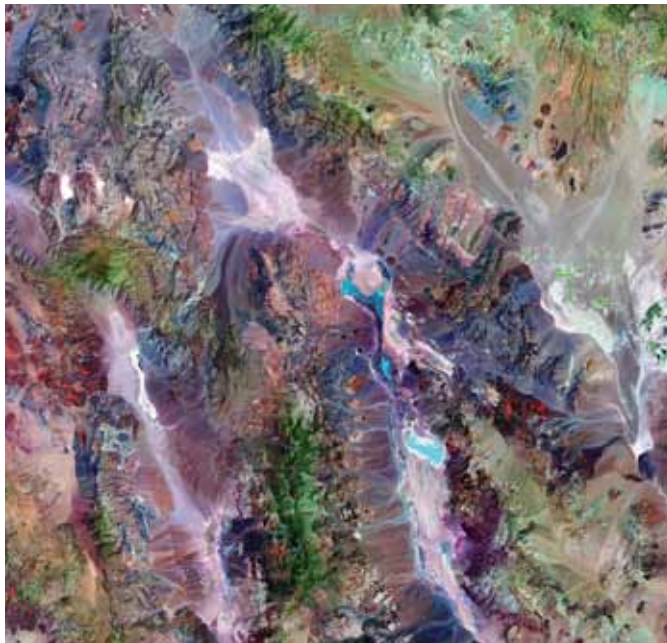
TRIPS FOR EVERYONE

Explore the Extremes of Death Valley National Park

11–17 March 2013

According to the National Park Service, Death Valley National Park (DVNP) is the “Hottest, Driest, Lowest! A superlative desert of streaming sand dunes, snowcapped mountains, multicolored rock layers and water-fluted canyons.”

Join GSA and the Mountains & Plains Institute as we explore the geology of these contrasts and extremes. The trip will visit various places within DVNP in order to create a rich understanding of its geology, including Harmony Borax Works, Mormon Point Turtleback, Lake Manly shorelines, Dante’s View, Race Track Playa, and more. Time permitting, areas outside of the park to the south may be visited. Instruction will appeal to all levels of geologic study.



Death Valley, California, USA. Image courtesy NASA.

TRIPS FOR STUDENTS

Geology of Dinosaur National Monument– Yampa River Trip

6–12 June 2013

Dinosaur fossils, canyons carved by the Green and Yampa Rivers, the magnificent colors of the Colorado Plateau—this trip has it all!

Investigate the geology of Dinosaur National Monument with GSA this summer. You’ll have the chance to delve into the stratigraphy of the Colorado Plateau, study the Laramide Orogeny, examine dinosaur fossils, and explore geomorphic landscapes created by rivers and tectonic uplift. This trip is geared toward college students and members of the general public who are interested in the geology of this region.

TRIPS FOR TEACHERS

Ecuador and the Galápagos Islands

4–14 June 2013

Join The Geological Society of America and Holbrook Travel on an adventure to discover some of the most fascinating geology and biodiversity in the world. Guided by expert Dr. Theofilos Toulkeridis, this GeoVenture explores the serene volcanic landscape of the Galápagos Islands. Red and black lava formations and rolling highlands provide access to wildlife populations so unique they inspired Charles Darwin’s theory of evolution, including huge colonies of sea lions, marine iguanas, and the iconic blue-footed boobies.



For more information and to register, go to www.geoventures.org; follow us on Facebook at www.facebook.com/GSAGeoVentures/; or e-mail glewis@geosociety.org. Space is filling up fast, so please register today to secure your spot!

TRIPS FOR TEACHERS *(continued)*

Rocky Mountain Field Camp

21–26 June 2013

Join The Geological Society of America on a five-day adventure to discover some of the most exciting and fascinating geology in the continental United States. Collect rocks, minerals, and fossils; visit and tour a working gold mine; examine and interpret rock layers; create a stratigraphic column; split shale as you look for fossils; soak in mineral hot springs after a day in the field; and touch dinosaur footprints and bones from where the “dinosaur wars” began. This trip will encourage you to use your geological skills as you interpret the geology of the area.

Explore Hawaiian Volcanoes—For Educators and Their Families

11–19 July 2013

This summer, participate in a unique field experience that will increase your knowledge of volcanoes and give you the chance to work with aspiring Earth Science teachers. Join GSA as we hike the volcanoes of Hawaii and study plate tectonics, hot spot volcanism, volcanic features, and hazards first hand. Using your observation and new-found knowledge, you will discuss how to effectively communicate geologic concepts with students, peers, teachers, and the general public. You will witness lava flows, lava lakes, tree molds, lava trees, fault scarps, rifts, craters, and calderas. Not only will you hike through lava tubes and lava caves, but you will have the chance to swim, snorkel, and hike along black and green sandy beaches.

Discover Iceland’s Geology

29 July–5 August 2013

Join teachers from around the country, The Geological Society of America, and Holbrook Travel as we explore the geologic wonders of Iceland. During this GeoVenture, you will hike near one of the largest glaciers in Europe, tour geothermal energy facilities, witness the splitting of the continental plates, traverse near volcanoes, float among icebergs, hike the famous hexagonal basaltic columns, investigate changes in glacier development, explore volcanic craters, and soak in the mineral waters of the Blue Lagoon.



2013 GSA Section Meeting Calendar

Northeastern

18–20 March 2013

Bretton Woods, New Hampshire, USA

Southeastern

20–21 March 2013

San Juan, Puerto Rico

South-Central

4–5 April 2013

Austin, Texas, USA

Abstracts deadline: 15 January

North-Central

2–3 May 2013

Kalamazoo, Michigan, USA

Abstracts deadline: 5 February

Rocky Mountain

15–17 May 2013

Gunnison, Colorado, USA

Abstracts deadline: 12 February

Cordilleran

20–22 May 2013

Fresno, California, USA

Abstracts deadline: 19 February

International—Roof of the World

17–19 June 2013

Chengdu, Sichuan Province, China

Abstracts deadline: 1 March



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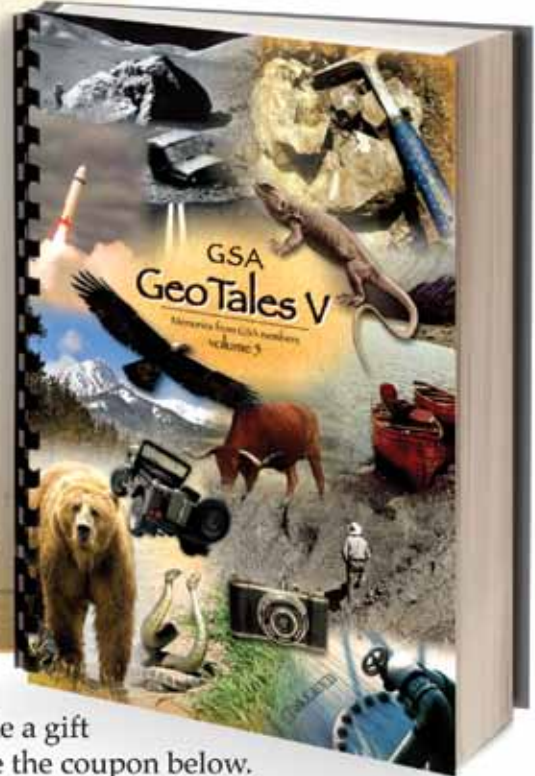


