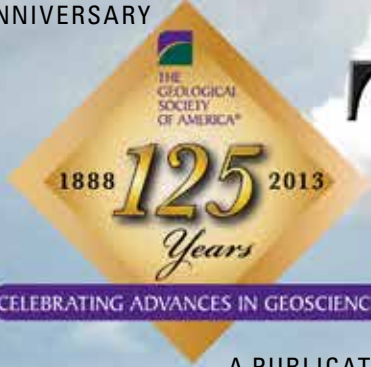


IT'S TIME!—RENEW YOUR MEMBERSHIP & SAVE 15%

CELEBRATE GSA'S 125TH ANNIVERSARY

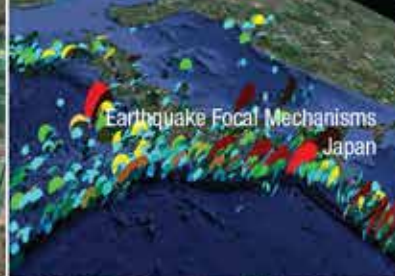
GSA  **TODAY**

A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA®

**Late Oligocene–early
Miocene Grand Canyon:
A Canadian connection?**



USGS Hydrostratigraphy
Sections
Miami, Florida



Earthquake Focal Mechanisms
Japan



Wallkill Watershed
New Jersey



Tornado Path and Magnitude
Midcontinent, USA



Wind Turbines
London, England



Public Land Survey Sections
Kansas



Beer Consumption
Per Capita, USA



Foliation Orientations
Talc Mine, SW Texas



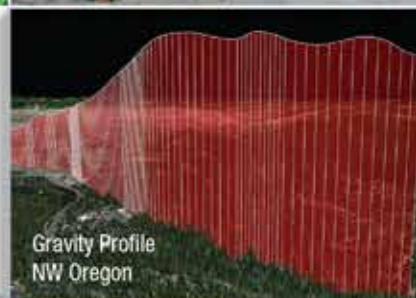
Salt Diapirs
Zagros Mtns, Iran



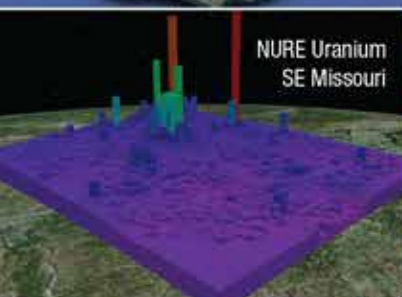
**RockWorks16
EarthApps**

FREE

The RockWorks16 EarthApps is a **FREE** collection of over 70 programs for plotting your data within Google Earth. It does **NOT** require any other software (other than Google Earth). It's **FREE**. Really.



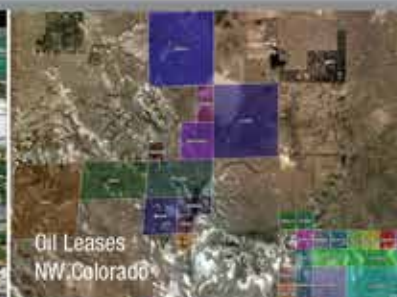
Gravity Profile
NW Oregon



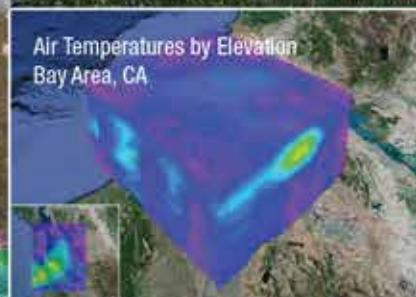
NURE Uranium
SE Missouri



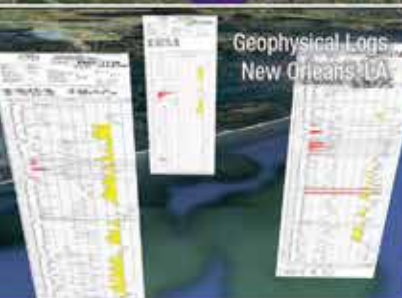
Trans-Alaska
Pipeline



Oil Leases
NW Colorado



Air Temperatures by Elevation
Bay Area, CA



Geophysical Logs
New Orleans, LA



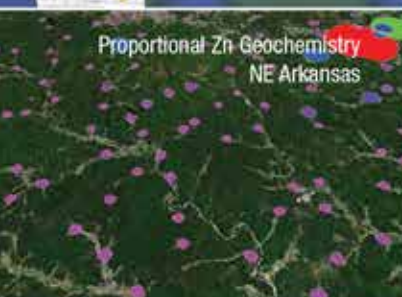
Seismic Profiles
Northern Afghanistan



Subdivision Lots
Ft. Myers, Florida



Mining Claims
W. Washington



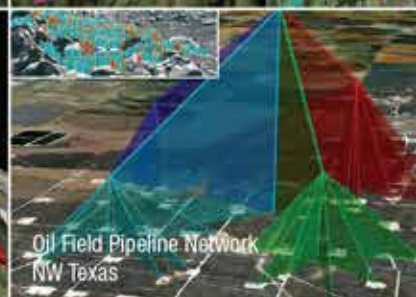
Proportional Zn Geochemistry
NE Arkansas



Weather Forecast
Siberia, Russia



Flight Paths
Persian Gulf



Oil Field Pipeline Network
NW Texas



Proposed Pipeline
N. Arizona



Lead Geochemistry
SE Missouri



Contaminant Plume
Washington, DC



Stacked Exploration Maps
Kentucky

GSA TODAY (ISSN 1052-5173 USPS 0456-530) prints news and information for more than 25,000 GSA member readers and subscribing libraries, with 11 monthly issues (April/May is a combined issue). *GSA TODAY* is published by The Geological Society of America® Inc. (GSA) with offices at 3300 Penrose Place, Boulder, Colorado, USA, and a mailing address of P.O. Box 9140, Boulder, CO 80301-9140, USA. GSA provides this and other forums for the presentation of diverse opinions and positions by scientists worldwide, regardless of race, citizenship, gender, sexual orientation, religion, or political viewpoint. Opinions presented in this publication do not reflect official positions of the Society.

© 2013 The Geological Society of America Inc. All rights reserved. Copyright not claimed on content prepared wholly by U.S. government employees within the scope of their employment. Individual scientists are hereby granted permission, without fees or request to GSA, to use a single figure, table, and/or brief paragraph of text in subsequent work and to make/print unlimited copies of items in *GSA TODAY* for noncommercial use in classrooms to further education and science. In addition, an author has the right to use his or her article or a portion of the article in a thesis or dissertation without requesting permission from GSA, provided the bibliographic citation and the GSA copyright credit line are given on the appropriate pages. For any other use, contact editing@geosociety.org.

Subscriptions: GSA members: Contact GSA Sales & Service, +1-888-443-4472; +1-303-357-1000 option 3; gsaservice@geosociety.org for information and/or to place a claim for non-receipt or damaged copies. **Nonmembers and institutions:** *GSA TODAY* is US\$80/yr; to subscribe, or for claims for non-receipt and damaged copies, contact gsaservice@geosociety.org. Claims are honored for one year; please allow sufficient delivery time for overseas copies. Periodicals postage paid at Boulder, Colorado, USA, and at additional mailing offices. Postmaster: Send address changes to GSA Sales & Service, P.O. Box 9140, Boulder, CO 80301-9140.

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@wwwu.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

GSA Online: www.geosociety.org

GSA TODAY: www.geosociety.org/gsatoday/

Printed in the USA using pure soy inks.

4 Late Oligocene-early Miocene Grand Canyon: A Canadian connection?

James W. Sears

Cover: Figure stands on Esplanade surface opposite Vulcan's Throne volcano, Grand Canyon, USA. Photo by J.W. Sears. See related article, p. 4–10.



- 11 2013–2014 Richard H. Jahns Distinguished Lecturer
- 12 2013–2014 Birdsall-Dreiss Distinguished Lecturer
- 13 2014 GSA Distinguished International Lecturer
- 13 2013 International Section Honorary Fellow
- 14 2014 Graduate Student Research Grants
- 15 Upcoming Award, Recognition & Grant Deadlines
- 17 Education & Outreach: Help Us Communicate Our Science to Teachers and Undergrads!
- 17 2014 GSA GeoVentures
- 17 Field Camps for K–12 Teachers
- 18 Preliminary Announcement and Call for Papers: GSA North-Central Section
- 20 Section Meeting Mentor Programs
- 21 2014 GSA Section Meeting Calendar
- 22 *Geology—Past and Future*: Revisited
- 24 GeoCorps™ America
- 27 Mosaics in Science
- 28 GSA Foundation Update
- 29 Classified Advertising
- 37 Call for Applications: 2014–2015 GSA-USGS Congressional Science Fellowship
- 39 Call for Proposals: Vancouver 2014

Late Oligocene–early Miocene Grand Canyon: A Canadian connection?

James W. Sears, Dept. of Geosciences, University of Montana, Missoula, Montana 59812, USA, james.sears@umontana.edu

ABSTRACT

Remnants of fluvial sediments and their paleovalleys may map out a late Oligocene–early Miocene “super-river” from headwaters in the southern Colorado Plateau, through a proto–Grand Canyon to the Labrador Sea, where delta deposits contain microfossils that may have been derived from the southwestern United States. The delta may explain the fate of sediment that was denuded from the southern Colorado Plateau during late Oligocene–early Miocene time.

I propose the following model:

1. Uplift of the Rio Grande Rift cut the southern Colorado Plateau out of the Great Plains at 26 Ma and tilted it to the southwest.
2. The upper Colorado River and its tributaries began as consequent streams that flowed down the structural plunge of the basin toward the southwest corner of the Colorado Plateau, where the river passed through a Paleogene canyon.
3. The river turned north in the Lake Mead region to enter Paleogene rifts of the eastern Great Basin.
4. NE-trending grabens across the Idaho and Montana Rockies provided the final link to the Great Plains, where the Miocene drainage joined the “Bell River” of Canada, which drained to the Labrador Sea.
5. Faulting and volcanism began to segment the paleo-river by ca. 16 Ma.
6. Faulting dammed Miocene Grand Canyon, creating a large ephemeral lake that persisted until after 6 Ma, when the Colorado River was captured by the Gulf of California.
7. The resulting shortcut to sea level greatly increased the gradient of the Colorado River, leading to headward incision of the Inner Gorge of Grand Canyon along the trace of the Miocene bedrock valley floor and renewed late Miocene–Holocene erosion of the Colorado Plateau.
8. The Yellowstone hotspot cut the river off in Idaho after 6 Ma.
9. Pleistocene continental glaciation destroyed the Canadian Bell River and diverted Montana’s drainage into the modern Missouri River.

INTRODUCTION

Apatite fission track and (U-Th)/He data indicate that Grand Canyon probably existed in some form by late Oligocene–early Miocene time (Flowers et al., 2008; Wernicke, 2011; Cather et al., 2012; Flowers and Farley, 2012; Lee et al., 2013). However, the fate of its eroded sediment remains uncertain, as does the outlet of a hypothetical late Oligocene–early Miocene Colorado River

(Karlstrom et al., 2012); the river did not reach the Gulf of California until 5.3 Ma (Dorsey et al., 2005). Several researchers have concluded that an early Miocene Colorado River most likely would have flowed northwest from a proto–Grand Canyon, because geologic barriers blocked avenues to the south and east (Lucchitta et al., 2011; Cather et al., 2012; Dickinson, 2013).

Here I propose that a late Oligocene–early Miocene Colorado River could have turned north in the Lake Mead region to follow paleovalleys and rift systems through Nevada and Idaho to the upper Missouri River in Montana. The upper Missouri joined the South Saskatchewan River of Canada before Pleistocene continental ice-sheets deflected it to the Mississippi (Howard, 1958). The South Saskatchewan was a branch of the pre-ice age “Bell River” of Canada (Fig. 1), which discharged into a massive delta in the Saglek basin of the Labrador Sea (McMillan, 1973; Balkwill et al., 1990; Duk-Rodkin and Hughes, 1994). Could the late Oligocene–early Miocene Colorado River have ultimately discharged into the Labrador Sea?

The following paragraphs outline geologic evidence for the evolution of a proposed late Oligocene–early Miocene paleovalley from Canada upstream to the Colorado Plateau, and suggest tests at

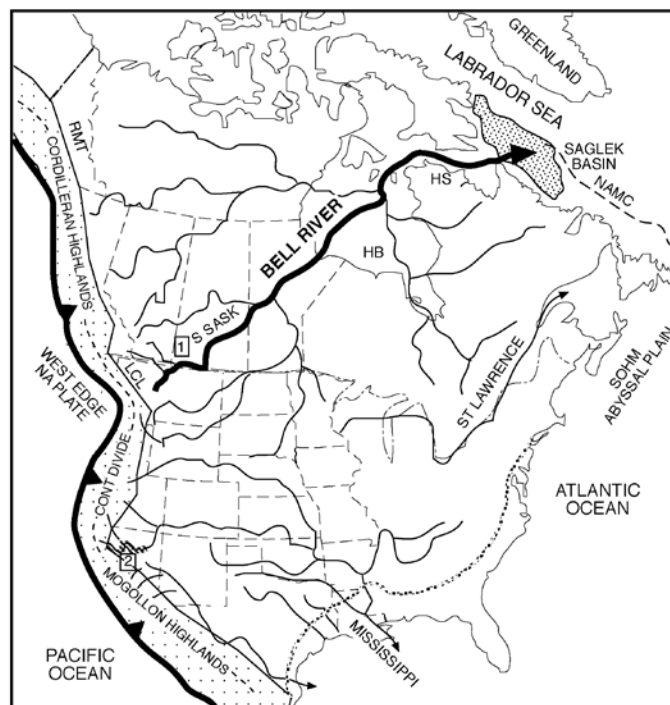


Figure 1. Early Oligocene drainage off North American Cordilleran highlands. 1—Cypress Hills and Wood Mountain; 2—Western Grand Canyon; after Duk-Rodkin and Hughes (1994). See Figure 2 for key to abbreviations.

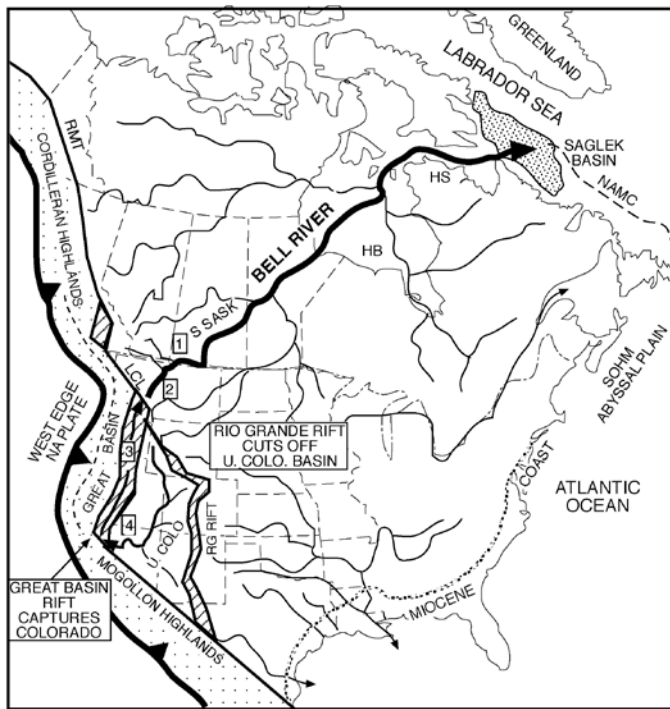


Figure 2. Miocene North American drainage. Rio Grande Rift has cut off western headwaters of Mississippi River and created upper Colorado basin, which drains into eastern Great Basin rift. 1—Cypress Hills and Wood Mountain; 2—Upper Missouri River; 3—Eastern Great Basin rift; 4—Early Grand Canyon; HB—Hudson Bay; HS—Hudson Strait; LCL—Lewis and Clark Line; NAMC—Northwest Atlantic Mid-Ocean Channel; RG—Rio Grande; RMT—Rocky Mountain Trench; S SASK—South Saskatchewan River; U. COLO—Upper Colorado River.

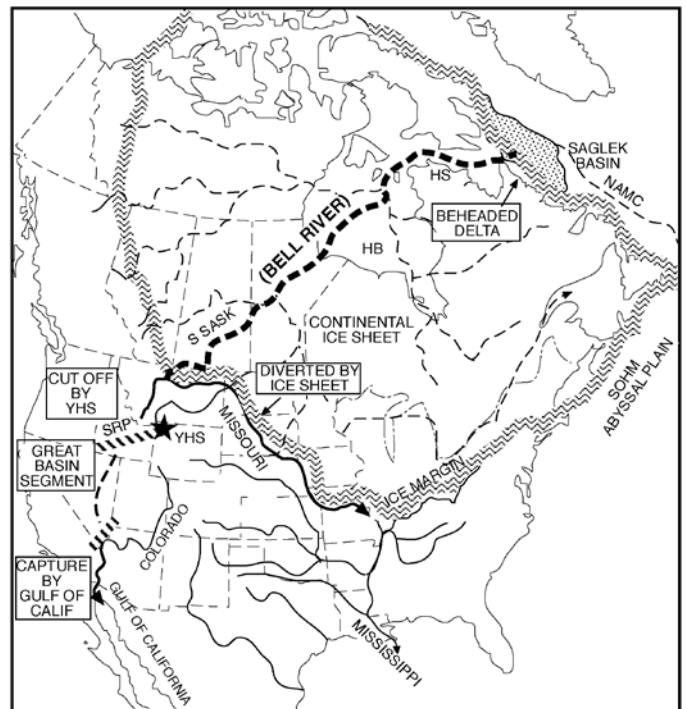


Figure 3. Pleistocene North American drainage. Continental ice sheets turn Montana drainage into modern Missouri. Yellowstone hotspot track has cut off Miocene River. Faulting in SE Nevada has diverted Colorado River to Gulf of California. HB—Hudson Bay; HS—Hudson Strait; NAMC—North Atlantic Mid-Ocean Channel; SRP—Snake River Plain, S SASK—South Saskatchewan River; YHS—Yellowstone hotspot.

critical linkages between proposed paleovalley segments. Figures 1, 2, and 3 summarize the proposed evolution of the drainage.

BELL RIVER OF CANADA AND ITS DELTA

The Cenozoic Bell River basin (McMillan, 1973) drained most of Canada before the basin was destroyed by Pleistocene continental glaciation. The tributaries gathered in the area of Hudson Bay and flowed out to sea through Hudson Strait (Duk-Rodkin and Hughes, 1994). Headwater valleys are preserved in the Rocky Mountains, Mackenzie Mountains, and northern Great Plains. The South Saskatchewan River, its main southern tributary, had sources in the Montana Rockies (Leckie et al., 2004).

The Bell River fed the >8-km-thick Saglek delta deposit in the Labrador Sea (Jauer and Budkewitsch, 2010). This delta comprises the largest sedimentary depocenter on the Atlantic seaboard of North America (Balkwill et al., 1990). An indication of the magnitude of the Bell River basin is given by the Northwest Atlantic Mid-Ocean Channel, one of the longest in the world, which winds along the seafloor for 3400 km, from the foot of the delta to the Sohm Abyssal Plain, east of New England. Continental glaciation beheaded the Saglek delta at Hudson Strait (Jauer and Budkewitsch, 2010).

Reworked fossil pollen recovered from exploration wells in the delta may support a direct link to headwaters in the Colorado Plateau. The pollen and associated sediment was derived from the western interior of North America (Hiscott, 1984; Williams, 1986). More than 15 recylant palynomorphs identified by

Williams (1986) match fossil pollen found in upper Paleozoic and lower Mesozoic continental strata that are widespread on the Colorado Plateau, but rarely crop out farther north (cf. Cook and Bally, 1975). From upper Eocene to lower Miocene muds drilled in the Roberval K-92 well of the Saglek basin, Williams (1986) identified *Calamospora*, *Convolutispora*, *Densoisporites*, *Foveotrilletes*, *Matonisporites*, and *Osmundacidites wellmanii*, which are also known from the Chinle Formation of northern Arizona (cf. Litwin et al., 1991), and a *Lycospora-Triquirites-Punctatisporites* assemblage, which is also known from the Supai Group of Grand Canyon (cf. McKee, 1982).

The Bell River drainage has been traced up the South Saskatchewan paleovalley to the Cypress Hills and Wood Mountain, river-gravel-capped nunatak ridges on the southern Canadian plains (Prest 1970). The gravel fills broad, overlapping Eocene to early Miocene paleovalleys (Leckie et al., 2004). Paleocurrent measurements indicate that the gravel was deposited by NNE flow in braided channels (Leckie et al., 2004). Provenance of placer gold, alkalic volcanics, and Belt Supergroup pebbles indicates derivation from the Montana Rockies (Leckie et al., 2004).

UPPER MISSOURI PALEOVALLEY, MONTANA

The South Saskatchewan paleovalley trends directly toward the upper Missouri River of northwest Montana (Fig. 4). Remnants of Miocene river gravel trace the ancestor of the upper Missouri for 350 km, from Great Falls southwest to the Continental Divide (Sears et al., 2009). Upper Missouri paleovalley segments are as

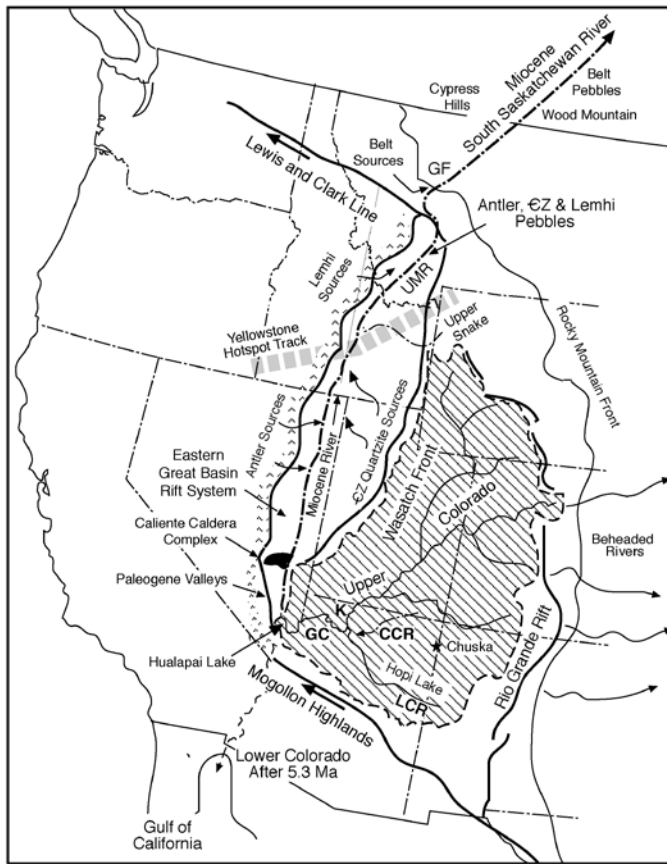


Figure 4. Miocene central-western United States drainage. Upper Colorado River basin (cross-hatched) drains structural trough toward southwest corner of Colorado Plateau, leading to rift systems through Nevada, Idaho, and Montana, to headwaters of South Saskatchewan River. Antler orogenic belt, Cambrian-Precambrian Z (EZ) quartzite, Lemhi Group, and Belt Supergroup bedrock sources feed gravel northeast along Miocene river. CCR—Crooked Ridge River; GC—Grand Canyon; GF—Great Falls; K—Kaibab Upwarp; LCR—Little Colorado River; UMR—Upper Missouri River; black—Caliente caldera complex; dotted, inverted Vs—uplifts on west flank of Miocene river. Dashed gray line—Yellowstone hotspot track. Note that northern part of upper Colorado River basin was not integrated with southern part until late Miocene (Cather et al., 2012).

broad as 10–15 km and contain Miocene fluvial deposits as thick as 200 m. The paleovalley was carved into beds as young as the Arikarean Renova Formation, and was filled by river beds as old as the Barstovian Sixmile Creek Formation (Fields et al., 1985). Active faults of the Intermountain Seismic Belt have disrupted the paleovalley (Stickney, 2007).

The upper Missouri paleovalley was superimposed over a Paleogene rift system that linked western Montana with Idaho, Nevada, and Utah (Janecke, 1994; Axen et al., 1993). The rift system and associated core complexes and high topography had propagated from Montana to southern Nevada in Eocene and Oligocene time in association with the southward-migrating Cordilleran magmatic arc (Mix et al., 2011). The rift system may have channeled volcanic ash from the magmatic in arc Nevada and Utah to Idaho and Montana, where it accumulated as thick claystone deposits in the Renova and correlative formations.

The Miocene fluvial deposits of the upper Missouri paleovalley contain an assemblage of exotic pebbles and cobbles that have no

possible bedrock sources in Montana (Sears et al., 2009). These clasts diminish in grain size northeast along the paleovalley, in accord with prevailing paleocurrents (Landon and Thomas 1999). They include abundant roundstone cobbles likely derived from Cambrian-Precambrian Z quartzites of southeastern Idaho and western Utah (cf. Oriol and Armstrong, 1971), along with pebbles that match distinctive lithologies of the Antler belt of Nevada, including: (1) Eureka Quartzite, (2) Valmy chert and Vinnini quartzite of the Roberts Mountain allochthon, and (3) Diamond Peak conglomerate of the Antler overlap assemblage (cf. Coats, 1987). These lithologies were exposed on the shoulders of the Paleogene rift that linked western Montana with Idaho and Nevada. Fluvial transport down the rift axis could have brought the exotic clasts into Montana.

The gravel-filled Miocene paleovalley crosses the Continental Divide from Montana into Idaho, where it is buried by Pliocene volcanics of the Yellowstone hotspot track and Pleistocene basalt of the Snake River Plain (cf. Pierce and Morgan, 1992). The distinctive river gravel reappears in windows through the basalt more than 100 km south of the Continental Divide, where it has been exploited in gravel pits. Detrital zircon studies show that, after 6 Ma, the Continental Divide migrated east from the Idaho batholith to its present location on the Montana border (Beranek et al., 2006), where it crosses the trend of the paleovalley.

Remnants of middle and upper Miocene fluvial and lacustrine deposits occur in isolated patches above a regional unconformity along the trend of the Paleogene rift system in Nevada (Coats, 1987; Stewart and Carlson, 1978). The Paleogene rift system was segmented by basin-range faulting, and the paleovalley deposits have been variably tilted, faulted, eroded, and buried in the modern landscape (cf. Henry et al., 2011).

The Caliente caldera complex erupted near the southern end of the rift system from 26 to 15 Ma (Axen, 1998). North of the caldera complex, north-trending paleochannels contain volcanic ash and well-rounded river pebbles of Caliente volcanics along with metamorphic lithologies that were ultimately derived from basement complexes exposed farther to the south.

Remnants of Paleogene paleovalleys may connect the Paleogene rift system to western Grand Canyon. Reconstruction of basin-range faulting in the Lake Mead region restores the pre-extensional, 26–16-Ma basal Horse Spring Formation against the southwest corner of the Colorado Plateau near the western edge of Grand Canyon (Umhoefer et al., 2010). The formation was deposited on alluvial plains that sloped off the flanks of Laramide ridges into a broad north-trending paleovalley on the west edge of the plateau (Anderson and Beard, 2010). The Laramide ridges coincide with the shoulder of the Paleogene rift system mapped by Mix et al. (2011), which had propagated south to that latitude by 28 Ma. Until basin-range faulting began at 17 Ma, most of the sediment in the Horse Spring paleovalley bypassed the system toward the northeast (Lamb et al., 2010).

EARLY MIOCENE PROTO-GRAND CANYON?

An early Miocene paleocanyon floor may transect the entire length of Grand Canyon, midway between the rim and the river. The feature is represented by a ~5-km-wide terrace that is incised by the deep and narrow Inner Gorge. The terrace transects hundreds of meters of tilted stratigraphy as it crosses the Kaibab

Upwarp, a major Laramide anticline in eastern Grand Canyon (Dickinson, 2013). It is offset by Pliocene and younger normal faults. It comprises the Hualapai Plateau in western Grand Canyon, the Esplanade terrace atop the Supai Group in central Grand Canyon, and a series of concordant buttes, mesas, spurs, and terraces on top of the Redwall Limestone in eastern Grand Canyon (Fig. 5). River-polished and fluted limestone and beheaded fluvial channels are locally preserved on the surface. The Redwall bench and Esplanade terrace are mutually exclusive; there is no Redwall bench in central and western Grand Canyon, and no Esplanade terrace in eastern Grand Canyon. They appear to be concordant parts of the same erosional surface.

The Hualapai Plateau is a mature cuestaform terrace cut by deep paleocanyons that are filled with Paleogene fluvial/alluvial sediments (Young, 2008). Wernicke (2011) and Flowers and Farley (2012) deduced from apatite dating that the paleocanyons may have been cut by 70 Ma. Wernicke (2011) proposed that the Late Cretaceous “California River” flowed eastward through the proto-Grand Canyon and delivered feldspathic sediment from the Sierra Nevada to the Cretaceous Interior Seaway in southern Utah, and later reversed its flow.

The Hualapai terrace is capped by 20- to 16-Ma volcanics that flowed across the filled paleocanyons, and is incised by the narrow, 1-km-deep Inner Gorge, which cuts across ca. 6-Ma dike swarms (Billingsley and Wellmeyer, 2003).

Lee et al. (2013) concluded from apatite dating that a canyon had eroded through the Kaibab Upwarp of eastern Grand Canyon in latest Oligocene–early Miocene time (28–20 Ma). Flowers et al. (2008) deduced from apatite dating that from 23 to 16 Ma erosion had cut a ~1-km-deep canyon through the Kaibab rim. That depth would correspond to the level of the mid-canyon bedrock bench.

East of Grand Canyon, Lucchitta et al. (2011) interpreted a meandering ridge of fluvial sediment as a topographically inverted Miocene paleovalley—the “Crooked Ridge River.” The feature crosses >100 km of the Navajo Nation and may have been a major tributary or even the main stem of the ancestral Colorado River. The fluvial sediment includes minor amounts of stream-rounded gravel ultimately derived from the San Juan and Needle Mountains of Colorado (Hunt, 1969). The gradient of the Crooked Ridge River projects toward that of the 16-Ma paleovalley of the Little Colorado River basin as well as toward that of the mid-canyon bedrock bench in eastern Grand Canyon (Dickinson, 2013).

COLORADO PLATEAU

Continental rifting separated the southern Colorado Plateau from the Great Plains beginning ca. 26 Ma (Chapin and Cather, 1994). Prior to the rifting, the region had relatively low relief and drained east from the Cordilleran highlands toward the mid-continental lowlands (Cather et al., 2008; Wernicke, 2011) (Fig. 1). The rifts formed when the western North American plate boundary became dextral-transensional, and the crustal block that became the Colorado Plateau rotated clockwise relative to North America (Chapin and Cather, 1994). The basin is bordered by rift systems (Fig. 4). On the west is the eastern Great Basin rift and Wasatch Front, on the south, the Mogollon Highlands, on the east, the Rio Grande Rift (Chapin and Cather, 1994). The Wyoming part of the basin was not integrated until late Miocene (Cather et al., 2012).



Figure 5. Miocene(?) mid-canyon bench as seen on Cheops Pyramid and adjacent ridges on top of Redwall Limestone, near Phantom Ranch, eastern Grand Canyon, USA. Photo by J.W. Sears.

Uplift of the rift zones created a broad structural trough that warped the mature, early Oligocene (ca. 35 Ma) Rocky Mountain erosional surface (Cather et al., 2008). The upper Colorado River and its tributaries formed a consequent drainage system that flowed down the structural trough toward the southwest corner of the Colorado Plateau. Since 26 Ma, the east side of the basin has risen nearly 3 km relative to the southwest corner (Epis and Chapin, 1975; Liu and Gurnis, 2010).

A number of erosional remnants document the timing of incision and the depth of erosion of the Colorado Plateau. For example, an Oligocene erg that caps the Chuska Mountains lies 1.2 km above the 16-Ma floor of the Little Colorado paleovalley (Dallegge et al., 2003; Cather et al., 2008).

I propose that much of the sediment that was denuded from the southern Colorado Plateau in late Oligocene–early Miocene time could have been deposited in the Labrador Sea and on the Sohms Abyssal Plain. The upper Oligocene to lower Miocene Mokami Formation of the Saglek basin received a tremendous influx of clay and silt during that interval, and the silt included palynomorphs of fossils from the western interior (Balkwill et al., 1990). The sediment largely bypassed deposition in the fluvial system leading to the Labrador Sea.

The deep erosion of the southern Colorado Plateau was coeval with the lead-up to the Miocene climatic optimum, ca. 20–17 Ma (Zachos et al., 2001). In the western U.S., this period experienced significantly elevated weathering and rainfall with the development of thick laterite soils (Thompson et al., 1982).

COLORADO RIVER DURING THE 16–5-MA INTERVAL

There is no record of Colorado River gravel in Grand Wash graben to the immediate west of Grand Canyon until after ca. 6 Ma, even though thick sections of Miocene sediment are well exposed in the graben (Lucchitta, 1972; Young, 2008). The graben sediment consists mainly of locally derived alluvium and lacustrine deposits of “Hualapai Lake”—evidence of closed-basin deposition; no Miocene Colorado River delta occurs in the graben (Anderson and Beard, 2010; Howard et al., 2010). Could the river

have begun to carve the canyon before 6 Ma, if the adjacent downstream graben contains no river delta (Pederson, 2008)?

To address this problem, Lucchitta et al. (2011) and Dickinson (2013) proposed that the river flowed through eastern Grand Canyon, as also suggested here, but turned north before reaching Grand Wash, and proceeded on a hypothetical route through southern Utah.

Alternatively, Young (2008) proposed that, before 5 Ma, Hualapai Lake had flooded Grand Wash and western Grand Canyon and had trapped clastic fluvial sediment far upstream. The lake could have been dammed by uplift of basin-range fault blocks on the west side of Grand Wash at 16–14 Ma (cf. Howard et al., 2010). A structural cross section indicates that 3 km of structural relief was attained between the fault blocks and western Grand Canyon by 16 Ma (Karlstrom et al., 2010).

Given the reconstructed gradient of the proposed Miocene river, a lake dammed by the basin-range fault blocks at the mouth of Grand Canyon could conceivably have backed water up to Miocene Hopi Lake on the Little Colorado River (Fig. 4), if Grand Canyon had already cut across the Kaibab Plateau. At present, the top of 16–6-Ma deposits of Hualapai Lake (~900 m) is ~1 km lower in elevation than the top of the lacustrine facies of the 16–6 Ma Bidahochi Formation of Hopi Lake (~1900 m), but in the past 3.5 m.y., the Grand Canyon east of the Hurricane and Toroweap fault systems has been uplifted ~600 m relative to the west (Karlstrom et al., 2008). Hualapai and Hopi lakes could have been parts of the same impoundment, if eastern Arizona shared the regional late Miocene–Holocene isostatic rock uplift that is indicated to measure ~1 km in southeastern Utah (cf. Cather et al., 2012). At full lake pool, coarse fluvial sediment would have been restricted to deltas at the mouths of drowned canyons, tens to hundreds of kilometers upstream of Grand Wash. Delta facies indeed occur in the Bidahochi Formation of Hopi Lake at the mouths of paleovalleys (Dickinson, 2013).

The lakes existed during a 15–6-m.y. period of erosional stagnation on the Colorado Plateau, according to apatite (U-Th)/He data (Cather et al., 2012). Lacustrine deposition of the Bidahochi Formation at Hopi Lake gave way to fluvial deposition ca. 6 Ma, after which the formation began to be incised by the Little Colorado River (Dickinson, 2013). Incision of the Bidahochi Formation coincided with incision of the Inner Gorge in western Grand Canyon and dissection of Hualapai Lake beds at Grand Wash graben by the integrated Colorado River system (Pederson, 2008; Karlstrom et al., 2008; Howard et al., 2010). Howard et al. (2010) mapped a series of Late Miocene paleovalleys across the fault blocks on the west side of Grand Wash that could mark successive outflow channels.

Cather et al. (2012) determined that the southern Colorado Plateau was denuded by ~1–2 km between 27 and 15 Ma, and that the northern plateau was denuded by about the same amount between 6 Ma and the present. There was apparently a relative lack of erosion between 15 and 6 Ma (Cather et al., 2012), the interval during which Hualapai and Hopi lakes were accumulating modest sediment loads. After 6 Ma, the sediment could have washed to the Gulf of California.

Consistent with the present model, comparisons of freshwater fish fossils indicate that the Bidahochi Formation and the upper Snake River of eastern Idaho occupied a common drainage basin during Miocene time (Lucchitta et al., 2011) (Fig. 4). DNA studies

show that fish of the upper Snake and upper Colorado basins have more in common with each other than they do with fish in the lower parts of their respective basins (Spencer et al., 2008).

DISCUSSION AND CONCLUSION

Capture of the Colorado River by the Gulf of California would have shortened its route to sea level from the ~5000 km proposed here (Lake Mead to Labrador Sea) to ~500 km (Lake Mead to the Gulf of California). Steepened gradients and deep erosion of side canyons would have permitted the transport of a gravel bedload, so that the first bona-fide Colorado River gravel appears above the 6-Ma Hualapai Limestone (Lucchitta, 1972; Karlstrom et al., 2008).

In the Great Basin, extension intermittently interrupted the flow of the proposed paleoriver after 17 Ma, so that ephemeral lakes formed and filled with sediment until river flow was restored. Thus, most upper Miocene sections include lacustrine, fluvial, and alluvial beds.

The Yellowstone hotspot crossed the proposed paleovalley between 10 and 6 Ma (cf. Pierce and Morgan, 1992). After 6 Ma, the Snake River first delivered sediment to the Boise area, the Continental Divide shifted eastward (Beranek et al., 2006), and the Montana reach of the paleovalley was cut off from former sources to the southwest.

In summary, the upper Colorado River may have been the southern tributary of one of the largest river basins in the world during the lead-up to the Miocene climatic optimum. Runoff may have carried a sediment load for >5000 km from the southern Colorado Plateau, through an early Grand Canyon, down rift zones in Nevada, Idaho, and Montana, and across the Canadian plains to the Labrador Sea. Turbidity flows from the delta then carved the 3400-km-long Northwest Atlantic Mid-Ocean Channel to spill out onto the Sohms Abyssal Plain southeast of New England.

A number of standard provenance tests could be made to evaluate the hypothesis at key locations along the trace of the proposed paleoriver—for example, detrital zircon analyses of paleoriver deposits, detailed petrographic comparisons of suggested sources and pebbles, and further analysis of palynomorphs from samples of Saglek delta muds and proposed source regions.

ACKNOWLEDGMENTS

I thank Ray Price for encouraging comments on an earlier draft of the manuscript. Discussions and field trips over the years with George Billingsley, Karl Karlstrom, Paul Umhoefer, Bill Fritz, Dave Alt, John MacLean, and many others helped formulate the concepts. Thoughtful suggestions by Steven Cather and an anonymous reviewer greatly improved the manuscript. Field work in southwestern Montana has been supported by the University of Montana field geology program.

REFERENCES CITED

- Anderson, R.E., and Beard, L.S., 2010, Geology of the Lake Mead region: An overview, *in* Umhoefer, P.J., Beard, L.S., and Lamb, M.A., eds., *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*: Geological Society of America Special Paper 463, p. 1–28, doi: 10.1130/2010.2463(01).
- Axen, G.J., 1998, The Caliente-Enterprise zone, southeastern Nevada and southwestern Utah, *in* Faulds, J.E., and Stewart, J.H., eds., *Accommodation zones and transfer zones; the regional segmentation of the Basin and Range Province*: Geological Society of America Special Paper 323, p. 181–194.