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Positions Open

TENURE TRACK POSITIONS IN STRUCTURAL GEOLOGY, HYDROLOGIC SCIENCES, AND GEOPHYSICS UNIVERSITY OF LOUISIANA, LAFAYETTE

The School of Geosciences at the University of Louisiana at Lafayette invites applications for three tenure track Assistant Professor Positions in **Structural Geology, Hydrologic Sciences, and Geophysics** that will begin in August 2013. The purpose of these hires is to build strength in the areas of petroleum and/or environmental geosciences and to support the formation of an interdisciplinary Geosciences Ph.D. program. Responsibilities for all candidates include teaching, research, and mentoring at the undergraduate and graduate level. The successful candidate will be expected to develop an independent, externally-funded research program. The ability to translate research interests into aspects of Gulf Coast geosciences/hydrology will be advantageous. Postdoctoral experience is preferred, but a Ph.D. in the appropriate concentration area is required at the time of hire. Specific qualifications include the following:

Structural Geology: He/she must have academic training and experience in structural geology. Skills that include field work, modeling, GIS, and/or 3D visualization will be advantageous.

Hydrologic Sciences: He/she must have academic training and demonstrated teaching and research experience in hydrologic sciences, water resources, or a closely-related field. Expertise in modeling and GIS and/or 3D visualization will be advantageous.

Geophysics: He/she must have academic training and demonstrated teaching and research experience in an area of Geophysics. Skills that include GIS, remote sensing, and/or 3D visualization will be advantageous. The Geophysics candidate will be expected to teach at least one upper-division course targeting physics majors and may be jointly appointed 70% in Geosciences and 30% in Physics.

The School of Geosciences (<http://geos.louisiana.edu/>) combines the programs of Geology (B.S. and M.S. degree programs) and Environmental Science (B.S.) and includes 13 full time faculty members, including three instructors, approx. 100 undergraduate majors and 50 graduate students. There are many opportunities for collaboration within other departments and colleges, as well as with local industry, institutes, and centers, including, The Louisiana Im-

mersive Technologies Enterprise, The GIS Regional Application Center, The Institute for Coastal Ecology and Engineering, and the USGS National Wetlands Center. The University of Louisiana at Lafayette, the leading institution within the University of Louisiana System, is a public institution of higher education offering bachelors, masters, and doctoral degrees and has a student population of about 18,000. Located mid-way between New Orleans and Houston, Lafayette is a city of 120,000, one of Louisiana's fastest growing areas, and is a hub for numerous cultural festivals and activities.

To be considered for this position, send as a **single PDF file that includes your name in the title**, an application letter, CV, separate statements of teaching and research interests, and the names and contact information (post and e-mail) of three references to geology@louisiana.edu. The review process will continue until the position is filled. To ensure full consideration, receipt of the complete application material is required before February 4, 2013. Questions regarding these positions can be directed to Dr. David Borrok (dborrok@louisiana.edu; phone 337-482-2888). The University of Louisiana at Lafayette is an Equal Opportunity Employer and encourages applications from minority group members and women.

ASSISTANT PROFESSOR EARTH SYSTEM SCIENCE COLLEGE OF SCIENCE, DEPARTMENT OF GEOLOGICAL SCIENCES UNIVERSITY OF TEXAS AT EL PASO

Position Description: The Dept. of Geological Sciences at the University of Texas at El Paso (UTEP) invites applications for a full time tenure-track assistant professor in Earth System Science to begin in Fall 2013. The department seeks applicants with strong interdisciplinary research and teaching interests that include biogeochemistry, geobiology, limnology, low temperature isotope geochemistry, soil science, or other interactions of lithosphere, hydrosphere, biosphere, and atmosphere; and is particularly interested in candidates intrigued by the environmental challenges stemming from land use and land cover change in a bi-national arid region. The department supports undergraduate, master's, and doctoral degrees in Geological Sciences as well as undergraduate and master's programs in Environmental Science. The successful candidate will teach introductory, upper division, and graduate classes that serve both the Environmental and Geological Sciences.

The Department: The UTEP Dept. of Geological Sciences has a faculty of 16 and includes over 160 undergraduates and 70 graduate students. The department is housed in an attractive 90,000 sq. ft. building that contains faculty and student offices and laboratory and classroom space. Research infrastructure includes wet chemical laboratories, a clean room, and a variety of analytical facilities, including a multi-collector (MC)-ICP-MS, an ICP-OES, and an electron microprobe. More information about the activities and facilities in the department can be found at www.geo.utep.edu. In addition, the collaborative research environment at UTEP affords easy access to a variety of analytical equipment in the Departments of Biological Sciences and Chemistry. The Dept. of Geological Sciences also participates in interdisciplinary Ph.D.

programs in Materials Science Engineering, Environmental Science and Engineering, and Computational Science. Applicants interested in co-advising students in the Ecology and Evolutionary Biology doctoral program are encouraged to apply.

About UTEP: The University of Texas at El Paso is an emerging national research university at the heart of the U.S.–Mexico border region committed to the ideals of access and excellence. A leader among Hispanic-serving institutions, UTEP enrolls more than 22,000 students—about 77% of them Hispanic—and is the only doctoral research university in the nation with a student body that is a majority Mexican-American.

UTEP offers 70 bachelor's, 79 master's, and 19 doctoral programs—with more in development. UTEP's nearly \$70 million in research spending a year ranks the University among the top 200 universities in the nation; and its more than \$35 million in federal research spending ranks fourth among all Texas public universities.

The center for intellectual capital in the region, UTEP awarded its 100,000th degree since its founding in 1914 at the May 2011 commencement. A major economic engine in the Paso del Norte region, UTEP generates \$438 million in local business volume and contributes over 6,900 jobs and \$423 million in household income. UTEP offers exciting Division I athletic programs; award-winning theater, dance, and music programs; several art galleries and a museum; and continuing and lifelong education programs open to the public.

Required Qualifications: The successful candidate must have a Ph.D. degree in a relevant field at the time of appointment. Candidates capable of building active research programs and who enjoy collaborative research are especially encouraged to apply.

Application Procedures: Review of applications will begin immediately and applications will be accepted until the position is filled. Applicants are encouraged to apply by January 10, 2013. Applications should be sent via e-mail to jhurtado@utep.edu and include the following: (1) letter of application; (2) curriculum vitae; (3) description of teaching and research interests; and (4) complete contact information for three references. Please include "Earth System Science Position: YOUR NAME" in the subject block of the email submission.

Dr. José Hurtado, jhurtado@utep.edu, Chair of the Earth System Science Search Committee, Dept. of Geological Sciences.

The University of Texas at El Paso is an Equal Opportunity/Affirmative Action Employer. The University does not discriminate on the basis of race, color, national origin, sex, religion, age, disability, genetic information, veteran status, or sexual orientation in employment or the provision of services.

TWO TENURE TRACK APPOINTMENTS AT THE ASSISTANT PROFESSOR LEVEL SAM HOUSTON STATE UNIVERSITY

The Dept. of Geography and Geology at Sam Houston State University invites applications for two tenure track appointments at the Assistant Professor level. The ideal candidates will have a commitment to a high quality undergraduate teaching program that values both field and laboratory instruction,

involve undergraduate students in research, and the ability to work with a diverse student body. Appointments would begin August 2013. Candidates must have a Ph.D. in geology, geophysics, other closely related field by the time of appointment. Prior teaching experience at the college level and evidence of developing a strong, independent research program is desirable.