- Axen, G.J., Taylor, W.J., and Bartley, J.M., 1993, Space-time patterns and tectonic controls of Tertiary extension and magmatism in the Great Basin of the western United States: *GSA Bulletin*, v. 105, p. 56–76, doi: 10.1130/0016-7606(1993)105<0056:STPATC>2.3.CO;2.
- Balkwill, H.R., McMillan, N.J., MacLean, B., Williams, G.L., and Srivastava, S.P., 1990, Geology of the Labrador shelf, Baffin Bay, and Davis Strait, *in* Keen, M.J., and Williams, G.L., eds., *Geology of the continental margin of eastern Canada*: Geological Society of America, *Geology of North America*, v. I-1, p. 293–348.
- Beranek, L.P., Link, P.K., and Fanning, C.M., 2006, Miocene to Holocene landscape evolution of the western Snake River Plain region, Idaho: Using the SHRIMP detrital zircon record to track eastward migration of the Yellowstone hotspot: *GSA Bulletin*, v. 118, p. 1027–1050, doi: 10.1130/B25896.1.
- Billingsley, G.H., and Wellmeyer, J.L., 2003, Geologic map of the Mount Trumbull 30' × 60' quadrangle, Mohave and Coconino Counties, northwestern Arizona: U.S. Geological Survey Geologic Investigations Map I-2766, 1:100,000, 36 p.
- Cather, S.M., Connell, S.D., Chamberlin, R.M., Jones, G.E., Potochnik, A.R., Lucas, S.G., and Johnson, P.S., 2008, The Chuska erg: Paleogeomorphic and paleoclimatic implications of an Oligocene sand sea on the Colorado Plateau: *GSA Bulletin*, v. 120, p. 13–33.
- Cather, S.M., Chapin, C.E., and Kelley, S.A., 2012, Diachronous episodes of Cenozoic erosion in southwestern North America and their relationship to surface uplift, paleoclimate, paleodrainage, and paleoaltimetry: *Geosphere*, v. 8, p. 1177–1206, doi: 10.1130/GES00801.1.
- Chapin, C.E., and Cather, S.M., 1994, Tectonic setting of the axial basins of the northern and central Rio Grande Rift, *in* Keller, G.R., and Cather, S.M., eds., *Basins of the Rio Grande Rift: Structure, Stratigraphy, and Tectonic Setting*: Geological Society of America Special Paper 291, p. 5–26, doi: 10.1130/SPE291-p5.
- Coats, R.R., 1987, Geology of Elko County, Nevada: Nevada Bureau of Mines and Geology Bulletin 101, 112 p., map 1: 250,000.
- Cook, T.D., and Bally, A.W., 1975, *Stratigraphic Atlas of North and Central America*: New Jersey, Princeton Press, 272 p.
- Dallegge, T.A., Ort, M.H., and McIntosh, W.C., 2003, Mio-Pliocene chronostratigraphy, basin morphology, and paleodrainage relations derived from the Bidahochi Formation, Hopi and Navajo Nations, northeastern Arizona: *The Mountain Geologist*, v. 4, p. 55–82.
- Dickinson, W.R., 2013, Rejection of the lake spillover model for initial incision of the Grand Canyon, and discussion of alternatives: *Geosphere*, v. 9, p. 1–20, doi: 10.1130/GES00839.1.
- Dorsey, R.J., Fluette, A., McDougall, K., Housen, B.A., and Janecke, S.U., 2005, Terminal Miocene arrival of Colorado River sand in the Salton Trough, southern California: Implications for initiation of the lower Colorado River drainage: *Geological Society of America Abstracts with Programs*, v. 37, no. 7, p. 109.
- Duk-Rodkin, A., and Hughes, O.L., 1994, Tertiary-Quaternary drainage of the pre-glacial MacKenzie River basin: *Quaternary International*, v. 22–23, p. 221–241, doi: 10.1016/1040-6182(94)90015-9.
- Epis, R.C., and Chapin, C.E., 1975, Geomorphic and tectonic implications of the post-Laramide, Late Eocene erosion surface in the southern Rocky Mountains, *in* Curtis, B.F., ed., *Cenozoic History of the Southern Rocky Mountains*: Geological Society of America Memoir 144, p. 45–74.
- Fields, R.W., Rasmussen, D.L., Nichols, R., and Tabrum, A.R., 1985, Cenozoic rocks of the intermontane basins of western Montana and eastern Idaho, *in* Flores R.M., and Kaplan, S.S., eds., *Cenozoic paleogeography of the west-central United States*: Denver, Colorado, Rocky Mountain Section of the Society of Economic Paleontologists and Mineralogists, p. 9–36.
- Flowers, R.M., and Farley, K.A., 2012, Apatite ⁴He/³He and (U-Th)/He evidence for an ancient Grand Canyon: *Science*, v. 338, p. 1616–1619, doi: 10.1126/science.1229390.
- Flowers, R.M., Wernicke, B.P., and Farley, K.A., 2008, Unroofing, incision, and uplift history of the southwestern Colorado Plateau from apatite (U-Th)/He thermochronometry: *GSA Bulletin*, v. 120, p. 571–587, doi: 10.1130/B26231.1.
- Henry, C.D., McGrew, A.J., Colgan, J.P., Snoke, A.W., and Brueseke, M.E., 2011, Timing, distribution, amount, and style of Cenozoic extension in the northern Great Basin, *in* Lee, J., and Evans, J.P., eds., *Geologic Field Trips to the Basin and Range, Rocky Mountains, Snake River Plain, and Terranes of the U.S. Cordillera*: Geological Society of America Field Guide 21, p. 27–66.
- Hiscott, R.N., 1984, Clay mineralogy and clay-mineral provenance of Cretaceous and Paleogene strata, Labrador and Baffin shelves: *Bulletin of Canadian Petroleum Geology*, v. 32, p. 272–280.
- Howard, A.D., 1958, Drainage evolution in northeastern Montana and northwestern North Dakota: *GSA Bulletin*, v. 69, p. 575–588, doi: 10.1130/0016-7606(1958)69[575:DEINMA]2.0.CO;2.
- Howard, K.A., Beard, L.S., Kuntz, M.A., Kunk, M.J., Sarna-Wojcicki, A.M., Perkins, M.E., and Lucchitta, I., 2010, Erosion of tilted fault blocks and deposition of coarse sediments in half-graben basins during late stages of extension: Gold Butte area, Basin and Range Province, *in* Umhoefer, P.J., Beard, L.S., and Lamb, M.A., eds., *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*: Geological Society of America Special Paper 463, p. 147–170, doi: 10.1130/2010.2463(07).
- Hunt, C.B., 1969, Geologic history of the Colorado River: USGS Professional Paper 669, p. 59–130.
- Janecke, S.U., 1994, Sedimentation and paleogeography of an Eocene to Oligocene rift zone, Idaho and Montana: *GSA Bulletin*, v. 106, p. 1083–1095, doi: 10.1130/0016-7606(1994)106<1083:SAPOAE>2.3.CO;2.
- Jauer, C.D., and Budkewitsch, P., 2010, Old marine seismic and new satellite radar data: Petroleum exploration of northwest Labrador Sea, Canada: *Marine and Petroleum Geology*, v. 27, p. 1379–1394, doi: 10.1016/j.marpetgeo.2010.03.003.
- Karlstrom, K.E., Crow, R., Crossey, L.J., Coblenz, D., and Van Wijk, J.W., 2008, Model for tectonically driven incision of the younger than 6 Ma Grand Canyon: *Geology*, v. 36, p. 835–838, doi: 10.1130/G25032A.1.
- Karlstrom, K.E., Heizler, M., and Quigley, M.C., 2010, Structure and ⁴⁰Ar/³⁹Ar K-feldspar thermal history of the Gold Butte block: Reevaluation of the tilted crustal section model, *in* Umhoefer, P.J., Beard, L.S., and Lamb, M.A., eds., *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*: Geological Society of America Special Paper 463, p. 331–352, doi: 10.1130/2010.2463(15).
- Karlstrom, K.E., Beard, L.S., House, K., Young, R.A., Aslan, A., Billingsley, G., and Pederson, J., 2012, Introduction: CRevolution 2: Origin and Evolution of the Colorado River System II: *Geosphere*, v. 8, p. 1170–1176, doi: 10.1130/GES00716.1.
- Lamb, M.A., Martin, K.L., Hickson, T.A., Umhoefer, P.J., and Eaton, L., 2010, Stratigraphy and age of the lower Horse Spring Formation in the Longwell Ridges area, southern Nevada: Implications for tectonic interpretations, *in* Umhoefer, P.J., Beard, L.S., and Lamb, M.A., eds., *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*: Geological Society of America Special Paper 463, p. 171–201, doi: 10.1130/2010.2463(08).
- Landon, S.C., and Thomas, R.C., 1999, Provenance of gravel deposits in the mid-Miocene Ruby Graben, southwest Montana: *Geological Society of America Abstracts with Programs*, v. 37, no. 7, p. 292.
- Leckie, D.A., Bednarski, J.M., and Young, H.R., 2004, Depositional and tectonic setting of the Miocene Wood Mountain Formation, southern Saskatchewan: *Canadian Journal of Earth Sciences*, v. 41, p. 1319–1328, doi: 10.1139/e04-076.
- Lee, J.P., Sockli, D.F., Kelley, S.A., Pederson, J.L., Karlstrom, K.E., and Ehlers, T.A., 2013, New thermochronometric constraints on the Tertiary landscape evolution of the central and eastern Grand Canyon, Arizona: *Geosphere*, v. 9, p. 216–228, doi: 10.1130/GES00842.1.
- Litwin, R.J., Traverse, A., and Ash, S.R., 1991, Preliminary palynological zonation of the Chinle Formation, southwestern U.S.A., and its correlation to the Newark Supergroup (eastern USA): *Review of Palaeobotany and Palynology*, v. 68, p. 269–287, doi: 10.1016/0034-6667(91)90028-2.
- Liu, L., and Gurnis, M., 2010, Dynamic subsidence and uplift of the Colorado Plateau: *Geology*, v. 38, p. 663–666, doi: 10.1130/G30624.1.
- Lucchitta, I., 1972, Early history of the Colorado River in the Basin and Range province: *GSA Bulletin*, v. 83, p. 1933–1947, doi: 10.1130/0016-7606(1972)83[1933:EHOTCR]2.0.CO;2.
- Lucchitta, I., Holm, R.F., and Lucchitta, B.K., 2011, A Miocene river in Northern Arizona and its implications for the origin of the Colorado River and Grand Canyon: *GSA Today*, v. 21, p. 4–10, doi: 10.1130/G119A.1.

- McKee, E.D., 1982, The Supai Group of Grand Canyon: USGS Professional Paper 1173, 504 p.
- McMillan, J.N., 1973, Shelves of the Labrador Sea and Baffin Bay, Canada: Canadian Society of Petroleum Geologists Memoir 1, p. 473–515.
- Mix, H.T., Mulch, A., Kent-Corson, M.L., and Chamberlain, C.P., 2011, Cenozoic migration of topography in the North American Cordillera: *Geology*, v. 39, p. 87–90, doi: 10.1130/G31450.1.
- Oriel, S.S., and Armstrong, F.C., 1971, Uppermost Precambrian and lowermost Cambrian rocks in southeastern Idaho: USGS Professional Paper 394, 52 p.
- Pederson, J.L., 2008, The mystery of the pre-Grand Canyon Colorado River—Results from the Muddy Creek Formation: *GSA Today*, v. 18, no. 3, p. 4–10, doi: 10.1130/GSAT01803A.1.
- Pierce, K.L., and Morgan, L.A., 1992, The track of the Yellowstone hotspot: Volcanism, faulting, and uplift, *in* Link, P.K., Kuntz, M.A., and Platt, L.B., eds., *Regional Geology of Eastern Idaho and Western Wyoming*: Geological Society of America Memoir 179, p. 1–54, doi: 10.1130/MEM179-p1.
- Prest, V.K., 1970, Quaternary Geology of Canada, *in* Douglas, R.J.W., ed., *Geology and economic minerals of Canada*: Geological Survey of Canada Economic Geology Report no. 1, p. 676–764.
- Sears, J.W., Hendrix, M.S., Thomas, R.C., and Fritz, W.J., 2009, Stratigraphic record of the Yellowstone hotspot track: Neogene Sixmile Creek Formation grabens, Southwest Montana: *Journal of Volcanology and Geothermal Research*, v. 188, p. 250–259, doi: 10.1016/j.jvolgeores.2009.08.017.
- Spencer, J.E., Smith, G.R., and Dowling, T.E., 2008, Middle to Late Cenozoic geology, hydrography, and fish evolution in the American southwest, *in* Reheis, M.C., Hershler, R., and Miller, D.M., eds., *Late Cenozoic Drainage History of the Southwestern Great Basin and Lower Colorado River Region: Geologic and Biotic Perspectives*: Geological Society of America Special Paper 439, p. 229–300.
- Stewart, J.H., and Carlson, J.E., 1978, Geologic Map of Nevada: U.S. Geological Survey and Nevada Bureau of Mines and Geology, scale 1:500,000.
- Stickney, M.C., 2007, Historic earthquakes and seismicity in southwestern Montana: *Northwest Geology*, v. 36, p. 167–186.
- Thompson, G.R., Fields, R.W., and Alt, D., 1982, Land-based evidence for Tertiary climatic variations: Northern Rockies: *Geology*, v. 10, p. 413–417, doi: 10.1130/0091-7613(1982)10<413:LEFTCV>2.0.CO;2.
- Umhoefer, P.J., Beard, L.S., Martin, K.L., and Blythe, N., 2010, From detachment to transtensional faulting: A model for the Lake Mead extensional domain based on new ages and correlation of sub-basins, *in* Umhoefer, P.J., Beard, L.S., and Lamb, M.A., eds., *Miocene Tectonics of the Lake Mead Region, Central Basin and Range*: Geological Society of America Special Paper 463, p. 371–394, doi: 10.1130/2010.2463(17).
- Wernicke, B., 2011, The California River and its role in carving Grand Canyon: *GSA Bulletin*, v. 123, p. 1288–1316, doi: 10.1130/B30274.1.
- Williams, V.E., 1986, Palynological study of the continental shelf sediments of the Labrador Sea [Ph.D. thesis]: Vancouver, B.C., University of British Columbia, 216 p.
- Young, R.A., 2008, Pre-Colorado River drainage in western Grand Canyon: Potential influence on Miocene stratigraphy in Grand Wash trough, *in* Reheis, M.C., Hershler, R., and Miller, D.M., eds., *Late Cenozoic Drainage History of the Southwestern Great Basin and Lower Colorado River Region: Geologic and Biotic Perspectives*: Geological Society of America Special Paper 439, p. 319–333.
- Zachos, J., Pagani, M., Sloan, L., Thomas, E., and Billups, K., 2001, Trends, rhythms, and aberrations in global climate 65 Ma to present: *Science*, v. 292, p. 686–693, doi: 10.1126/science.1059412.

Manuscript received 3 April 2013; accepted 30 June 2013. ★



101

American GEO-SITES

you've gotta see



ALBERT B. DICKAS

TAKE A TOUR OF AMERICA'S GEOLOGIC HALL OF FAME!

101 American Geo-Sites *you've gotta see*

ALBERT B. DICKAS

Exploring at least one site in each state, discover the geologic forces behind iconic landforms like Devils Tower, as well as overlooked locales that have fascinating stories to tell.

264 pages • 8³/₈ x 9 • full color throughout
glossary • suggested reading • index
paper, \$24.00 • Item #370

MP Mountain Press
PUBLISHING COMPANY
P.O. Box 2399 • Missoula, MT 59806 • 406-728-1900
800-234-5308 • info@mtnpublish.com
www.mountain-press.com

2013—2014 Richard H. Jahns Distinguished Lecturer



Gregory (Greg) L. Hempen

has been named the 2013–2014 Richard H. Jahns Distinguished Lecturer in Applied Geology.

Hempen is a geophysicist and geological engineer, currently consulting for URS Corporation's St. Louis (Missouri, USA) Office. Throughout his 40+-year career, he has held only one title: geophysicist. He specializes in all types of vibration mitigation, including earthquakes, blasting, and pile driving, and in recommending

appropriate geophysical studies for complex sites. His job history includes a long tenure at (and retirement from) the St. Louis District Corps of Engineers.

Hempen has conducted business for all levels of government and now works in the private sector. His duties have included assessment of dam sites and regional earthquake studies for federal dam sites, probabilistic and deterministic appraisal of potential earthquake impacts, varied geophysical studies for different project concerns (from archeological to environmental transport to groundwater to rock weaknesses), blast vibration mitigation while effectively achieving the blasting goal, environmental mitigation, and the dreaded "other duties, as assigned."

Hempen received a B.S. in geophysical engineering from St. Louis University, a M.S. in geo-engineering from the University of Minnesota–Minneapolis–St. Paul, and a Ph.D. in geological engineering from the University of Missouri–Rolla (now Missouri University of Science & Technology). He is a registered professional engineer in Missouri and a registered professional geologist in Arkansas and Missouri.

Hempen has authored a variety of publications that share the understanding of procedures instead of keeping proprietary control of methodologies. Hempen has been an adjunct professor at all the engineering universities in the St. Louis area, teaching environmental science and geotechnical engineering courses. His longest running class (1989–2004) was "Seismology and Seismic Design," in the Civil Engineering Dept. of Washington University of St. Louis. Hempen has also taught several Corps of Engineers professional training courses.

Several causes have gained Hempen's attention over the years. He has long been active with the Association of Geologists (AEG), serving as AEG president in 1989–1990, and with GSA's Environmental & Engineering Geology Division. He had a minor role in developing the administration of the Jahns' Lectureship. Hempen is also active with several other professional

organizations and public issues such as geologists registration, public disaster preparedness, and building-code adoption. He has served on state commissions and is presently serving on two Missouri state organizations.

Some of the accolades that Hempen has received are the Otto Nuttli Award from the St. Louis Section of the American Society of Civil Engineers in October 2011; a professional (honorary) degree from Missouri University of Science & Technology in December 2010; an award with the Army and Corps team for the Embrey Dam removal in May 2004; the Johnston Service Award from AEG in October 2002; an Achievement Medal for Civil Service in December 1998; and Regional Outstanding Engineer from the Missouri River Region of the Society of American Military Engineers in 1991.

Interested geology departments should contact Greg Hempen at +1-314-743-4136 or greg.hempen@urs.com to make arrangements for one or more of the following talks:

1. **Hello??? Are you ready for the Big One?** This presentation discusses the application of recent research to the paleoseismic and historic events of the New Madrid Seismic Zone and considers some actions to inform the public about appropriate preparedness.
2. **Kaboom! (or whoosh?)** This talk considers the application of mitigation research to unusual blasting sites, such as a natural gas pipeline near a quarry, removal of the Embrey Dam (Rappahannock River near Fredericksburg, Virginia, USA), and blasting of, or near, important waterside structures.
3. **What's my line? Site assessment!** This presentation on the applied geologist's most important duty—site assessment—explains how geophysics may advance the information at a site and reduce the risk of unanticipated site conditions.
4. **You're going to drink THAT water?!** This talk weighs the challenges of reducing groundwater impacts at old, low-level radioactive waste sites. The issues are not only the problem of assessing waste transit, but also convincing the public of what is known/unknown, and what is an acceptable, plausible solution.

2013–2014 Birdsall-Dreiss Distinguished Lecturer



Larry Band is the Voit Gilmore Distinguished Professor of Geography and the Director of the Institute for the Environment at the University of North Carolina at Chapel Hill and a Visiting Professor at the Chinese Academy of Science. Band's research is in watershed ecohydrology, including the co-evolution of ecological and hydrological systems. His current research focuses on two long-term ecological research sites: Coweeta (North Carolina,

USA) and the Baltimore (Maryland, USA) Ecosystem Study. In 2010, Band was board chair for the Consortium of Universities for the Advancement of Hydrologic Science Inc. (CUAHSI) and was a deputy editor for *Water Resources Research*. Band was a visiting scientist at the Australian Cooperative Research Centre for Catchment Hydrology in 1992–1993 and at the Bureau of Meteorology and CSIRO in 2008, the latter on science and management response to the Australian drought. Band has published more than 130 papers, book chapters, and technical reports. His 2014 Birdsall-Dreiss lectures will be based on research linking surface/subsurface flowpath dynamics with ecosystem development in forested and urban sites.

Interested institutions should contact Larry Band at lband@email.unc.edu to schedule a lecture on one of the following topics:

1. Critical zone processes at the watershed scale: Hydroclimate and groundwater flowpath-mediated evolution of forest canopy patterns. Abstract: Since the classic work by Hack and Goodlett in 1960, it has been recognized that there is a close coupling of geomorphic, groundwater, ecosystems, and soil processes in mountainous catchments. In the southern Appalachians, forest cover provides high-quality fresh water and regulates net recharge and is in turn strongly influenced by subsurface redistribution and the availability of water and nutrients. Classic experiments by Hewlett and Hibbert in lined soil troughs fifty years ago at

Coweeta Hydrologic Laboratory suggested stream baseflow may be supplied by shallow subsurface throughflow, and this has since been a dominant paradigm. However, deeply weathered saprolites and fracture networks may be responsible for a range of shallow to deeper flowpaths, resulting in distinct, observable space/time distributions of soil water, nutrients, and canopy patterns. In this presentation, Band will combine long-term observations from Coweeta with coupled simulation of ecosystem, hydroclimate, and subsurface hydrology to explore co-evolution of critical zone hydrologic and ecosystem dynamics. The three-decade, high-resolution remote-sensing record confirms distinct signatures of the response of catchment canopy patterns to hydroclimate change mediated through subsurface flowpaths.

2. Green infrastructure, groundwater, and the sustainable city. Abstract: Provision of sufficient quantities and quality of freshwater, treatment and disposal of wastewater, and flood protection are critical for urban sustainability. Over the last century, two major shifts in drainage paradigms have occurred; the first to improve public health with centralized sanitary effluent collection and treatment, and the rapid drainage and routing of stormwater. A second shift is now being implemented to retain, rather than rapidly drain, stormwater, with a focus on infiltration-based methods shifting hydrologic behavior to depression-focused recharge. While stormwater is defined as surface flow resulting from developed areas, an integrated hydrologic systems approach to urban water management requires treatment of the full critical zone, extending from the top of the vegetation and building canopy to depths including natural soils, fill, saprolite, and bedrock. In addition to matrix and network flow in fracture systems, an urban "karst" includes multiple generations of infrastructure, with extensive supply and drainage pipe networks, enhancing surface/groundwater exchange. In this presentation, Band will focus on the urban critical zone, and the synthesis of modeling and analytical approaches to understand and plan green infrastructure based on surface/groundwater/ecosystem interactions, as well as implications for the restoration and new design of cities.

Now Accepting Penrose Conference and Thompson Field Forum Proposals

Penrose Conferences bring together multidisciplinary groups for open and frank discussion of geoscience research and ideas on location in some of the most fascinating places in the world. Learn more at www.geosociety.org/penrose/.

Thompson Field Forums capture the essence of exciting discoveries or controversial topics via forays into the field for on-the-spot discussions. Learn more at www.geosociety.org/fieldforums/.

2014 GSA Distinguished International Lecturer



GSA is pleased to announce our 2014 Distinguished International Lecturer: **Marjorie A. Chan.**

Chan is a professor of geology at the University of Utah in Salt Lake City, Utah, USA. She earned a B.S. in geology from the University of California–Davis in 1977 and a Ph.D. in geology from the University of Wisconsin–Madison in 1982.

Chan’s research spans the geologic time scale from the Precambrian to

the Pleistocene, and her recent projects connect geology and planetary science to better understand and interpret Mars. She has authored or co-authored more than 100 peer-reviewed articles on a wide range of sedimentary topics involving clastic depositional environments, sedimentology, fluid flow/diagenesis (e.g., iron oxide sandstone coloration and concretions), Earth analogs to Martian environments, and geoconservation.

Chan is a popular, sought-out speaker—she is on the speaker bureau list for the Association of Women Geoscientists (AWG) and received two national meeting “excellence of presentation awards” from SEPM (Society for Sedimentary Geology). Her research has been featured in several television documentaries, including shows on the National Geographic Channel and the Discovery Channel. In 2013, Chan was a guest on National Public Radio’s “Science Friday,” and she is a science advisor for the PBS Nova “ScienceNow” series. Chan is experienced in giving public lectures to a variety of audiences and is known for making science interesting and accessible.

Chan has been a strong advocate and role model for women in science for the past three decades, and she is active in encouraging women and minorities in science disciplines. She is excited to represent GSA and a new age of science that will be dependent on sustainable practices, global cooperation, and engaged students who will help lead our future.

LECTURE TOPICS

Eolian Explorations: Dunes, Deformation, and Diagenesis

Mars for Earthlings: Using Earth Analogs to Decode the Sedimentary History of Mars



The GSA International Lecture Tour is made possible through a gift to the GSA Foundation and is organized under the guidance of GSA’s International Section. Chan’s lectureship is cosponsored with generous support from the University of Utah.



Please visit the GSA International Lecture Tour webpage for Chan’s 2014 lecture tour dates and detailed information.
<http://www.geosociety.org/Sections/International/LectureTour.htm>

2013 International Section Honorary Fellow



The GSA International Section is pleased to announce the selection of their 2013 International Honorary Fellow, **Dong Shuwen**, professor of geology and Vice President of the Chinese Academy of Geological Sciences. Dong also serves as treasurer for the International Union of Geological Sciences.

The section's International Honorary Fellowship is presented to an international geoscientist who has distinguished him- or herself in geoscience investigations, promoting environmental awareness, linking science and society, providing notable service to implementing public policy in natural resource managements, or otherwise making outstanding contributions to science. The award was presented at the International Section Reception and Awards Ceremony during the 2013 GSA Annual Meeting in October, in Denver, Colorado, USA.

Dong's major scientific achievements include innovative research in understanding Mesozoic metallogenic processes in east-central China along the Yangtze River valley and critical contributions via combined geologic and geophysical investigations to our current understanding of the tectonic evolution of the Qinling-Dabie collisional orogen, the intracontinental Daba Shan Yan Shan orogenic belts, and the central Asia accretionary orogen.

Since 1996, Dong has published five books and more than 140 research papers. Many of the published papers appeared in top international journals and received high citations. Dong thinks broadly and works widely with top international researchers, such as Lothar Ratschbacher in Germany and Simon Klemperer, Larry Brown, Randy Keller, and Mian Liu in the United States, and numerous scientists from central Asian countries.

Dong is one of the most prominent leaders in the Chinese earth sciences community today. He was the main driver for the successful funding of the multi-billion dollar project—SinoProbe. As a result, he is appointed as the chief scientist overseeing its entire scientific operation. This project has already gained international attentions with several featured articles published in *Nature*, *Science*, and *EOS*.

In addition to his remarkable scientific achievements, Dong has also been an active member of several international organizations, which includes his service as a board member of the International Union of Geological Sciences (IUGS), International Lithosphere Programme (ILP), the International Geoscience Programme (IGCP), and the International Continental Scientific Drilling Programme (ICDP). Dong was instrumental in developing and coordinating the very successful joint GSA–Geological Society of China meeting, *Roof of the World*, held in Chengdu, China, in June 2013.

2014 Graduate Student Research Grants

Submission deadline: 3 Feb. 2014 at 11:59 p.m. (MST)

GSA is proud to offer research grants to its highly qualified student members. Last year, GSA awarded 307 grants, totaling US\$582,340. Graduate students may receive two grants during their academic career, regardless of the program in which they are enrolled. The standard maximum award per grant is US\$2,500.

New! Starting in 2014, ExxonMobil will sponsor 10 research grants at US\$7,500 per grant. All applicants in the GSA Student Research Grant Program are eligible for these awards, regardless of the topic or location of their research. ExxonMobil will select the top ten proposals based on merit as recommended by the GSA Research Grant Review Committee.

Applications should be submitted *online only* beginning later this month at www.geosociety.org/grants/gradgrants.htm. Paper applications and letters will not be accepted.

Sponsored by



ExxonMobil

Questions? Call +1-303-357-1028 or e-mail awards@geosociety.org.

Upcoming Award, Recognition & Grant Deadlines



For details on the following awards and grants, see the October *GSA Today* or go to www.geosociety.org/awards/nominations.htm. Information and nomination forms can also be obtained from GSA Grants, Awards, and Recognition, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, awards@geosociety.org.

2014 GSA MEDALS AND AWARDS

Nomination deadline: 1 Feb. 2014

- 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 Feb. 2014

GSA Fellowship is an honor bestowed on the best of our profession at each spring GSA Council meeting. **GSA Fellows** may support two nominees each year but only **one** as a primary nominator, and **GSA members** who are not Fellows may be secondary nominators for up to **two** nominees.

AGI MEDAL IN MEMORY OF IAN CAMPBELL

Nomination deadline: 1 Feb. 2014

This award recognizes singular performance in and contribution to the profession of geology. To submit a nomination, go to www.agiweb.org/direct/awards.html.

AGI MARCUS MILLING LEGENDARY GEOSCIENTIST MEDAL

Nomination deadline: 1 Feb. 2014

This medal is given to a recipient with consistent contributions of high-quality scientific achievements and service to the earth sciences having lasting, historic value; who has been recognized for accomplishments in field(s) of expertise by professional societies, universities, or other organizations; and is a senior scientist nearing completion or has completed full-time regular employment. To submit a nomination, go to www.agiweb.org/direct/awards.html.

2014 NATIONAL AWARDS

- **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 2014


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.

2014 POST-DOCTORAL RESEARCH AWARDS

Application deadline: 1 Feb. 2014

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 annually 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 annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.



Recent, Rare, and Out-of-Print Books

GEOSCIENCE, PALEONTOLOGY, MINERALOGY,
MINING HISTORY, ORE DEPOSITS,
USGS AND USBM PUBLICATIONS, PETROLEUM,
SURFACE PROCESSES AND EXTRACTIVE METALLURGY

<http://booksgeology.com>

MSBOOKS@BOOKSGEOLOGY.COM

WE PURCHASE BOOKS AND ENTIRE COLLECTIONS

MS Book and Mineral Company
P.O. Box 6774, Lake Charles, LA 70606-6774 USA

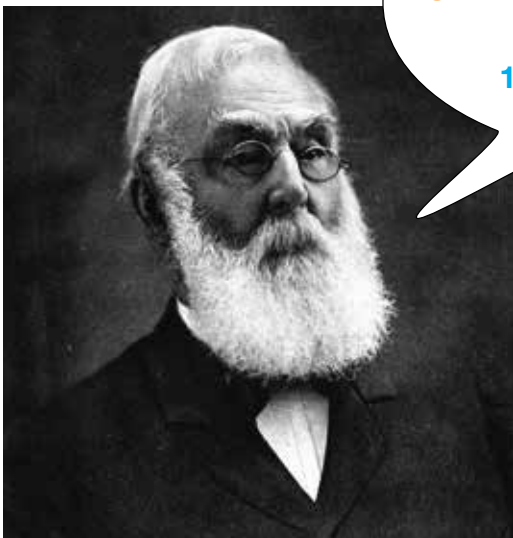
Renew your GSA MEMBERSHIP



Journal Subscriptions Division Memberships Section Affiliations GSA Foundation Support

SAVE 15%*
off Membership Dues

RENEW by
15 December 2013



James Hall
(1811–1898)
First President and Active Founder of GSA.

- Premier Journals
- Scientific Exchange—GSA Meetings and 17 Geoscience Divisions
- Publish and Present Research
- Public Policy Updates
- Member-Only Discounts
GSA Meetings, Journals, Online Store

Student and Recent Grad Extras

- FREE Online Access to Journals
- Research Funding
(geographic restrictions may apply)
- Mentor Programs and Employment Contacts

www.geosociety.org/members/

P.O. Box 9140, Boulder, CO 80301-9140, USA • Phone: +1-303-357-1000, option 3
Toll-free: +1-888-443-4472 • Fax: +1-303-357-1071 • E-mail: gsaservice@geosociety.org

*Discount applies to those in high income country economies.



THE GEOLOGICAL SOCIETY
OF AMERICA®

Help Communicate Our Science to Teachers and Undergrads!

GSA's K–12 Teacher Programs are continuing to grow, and as they grow, we continue to examine ways to make the K–12 GSA membership even more valuable.

Teachers often comment on the excellent articles published in *GSA Today*; however, they also comment that many articles are too technical for them. GSA's Education & Outreach Dept. is looking for two or three geologists who excel in communicating complex geologic concepts to audiences with an introductory background in geology. Selected geologists will be asked to find two or three previously published *GSA Today* articles and write

summaries about the science behind the articles. Summaries will be posted within GSA's Connected Community and will be sent out via GSA's e-newsletter for teachers. As a thank you, the selected geologists will receive *free registration* for GSA's 2014 Annual Meeting in Vancouver.

If you are interested in assisting with this project, please submit a sample of your writing to Davida Buehler, dbuehler@geosociety.org, by 15 January. This sample should clearly demonstrate your ability to write about geological concepts for those with only an introductory background in geology.

FOR MORE INFORMATION, please contact Davida Buehler at dbuehler@geosociety.org.

2014 GSA GeoVentures

Because the best geologists have seen the most rocks!

Join GSA on amazing field experiences to some of the world's greatest geologic sites. These 2014 GeoVentures are beginning to fill up! Register now to secure your spot on one of these amazing trips. **For more information**, e-mail Gary Lewis at glewis@geosociety.org.

- 14 June–3 July:** Explore Australia and Explore Southern Australia
- 27 July–7 August:** Explore Dynamic Iceland—Volcanoes and Glaciers on a Spreading Plate Boundary
- 27 July–4 August:** Hawaii—For College Students
- 6–13 August:** Hawaii—For Educators
- 8–15 November:** Hawaii—GeoCaching on an Active Volcano

www.geoventures.org

FIELD CAMPS for K–12 Teachers

In 2014, GSA's Teacher Advocate Program (TAP) will present three special field camps designed just for K–12 educators. These camps are a great way for educators to gain real geoscience field experience and collect great rock and mineral samples to share with their students. **For more information**, contact Davida Buehler, dbuehler@geosociety.org.

- 15–19 June:** Illinois Basin Field Camp for K–12 Educators
- 21–26 June:** Rocky Mountain Field Camp for K–12 Educators
- 14–19 July:** Mammoth Cave Field Camp for K–12 Educators



Like us on Facebook!

www.facebook.com/GSAK12Education

Preliminary Announcement and Call for Papers

NORTH-CENTRAL SECTION

48th Annual Meeting
Lincoln, Nebraska, USA

24–25 April 2014

www.geosociety.org/Sections/nc/2014mtg/



Chimney Rock National Historic Site, Morrill County, Nebraska. Photo by Mike Tigas; photo courtesy Wikimedia Commons.

Explore Midcontinental Geology and Walk with Mammoths in Nebraska's Beautiful Capital City!

LOCATION

Lincoln, Nebraska, USA, is located near the boundary between the Great Plains and the glaciated Central Lowlands and the Nebraska Sand Hills—the largest dunefield in the Western Hemisphere as well as the thickest loess sequence in North America—all within a half-day's drive. The Missouri River, which drains a significant portion of the North American continent, and the Platte River, which is a classic braided stream, lie within 60 km. Rock strata from Upper Pennsylvanian to Upper Neogene in age are exposed in the eastern half of Nebraska, including the type sections of the Cretaceous Niobrara and the Dakota Formations. Nebraska is one of the most important regions in the world for the collection and study of Cenozoic mammals, and the University of Nebraska State Museum is one of the premier repositories for such fossils.

Call for Papers

Abstract deadline: 14 January

Submit your abstract at www.geosociety.org/meetings.

Fees: US\$10/students and \$15/all others (required for each abstract submitted).

Need help? Please contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

Technical Program Chairs: David Loope, dloope1@unl.edu; Paul R. Hanson, phanson2@unl.edu.

THEME SESSIONS

1. **Rivers, Past and Present: Sediments, Stratigraphy, and Geomorphology.** Chris Fielding, University of Nebraska–Lincoln; Jim Best, University of Illinois at Urbana–Champaign.
2. **Cenozoic Stratigraphy of the Great Plains.** Greg Ludvigson, University of Kansas; Jon Smith, University of Kansas; Robert M. Joeckel, University of Nebraska–Lincoln.
3. **Vertebrate Paleontology from the Appalachians to the Rockies.** Shane Tucker, University of Nebraska–Lincoln; George Corner, University of Nebraska–Lincoln; Robert M. Joeckel, University of Nebraska–Lincoln.
4. **Structure, Tectonics, and Geologic Evolution of the North American Interior.** Caroline M. Burberry, University of Nebraska–Lincoln; Robert M. Joeckel, University of Nebraska–Lincoln; Jesse T. Korus, University of Nebraska–Lincoln.
5. **Carbonatites and Other Alkalic Rocks.** Richard M. Kettler, University of Nebraska–Lincoln; Philip Verplanck, USGS; Benjamin Drenth, USGS.
6. **New Insights into the White River Chronofauna.** Clint Boyd, South Dakota School of Mines.
7. **Quaternary Time Machine: Methods and Analyses of Soils and Sediments to Reveal Secrets of Past Environments.** Maija Sipola, University of Iowa; M. Kathryn Rocheford, University of Iowa.
8. **Advances in Invertebrate Paleocology, Taphonomy, and Ichnology: Insights from the North American Midcontinent and Beyond.** James R. Thomka, University of Cincinnati; Rebecca L. Freeman, University of Kentucky.
9. **Quaternary Evolution of the Central Lowlands and Great Plains.** Charles W. Rovey III, Missouri State University; J. Elmo Rawling III, University of Wisconsin–Platteville.
10. **Applications of Optically Stimulated Luminescence Dating in Quaternary Studies.** Joel Q. Spencer, Kansas State University; Paul R. Hanson, University of Nebraska–Lincoln.
11. **The Midcontinent Rift System and Beyond: New Developments in Central North American Precambrian Geology.** Benjamin J. Drenth, USGS; G. Randy Keller, University of Oklahoma; Joshua M. Feinburg, University of Minnesota.
12. **Applied Geology: Environmental, Engineering, Hydrogeology, Geotechnical, and Exploration Geophysics.** Terry West, Purdue University.
13. **Cultural Geology: Capitol Buildings, Heritage Stone, Parks, and More.** Joe Hannibal, Cleveland Museum of Natural History; Nelson R. Shaffer, Indiana Geological Survey.

14. **Undergraduate Research (Posters).** *Cosponsored by the Council on Undergraduate Research Geoscience Division.* Robert Shuster, University of Nebraska–Omaha.
15. **Pennsylvanian Cyclothem and Stratigraphy of the Midcontinent and Illinois Basins.** John P. Pope, Northwest Missouri State University.
16. **Geoscience Education for K–16: Novel Approaches and Current Research.** Katie Lewandowski, Eastern Illinois University; Mindi Searls, University of Nebraska–Lincoln.

FIELD TRIPS

Field Trip Chairs: Duane Eversoll, deversoll2@unl.edu; Jesse Korus, jkorus3@unl.edu.

1. **Building and Ornamental Stones in the Nebraska State Capital Building.** Wed., 23 April. Location: Lincoln, Nebraska, USA. Principal organizer: Joe Hannibal, Cleveland Museum of Natural History.
2. **Ashfall Fossil Beds State Historical Park, Orchard/Royal, Nebraska.** Sat., 26 April. Location: Royal, Nebraska, USA. Principal organizer: Shane Tucker, University of Nebraska State Museum; stucker3@unl.edu.
3. **Pleistocene Geology and Classic Type Sections along the Missouri River Valley.** Sat., 26 April. Location: area near Council Bluffs, Iowa, USA. Principal organizer: Charles Rovey, Missouri State University, charlesrovey@missouristate.edu.
4. **The Nebraska Sand Hills.** Sat.–Sun., 26–27 April. Location: area near Thedford, Nebraska, USA. Principal organizer: Dave Loope, University of Nebraska–Lincoln.