Sedimentology & Stratigraphy: Teaching and research specialty in stratigraphy/sedimentology. Ability to teach stratigraphy/sedimentology, oceanography, introductory geology courses, and possibly an upper level course in paleobiology, paleontology, or the candidate's area of expertise.

Geophysics: Teaching and research specialty in geophysics. Ability to teach undergraduate level geophysics, introductory geology courses, and specialty courses related to the application of geophysics in petroleum and/or environmental geology.

Sam Houston State University was founded in 1879 and named after Texas' greatest hero, General Sam Houston. With a total enrollment of approximately 18,000 students, SHSU is classified as a Doctoral Research Institution by the Carnegie Commission on Higher Education and offers 79 undergraduate degree programs, 54 masters programs, and five doctoral programs. The department has approx. 100 geology majors and offers degrees in geology and geoscience. More information is available on the department's website at www.shsu.edu/~gel_geo.

Interested applicants should submit an online application through Human Resources via PeopleAdmin (www.shsu.edu/~hrd_www/apply.html) and include a letter of interest, current vita, contact information for three professional references, and statements of teaching philosophy and research interests. The contacts for each position are as follows:

Sedimentology: Dr. Pat Harris, Chair of Sedimentology Search (e-mail: pat-harris@shsu.edu).

Geophysics: Dr. Joseph Hill, Chair of Geophysics Search (e-mail: geojoe@shsu.edu).

Mailing Address: Dept. of Geography and Geology, Box 2148, Sam Houston State University, Huntsville, TX 77341-2148.

Sam Houston State University is an Equal Employment Opportunity/Affirmative Action Plan Employer and Smoke/Drug-Free Workplace. Sam Houston State University is an "at will" employer. All positions at SHSU are considered security sensitive requiring background checks in accordance with Education Code 51.215. SHSU is a Member of the Texas State University System. Applications from underrepresented minorities are strongly encouraged. Review of applications will begin December 10, 2012, and continue until the position is filled.

CHAIR, DEPARTMENT OF GEOSCIENCES THE UNIVERSITY OF AKRON, AKRON, OHIO

The Dept. of Geosciences at the University of Akron invites applications from dynamic individuals for the position of Dept. Chair. We seek an academic leader who will help the department make major contributions to the university's Vision 2020 Strategic Plan by ensuring student success and enhancing its research performance. The department's 10 faculty currently serve 38 M.S. students and more than 130 undergraduates majoring in geology, geophysics, engi-

neering geology, environmental science, geographic information systems and geography. There are opportunities to supervise Ph.D. students through collaboration with the Integrated Biosciences Program, Dept. of Chemistry and the College of Engineering.

A Ph.D. in a field related to the earth sciences and the ability to work with and lead a department with expertise in geology, geography, environmental science and GIS is required. Candidates must have a record of achievement supporting appointment at the rank of professor with tenure at The University of Akron. Review of applications will begin February 15, 2013 and continue until the position is filled. For more information and to apply, visit www.uakron.edu/jobs. Job#7637. Inquiries should be addressed to Dr. John Peck at jpeck@uakron.edu. EEO/AA.

LECTURER IN EARTH SCIENCES THE UNIVERSITY OF MARY WASHINGTON

The Dept. of Earth and Environmental Sciences at the University of Mary Washington invites applications for a full-time, non-tenure track position (renewable term appointment, with an initial contract of two years) in Earth Science to begin in August 2013. The successful candidate must have a M.S. or Ph.D. in an earth science discipline at the time of appointment, and must have the ability to teach a two-semester introductory geology sequence with lab. The candidate will also serve as the manager of our introductory geology laboratories, and equipment manager of our environmental and geological field equipment. Teaching a course in his or her area of expertise is a possibility. Candidates must have a strong commitment to teaching undergraduates; teaching experience is preferred.

The University of Mary Washington is a primarily undergraduate, public institution that stresses teaching excellence and the engagement of students in research. The University is located within the Rappahannock River watershed on the margin between Coastal Plain sediments and Piedmont crystalline rocks. The department has expertise in GIS, structural geology, mineralogy/petrology, watershed analysis, aquatic ecology, hydrology, environmental geochemistry, studies of historic climate change, and environmental policy. For additional information, please visit our department web site at <http://cas.umw.edu/ees/>.

To apply for this position and/or obtain additional information about the University, please visit our web site at www.umw.edu/hr. Only applications submitted through this site will be considered. A complete application package includes a Commonwealth of Virginia Application form, letter of application, curriculum vitae, undergraduate and graduate transcripts, statement of teaching philosophy and three letters of reference. Transcripts should be mailed directly to Chuck Whipkey, Search Chair, Dept. of Earth and Environmental Sciences, University of Mary Washington, 1301 College Avenue, Fredericksburg, VA 22401. The deadline date for application submission is January 31, 2013 by 11:59 p.m. Send e-mail enquiries to cwhipkey@umw.edu.

Office of Human Resources and Affirmative Action, University of Mary Washington, 1301 College Avenue, Fredericksburg, VA 22401 (phone 540/654-1211; TTY 540/654-1104).

In a continuing effort to enrich its academic environment and provide equal educational and employment opportunities, University of Mary Washington actively encourages women, minorities, disabled individuals and veterans to apply.

THREE TENURE-TRACK FACULTY POSITIONS UNIVERSITY OF HOUSTON

The Dept. of Earth and Atmospheric Sciences of the University of Houston invites applicants for the following tenure track faculty positions. Candidates must have completed their PhD at the time of appointment. Successful candidates will be expected to build a vigorous externally-funded research program, and should be able to demonstrate productivity in peer-reviewed publication. Candidates will also be expected to teach at both the undergraduate and graduate levels and will be expected to mentor MS and PhD students. We expect to fill the positions by August, 2013. Candidate evaluation will begin **January 20, 2013** and continue until the position is filled.

Exploration Geophysics: Assistant to Full Professor level in the field of Exploration Geophysics, specializing in reflection seismic processing, imaging, and interpretation. We seek candidates of outstanding ability in signal processing, algorithm development, and seismic data analysis. Strength in subjects such as elastic-wave propagation, tomography, migration, and inversion will be especially valued. The successful candidate should have the ability to use high-performance computing to image, visualize, and interpret seismic data and will have use of our wide variety of seismic software packages, hardware systems, and geophysical data. The successful candidate will participate with an enthusiastic team of geophysics faculty and students in one of the leading energy communities in the world. Preference will be given to candidates with related industry experience.

Organic Geochemistry: Assistant to Full Professor level in the broad field of organic geochemistry. Applicants should have experience in the application of chemical principles to the study of the origin, migration, accumulation, and alteration of hydrocarbons and organic contaminants using a range of petroleum geochemical techniques, such as stable isotope geochemistry, hydrocarbon analysis of organic compounds and biomarkers with GC and GC-MS, vitrinite reflectance or other maturity indicators, laboratory pyrolysis, and/or kerogen typing. The successful candidate will also enjoy access to new major and sophisticated organic geochemical research equipment being delivered in the Fall of 2012 to the department, including an Agilent GC-QQQ 7000, an Agilent GC-Q-TOF 7200, an Agilent GC-MS 5975, an Agilent GC 7890, a Finigan Delta 5 Gas Stable Isotope Mass Spectrometer coupled with a GC-C-IRMS, and a Rock Eval VI Pyrolysis Instrument. Research analytical expertise in these instruments and/or experience in related environmental organic fluid and rock geochemistry, especially aligned with studies of water quality, identifying natural water and rock contaminants and toxicity levels, carrying out epidemiologic environmental forensics studies, environmental remediation monitoring, and/or ground water quality studies in gas and oil shale fracking regions, is considered advantageous to

the broad areas of research in the department.