REGISTRATION

Early Registration Deadline: 24 March

Cancellation Deadline: 31 March

Registration opens in February 2014. For further information or if you need special accommodations, please contact Local Chair R. Matthew Joeckel at rjoeckel3@unl.edu, or Vice Chair Paul R. Hanson at phanson2@unl.edu.

ACCOMMODATIONS

A block of rooms has been reserved at The Cornhusker, a Marriott Hotel, 333 S. 13th Street, Lincoln, Nebraska 68508, USA, at US\$104 + 16.48% hotel tax per night. Please call The Cornhusker, a Marriott Hotel, reservation line, +1-866-706-7706, and request a reservation under “The Geological Society of America Group Rate.”

OPPORTUNITIES FOR STUDENTS

Mentor Programs

Roy J. Shlemon Mentor Program in Applied Geoscience: Thurs., 24 April, lunchtime: www.geosociety.org/mentors/shlemon.htm.

Mann Mentors in Applied Hydrogeology Program: Fri., 25 April, lunchtime: www.geosociety.org/mentors/mann.htm.



WHERE THEORY MEETS PRACTICE.

At Penn's Master of Science in Applied Geosciences (MSAG) program, we don't prepare students to make a difference once they graduate. They start right away.

Through internships, field work, and projects tailored to their individual career goals, students gain real experience in their field of choice and get a year's head start on licensure as a Professional Geologist.

To learn more about the program and read about the difference you can make as a Penn MSAG student, visit

WWW.UPENN.EDU/MSAG.

Earn a masters degree in Applied Geosciences without interrupting your career. Full-time and part-time tracks are available. Students can complete this 12-course geology masters program in just two to four years.



GSA Mentor Programs at the 2014 Section Meetings

Enjoy a free lunch while meeting with mentors working in geoscience. Times and locations will be announced as the meeting date draws closer. The popularity of these programs means that space is limited, so plan to arrive early, because lunch is first-come, first-served.



SOUTH-CENTRAL SECTION

Fayetteville, Arkansas, USA

Shlemon Mentor Luncheon Program:

Monday, 17 March

Mann Mentors in Applied Hydrology Luncheon:

Tuesday, 18 March

NORTHEASTERN SECTION

Lancaster, Pennsylvania, USA

Shlemon Mentor Luncheon Program:

Sunday, 23 March

Mann Mentors in Applied Hydrology Luncheon:

Monday, 24 March

SOUTHEASTERN SECTION

Blacksburg, Virginia, USA

Shlemon Mentor Luncheon Program:

Thursday, 10 April

Mann Mentors in Applied Hydrology Luncheon:

Friday, 11 April

NORTH-CENTRAL SECTION

Lincoln, Nebraska, USA

Shlemon Mentor Luncheon Program:

Thursday, 24 April

Mann Mentors in Applied Hydrology Luncheon:

Friday, 25 April

JOINT MEETING: ROCKY MOUNTAIN AND CORDILLERAN SECTIONS

Bozeman, Montana, USA

Shlemon Mentor Luncheon Program:

Monday, 19 May

Mann Mentors in Applied Hydrology Luncheon:

Tuesday, 20 May

For further information, contact Jennifer Nocerino at

jnocerino@geosociety.org.

2014 Section Meeting Calendar

www.geosociety.org/Sections/



SOUTH-CENTRAL SECTION
Fayetteville, Arkansas, USA
17–18 March 2014
 University of Arkansas Global
 Local Committee chair: Steve Boss
 Abstracts deadline: 3 Dec. 2013
 Early registration deadline: 10 Feb. 2014



NORTHEASTERN SECTION
Lancaster, Pennsylvania, USA
23–25 March 2014
 Lancaster Marriott
 Local Committee co-chairs: Noel Potter
 and Roger Thomas
 Abstracts deadline: 10 Dec. 2013
 Early registration deadline: 18 Feb. 2014



SOUTHEASTERN SECTION
Blacksburg, Virginia, USA
10–11 April 2014
 Skelton Conference Center at Virginia Tech
 Local Committee chair: Robert Tracy
 Abstracts deadline: 7 Jan. 2014
 Early registration deadline: 10 Mar. 2014



NORTH-CENTRAL SECTION
Lincoln, Nebraska, USA
24–25 April 2014
 Cornhusker Marriott
 Local Committee chair: Matt Joeckel
 Abstracts deadline: 14 Jan. 2014
 Early registration deadline: 24 Mar. 2014



**ROCKY MOUNTAIN/
 CORDILLERAN SECTIONS**
Bozeman, Montana, USA
19–21 May 2014
 Montana State University,
 Strand Union Building
 Local Committee chair: Dave Lageson
 and Jeff Vervoort
 Abstracts deadline: 11 Feb. 2014
 Early registration deadline: 14 Apr. 2014



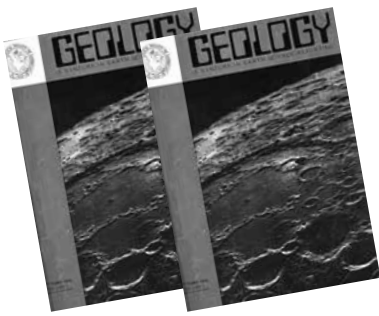
Wilson Park, Fayetteville, Arkansas; used with permission of Wikimedia Commons.

Ohioyle falls at Ohioyle State Park, Ohioyle, Pennsylvania; used with permission of Wikimedia Commons.

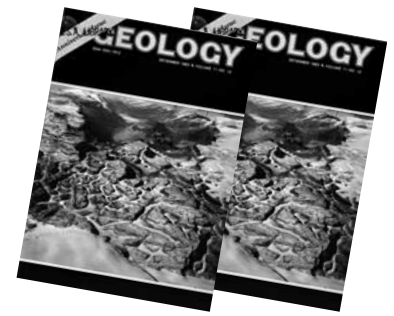
Blue Ridge Mountains, Shenandoah National Park, Virginia. Photo by Amrinder Arora; used with permission of Wikimedia Commons.

Chimney Rock National Historic Site, Morrill County, Nebraska. Photo by Allen Stutheit; used with permission of Wikimedia Commons.

Grinnell Glacier, Glacier National Park, Montana. Public Domain.



Geology—Past & Future REVISITED



Editor's note: The following is the fourth installment of our encore presentation of articles highlighting the 10th anniversary of the first issue of *Geology*, as published in *Geology* in Dec. 1983 [v. 11, no. 12, p. 679–691, doi: 10.1130/0091-7613(1983)11<679:GAF>2.0.CO;2]. Each section was written by a different author (author affiliation notations are as originally published in 1983).

See the August 2013 *GSA Today* (v. 23, no. 8, p. 18–19) for the first installment and table of contents. In this issue: article 8:

“Planetary geology,” by Baerbel K. Lucchitta; and article 9: “Uniformitarianism under scrutiny,” by Kenneth J. Hsü.

Planetary geology

Baerbel K. Lucchitta, U.S. Geological Survey, Flagstaff, Arizona 86001, USA

Ten years ago it was a time of change, the end of manned space exploration and the beginning of spectacular unmanned successes, the end of mission-oriented research and the emergence of planetary geology, the end of lavish spending and the start of fiscal restraint. The public had become blasé about space exploration, but enthusiasm among scientists was on the rise. The space program was in full swing. Six manned lunar landings had taken place; unmanned spacecraft showed close-up views of the surface of Mars; probes were on the way to Jupiter, Saturn, Mercury, and Venus; and the first Earth resources satellite was launched. Scientific results were pouring in: accretion of planetary bodies, we realized, left densely cratered early surfaces; anorthosites may have formed primeval crusts. A picture of the interior of the Moon took shape. Mars emerged as a body with a dynamic geologic history of volcanism, tectonism, and surface processes involving wind, water, and ice. Scientists saw the potential for a decade of fruitful analysis and synthesis—a virtual revolution in planetary exploration was foreseen for the late 70s and early 80s, and a vigorous program was planned, centered mostly on unmanned exploration with an added dimension, the search for life.

Looking back from 1983 we recognize that the two past decades were a golden age of space exploration. The *Viking* missions sent orbiters and landers to Mars; the search for life began. *Mariner 10* flew by Mercury three times. *Voyagers 1* and *2* returned spectacular pictures from Jupiter and Saturn and their fiery and icy moons. *Pioneer Venus* revealed the gross topography of Venus, with its gigantic mountains and great rift-like valleys. We have glimpsed all planetary bodies known to the ancients.

By the end of the decade, however, the political outlook became grim. Space exploration no longer was seen as one of the nation's pressing needs. Severe budget cuts loomed. All new efforts concentrated on the development of the shuttle; new planetary missions would have to await its arrival. No new missions have

been approved in the past six years, and in 1982 NASA seriously considered the abolishment of the entire United States planetary exploration program. Except for a brief encounter with Uranus by *Voyager 1* in 1986, there will be no planetary data returned by U.S. spacecraft until the *Galileo* Orbiter of Jupiter and the Venus Radar Mapper reach their targets late in this decade. No comets or asteroids have yet been explored. Whereas spacecraft from several other countries will intercept Halley's Comet, the United States elected to stay home. In the meantime, the Soviets have landed successfully on Venus several times, and a Soviet Venus Orbiter with radar capabilities and entry probes is now en route.

However, hope is high for a new start. A unified plan setting firm goals was recently proposed by a committee of scientists throughout the nation. The plan envisions frequent modest missions of high scientific priority; their number, beginning in 1984, may be as high as in the 1960s and 70s, but at far reduced cost. Inherited hardware and software are to be used on missions that we know how to do well, such as planetary orbiters, flybys, and atmospheric probes. The first mission in the plan, the Venus Radar Mapper, is clearing the last hurdles for approval. Other high priorities are a comet rendezvous, a geochemically instrumented spacecraft to Mars, and a probe to explore the atmosphere and surface of Titan.

The new missions are designed to address well-established scientific goals: to shed light on the present state, origin, and evolution of the Solar System; to understand Earth better; to improve our knowledge of the origin of life; and (a newly emerging goal) to provide a scientific basis for future utilization of resources in near-Earth space.

In the past decade our understanding of the Solar System and the Universe has vastly improved. Models for planetary origins and compositions became refined. Theories we previously used for the shaping of other worlds were largely based on our terrestrial experiences: size of the planetary body and abundance of radio nucleides were considered major determinants in planetary evolution. We now know that heat engines driving evolution may be tidal or perhaps even electromagnetic forces, that surface compositions may be silicates, sulfur, or ices.

Send brief comments to gsatoday@geosociety.org. Should this article spark a longer comment, please consider writing a *GSA Today* Groundwork or science article; learn more at www.geosociety.org/gsatoday/.

We have also learned about Earth. Ten years ago the news was that accretionary bombardment probably left scars on the early Earth similar to those on the Moon. Today the news is that throughout Earth's history, impact events may have interrupted the evolutionary sequences of life. We have improved our understanding of early crusts and atmospheres and contributed to the knowledge of astronomical influences on climate. Above all, we have come to realize that Earth is unique, its environment fragile, and that it must be protected from adverse and unwise human intervention.

Uniformitarianism under scrutiny

Kenneth J. Hsü, Federal Institute of Technology, Zurich, Switzerland

I met Steve Gould 10 years ago; I knew him by name because he coined the phrase "substantive uniformitarianism," which was applicable to the hot debate over our hypothesis that the Mediterranean was a desiccated deep basin during the late Miocene. No desert of comparable dimensions exists today, so it was difficult for substantive uniformitarianists to envision a Miocene desert 2,000–3,000 m below sea level. Finally, the JOIDES project scheduled a second cruise to the Mediterranean to test our unorthodox idea, but the results confirmed the earlier postulate.

What I did not know 10 years ago was that Gould also coauthored an article on punctuated evolution. The whole issue of tempo and mode of evolution has received increasing attention from the professionals and lay alike during the past decade. In a talk in 1978, Nick Shackleton told how he and his associates, using stable-isotope technique, found an oxygen-isotope perturbation across the Cretaceous-Tertiary boundary, which signifies a 5 °C rise in ocean temperatures. Recalling a speculative paper by M.W. de Laubenfels in 1956 on dinosaur extinction, which I read as a youth, I suggested in 1980 a connection between the sudden temperature rise and an impact event.

Also in 1980, Walter Alvarez and his associates reported unusual concentrations of iridium in the Cretaceous-Tertiary boundary clay, but they had related the anomaly to a nearby supernova explosion. New data on plutonium isotopes led them, however, to conclude that the iridium came from the ejecta fallout after an impact event. Their discovery is undoubtedly one of the greatest contributions in geology during the past decade. Having been encouraged that my speculations might be upgraded into a working hypothesis, I managed to persuade my shipboard colleagues and the JOIDES Planning Committee to drill in 1980 a South Atlantic site to explore the C-T boundary event. We obtained a good suite of cores, and our analyses indicated (1) mass mortality after an impact event, (2) drastic environmental changes and (3) mass extinction during the ensuing 50,000 yr.

GSA Special Paper 190, *Geological Implications of Impacts of Large Asteroids and Comets on the Earth*, contains statistical evidence that meteorites capable of causing catastrophic environmental changes must have fallen repeatedly during Phanerozoic time. In my International Association of Sedimentologists presidential address, on actualistic catastrophism, I pointed out that it is the magnitude and catastrophic consequences of certain events which make them rare. The effects of steady state are in many cases far overshadowed by these rare events of great magnitude. This concept may be a philosophical basis for interpreting the record of punctuated evolution.

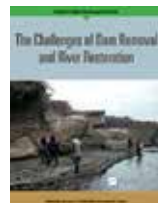
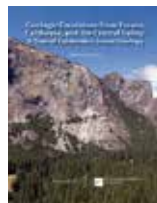
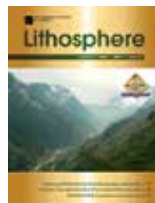
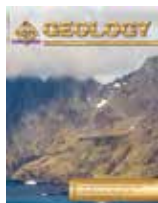
The Darwinian theory of evolution has two essential components: (1) derivation from common descent, and (2) natural selection. No scientists today question the first premise. However, as M.J. Benton recently pointed out, the possibility of chance selections is real. Instead of adaptation for survival, the general pattern seems to be one of mass extinctions caused by catastrophic events, followed by rapid replacement by surviving opportunists, as advocated by Digby McLaren. At a recent Dahlem Conference on Patterns of Evolution in Earth History, the consensus developed that the biological effects of sudden catastrophic events can no longer be ignored. During the next decade, I envision, therefore, a marked increase in investigations on epoch, period, or era boundaries in the geologic time scale, to explore especially the possible consequences of large-body impacts on biologic evolution.



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

Browse GSA's journals & books at www.gsapubs.org.

Geology – GSA Bulletin – Geosphere – Lithosphere
Special Papers – Memoirs – Field Guides – Reviews in Engineering Geology



GeoCorps™ America

Thank You 2013 Participants, Partners, and Donors!



Christopher Dombkowski, Gunnison Field Office (Bureau of Land Management).

GeoCorps™ America places geoscientists of all levels—university students, teachers, professionals, and retirees—in short-term geoscience projects on public lands throughout the United States. The program also includes “Guest Scientist” positions, GeoCorps Diversity Internships, and GeoCorps American Indian Internships. GeoCorps projects are hosted by three major federal partners—the National Park Service (NPS), the U.S. Department of Agriculture (USDA) Forest Service, and the Bureau of Land Management (BLM). In 2012–2013, the State of California Department of Conservation’s Abandoned Mine Lands (AML) Unit also hosted GeoCorps participants. These projects cover a wide variety of subjects related to the geosciences, including geology, hydrology, paleontology, soils, geohazards, mapping, GIS, education, and interpretation. This GSA Education & Outreach program is sponsored by individual donors and the organizations listed below.

GeoCorps is also funded by the following organizations that support public lands:

Badlands Natural History Association
 Bryce Canyon Natural History Association
 Capitol Reef Natural History Association
 Colorado National Monument Association
 Discover Your Northwest

Friends of the Florissant Fossil Beds
 Grand Canyon Association
 Lake Fork Valley Conservancy
 Rocky Mountain Nature Association
 Western National Parks Association
 Zion Natural History Association

PARTICIPANTS—FALL/WINTER 2012–2013

Bureau of Land Management

Public Lands Washington Office: Alex Eddy

Royal Gorge Field Office: Sarah Doyle

National Park Service

Assateague Island National Seashore: Pamela Stewart

Big Thicket National Preserve: Nicole Thomas

Catoctin Mountain Park: Thomas Schenck

Chesapeake and Ohio Canal National Historical Park:

Emily Long

Congaree National Park: Kate Baustian

Conservation and Outdoor Recreation Division, Washington

Office: Peter Bonsall

Geologic Resources Division: Maria Caffrey

Geologic Resources Division: Lynn Moore

Geologic Resources Division: Steven Park

Grand Canyon National Park: Christine Chan

Grand Canyon National Park: Graham Schindel

Grand Canyon National Park: Cynthia Valle

Horseshoe Bend National Military Park: Kevin Jones

Mojave National Preserve: Franklin Dekker

Oregon Caves National Monument: Louis Bodin

Oregon Caves National Monument: Audrey Ledford

Redwood National and State Parks: Kendall Story

Rocky Mountain National Park: Lana Morris

Wrangell–St. Elias National Park & Preserve: Harpreet Narang

Yosemite National Park: Jessica Thompson

Zion National Park: David Tarailo

USDA Forest Service

Klamath National Forest: Griffin Heard

Government Partners and Major Donors to the GeoCorp Program

Government Partners



National Park Service (NPS)



U.S. Dept. of Agriculture (USDA) Forest Service



Bureau of Land Management (BLM)



California Dept. of Conservation AML Unit

Major Donors



GSA Foundation

Ms. Sally Newcomb



Association for Women Geoscientists (AWG)



Tirzah Abbott, Nebraska National Forest (U.S. Forest Service).

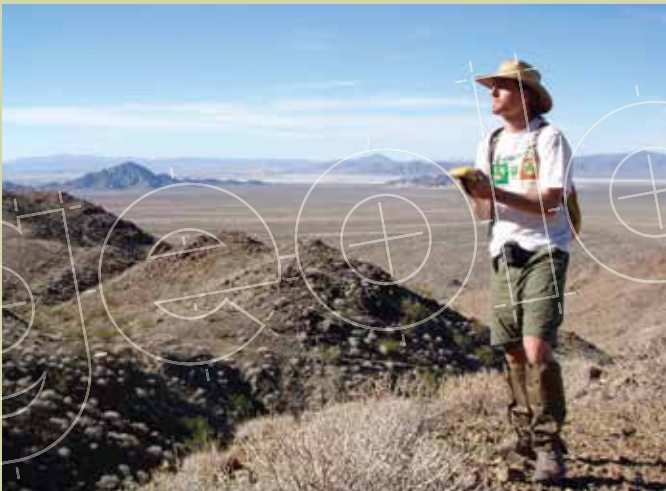
PARTICIPANTS—SUMMER 2013

Bureau of Land Management

Arizona Strip District: William Thompson
Grand Staircase–Escalante National Monument: Michele Conrad
Gunnison Field Office: Christopher Dombkowski
Moab Field Office: Christopher Chesser
Moab Field Office: Robert Gay
National Landscape Conservation System: Douglas Hessler
Price Field Office: Tait Erichsen
Royal Gorge Field Office: Sarah Doyle
Royal Gorge Field Office: Lisa Luna
Royal Gorge Field Office: Carissa Snyder
San Juan Public Lands Center: Gregory Welter
Upper Missouri River Breaks National Monument: David Kambhu

California Department of Conservation

Abandoned Mine Lands Unit: Vanessa Calder
Abandoned Mine Lands Unit: Sean McCartney
Abandoned Mine Lands Unit: Brett Sherman



Sean McCartney, Mojave National Preserve (California Department of Conservation Abandoned Mine Lands Unit).

National Park Service

Assateague Island National Seashore: Aurora Crooks
Assateague Island National Seashore: Heather Grybas
Assateague Island National Seashore: Thomas Schenck
Badlands National Park: Michael Catches-Enemy
Badlands National Park: Alaina Fike
Badlands National Park: Christine Gardner
Badlands National Park: Kathryn Pauls
Bryce Canyon National Park: Brian Castro
Bryce Canyon National Park: Katherine Lodder
Bryce Canyon National Park: Stephanie Lukowski
Bryce Canyon National Park: Andrew Patel
Cape Cod National Seashore: Catalina Mejia
Capitol Reef National Park: Joshua Johnson
Capitol Reef National Park: Jennifer Kolm
Catoctin Mountain Park: Kent Walters
Chaco Culture National Historical Park: Kayla Lanoue
Chattahoochee National Recreation Area: Hailey Harden
Chattahoochee National Recreation Area: Randy Kath
Colorado National Monument: Cyrus Green
Craters of the Moon National Monument and Preserve: Holly Keimig
Craters of the Moon National Monument and Preserve: Sonja Melander
Delaware Water Gap National Recreation Area: Kelly Gray
Denali National Park and Preserve: Amy Atwater
Denali National Park and Preserve: Montana Hodges
Dinosaur National Monument: Garrison Loope
Dinosaur National Monument: Philip Varela
El Malpais National Monument: Justin Peinado
Florissant Fossil Beds National Monument: Alison Dernbach
Florissant Fossil Beds National Monument: Heather Falkner
Florissant Fossil Beds National Monument: Kelly Hattori
Florissant Fossil Beds National Monument: Lindsey Yann
Fort Pulaski National Monument and Fort Frederica National Monument: Chester (CJ) Jackson
Fort Pulaski National Monument and Fort Frederica National Monument: Ryan Jubran
Fossil Butte National Monument: Taryn O'Connell
Gateway National Recreation Area Northeast Coastal and Barrier Network: Randall Fullmer
Geologic Resources Division: Cassi Knight
Geologic Resources Division: Matthew Miller
Geologic Resources Division: Heather Walborn
Glacier National Park: Nicole Bader
Glacier National Park: Siobhan Kenney
Grand Canyon National Park (North Rim): Peri Sasnett
Grand Canyon National Park (South Rim): Cassi Knight
Grand Canyon National Park (South Rim): Russell Rosenberg
Grand Teton National Park: Erica Stephens
Great Basin National Park: Chris Ciervo
Great Sand Dunes National Monument: Katie Schultz
Guadalupe Mountains National Park: Jory Lerback
John Day Fossil Beds National Monument: Elizabeth Baker
John Day Fossil Beds National Monument: Steven Lundblad
Mammoth Cave National Park: Courtney Van Stolk

GeoCorps participants continued on p. 26

GeoCorps participants continued from p. 25

Mount Rainier National Park: Jonathan Beyeler
Mount Rainier National Park: Amishi Kumar
Mount Rainier National Park: Eric McPherren
Mount Rainier National Park: Rebecca Rossi
Mount Rainier National Park: Erin Smith
Oregon Caves National Monument: Chuqiao Dong
Oregon Caves National Monument: Laura Gerbi
Oregon Caves National Monument: Flora Sperberg
Oregon Caves National Monument: Michelle Torres
Pictured Rocks National Lakeshore: Sarah Blakely
Rock Creek Park: Robert Kelley
Rock Creek Park: Chelsea Lewis
Shenandoah National Park: George Carson
Shenandoah National Park: Denna Moore

USDA Forest Service

Bridger-Teton National Forest: Ben Kraushaar
Bridger-Teton National Forest: Ryan Richardson
Eldorado National Forest: Taylor Kravits
Eldorado National Forest: Richard (Scott) Van Winkle
Huron-Manistee National Forests: Trevor Hobbs
Medicine Bow National Forest and Arapaho-Roosevelt National Forest: Tyler Miller
Medicine Bow-Routt National Forests: William Chamlee
Nebraska National Forest: Tirzah Abbott
Sawtooth National Forest: Kyle Makovsky
Sierra National Forest: Tiffany Steinert
Tongass National Forest: Nicole Braudy
Tongass National Forest: Daniel Pawlak
Umpqua National Forest: Jonathan Moskal
Willamette National Forest: Kelli Parsons



Aurora Crooks, Assateague Island National Seashore (National Park Service).



Michelle Torres, Oregon Caves National Monument (National Park Service).

Positions for spring/summer 2014
will be posted 1 Dec. 2013.

Positions for fall/winter 2014
will be posted 1 May 2014.

www.geosociety.org/geocorps/



Phil Varela, Dinosaur National Monument (National Park Service).

Mosaics in Science



THANK YOU 2013 PARTICIPANTS AND PARTNERS!

The new U.S. National Park Service and Geological Society of America **Mosaics in Science** program provides youth who are typically underrepresented in science career fields with on-the-ground, science-based work experiences with the National Park Service (NPS). Established in 2013, this multidisciplinary program provides opportunities for youth to work on inventory and monitoring, research, GIS, and interpretation and education projects. After these jobs are completed, participants attend a career workshop in Washington D.C., where they present the results of their work. They are also introduced to different science career paths and gain skills in order to apply for and obtain a federal job.

Program Objectives

- Encourage diverse youth (17–25 years old) to pursue studies in geoscience and other STEM fields;
- Introduce youth to geoscience and other STEM careers in the NPS;
- Provide meaningful and relevant STEM-based internships in parks; and
- Increase relevance, diversity, and inclusion in the NPS workplace.

PARTICIPANTS—SUMMER 2013

Catoctin Mountain Park: Kristan Culbert

Chesapeake and Ohio Canal National Historical Park:

Ivan Carabajal

Florissant Fossil Beds National Monument: Selva Marroquin

Gateway National Recreation Area: Carlos Carvajal

Grand Canyon National Park (South Rim): Kaytan Kelkar

Mammoth Cave National Park: Jay Kim

Mount Rainier National Park: Marissa Reis

National Capital Parks—East: Juana Aguilar

National Capital Parks—East: Rebecca Fraker

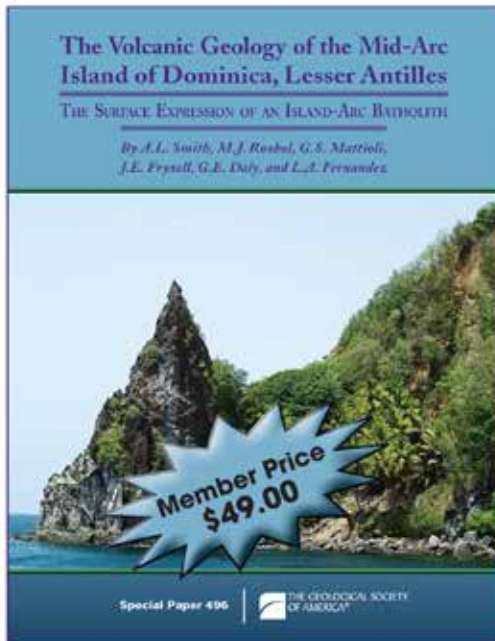
Prince William Forest Park: Leyla Farshidpour

Prince William Forest Park: Javar Henry

Rock Creek Park: Zenovia Mitchell

The Mosaics in Science program is administered by GSA in close collaboration with the NPS Geologic Resources Division and the NPS Youth Program Office. Positions for spring/summer 2014 will be posted 1 Dec. 2013.

www.geosociety.org/mosaic/



The Volcanic Geology of the Mid-Arc Island of Dominica, Lesser Antilles

THE SURFACE EXPRESSION OF AN ISLAND-ARC BATHOLITH

By *A.L. Smith, M.J. Roobol, G.S. Mattioli, J.E. Fryxell, G.E. Daly, and L.A. Fernandez*

Dominica shows unique characteristics not seen on other islands in the Lesser Antilles island arc or on many island arcs worldwide. These unique features include the eruption of rocks, since the upper Pleistocene, of a very restricted compositional range from multiple centers throughout the island, as well as the occurrence of present-day island-wide seismic and geothermal activity. This volume presents the results of geological mapping, detailed stratigraphy, petrography/mineral chemistry, and geochemistry that have allowed the authors to develop a model to explain these features. The model, which traces the development of the island since the upper Miocene, suggests that during the Pleistocene partial melting of the island-arc crust eventually generated a single magma body of batholithic proportions beneath the island. The distinctive phenomena from Dominica are therefore thought to reflect the volcanic and related responses associated with the formation and development of this unexposed batholith.

SPE496, 249 p., ISBN 9780813724966, \$70.00, member price \$49.00

GSA Sales and Service

P.O. Box 9140, Boulder, CO 80301-9140, USA
+1-303-357-1000, option 3
toll-free +1-888-443-4472
fax +1-303-357-1071



Special Paper 496

Buy online at <http://rock.geosociety.org/store/>



GSA FOUNDATION UPDATE

P. Geoffrey Feiss, GSA Foundation President



The recent success of the inaugural GSA Distinguished International Lecture tour is an excellent example of two enduring strengths of our Society: a commitment to advancing the geosciences and the generosity of GSA's members. In 2012, GSA Fellow **Robbie Gries** contacted the GSA Foundation regarding her interest in providing financial support for a new program. Consistent with GSA's strategic priority of expanding the Society's global outreach, and with the enthusiastic support of the International Section, a new international lecture tour program was launched. With Gries' commitment of US\$10,000, **Vic Baker**, Regents Professor of planetary sciences and geosciences at the University of Arizona, was selected to be the first speaker for the GSA Distinguished International Lecture tour.

Thanks to in-kind support from hosting institutions, Baker delivered 24 lectures in nine countries to a total of 1,500 people! Also, as a result of the lectures in Israel, the Israel Geological Society became a GSA Associated Society. Based on the success of this pilot program, Gries agreed to fund the lecture tour a second year, this time focusing on speaking engagements in Asia.

Marjorie Chan, professor of geology and geophysics at the University of Utah, will bring the Distinguished International Lecture tour to Asia in 2013–2014 (see p. 13). Within weeks of her selection, Chan obtained matching support (equivalent to Gries' initial gift) from the University of Utah Office for Academic Affairs and Office for Global Engagement. Michael Hardman, the University of Utah's chief global officer, writes, "The university congratulates Professor Chan on this well-deserved honor, and is pleased to play a role in partnership with GSA to support this prestigious international lecture tour." This collaboration with the

University of Utah will greatly expand the outreach achieved by the lecture tour.

This is only the beginning of the story. Based on the impact of the international lecture tour, a portion of the transformative bequest to the Foundation from the estate of James B. Thompson Jr. will fund and expand the lecture series on an ongoing basis. The James B. Thompson Jr. Distinguished International Lecturers tour will support one North American geoscientist to travel abroad and bring one non-North American geoscientist to lecture across North America each year.

"I am delighted with the broad scope and amazing commitment Vic Baker dedicated to making our first International DL Tour a profound success. He made a great start and I am sure that Margie Chan will match the effort ... what pleasure it gives me!" says Gries.

This incredible step forward for GSA, initiated and then sustained by the support of dedicated GSA members, is an example for us all. Gifts in any amount, through an estate provision, donation, or membership renewal, includes you among a community of students, academics, and professionals who strengthen GSA by creating new opportunities to advance our science. These truly are the characteristics of a dynamic scientific society with generous members.

Thank you for your support!

DR. VIC BAKER—2012 DISTINGUISHED INTERNATIONAL LECTURE TOUR

"Megafloods on Earth, Mars, and Beyond"

"Geological History of Water on an Earth-like Planet"

24 lectures • 1,500 attendees • Nine countries:

Finland	Israel	Scotland	Turkey
France	Italy	Spain	
Germany	Netherlands	Sweden	



Test your GSA knowledge!

1

What is the northernmost, easternmost, southernmost, and westernmost city in which GSA has held an annual meeting?

2

Name the city where GSA held its 25th, 50th, 75th, 100th annual meetings.

Please submit answers by the end of the month to gsaf@geosociety.org

One winner will be selected each month to receive a copy of *GeoTales V: A Collection of Stories & Memories Written by GSA Members*.

Positions Open

TENURE TRACK ASSISTANT PROFESSOR PALEOBIOLOGY AND/OR GEOBIOLOGY UNIVERSITY OF NEW MEXICO

The Dept. of Earth and Planetary Sciences at the University of New Mexico invites applications for a tenure track faculty position at the rank of Assistant Professor in Paleobiology and/or Geobiology. We seek candidates who use field, laboratory, and/or quantitative methods to reconstruct the co-evolutionary history of the Earth and its biosphere. Candidates with demonstrated research expertise that complement existing departmental strengths (epswww.unm.edu) are especially encouraged to apply. Minimum qualifications are a Ph.D. in Geosciences or a related field at the time of appointment, targeted for August 2014.

The application package, containing a letter of interest, CV, a statement of teaching and research interests, and the names of three references with contact information, should be submitted electronically to UNM Jobs: <http://unmjobs.unm.edu/applicants/Central?quickFind=74723>.

For best consideration, all materials must be received by 6 Jan. 2014. However, the position will remain open until filled.

For questions regarding the application process please contact Paula Pascetti, pascetti@unm.edu, Search Coordinator, Dept. of Earth and Planetary Sciences, +1-505 277-1633.

Women and under-represented minorities are strongly encouraged to apply.

The University of New Mexico is an equal employment/affirmative action employer and educator.

GEOLOGY, TERM POSITION, HOPE COLLEGE

The Dept. of Geological & Environmental Sciences at Hope College seeks applicants for a one-year term position, beginning in the fall of 2014, with a possibility of renewal for an additional year. This non-tenure track position will be at the assistant professor level. A Ph.D. is required. The exact teaching responsibilities will depend on the background of the candidate but will entail 12 contact hours per semester (combination of lab and lecture) in some subset of introductory Earth science, mineralogy, petrology, and an introductory level plate tectonics course. The ability to teach geomorphology or structural geology and the ability to integrate undergraduates into summer scholarly research are desirable for candidates interested in renewing the position for a possible second year. The appointee to this position will also be encouraged to collaborate in research with Hope College faculty.

Hope College is a distinctive and distinguished four-year, liberal arts, undergraduate institution, affiliated with the Reformed Church in America, and known and respected for excellence in science and mathematics. The mission of Hope College is to educate students for lives of leadership and service in a global society through academic and co-curricular programs of recognized excellence in the liberal arts and in the context of the historic Christian faith. The Division of Natural and Applied Sciences at Hope includes the departments of Biology, Chemistry,

Computer Science, Geological and Environmental Sciences, Engineering, Mathematics, Nursing, and Physics and totals over 60 FTE faculty.

Hope College places a high priority on sustaining a supportive environment that recognizes the important role of a diverse faculty and staff in preparing students for successful careers in our multicultural nation and global community. Applications from persons with diverse backgrounds and cultures, including women and persons of color, are therefore especially welcomed. Hope College complies with federal and state requirements for nondiscrimination in employment. All new Hope College employees undergo a background check before employment.

Interested applicants should apply online at www.hope.edu/employment by uploading a letter of application, curriculum vitae, transcripts (unofficial accepted for the initial application), a statement of teaching philosophy and competencies, and a description of scholarly research. Applicants should also provide contact information for three potential references. Application deadline is 15 Dec. 2013. Preliminary inquiries may be sent by e-mail to bodenbender@hope.edu.

PETROLOGIST/MINERALOGIST/ GEOCHEMIST, LAFAYETTE COLLEGE

The Dept. of Geology and Environmental Geosciences at Lafayette College invites applications for a full-time tenure-track position beginning academic year 2014–2015 with expertise in petrology/mineralogy/geochemistry. We seek a person with academic



ASSISTANT/ASSOCIATE PROFESSOR IN GEOPHYSICS THE UNIVERSITY OF OKLAHOMA

The University of Oklahoma invites applications for a tenure track position in Geophysics at the Assistant or Associate Professor level. Departmental interests range from the deep lithosphere, through hydrocarbon exploration, to near surface geophysics. We search for a dynamic candidate to supervise students at all levels, and to conduct independent, externally funded research program in his/her field of expertise.

The candidate should hold a Ph.D. in Geophysics; have a demonstrated research record, and an interest in teaching undergraduate and mentoring graduate students in lithospheric and exploration geophysics. Salary, benefits, and start-up funds will be competitive and commensurate with experience. The ConocoPhillips School of Geology and Geophysics has a large, vibrant faculty with a broad range of research activities and strong ties to the petroleum industry. The student body includes about 150 undergraduates and 100 M.S. and Ph.D. students. The Mewbourne College of Earth & Energy possesses extensive software and computing labs of PC and Linux platforms networked to our own Beowulf cluster and to the OU supercomputer center (OSCER). It hosts numerous industrial consortia, a research institute focused on seismic monitoring, and a new field campus in Colorado for field courses in geology and geophysics. The geophysics group conducts active research projects on several continents that are funded by NSF, industry, and foreign national institutes. The College maintains a comprehensive pool of geophysical equipment including GPR, seismic (active and passive), magnetic, and gravity instruments as well as extensive rock physics characterization laboratories. Through collaboration with industry, we have a suite of 3D seismic and microseismic data volumes that are used for teaching, algorithm calibration, seismic geomorphological analysis, crustal imaging, and a range of open source software for lithospheric-scale research. Information about the School and College, the facilities and the entities that it houses can be found at <http://geology.ou.edu>.

Review of applications will begin December 1, 2013, and on-campus interviews will start early 2014. The search will continue until the position is filled. The anticipated starting date is August 16, 2014. Applicants are requested to submit a complete vita/resume, statement of research and teaching interests, and a list of five references who can be contacted, including phone numbers, e-mail addresses, and mailing addresses. Questions or information requests may be addressed to Chair of the Geophysics Search Committee, at (405) 325-3253, or ougeophysicssearch@ou.edu. Applications and nominations should be addressed to: Geophysics Search Committee, The University of Oklahoma, Sarkeys Energy Center, 100 E. Boyd Street, Room 710, Norman, OK, 73019-1008.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women and minorities are encouraged to apply.

preparation to teach a two-course sequence in mineralogy and igneous/metamorphic petrology, and courses in geochemistry and introductory physical geology. Candidates must be dedicated to high-quality teaching and establishing and maintaining an active research program involving undergraduates. Applicants are expected to contribute to the College Common Course of Study and are encouraged to describe additional courses they may wish to teach.

Lafayette College is a highly selective private undergraduate college with academic programs and opportunities characteristic of larger institutions. The Dept. of Geology and Environmental Geosciences has approximately 50 students across all class years and features small class sizes, hands-on laboratory and field experiences, and strong support for faculty research and professional development. The College is approximately 70 miles from both New York City and Philadelphia. Lafayette College is committed to creating a diverse community: one that is inclusive and responsive, and is supportive of each and all of its faculty, students, and staff. All members of the College community share a responsibility for creating, maintaining, and developing a learning environment in which difference is valued, equity is sought, and inclusiveness is practiced. Lafayette College is an equal opportunity employer and encourages applications from women and minorities.

Candidates should submit a letter of application, statement of teaching and research interests, vita, college and graduate school transcripts by uploading a single PDF attachment to the application form

at <http://geology.lafayette.edu/job-opportunities> and candidate should arrange to have three letters of reference submitted by their referees to the reference form at <http://geology.lafayette.edu/job-opportunities>. We will interview at the Geological Society of America meeting in Denver, CO; however, applications will be accepted through 15 Jan. 2014 or until position is filled

HYDROGEOCHEMIST, GEOHYDROLOGY SECTION KANSAS GEOLOGICAL SURVEY THE UNIVERSITY OF KANSAS—LAWRENCE

Full-time position to lead KGS hydrogeochemical investigations. Faculty-equivalent, sabbatical-eligible position at the rank of Assistant or entry-level Associate Scientist. Requires Ph.D. with an emphasis on aqueous geochemistry related to groundwater resources and scientific leadership potential. Background in hydrogeochemistry applied to regional-scale groundwater investigations is desired. The Geohydrology Section has 7 full-time professionals with additional support personnel. Emphasis on state-of-the-science field studies and complementary theoretical research. Complete announcement/application info at www.kgs.ku.edu/General/jobs.html. First consideration deadline: 7 Feb. 2014. Apply online at http://jobs.brassring.com/1033/ASP/TG/cim_jobdetail.asp?partnerid=25752&siteid=5447&AReq=44BR. For further information contact Geoff Bohling (geoff@kgs.ku.edu) or Don Whittemore (donwhitt@kgs.ku.edu). Equal Opportunity Employer M/F/D/V.