Sedimentary Geology: Assistant Professor level in the general field of Sedimentary Geology and Stratigraphy. Candidates may conduct research on ancient or modern systems and may have expertise in areas such as facies and stratigraphic architecture, sedimentary petrology, experimental or numerical modeling, and/or reservoir characterization. Ideally the candidate will have experience with field-based research to solve fundamental geological problems. This position is linked to the UH Energy initiative, and we encourage applications from candidates with some industry experience.

Information for Applicants: Candidates for each position should submit: (1) a letter of application including statements of teaching and research interests, (2) a curriculum vitae, and (3) three letters of reference (letters must be received before the applications will be considered) to Dr. Janok P. Bhattacharya, Chair, Dept. of Earth and Atmospheric Sciences, College of Natural Sciences and Mathematics, Room 312 Science Research 1, University of Houston, 4800 Calhoun Rd., Houston, Texas 77204-5503.

Signed reference letters may be submitted by referees as attached files via email to Penny Maher: plmaher@uh.edu. Further information can be obtained by viewing the departmental web page at www.geosc.uh.edu/ or by calling the department at (713) 743-3399.

The University of Houston is an Equal Opportunity/Affirmative Action Employer. Minorities, women, veterans, and persons with disabilities are encouraged to apply.

**POSTDOCTORAL FELLOWS PROGRAM
JACKSON SCHOOL OF GEOSCIENCES
AT THE UNIVERSITY OF TEXAS AT AUSTIN**

The Jackson School of Geosciences at the University of Texas at Austin invites applications for its 2013-2014 school-wide postdoctoral fellows program. This highly competitive institutional award is open to recent doctorates (degree within the past 3 years) in geosciences. We welcome applicants with research interests across the full range of geosciences disciplines. The postdoctoral fellow is expected to pursue their own independent research interests. The appointment is for 2 years with a salary of \$60,000 per year plus health and dental benefits. Research support of \$10,000 per year is also provided. Successful applicants can begin their program as early as September 1, 2013, but no later than December 31, 2013.

To apply, submit a current CV that includes education, employment history, awards, publications, and extramural funding record, a short (2-3 page) statement of research interests and proposed research, and the names and contact information for 3 references. Deadline for applications is February 15, 2013. Applicants should send applications electronically as email attachment to PostDocJSG@jsg.utexas.edu.

The University of Texas at Austin is an Affirmative Action / Equal Opportunity Employer.

Application website: www.jsg.utexas.edu/hiring/postdocs.html.

Application email: PostDocJSG@jsg.utexas.edu.

Application deadline: February 15, 2013.

**GEOSCIENCE EDUCATION RESEARCH
POSTDOCTORAL RESEARCH ASSOCIATE
UNIVERSITY OF NEBRASKA-LINCOLN (UNL)**

The Dept. of Earth & Atmospheric Sciences at UNL (www.eas.unl.edu) invites applications for Postdoctoral Research Associates to carry out geoscience education research projects in collaboration with faculty. Projects may be in the areas of assessment design, teaching and learning strategies, instructional technologies, and/or geocognition. We have a geocognition lab and resources to conduct research using mixed methods approaches that utilize eye-tracking, survey, interview, observational, and web-based techniques. Ideal candidates will have a strong background in the discipline of geoscience (e.g. Earth, atmospheric, and ocean sciences), have experience in course design and/or science education research, and be highly motivated to integrate them in conducting discipline-based education research. Applicants will have a recent Ph.D. or will be 2013 degree candidates. Completion of Ph.D. is required by start of appointment. Appointments are for six months to one year, with the possibility of extending a year. We seek applicants who can start in June-August 2013. For queries and additional information about research projects, contact Dr. L. Arthurs (larthurs2@unl.edu). To apply, email cover letter describing your research interests, transcripts, CV, and contact information for three references (telephone numbers, postal and email addresses) in a single PDF file to larthurs2@unl.edu with the subject line "GER-Postdoc" no later than February 1, 2013. Decisions will be made in Spring 2013 for a position start date as early as June 1, 2013. The University of Nebraska-Lincoln is an equal opportunity/affirmative action employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

**POSITION IN EARTH AND ENVIRONMENTAL
SCIENCES EDUCATION
CLINICAL ASSISTANT PROFESSOR
UNIVERSITY OF ILLINOIS AT CHICAGO**

The Dept. of Earth and Environmental Sciences at the University of Illinois at Chicago (UIC) invites applications for a multi-year non-tenure track teaching position. The successful candidate will teach undergraduate courses and aid the department in developing education and outreach activities and improving undergraduate teaching laboratories and materials. The initial appointment is expected to be for three years, subject to renewal based on annual evaluations, and carries the title of Clinical Assistant Professor. Applicants must have a Ph.D. in the earth and environmental sciences or in a closely related field; demonstrated expertise in earth and environmental science education is highly preferred. The department is ranked nationally in the top 10% in terms of research activity (2010 NRC Survey of Geoscience Departments) and hosts a diverse and growing undergraduate and graduate student body. To apply, please complete the online application providing contact information of three professional references at <https://jobs.uic.edu> (click on the Job Board and then on the position link) and upload a cover letter, curriculum vitae, statement of teaching philosophy and interests, evidence of teaching effectiveness (if available), and a statement of research interests.

For fullest consideration please apply by January 15, 2013. Women and minority candidates are strongly encouraged to apply. Final authorization of the position is subject to availability of state funding. Please contact Prof. Roy Plotnick (plotnick@uic.edu) with any inquiries. UIC is one of the nation's leading urban research universities and an Affirmative Action/Equal Opportunity Employer.

**TENURE TRACK POSITION IN
SOLID EARTH GEOSCIENCES
(EARTHQUAKE PHYSICS,
ACTIVE TECTONICS
AND QUANTITATIVE GEOMORPHOLOGY),
CENTER FOR EARTHQUAKE RESEARCH
AND INFORMATION (CERI)
AT THE UNIVERSITY OF MEMPHIS**

The Center for Earthquake Research and Information (CERI) at the University of Memphis invites applications for a tenure-track faculty position, with tenure in the Dept. of Earth Sciences, at the Assistant Professor level to begin August 2013. We seek an individual with research interests in the fields of Earthquake Physics, Quantitative Geomorphology, or Active Tectonics that complement our existing strengths in seismology, geodesy, tectonophysics, seismic hazard and geodynamics. We particularly encourage applicants with research interests related to fault zone processes and seismogenic crustal deformation. Applicants must have a Ph.D. at the time of employment, and show a demonstrated record or strong promise of research productivity. The successful candidate is expected to build a vigorous, externally funded research program, mentor M.S. and Ph.D. graduate students, and teach graduate courses in her or his specialty. CERI faculty are engaged in a variety of regional, national, and international research projects in seismology, geodesy, geology, geophysics, and earthquake hazards (www.ceri.memphis.edu). More information about this position can be obtained by contacting the chair of the search committee, M. Beatrice Magnani (mmagnani@memphis.edu).