TENURE-TRACK ASSISTANT PROFESSOR APPOINTMENT IN STRATIGRAPHY AND SEDIMENTATION NORTHERN ARIZONA UNIVERSITY

We seek applicants for a tenure-track, Assistant Professor position in Stratigraphy and Sedimentology for August 2014. Minimum qualifications are a doctorate in a field related to stratigraphy by the start date, teaching experience at the college level, and field-based research experience in sedimentary rocks. Preferred candidates will show an ability to teach undergraduate (GLG 324) and graduate-level courses in sedimentation and stratigraphy; broad interest in stratigraphy across the time scale; experience in theory and applications of seismic stratigraphy; strong research productivity commensurate with experience; ability to connect with and build upon on-going research within SESES; expertise in modern techniques addressing stratigraphic and/or sedimentologic problems; experience in process or numerical modeling and geospatial analysis; expertise in ESRI-based GIS; and a demonstrated experience in, or commitment to, working with students, colleagues, and community members from diverse cultures. Applicants should send a pdf that contains a letter of application describing their professional goals and how they meet the minimum and preferred qualifications, including evidence for preparedness to teach an undergraduate- and graduate-level courses in stratigraphy and sedimentology, a curriculum vita, and contact information for three references to SESES_Admin_Support@nau.edu. For questions regarding the position, contact the

Chair of the search committee, Nancy.Riggs@nau.edu; see the full announcement at www.nau.edu/hr. Northern Arizona University is a committed Equal Opportunity/Affirmative Action Institution. Women, minorities, veterans and individuals with disabilities are encouraged to apply.

STRUCTURAL GEOLOGY TENURE TRACK FACULTY POSITION DEPT. OF GEOLOGY UNIVERSITY OF GEORGIA

The Dept. of Geology, University of Georgia (UGA), invites applications for a tenure-track Assistant Professor position in the broad area of structural geology starting 1 Aug. 2014. The preferred applicant will be an innovative geologist who combines field observations with analytical data to examine large-scale tectonic processes.

Although the specific area of technical expertise is open, we seek a creative scientist who will complement our existing programs in tectonics, petrology, and solid-earth geophysics. Preference will be given to candidates whose research includes a strong field-based component. The successful candidate will be encouraged to participate in the UGA Dept. of Geology Summer Field School in Colorado.

The successful candidate will be expected to establish an externally funded research program, direct graduate and undergraduate student research, and teach undergraduate structural geology, introductory geology, and graduate-level courses in his/her specialty. A Ph.D. in geology is required at the time of appointment

Candidates should submit a cover letter, a CV, a statement of research and teaching interests, and contact information for three referees to <http://recruitment.franklin.uga.edu>. Review of applications will begin 2 Dec. 2013, and the position will remain open until filled.

The Franklin College of Arts and Sciences, its many units, and the University of Georgia are committed to increasing the diversity of its faculty and students, and sustaining a work and learning environment that is inclusive. Women, minorities and people with disabilities are encouraged to apply. The University is an EEO/AA institution. Georgia is well known for its quality of life in regard to both outdoor and urban activities (www.georgia.gov). UGA is a land and sea grant institution located in Athens, 90 miles northeast of Atlanta, the state capital (www.visitathensga.com; www.uga.edu).

HYDROLOGICAL MODELING ASSISTANT PROFESSOR BAYLOR UNIVERSITY

The Baylor University Dept. of Geology seeks a dynamic scholar to fill this position beginning August 2014. Candidates should have a Ph.D. in Geology, Hydrogeology, Hydrology, Hydraulics or a closely related discipline with a strong emphasis on numerical modeling of surface and/or groundwater systems. Integration of measurements from Earth and space-based sensors, hydrogeophysics and other ground based measurements is encouraged. Research areas may range in scope from the critical zone to global hydrological cycles and sustainability. Regardless of

research focus area, enthusiasm for interdisciplinary research and cultivation of new collaborations is essential to this position. The successful candidate will teach courses in hydrologic/hydrogeologic systems modeling, establish and participate in externally-funded research, and successfully mentor M.S. and Ph.D. candidates to graduation.

Applications for the position will be accepted until the position is filled. Please submit a letter of application, current curriculum vitae, transcripts, and a description of your research plan and teaching philosophy. Include names, addresses, and phone numbers of three individuals from whom you have requested letters of recommendation to Dr. Joe C. Yelderman, Jr., Search Committee Chair, Baylor University, One Bear Place #97354, Waco, Texas 76798-7354, +1-254-710-2361.

Materials may be submitted electronically to joe_yelderman@baylor.edu with a cc: to stacy_atchley@baylor.edu.

Baylor is a Baptist university affiliated with the Baptist General Convention of Texas. As an AA/EEO employer, Baylor encourages minorities, women, veterans, & persons with disabilities to apply.

THE ROY J. SHLEMON CHAIR IN APPLIED GEOSCIENCES DEPT. OF EARTH AND PLANETARY SCIENCES UNIVERSITY OF CALIFORNIA AT DAVIS

The Dept. of Earth and Planetary Sciences at the University of California at Davis seeks an outstanding scholar for The Roy J. Shlemon Chair in Applied Geosciences in the College of Letters and Science. We seek an individual with a well-established, highly visible and interdisciplinary research program in Quaternary geomorphology with a strong quantitative background and an active interest in understanding the dynamics of Earth's surface through studies of the physics of surficial processes and the broad-scale interactions among tectonics, topography, and climate. Areas of interest include, but are not limited to, the dynamics of river and delta systems in response to tectonism, climate change and sea level change, the geomorphic evolution of mountain ranges and their local and regional impact on and feedback with climate dynamics, and theoretical modeling of fluid mechanics and sediment transport as applied to problems of geomorphology.

We anticipate an appointment at the Associate or Full Professor level to begin 1 July 2014. The successful candidate is expected to hold the academic distinction for appointment to an endowed Chair at the post-tenure level. The candidate is further expected to create a focal point for Quaternary Science research on the UC Davis campus as well as to explore links to the Center for Watershed Sciences (<http://watershed.ucdavis.edu/>) of the John Muir Institute of the Environment. An interest in policy development of water resource issues in California and/or the western United States is desirable.

For more information about the UC Davis Dept. of Earth and Planetary Sciences, see <http://geology.ucdavis.edu>.

To apply, please go to <https://recruit.ucdavis.edu/apply/PPF00159>.

Review of applications will begin on 20 Dec. and will continue until the position is filled. UC Davis

is an affirmative action/equal employment opportunity employer and is dedicated to recruiting a diverse faculty community. We welcome all qualified applicants to apply, including women, minorities, individuals with disabilities and veterans.

**FACULTY POSITION IN TECTONICS
BOSTON UNIVERSITY**

The Dept. of Earth & Environment at Boston University invites applications for an Assistant Professor (tenure-track) in Tectonics, beginning in Fall 2014 (subject to budgetary approval). We seek applicants whose research encompasses broad field-based investigations aimed at understanding the evolution and dynamics of the continental lithosphere at regional to global scale. We especially welcome applicants whose research emphasizes interactions between tectonics and other aspects of the evolving Earth system such as Earth history, mantle dynamics, climate & sea level change, landscape evolution, natural resources, hazards, and more. Candidates' research might span such disciplines as structural geology, geochemistry, geo/thermochronology, sedimentology, stratigraphy, tectonic-geomorphology, and paleomagnetism.

The successful applicant will be expected to supervise graduate research in M.A. and Ph.D. programs, maintain an externally funded research program, and teach at all levels in the Earth & Environment curriculum. We seek an applicant whose research complements departmental expertise in solid Earth geosciences and integrates well with other departmental themes. Interaction is encouraged with other departments including Chemistry, Physics, Astronomy, and the B.U. Marine Program. For more information about the Department, see www.bu.edu/earth. A Ph.D. at the time of appointment is required. Please apply online at <https://academicjobsonline.org>, including a curriculum vitae, a statement of research and teaching interests, and the names and addresses of at least three references. Should you have questions, feel free to contact Ethan Baxter, Search Committee Chair, Dept. of Earth & Environment, Boston University, 685 Commonwealth Ave., Boston MA 02215 USA; e-mail: earth@bu.edu. Review of applications will begin on 1 Dec. 2013. Women and underrepresented minorities are particularly encouraged to apply. Boston University is an equal opportunity/affirmative action employer.

**KARST HYDROGEOLOGIST
MIDDLE TENNESSEE STATE UNIVERSITY**

The Geosciences Dept. of Middle Tennessee State University seeks a karst hydrogeologist with a broad background in surficial processes. Teaching responsibilities include undergraduate and graduate courses in hydrogeology and environmental geology. Other teaching responsibilities may include introductory courses such as Earth Science and Physical Geology. The selected candidate is expected to have a background in geomorphology, geological applications of GIS, and geology of soils. Research, university/community service, and cooperative work with department faculty and staff are expected. Excellence in teaching, research/creative activity and service is expected for all positions. MTSU seeks candidates

committed to using integrative technologies in teaching. A Ph.D. in Geology or related field is required.

To apply for this position, go to <http://mtnsubjobs.mtsu.edu> and follow the instructions on how to complete an application, attach documents, and submit online. Review of applications begins 10-28-2013 and continues until position is filled. Rank and salary are commensurate with education and experience. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Control Act of 1986). Clery Act crime statistics for MTSU available at http://police.mtsu.edu/crime_statistics.htm or by contacting MTSU Public Safety at +1-615-898-2424. EO/AA employer.

**ASSISTANT PROFESSOR
EARTH & ATMOSPHERIC SCIENCES
(EXPLORATION GEOPHYSICS)**

UNIVERSITY OF NEBRASKA-LINCOLN

Applications are invited for a tenure track position as Assistant Professor in the Dept. of Earth & Atmospheric Sciences at the University of Nebraska-Lincoln. This hire would become part of vibrant and growing geology program.

Strong potential for research and teaching and must hold a Ph.D. in geology or a related field at the time of appointment. The successful candidate will be expected to teach courses in the undergraduate and graduate core curricula and develop courses in their area of expertise. The successful candidate will also be expected to advise and direct graduate students and to develop a rigorous research program that is supported by external funding. We seek applicants with research and teaching interests that complement departmental strengths. Female and ethnic minority candidates are strongly encouraged to apply.

Additional information on the geology program can be found on the department's website: <http://eas.unl.edu>.

To apply, go to <http://employment.unl.edu> requisition F_130184 and click on "apply to this job," complete this form and attach a cover letter, curriculum vitae, statement of research and teaching interests, and names of at least three references via the above website. Review of applications will begin on 2 Jan. 2014 but the position will remain open until it is filled.

The University of Nebraska is committed to a pluralistic campus community through affirmative action, equal opportunity, work-life balance and dual careers. More information is available at www.unl.edu/svcaa/faculty/policies/work_life_balance.shtml. Lincoln is a highly livable city with affordable housing and excellent schools (www.unl.edu/ucomm/lincoln/). For further information, contact Dr. Christopher Fielding, Search Committee Chair by e-mail, phone, or mail at cfielding@unl.edu, +1-402-472-9801; Dept. of Earth and Atmospheric Sciences, University of Nebraska, 214 Bessey Hall, Lincoln, NE 68588-0340.

**TENURE-TRACK POSITION
EARTH SYSTEMS (BIOSPHERIC PROCESSES)
DEPT. OF EARTH AND ENVIRONMENTAL
SCIENCES, VANDERBILT UNIVERSITY**

The Dept. of Earth and Environmental Sciences at Vanderbilt University invites applications for a tenure-track faculty position in the general area of

Earth Systems. This position, effective the Fall 2014 semester, is at the Assistant Professor level.

We seek an individual who is aimed at the highest standards of scholarship in research and teaching at both the undergraduate and graduate levels, and who will be attracted by opportunities at Vanderbilt for interaction with a diverse faculty and student body in the Earth and environmental sciences and related fields. The research specialty is open, although we are particularly aimed at those studying biospheric processes and/or history, and interactions with other Earth systems. We welcome applications from candidates pursuing theoretical, experimental, and/or field-based work, and we are especially aimed at individuals with interest in both modern and ancient systems.

Applications should include a vita, a statement of research and teaching interests, and names of at least three references (including mail and e-mail addresses and phone numbers). Select applicants will be later asked to provide evidence of teaching effectiveness. Applications should be submitted by e-mail in PDF format to EESposition@vanderbilt.edu. Up to three representative papers may be sent via normal mail to Search Committee Chair, Dept. of Earth and Environmental Sciences, Vanderbilt University, VU Station B Box 351805, 2301 Vanderbilt Place, Nashville, TN 37235-1805. Review of applications will begin 15 Dec. 2013. Vanderbilt is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

**TENURE-TRACK FACULTY POSITION IN
LANDFORM EVOLUTION AND SURFICIAL
PROCESSES, DEPT. OF GEOSCIENCE,
UNIVERSITY OF WISCONSIN-MADISON**

The Dept. of Geoscience at the University of Wisconsin-Madison seeks a geoscientist for an assistant professor, tenure-track position in Landform Evolution and Surficial Processes beginning August 2014. We are particularly interested in a quantitative and field-oriented geoscientist. Specialties may include, but are not limited to, glacial geomorphology, fluvial geomorphology, paleoclimate, environmental/climatic interactions, Quaternary geology, tectonic geomorphology, submarine geomorphology, and geologic hazards.

A Ph.D. in Geoscience or related field is required at the time of the appointment. Responsibilities include conducting scientific research, advising graduate students, teaching undergraduate and graduate courses, and performing appropriate university and professional service.

Potential collaborative interactions exist within the department, with other departments and programs on campus (e.g., Atmospheric and Oceanic Sciences, Geological Engineering, Geography, Nelson Institute for the Environment), with the Wisconsin Geological and Natural History Survey, and with state and federal agency researchers in the Madison area (USGS, WI Dept. of Natural Resources, USDA).

Applicants should submit a curriculum vitae, statement of research and teaching interests, and the names and addresses of at least three references to lespsearch@geology.wisc.edu. If necessary, you can contact Dr. Basil Tikoff, Landform Evolution and

Surficial Processes Search Chair, Dept. of Geoscience, University of Wisconsin-Madison, 1215 W. Dayton St., Madison WI 53706-1692. To ensure full consideration, applications must be received by 1 Dec. 2013.

For additional information, please visit <http://geoscience.wisc.edu/geoscience/>. UW-Madison is an equal opportunity/affirmative action employer and encourages applications from women and minorities. A background check will be required prior to employment. Unless confidentiality is requested in writing, information regarding applicants must be released upon request. Finalists cannot be guaranteed confidentiality.

**TENURE-TRACK
ASSISTANT PROFESSOR OF HYDROLOGY
GEORGIA STATE UNIVERSITY**

The Dept. of Geosciences at Georgia State University anticipates hiring a tenure-track faculty member at the Assistant Professor level pending budgetary approval in the area of Hydrology with research interests in surface-water hydrology or fluvial geomorphology. The candidate should have a willingness to participate in interdisciplinary collaborations centered on urban issues, in line with one of GSU's strategic goals of understanding the complex challenges of cities and developing effective solutions. The successful candidate will have an active, funded/able research agenda in his or her area, and will be expected to teach both lower- and upper-division courses, and direct graduate students. A Ph.D. in geography, geology, or a closely related discipline is required by the time of appointment. The position will begin in August 2014.

Georgia State University is a growing research university in the dynamic heart of downtown Atlanta with a diverse student body of over 32,000 students. The Dept. of Geosciences (<http://geosciences.gsu.edu/>) offers bachelors and masters degrees in Geosciences, with concentrations in geography and geology, and a Ph.D. in Chemistry with a geology specialization. Extensive geochemical facilities are available in the department and many others through core facilities in Biology and Chemistry.

Candidates should provide a cover letter, statements of research and teaching interests and goals, names and email addresses of at least three references, and curriculum vitae to Dr. Larry Kiage, Chair, Hydrology Search Committee, Dept. of Geosciences, Georgia State University, P.O. Box 4105, Atlanta, GA 30302-4105. To ensure full consideration, applicants should send their materials by 30 Nov. 2013. Electronic submissions are welcomed, please send submissions to geosjobsearch@gsu.edu. This position is open until filled. An offer of employment will be conditional upon background verification. Georgia State University is a Research University of the University System of Georgia and is an EEO/AA employer.

**ASSISTANT PROFESSOR DIVISION OF
GEOLOGICAL AND PLANETARY SCIENCES
CALIFORNIA INSTITUTE OF TECHNOLOGY**

The Division of Geological and Planetary Sciences at the California Institute of Technology (Caltech) is seeking applicants for a tenure-track position at the assistant professor level. We seek applicants for a po-

sition in any area within the purview of the Division of Geological and Planetary Sciences, with a strong commitment to high quality teaching. We solicit applicants from the broad range of disciplines within Earth and planetary science, including geology, geophysics, geochemistry, geobiology, and planetary science, and who are interested in all aspects of earth and planetary dynamics, interiors, surfaces, atmospheres, oceans, and cryospheres.

The term of the initial appointment at the assistant professor level is normally four years, with appointment contingent upon completion of a Ph.D. in a relevant field. Exceptionally well-qualified candidates may also be considered at the tenured professor level. Interested applicants should submit an electronic application at www.gps.caltech.edu/ employment. Applications will be accepted until the position is filled.

If there are any questions during the search process, please contact us at gps-search@caltech.edu.

The California Institute of Technology is an Equal-Opportunity/Affirmative-Action Employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

**TWO ASSISTANT PROFESSOR POSITIONS
GEOCHEMISTRY AND
HYDROGEOLOGY/GEOFLUIDS
BOONE PICKENS SCHOOL OF GEOLOGY
OKLAHOMA STATE UNIVERSITY**

The Boone Pickens School of Geology at Oklahoma State University seeks two tenure track assistant professors: one in sedimentary geochemistry and another in hydrogeology/geofluids. These positions will be effective August 2014 contingent on funding. The applicant should have a Ph.D. degree in geosciences or a related field at the time of appointment.

For the sedimentary geochemistry position, we are seeking candidates with strengths in one or more of the following areas: organic geochemistry, low temperature metals geochemistry, biomarkers as applied to petroleum systems, environmental systems, and paleo/climate change.

For the hydrogeology/geofluids position, we are seeking candidates with strengths in one or more of the following: simulation of subsurface flow and solute transport, variable-density or multiphase fluid modeling, reactive transport modeling in porous/fractured media, and hydrogeophysics as applied to sedimentary basins, biogeophysics, petroleum, hydrodynamic systems, and environmental change.

The successful candidates will complement School strengths in stable isotope geochemistry, petroleum geology (conventional and unconventional), paleoenvironment, biogeochemistry and biogeophysics. We seek candidates who will develop vigorous and innovative research programs and who will contribute to School teaching at both undergraduate and graduate levels. The candidates will be expected to supervise M.S. and Ph.D. students and develop courses in their areas of expertise.

The successful candidates will join a faculty of fourteen geoscientists in a department that has close ties to the petroleum and water resource industries. The School's teaching and research facilities include state of the art geochemistry laboratory facilities and equipment, geophysical field and laboratory equip-

ment and software, the Devon Visualization Laboratory, and a wide range of petrographic and hydrogeological instrumentation and field equipment. The School operates a field camp facility near Cañon City, Colorado.