Applicants should submit an application letter, full curriculum vitae, statements of research and teaching interests, and the names and addresses (with phone numbers and email) of at least three references. To receive full consideration, applications must be submitted through the University of Memphis *workForum* online application system (<http://workforum.memphis.edu>) by February 1, 2013. The University of Memphis is an Equal Opportunity/Affirmative Action employer.

**PETROGRAPHER/CONSULTANT
WALTHAM, MASS.**

SIMPSON GUMPERTZ & HEGER (SGH)

Simpson Gumpertz & Heger (SGH) is actively recruiting an experienced candidate for a position as Petrographer/Consultant in our Waltham, MA, office. SGH is a nationally known civil and structural engineering firm that works in all aspects of design, investigation, and rehabilitation of structures. At SGH, petrographers provide front-line collaborative support to our investigative teams as well as for external clients, including other engineering firms. The successful candidate will work on investigations

of concrete, masonry, stone, and related construction materials.

Applicants should have at least 10 years of experience with stone and concrete petrography; meet the requirements of ASTM C856 and C295; and understand the use of supplemental testing and analytical techniques such as XRD, IR, SEM/EDS, and chemical testing. Exceptional communication skills, experience in research and investigations, and a demonstrated ability for managing and developing staff are also required skills.

To learn more about SGH and to apply for this position, please visit our website at www.sgh.com or e-mail your resume to Stella Mereves-Carolan, Corporate Recruiter at smereves-carolan@sgh.com or Apply online at www.sgh.com.

Equal Employment Opportunities Employer.

CHAIR, DEPARTMENT OF GEOLOGY STEPHEN F. AUSTIN STATE UNIVERSITY

The Dept. of Geology at Stephen F. Austin State University (SFA) invites applications for the department chair position. We seek an individual with strong management, communication, and interpersonal skills to provide innovative and energetic leadership. Duties include managing curricula, budgets, student enrollment, personnel, program and unit assessment, and developing strong, mutually beneficial relationships with industry and alumni. The incumbent will teach a reduced load of courses and develop a research program in his/her area of expertise. Applicants must have credentials for appointment at the associate or professor rank.

Submit a letter of application, CV, and a list of three references online at <https://careers.sfasu.edu> (posting 0602010). Also submit all official transcripts by mail to: Dr. Kenneth Farrish, Search Committee Chair (936-468-3701), Dept. of Geology, Stephen F. Austin State University, Box 13011 SFA, Nacogdoches, TX 75962. Review of applications will begin on January 15 and will continue until the position is filled. Equal Opportunity Employer; Security-sensitive position; this position will be subject to a criminal history check.

ASSISTANT/ASSOCIATE PROFESSOR OF GEOLOGY AND GEOPHYSICS MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

The Dept. of Geological Sciences and Engineering invites applications for a full-time tenure-track faculty position in Geology and Geophysics at the Assistant Professor level, with exceptional candidates considered at the Associate Professor level, in either Tectonics or Economic Geology to begin August, 2013. The successful candidate will be expected to develop an externally-funded research program integrated with excellence in teaching at both the graduate and undergraduate levels with a commitment to interdisciplinary work. Teaching responsibilities will include service courses as well as courses in the individual's area of expertise. The department currently has 20 full-time faculty, and 318 undergraduate and 241 graduate degree-seeking students with established B.S., M.S., and Ph.D. programs in Geology & Geophysics, Petroleum Engineering, and Geological Engineering. Closely associated departments include Environmental Engineering and Mining Engineering. Local area establishments with active research

include the U.S. Geological Survey (Mid-continent Geospatial Mapping Center), Missouri Dept. of Natural Resources, Fort Leonard Wood, the Missouri S&T Rock Mechanics and Explosives Research Center, Materials Research Center, and Energy Research and Development Center. Visit our department web pages for more information on faculty and research (<http://gse.mst.edu/>). Questions regarding this position should be directed to the chair of the search committee, Dr. John P. Hogan (jhogan@mst.edu). To apply please visit <http://hraadi.mst.edu/hr/employment/faculty/> and click on the link "prospective employees" and then click on the link for Assistant/Associate Professor #00031149. Review of applications will begin on January 7th, 2013 and continue until the search is completed. Missouri University of Science and Technology is an affirmative action/equal opportunity employer.

ACTINIDE SCIENCE FACULTY POSITION UNIVERSITY OF NOTRE DAME

The Dept. of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, invites applications for a tenure-track position in Actinide Science to expand the Energy Frontier Research Center *Materials Science of Actinides* and to complement existing faculty in Environmental Engineering and Earth Sciences. Qualified candidates at all levels will be considered, with hiring rank and tenure status commensurate with academic accomplishments. *Materials Science of Actinides* is a multi-institution effort led by the University of Notre Dame that is focused on understanding and mastering the nanoscale control of actinides, complex actinide materials, and actinide materials in extreme environments of temperature, pressure, and radiation field (www.ndefrc.com). We seek candidates with interests spanning environmental and energy aspects of actinide sciences, including experimental and/or computational approaches.

The department has a unique blend of environmental engineering and environmental geoscience faculty, and has outstanding research facilities that include laboratories dedicated to actinide science. Current department strengths include environmental microbiology, biofilms and biofilm processes, environmental geochemistry and geomicrobiology, environmental nanoscience and technology, environmental surface chemistry, groundwater hydrology, environmental and computational fluid mechanics, and actinide chemistry and mineralogy. Information about the department can be found at www.ceees.nd.edu/. We seek individuals with dynamic and highly innovative research agendas that may cross traditional disciplinary boundaries. Qualifications include a Ph.D. in an appropriate field relating to actinide science. Candidates are expected to exhibit a dedication to excellence in research, teaching, and professional service. The application package should include a cover letter addressing preparation for this position, curriculum vitae, a statement of research and teaching interests, and names and contact information of at least three references. Applications should be uploaded directly, as a single PDF file, to: <http://engineering.nd.edu/departments/ceees/positions-available/>. Please direct any questions to Prof. Peter C. Burns, Director of the Energy Frontier Research Center and Chair of the Search Committee

(pburns@nd.edu), Dept. of Civil and Environmental Engineering and Earth Sciences, 156 Fitzpatrick Hall, University of Notre Dame, Notre Dame, IN 46556-0767. Review of applications will begin immediately, and applications will be accepted until the position is filled. University of Notre Dame is committed to diversity and equality in education and employment, and women and members of underrepresented minority groups are strongly encouraged to apply.

Opportunities for Students

MS & Ph.D. Positions, Geoscience Education Research, University of Nebraska-Lincoln (UNL). If you are passionate about geoscience and education and if you have an interest in advancing geoscience education through research, UNL has an opportunity for you. In the Dept. of Earth & Atmospheric Sciences, students may pursue advanced studies and conduct geoscience education research in the areas of assessment design, teaching and learning strategies, instructional technologies, and/or geocognition. We have a geocognition lab and resources to conduct research using mixed methods approaches with eye-tracking, survey, interview, observational, and web-based techniques. Ideal candidates will have a strong background in the discipline of geoscience (e.g. Earth, atmospheric, and ocean sciences) and be highly motivated to integrate this background with discipline-based education research. Applicants are sought for Spring & Fall 2013. Send queries to Dr. L. Arthurs (larthurs2@unl.edu).

Graduate Student Opportunities, Ohio University. The Dept. of Geological Sciences at Ohio University invites applications to its graduate program for the Fall of 2013. The department offers an MS degree in Geological Sciences with areas of emphasis including paleobiology and sedimentary systems, geomorphology and environmental geology, and petrography, structural, and planetary geology. Prospective students are encouraged to contact faculty directly to discuss potential research topics. Qualified students are eligible to receive teaching or research assistantships that carry a full tuition scholarship and a competitive stipend. For additional program and application information, visit the department website at www.ohiou.edu/geology/ or contact the graduate chair, Dr. Keith Milam (milamk@ohio.edu). Review of applications begins 1 February.

Graduate Assistantships and Fellowships, University of Kentucky. The Dept. of Earth and Environmental Sciences at the University of Kentucky has assistantships and fellowships available for the 2013–2014 academic year for MS and Ph.D. students. All awards include tuition and health insurance. The department has 10 tenured/tenure-track faculty, 3 lecturers, and 11 adjuncts at the Kentucky Geological Survey and the UK Center for Applied Energy Research. Research specializations include geochemistry, geophysics, hydrogeology, igneous/metamorphic petrology, sedimentary geology, and tectonics. Facilities include the Sedimentary, Environmental and Radiochemical Research Laboratory; a state-of-the-art stable isotope laboratory; the Kentucky Seismic and Strong-Motion Network; instruments for

potential field geophysics; electron microprobe and X-ray diffraction laboratories; and extensive library holdings. UK is located in Lexington, a vibrant community of nearly 300,000. The surrounding area offers a wealth of outdoor and cultural opportunities. For more information, visit <http://ees.as.uky.edu> or contact Dr. Alan Fryar, Director of Graduate Studies (859-257-4392 or alan.fryar@uky.edu).

Ph.D. Fellowships with the University of Florida Water Institute: Impacts of Sea Level Change on Coastal Aquifers, Water Resources, and Ecosystems. This interdisciplinary program will provide four years of support (stipend, tuition, and health insurance) for Ph.D. Fellows to work collaboratively to explore the effects of sea level change. Examples of individual projects could include studies to improve understanding of past sea level change, salt exchange between saline marine water and fresh groundwater, impacts from salt water intrusion on water supply and treatment, ecology of coastal environments, microbial ecology, chemical changes in coastal aquifers, or other topics related to the students' interests. The program is sponsored by the University of Florida, and administered by the UF Water Institute. Link: <http://waterinstitute.ufl.edu/WIGF/>.

NSF Research Experience for Undergraduates, Georgia State University (Atlanta). The CSAW Initiative (Community-Soil-Air-Water) at Georgia State University in Atlanta is seeking advanced undergraduates interested in participating in an NSF-

sponsored Research Experiences for Undergraduates project. The project is an interdisciplinary effort bringing together social and physical sciences to tackle contemporary environmental issues in urban communities. The project's Research Track 3 focuses on environmental geochemistry in the urban environment. Applicants should have a basic background in geology or geochemistry, a desire to get involved with a local urban community, and a desire to collaborate with a group of geologists, geochemists, public health scientists, physical geographers, and human geographers. Participating students will receive a stipend, travel costs, room and board, and support to present research results at a future national conference (e.g. GSA). For more information please visit <http://csaw.gsu.edu/nsf-reu> or contact Dr. Tim Hawthorne (thawthorne@gsu.edu) or Dr. Dan Deocampo (deocampo@gsu.edu). The application deadline is Friday, February 15, 2013 at 5 PM EST.

IGERT: Adaptation to Abrupt Climate Change (A2c2), University of Maine. Ph.D. assistantships available. The University of Maine is seeking outstanding applicants for a doctoral graduate training program in adaptation to abrupt climate change funded by the NSF IGERT program. This is a joint program between the Climate Change Institute and the School of Policy & International Affairs at UMaine (www.umaine.edu/a2c2igert). The A2C2 IGERT is designed to train doctoral students in **earth sciences, ecology, anthropology, archaeology, international affairs, and economics** to meet critical

societal needs in human adaptation to ACC. Please see the program website for descriptions of program goals and research themes.

Students in this program will receive an annual stipend of \$30,000 per year in each of the first two years, plus tuition, fees, and health insurance coverage. Students must be U.S. citizens or permanent residents to receive IGERT support.

Application instructions are provided on the program website. For full consideration, submit all documents no later than **February 1** for the following academic year. Any questions about this program should be sent to the IGERT A2C2 Project Director, Dr. Jasmine Saros, jasmine.saros@umit.maine.edu.

The Jonathan O. Davis Scholarship supports graduate students working on the Quaternary geology of the Great Basin. The national scholarship is \$5,000 and the University of Nevada, Reno stipend is \$1,500. The national scholarship is open to graduate students enrolled in an M.S. or Ph.D. program at any university in the United States. The stipend is open to graduate students enrolled in an M.S. or Ph.D. program at the University of Nevada, Reno. Details on application requirements can be found at: www.dri.edu/GradPrograms/Opportunities/JonathanDavis. Applications must be post-marked by Feb. 15, 2013. Proposal reviews will not be returned. Applications should be addressed to Executive Director, Division of Earth and Ecosystem Sciences, Desert Research Institute, 2215 Raggio Parkway Reno, NV 89512, USA.

Graduate Fellowships, in Sedimentary Basin Modeling, Berg-Hughes Center and Department of Geology and Geophysics, Texas A&M University



The Berg Hughes Center (BHC) for Sedimentary and Petroleum Systems and the Department of Geology and Geophysics at Texas A&M University invite applications from outstanding students for graduate fellowships in sedimentary basin modeling. Five fellowships will be awarded. These fellowships are for three years for Ph.D. students and for two years for M.S. students. The fellowships are \$30,000 per year. Awards will be made starting the fall semester of 2013.

The fellowships are an integral part of a robust research and education program initiated by the newly established Chevron TAMU/BHC Basin Modeling Center of Research Excellence in the Berg Hughes Center and Department of Geology and Geophysics at Texas A&M University. The Center was established to contribute to the advancement of science, technology and higher education through the teaching and mentoring of students and the supporting of independent academic research. The research focus of the Center is to further the understanding of the geohistory of sedimentary basins and the origin and location of unconventional and conventional petroleum resources inherent to sedimentary basins. Research will be conducted in collaboration with researchers at the University and geoscientists and petroleum engineers in the petroleum industry and is designed to solve complex geoscientific problems through integrated solutions.

Interested students should send a letter of application to Dr. Michael C. Pope (mcpope@geos.tamu.edu) by February 1, 2013.

The Berg-Hughes Center (berghughes.tamu.edu) and the Department of Geology and Geophysics (geoweb.tamu.edu) are part of the College of Geosciences, which also includes the Departments of Atmospheric Sciences, Geography, and Oceanography; 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 172,000 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.

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GSA members on climate change: Where, what, and ways forward?

Robert E. Drost and Sheldon P. Turner, Dept. of Geological Sciences, 206 Natural Science, Michigan State University, East Lansing, Michigan 48823, USA

Climate change is one of the most pressing environmental, economic, and societal issues of the twenty-first century. Addressing climate change issues is difficult partly due to the disconnect between the scientific community and the public's understanding and perception of climate change issues. A number of studies have examined the views of the public and suggest that basic knowledge about climate change is limited and that many believe there is still no agreement in the scientific community about the possible causes and impacts (Hamilton, 2011; Whitmarsh, 2009). Fewer studies have looked at the broad scientific community, but those that have report that climate scientists who understand the climate process generally accept that anthropogenic climate change exists and agree that human activity has had a profound impact on Earth's climate (Doran, 2009; Oreskes, 2004). However, in order for vital information to be passed on to policy makers and voters, the scientists must put forth the effort to inform. *Included in that effort is the need to communicate the agreement scientists share on climate change factors.* Studies indicate that only 47% of the American public believes that there is scientific consensus on climate change (Doran, 2009); this belief needs to be addressed if scientists' views are to be accepted by the public. Here we look at the perceptions of Geological Society of America (GSA) scientists on climate change to understand (1) what are their biggest concerns; (2) what regions of the USA will be most impacted; and (3) how we bridge the gap between scientists and the public.

Surveys were collected in the exhibit halls of the GSA Annual Meetings in 2009 and 2011. GSA has more than 20,000 members, and each annual meeting attracts nearly 6,000 geoscientists (www.geosociety.org). We collected 181 surveys. Forty-nine percent of participants were female, and ages ranged from 19 to 70 years. The brief two-page survey varied slightly between the two years but both asked participants to indicate on a map where they believe climate change will have the most impact. They were then asked to answer questions (Table 1) about the region they indicated.

The most common response to the open-ended question about the impact of climate change was **sea-level rise** (32%), followed by **more severe weather** (22%) and **water resource issues** (20%). These responses make sense because people generally show the most concern for "salient, palatable" risks (Seacrest et al., 2000).

GSA Today, v. 23, no. 1, doi: 10.1130/GSATG157GW.1.

E-mails: drostrob@msu.edu, turne184@msu.edu

Editor's note: This article was written and accepted for publication prior to the late October 2012 Hurricane Sandy superstorm.

Table 1. Survey questions

Question	Response Type
Shade in one region on the map below that you feel has been or will be impacted by climate change.	Shading/circling
This region has been or will be severely impacted by climate change.	Likert scale
I believe the general public is sufficiently informed about the impacts of climate change in this region.	Likert scale
Describe the climate change impact(s) that the region you shaded has or will experience.	Open-ended
Explain what you believe would be the most effective way to increase public understanding of climate change.	Open-ended

The remaining responses were varied and specific, with the next most common being agricultural shifts, both spatially and temporally (6%). Geographically specific impacts included pine-beetle expansion and loss of the maple-syrup industry. Of all 181 surveys, there were only two "climate change skeptics" who clearly stated they do not believe anything will occur because climate change is not happening.

Circled regions from the surveys were digitized into ESRI ArcGIS to visualize the overall regions of concern. Figure 1 represents the overall density of regions circled across all participants. The focus on coasts is consistent with the impacts given on the open-ended portion of the survey, including sea-level rise and increase in hurricanes. Water resource issues are also reflected in the focus on the southwestern United States. There were minor differences between years, based on the location of the meeting (more focus on the Northwest in 2009 and the northern Midwest in 2011). These signals, however, were relatively insignificant compared to the concern over the coasts.

Survey results indicate that 89% of the respondents believe that climate change presents a significant risk to the public, whereas only about half the general population is concerned. This difference in perceived risk may be influenced by a number of potentially mitigating factors shared by both the respondents and the public. These include personal experiences with climate change (Whitmarsh, 2009) as well as social and demographic factors (Leiserowitz, 2006). Perhaps the difference is rooted in the scientists' understanding and acceptance of the evidence, which may be immune to influences by informational sources available



Figure 1. Regions of most climate change concerns among GSA respondents. Darker orange areas mark where more respondents shaded.

to the public. Although recent studies have demonstrated varying beliefs in climate change by Americans (Hamilton, 2011; Whitmarsh, 2009), substantial doubt and lower perceived risk of climate change still remain among the population.

As the public's trusted source, what do these scientists think of the current state of the public's awareness of climate change? Most respondents (84%) believe the public is not adequately informed on the potential climate change impacts in the United States. This position is reflected by recent studies that indicate the American public is not well informed on climate change issues (Malka et al., 2009). Although potentially alarming, the geoscientists were forthcoming with possible solutions to increasing public awareness.

The majority of survey respondents (52%) believe the public is best informed through educational means, varying from formal K–12 education to specific public outreach programs delivered through a variety of methods to enable the greatest coverage. The remainder of responses varied in the delivery mechanism of climate information to the public. Some believed in a pure source of information derived from the scientific community, while others felt the government should take a role in disseminating the information in an understandable public format. Interestingly, 6% of the respondents indicated that an actual climate-related disaster would serve best to wake up the public to the risk associated with climate change in their respective regions. Although drastic in comparison with more reasonable alternatives, the impact of disasters and the national attention focused on these events have the tendency to grip the public's scrutiny in an immediate and urgent manner.

The link between scientists and the public thirst for knowledge is an opportunity for the geoscience community. The public generally relies on the media to navigate science-based issues, ranging from local weather to complex information about geohappenings, including climate change. Since scientists usually generate this information, a more direct connection between the media and scientists, or perhaps alternative methods of providing for the interaction between scientists and the public would be beneficial. Malka et al. (2009) show that nearly three-quarters of the public relies on scientists for information because the complexity and number of issues is too much to fully grasp without conducting research oneself.

Survey data demonstrate that climate change concerns among geoscientists are consistent and aligned with current climate

science (Bray and von Storch, 2010). This community has great potential to influence public awareness and understanding of climate issues by acting in unison (Anderegg et al., 2010) and reinforcing the public's trust (Hamilton, 2011; Whitmarsh, 2009). GSA's official position statement on climate change (www.geosociety.org/positions/position10.htm) highlights the opportunities available to members in order to help this cause. These include participating in professional education, engaging in public education activities, collaborating with stakeholders, working with other science and policy societies, and utilizing the most up-to-date sources of climate science (GSA, 2010). The impacts of climate change range from local communities to the global population. With overwhelming consensus, and armed with the best science, each member of the geoscience community can find his or her niche in moving the public toward better understanding of the risks and solutions for the changing climate.

ACKNOWLEDGMENT

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LETTER

Dear Editor,

David R. Montgomery's article on "The evolution of creationism" in the November 2012 issue (*GSA Today*, v. 22, no. 11, p. 4–9) is a welcome addition to a dialogue that continues mostly off the pages of conventional journals. While I hope his book is better, he at least attempts to provide a glimpse into a different way of looking at the world.

There are two basic paradigms for natural history. One exclusively focuses on looking at objects and another that also considers human testimony. It is like a jury's decision in a courtroom trial: either they are swayed by the key witness of one side or by the circumstantial evidence of the other. In skeptical times, people distrust others, and objects are given greater weight. But it is perfectly legitimate to let people have greater weight.

Moreover, deep time was devised as much to avoid any hint of the supernatural as it was to account for geological observations. Vast durations that no human has ever lived through provide a kind of fudge factor for theorizing. While this works in some sense, it is far from satisfactory, and for those who take a more sanguine view of ancient records, the Bible in particular, other possibilities must be considered.

The case for a worldwide flood is based in the first place on human attestation. That does not answer the question of the earth's present condition, but it provides a key to it that should not be ignored, even if it's not obvious how it all fits together. This calls for more research, something every geologist should welcome.

Creationism has developed beyond 1961, though the article stops there. It has an active research program, funded without government aid, and will continue to make contributions to geological knowledge.

Sincerely,

Ralph Gillmann

Burke, Virginia, USA

Received 13 Nov. 2012

LETTERS TO THE EDITOR

Send letters by e-mail to gsatoday@geosociety.org or by post to Managing Editor, *GSA Today*, P.O. Box 9140, Boulder, CO 80301-9140, USA. Please keep your letter to 300 words or fewer; letters longer than 300 words will not be published. The *GSA Today* managing editor will edit letters for length and clarity. All letters will be forwarded to the *GSA Today* science editors for review before publication, and *GSA Today* reserves the right to reject any letter at the discretion of the science editor. Opinions presented do not reflect official positions of the Society.

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BULLETIN

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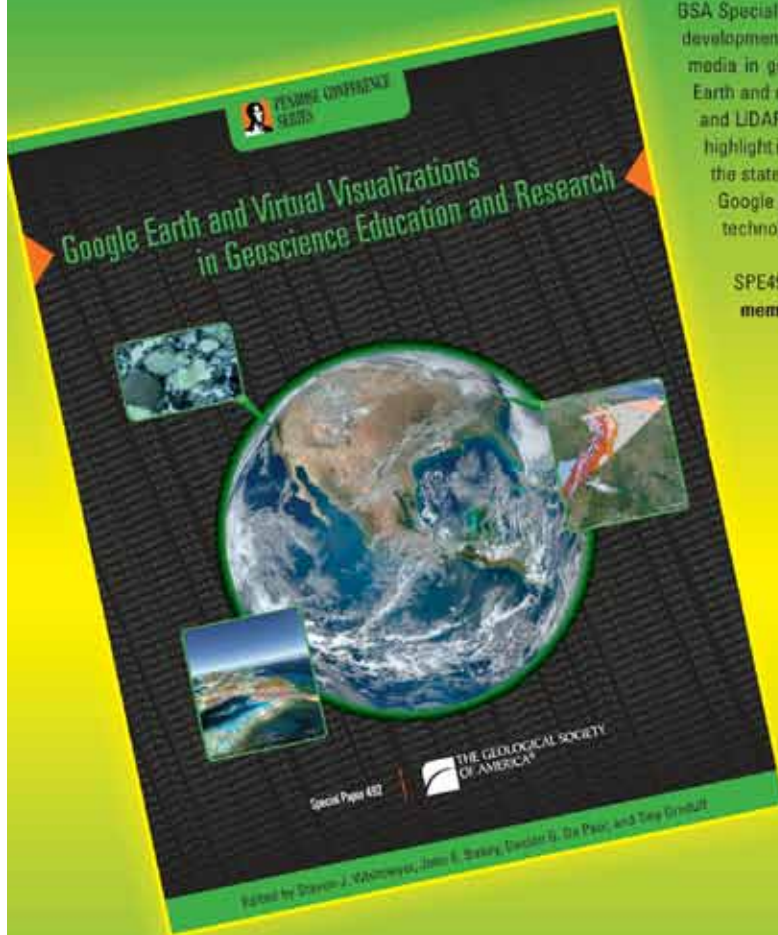
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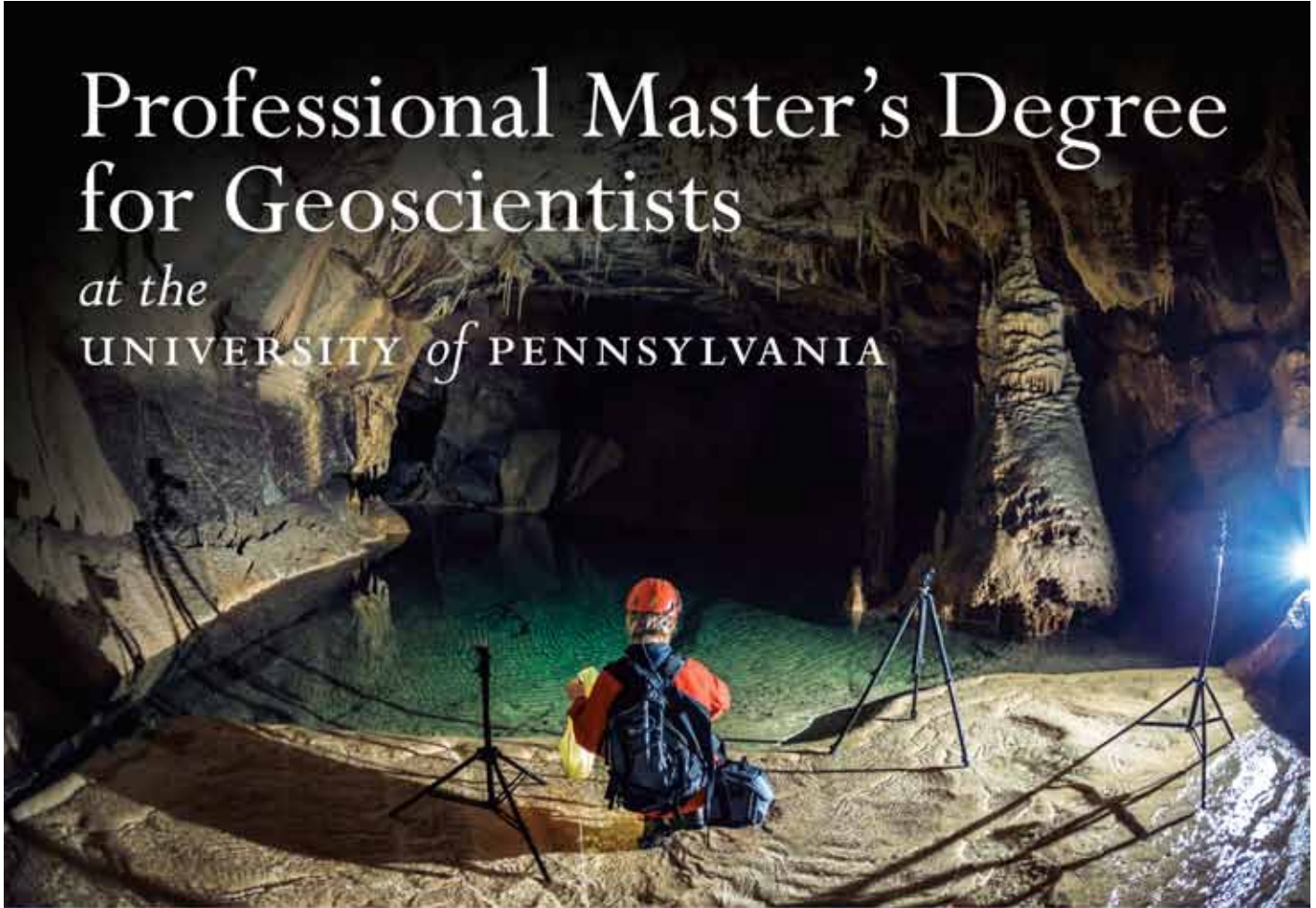
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