Candidates should submit an application package that includes a cover letter; curriculum vitae; reprints of three published papers; contact information for three referees; and separate statements of research and teaching vision. Candidates should include in their research vision a brief description of how their research will interface with that of existing faculty. All application materials should be submitted to Assistant Professor Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031. Screening of candidates will begin on 15 Nov. 2013 and continue until the position is filled. More information about the Boone Pickens School of Geology can be found on the web at <http://geology.okstate.edu>. Inquiries may be directed to Dr. Todd Halihan (todd.halihan@okstate.edu) or Dr. Jay Gregg (jay.gregg@okstate.edu). Committed to health and safety, Oklahoma State University maintains a tobacco-free work environment. Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

**ENVIRONMENTAL BIOGEOCHEMISTRY/
GEOBIOLOGY, DARTMOUTH COLLEGE**

The Dept. of Earth Sciences at Dartmouth College invites applications for a junior rank tenure-track position in the general areas of biogeochemistry and geobiology. We especially welcome applications from candidates with research interests that include microbially-mediated biogeochemical interactions in processes of mineralization, weathering, and sequestration of contaminants; hydrocarbon formation and degradation; biogeochemical cycling in fluvial and/or cold environments, including river-channel, floodplain, and lacustrine ecosystem response to environmental change. Particular attention will be given to candidates who combine a focus on understanding fundamental processes with state-of-the-art laboratory and/or field research programs that complement and contribute to ongoing research activities in the department as well as in Dartmouth's Geisel School of Medicine and Thayer School of Engineering. The successful candidate will continue Dartmouth's strong traditions in graduate and undergraduate research and teaching. Teaching responsibilities consist of three courses spread over three of four ten-week terms.

The Dept. of Earth Sciences is home to 11 tenured and tenure-track faculty members in the School of Arts and Sciences, and enjoys strong Ph.D. and M.S. programs and outstanding undergraduate majors. To create an atmosphere supportive of research, Dartmouth College offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities.

Dartmouth College, a member of the Ivy League, is located in Hanover, New Hampshire (on the Vermont border). Dartmouth has a beautiful, historic campus located in a scenic area on the Connecticut River. Recreational opportunities abound

in all four seasons. To learn more about Dartmouth College and the Dept. of Earth Sciences, please visit www.dartmouth.edu/~earthsci.

To submit an application, send curriculum vitae, statements of teaching and research interests and objectives, reprints or preprints of up to three of your most significant publications, and the name, address (including street address), e-mail address and fax/phone numbers of at least three references to Environmental Biogeochemistry/Geobiology Search Committee, Dept. of Earth Sciences, Dartmouth College 6105 Fairchild Hall, Hanover, NH 03755, e-mail: earth.sciences@dartmouth.edu.

Applications received by 8 Nov. 2013 will receive first consideration. The appointment will be effective 1 July 2014.

With an even distribution of male and female students and over a quarter of the undergraduate student population members of minority groups, Dartmouth is committed to diversity and encourages applications from women and minorities. Dartmouth College is an equal opportunity and affirmative action employer.

SEDIMENTARY SYSTEMS DARTMOUTH COLLEGE

The Dept. of Earth Sciences at Dartmouth College invites applications for a junior-rank, tenure-track position in the area of environmental change in sedimentary systems. We welcome applications from candidates with specific research interests in biogeochemical interactions in processes of mineralization in sedimentary systems, and/or quantitative analysis of evolving sedimentary systems on local environmental to basin-wide to global scales. Particular attention will be given to candidates who combine a focus on fundamental processes with state-of-the-art field and/or laboratory research programs that complement and contribute to ongoing research activities at Dartmouth. The successful candidate will continue Dartmouth's strong traditions in graduate and undergraduate research and teaching. Teaching responsibilities consist of three courses, including sedimentary geology and sedimentary petrology, spread over three of four ten-week terms.

The Dept. of Earth Sciences is home to 11 tenured and tenure-track faculty members in the School of Arts and Sciences, and enjoys strong Ph.D. and M.S. programs and outstanding undergraduate majors. To create an atmosphere supportive of research, Dartmouth College offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities.

Dartmouth College, a member of the Ivy League, is located in Hanover, New Hampshire (on the Vermont border). Dartmouth has a beautiful, historic campus located in a scenic area on the Connecticut River. Recreational opportunities abound in all four seasons. To learn more about Dartmouth College and the Dept. of Earth Sciences, please visit www.dartmouth.edu/~earthsci.

To submit an application, send curriculum vitae, statements of teaching and research interests and objectives, reprints or preprints of up to three of your most significant publications, and the name, address (including street address), e-mail address

and fax/phone numbers of at least three references to Sedimentary Systems Search Committee, Dept. of Earth Sciences, Dartmouth College 6105 Fairchild Hall, Hanover, NH 03755, e-mail: earth.sciences@dartmouth.edu

Applications received by 8 Nov. 2013 will receive first consideration. The appointment will be effective 1 July 2014.

With an even distribution of male and female students and over a quarter of the undergraduate student population members of minority groups, Dartmouth is committed to diversity and encourages applications from women and minorities. Dartmouth College is an equal opportunity and affirmative action employer

FACULTY POSITION SOLID EARTH PROCESSES UNIVERSITY OF ROCHESTER

The Dept. of Earth and Environmental Sciences at the University of Rochester will be hiring a tenure-track faculty in Solid Earth Processes, in disciplines that include, but are not limited to Petrology and/or Geochemistry. The rank of the position is open, with a start date of 1 July 2014. We are interested in a dynamic educator and researcher who uses geochemical and/or computational approaches in their research and can establish externally funded, internationally recognized research programs. Preference will be given to applicants who can build cross-disciplinary programs involving undergraduate and graduate students that complement the University of Rochester's strengths in tectonics, Earth and planetary evolution, geophysics, geochemistry, and climate science (see www.ees.rochester.edu for more information about programs in the department). We seek applicants who can teach Petrology. The University of Rochester is a highly ranked research university, and Rochester's cultural, educational, and recreational assets consistently place the city in the top 10 places to live within the U.S. Applicants should submit materials via: <https://www.rochester.edu/fort/ees/>. Materials include a curriculum vitae, select reprints, statements of research and teaching goals, and the names and contact information of four references. The review of applications will begin 15 Dec. 2013 and will continue until the position is filled. The University of Rochester has a strong commitment to principles of diversity and, in that spirit, actively encourages applications from groups underrepresented in higher education.

ASSISTANT PROFESSOR STRUCTURAL GEOLOGY AND TECTONICS UNIVERSITY OF MISSOURI

The Dept. of Geological Sciences at the University of Missouri invites applications for a tenure-track, Assistant Professor position beginning in August 2014 in the broadly defined area of Structural Geology and Tectonics. The successful candidate's research will ideally complement and expand upon one or more of the areas of departmental expertise in solid-earth processes including geodynamics, igneous and metamorphic petrology, neotectonics, and seismology. Completion of the Ph.D. at the time of appointment is required. Applicants should be prepared to prove eligibility to work in the United States.

The successful applicant will be expected to teach across the curriculum, i.e., introductory classes, advanced undergraduate courses, and graduate courses in his/her area of expertise. The applicant will also be expected to develop an active, externally funded research program and to direct graduate student research at the M.S. and Ph.D. levels.

Please apply online at <http://hrs.missouri.edu/find-a-job/academic>. In addition to a curriculum vitae (CV), applicants should include a letter describing their geologic interests and qualifications for the position, a teaching portfolio, and a list of three references (including contact information). Items other than the CV should be uploaded in the Attachments section of the application system. Initial screening of applicants will begin 6 Jan. 2014 and will continue until a suitable candidate is hired. Information about our department is available at <http://geology.missouri.edu>. The University of Missouri is an EO/AA/ADA employer.

GEOLOGY, PETROLOGY UNIVERSITY OF WISCONSIN OSHKOSH

University of Wisconsin Oshkosh, Dept. of Geology, seeks hard rock, field-oriented geologist for full-time, tenure-track assistant or associate professor position starting 1 Sept. 2014. Specialty area should complement existing faculty expertise. Ph.D. required; prior college/university teaching experience preferred. Successful candidate is expected to develop a vigorous research program, which includes publishing peer-reviewed papers. Teaching responsibilities include introductory courses, lithology, economic geology, geochemistry, field trips, and advising majors. Submit letter of application, concise statement of teaching and research interests and experience, curriculum vitae, and undergraduate and graduate transcripts (original or photocopy) by 31 Dec. 2013 to Dr. William Mode, Chair, Dept. of Geology, University of Wisconsin Oshkosh, Oshkosh, WI 54901. Have three current letters of reference sent directly to the department by that date. For additional information see www.uwosh.edu/departments/geology/. Employment requires criminal background check. AA/EOE

CHAIR, DEPT. 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 0602535). Also submit all official transcripts by mail to Dr. Kenneth Farrish, Search Committee Chair, +1-936-468-3701, Dept. of Geology, Stephen F. Austin State University, Box 13011 SFA,

Nacogdoches, TX 75962. Review of applications will begin on 1 Dec. 2013 and will continue until the position is filled. Equal Opportunity Employer; Security-sensitive position; this position will be subject to a criminal history check.

**FACULTY POSITION
EARTH SURFACE PROCESSES/
GEOMORPHOLOGY**

NANYANG TECHNOLOGICAL UNIVERSITY

The Division of Earth Sciences and the Earth Observatory of Singapore at Nanyang Technological University Singapore invites applications for a tenure-track position in geomorphology/Earth surface processes with emphasis on the geomorphic response to climate and/or anthropogenic change. Specific areas of interest include (but are not limited to) **physical, chemical, and/or biological aspects of Earth-surface dynamics and evolution or changes in the Earth's surface** as a result of human and natural impacts. Research approaches should encompass some combination of field, laboratory, and modeling. We seek an individual with research interests that augment our existing strengths in Earth systems science and surficial processes. This position is part of the continued expansion of the Division of Earth Sciences with the Earth Observatory of Singapore.

We invite candidates who have developed an internationally recognized, externally funded, multi-disciplinary research program to apply at the assistant, associate or full professor level. Successful candidates will also be required to actively participate in our core undergraduate and graduate teaching and in the administration of the Division of Earth Sciences.

To apply, please submit the following materials to eos_humanresources@ntu.edu.sg:

- Statement of research and teaching interests;
- Curriculum vitae;
- A copy of three relevant publications; and
- The names of three references who are familiar with your work.

Further information about the Division of Earth Sciences and the Earth Observatory of Singapore is available at www.earthobservatory.sg, and to contact cmrubin@ntu.edu.sg for job specific information. Review of applications will begin on 1 Feb. 2014 and will continue until the position is filled.

**RESEARCH POSITION
COASTAL PALEOSEISMOLOGY/QUATERNARY
ENVIRONMENTAL CHANGE**

NANYANG TECHNOLOGICAL UNIVERSITY

The Earth Observatory of Singapore, Nanyang Technological University, invites applications for a Research Fellow (post-doctoral level) in Coastal Paleoseismology/Quaternary Environmental change.

This project is part of an ongoing program to recover stratigraphic records of past earthquakes and tsunamis and sea-level change in Indonesia. Skills in quantitative micropaleontology/palaeoenvironmental reconstructions and/or sedimentology of coastal systems are highly desirable. The candidate is required to have a Ph.D. in coastal geomorphology/geology.

The coastal paleoseismic project is led by Charles Rubin and Ben Horton and supported by the Earth Observatory of Singapore. All applicants should

demonstrate a clear desire for adventurous field-work and exceptional science. Further details may be obtained from the Earth Observatory of Singapore, Nanyang Technological University, cmrubin@ntu.edu.sg.

Initially the contract duration will be 2 years, although a longer period (up to 4 years) can be negotiated. Excellent knowledge of English, both in speaking and writing, is a requirement.

International candidates are highly encouraged to apply. Applications should include a CV, list of publications, a short (1-page) synopsis of previous research achievements and research plans, and the names of at least two referees.

Applications and inquiries should be sent electronically to eos_humanresources@ntu.edu.sg

We will begin reviewing applications 1 Feb. 2014. However applications will be reviewed until the position is filled.

**MULTIPLE TENURE-TRACK
FACULTY POSITIONS DEPT. OF GEOLOGICAL
SCIENCES, CALIFORNIA STATE
UNIVERSITY FULLERTON**

The Dept. of Geological Sciences at California State University Fullerton <http://geology.fullerton.edu/> invites applications for two tenure-track Assistant Professorships to begin 15 Aug. 2014. The successful candidates: (1) will be key members in establishing a College of Natural Sciences and Mathematics center for the environment, resources, and sustainability; (2) will be expected to develop active, field-based, externally funded research programs involving undergraduate and master's students in the candidates' field of study; (3) be committed to excellence in teaching at the undergraduate and master's levels; and (4) will have the ability to communicate effectively with an ethnically and culturally diverse campus community.

Resource Geology. Research interests may include mineralogy, petrology, ore deposit/economic resource geology, or volcanology as they pertain to the environment, resources, and sustainability. The successful candidate must demonstrate interest and ability to teach Earth Materials (Mineralogy) and introductory-level geosciences and upper-division/graduate courses in the candidate's area of specialization. Preference will be given to candidates who also demonstrate the interest and ability to teach field geology. For a complete position description, see http://diversity.fullerton.edu/jobs/ft/resource_geology.asp.

Coastal Sedimentology. Research interests may include the study of coastal processes or modern coastal marine systems as analogs for ancient environments and/or petroleum geology, as they pertain to the environment, resources, and sustainability. The successful candidate must demonstrate interest and ability to teach marine geology and oceanography. Preference will be given to applicants who have the ability to teach sedimentology/stratigraphy and/or field geology classes, introductory-level geosciences courses, and upper-division/graduate courses in the candidate's area of specialization. For a complete position description, see http://diversity.fullerton.edu/jobs/ft/coastal_sedimentology.asp.

Application Procedures. For both searches, a Ph.D. in Geological Sciences or related field is required at

the time of appointment. Send a single pdf document containing: (1) a detailed curriculum vita; (2) a letter of application; (3) a teaching statement that includes: a discussion of relevant course work and/or experience in preparation for teaching, a list of courses you are qualified to teach, and a statement of your teaching philosophy; and (4) a statement of your future research plans and goals. Letters of recommendation from at least three referees familiar with your teaching and research background should be sent separately. For the Coastal Sedimentology search, applicants and referees should email materials directly to Dr. Matthew Kirby at coastal_search@fullerton.edu. For the Resource Geology search, applicants and referees should email materials directly to Dr. David Bowman at resource_search@fullerton.edu.

Applications will be accepted until the position is filled. To ensure full consideration, submit all application materials by 15 Nov. 2013. Cal State Fullerton is an Equal Opportunity/Title IX/503/504/VEVRA/ADA Employer.

**FACULTY POSITION IN PETROLOGY
DEPT. OF EARTH AND
ENVIRONMENTAL SCIENCES
BOSTON COLLEGE**

The Dept. of Earth and Environmental Sciences at Boston College invites applications for a tenure-track position in the field of Petrology to start in Fall 2014. The successful candidate will be expected to develop an externally funded research program integrated with excellence in teaching within the geological sciences and environmental geoscience curriculum at both the undergraduate and graduate levels. Teaching responsibilities will include Mineralogy, Igneous and Metamorphic Petrology, and other courses in the candidate's area of research expertise. The successful candidate should have a commitment to integrate with existing department research expertise in structural geology, sedimentary geology, igneous and metamorphic terrane analysis, and geochronology/geochemistry. Candidates with a strong field emphasis in research and teaching are particularly desired. This is an open-rank position, and applications at all levels are invited. The department is equipped with a range of modern research instrumentation listed on our website (www.bc.edu/content/bc/schools/cas/geo/instrumentation-and-facilities.html). Information on the department, its faculty and research strengths can be viewed on the department's web page at www.bc.edu/eesciences. Applicants should submit a curriculum vitae, statements of teaching and research interests, and at least three references online at <https://secure.interfolio.com/apply/21996>. Review of applications will begin on 11 Nov. 2013. Department faculty will be available at the GSA and AGU fall meetings to meet with applicants. Boston College is an academic community whose doors are open to all students and employees without regard to race, religion, age, sex, marital or parental status, national origin, veteran status, or handicap.

**STRUCTURAL OR SEDIMENTARY GEOLOGY
BROOKLYN COLLEGE**

Brooklyn College seeks applicants for a full-time tenure-track Assistant Professorship in Structural or Sedimentary Geology in the Dept. of Earth and

Environmental Sciences. Preference will be given to candidates with a strong background in geographic information systems and field-based investigations. The department is part of the School of Natural and Behavioral Sciences and in addition to undergraduate programs, offers doctoral and masters level programs. For more information, please visit www.brooklyn.cuny.edu/faculty2014 and search for Job ID 9014. Brooklyn College is an AA/EEO employer.

PEVEHOUSE CHAIR IN GEOSCIENCES TEXAS TECH UNIVERSITY

The Dept. of Geosciences at Texas Tech University invites applications for the Pevehouse Chair in Geosciences. The purpose of this endowed position is to support innovative research and education that are broadly aligned with petroleum geosciences and may include geophysics, structural geology, geomechanics, sedimentology, petrophysics, and organic geochemistry. A Ph.D. in geosciences or closely allied field is required, as is a record of research as demonstrated by professional publications. The chair holder will conduct a vigorous, externally-funded research program, direct graduate student research, and teach undergraduate and graduate courses in his/her specialty. The position is expected to be filled at the tenured Full Professor level.

Texas Tech is a state-supported, graduate research-oriented university with over 32,000 students. The Dept. of Geosciences consists of twenty-four tenured/tenure-track faculty, with teaching and research emphases in solid earth geosciences, atmospheric science, and geography. It offers degree programs in solid earth geosciences at the BS, MS, and Ph.D. levels. The chairholder will join a dynamic, growing department with more than 200 undergraduate majors and more than 60 graduate students. Texas Tech is committed to growth in disciplines aligned with hydrocarbon geology through addition of at least one junior faculty position.

The department computer labs are equipped with GIS, geologic mapping/modeling, and seismic processing/interpretation software packages. Available experimental/analytical facilities include a stable isotope laboratory, XRD, XRF, analytical SEM, TEM, laser ablation ICP-MS, a heat flow lab, and remote sensing spectroradiometers. In addition, the Dept. of Petroleum Engineering maintains experimental and analytical facilities in petrophysics, drill fluids, cement, enhanced recovery, and reservoir simulation, as well as X-ray CT/nuclear magnetic resonance imaging lab.

Lubbock is located on the Southern High Plains in close proximity to the Permian Basin. The city has a population of over 225,000 and the semi-arid climate is conducive to outdoor activities. Cultural amenities include musical, theatrical, and sports events, and the city offers numerous options for shopping and dining. The city also offers the best healthcare facilities in the region, including the university's Health Sciences Center. The cost of living is low compared to national norms.

Applicants must first go to the university employment website at <http://jobs.texasastech.edu>. There, go to "Search Postings," search for requisition number 87107, and fill out necessary forms in applying for the position online. Then, applicants should submit

PENNSTATE



ASSISTANT PROFESSOR IN THE FIELDS OF HYDROGEOLOGY AND GEOMORPHOLOGY

The Department of Geosciences at The Pennsylvania State University invites applications for two tenure-track faculty positions at the rank of Assistant Professor, in the fields of Hydrogeology and Geomorphology. We seek colleagues who will continue strong legacies in hydrologic sciences and geomorphology, contribute to highly active and diverse research programs in the Department and College through the development of vigorous externally funded research programs, and teach undergraduate and graduate courses in their discipline. Applicants must have a Ph.D. in geosciences or related field at the time of appointment.

Assistant Professor of Hydrogeology: Candidates who creatively use theoretical, observational, and/or experimental approaches to address fundamental problems in hydrosciences are encouraged to apply. The successful candidate will have the opportunity to participate in several campus-wide initiatives in water resources through the Penn State Institute for Energy and the Environment (<http://www.psiee.psu.edu>) and the Earth and Environmental Systems Institute (<http://www.eesi.psu.edu>).

Assistant Professor of Geomorphology and Landscape Dynamics: We are seeking candidates who conduct innovative research on landscape dynamics at a range of temporal and spatial scales in order to understand, for example, natural hazards, the evolution of Earth and planetary surfaces, and/or feedbacks between surface processes, climate, and tectonics.

The Department of Geosciences is part of the College of Earth and Mineral Sciences, and houses top-ranked research programs in environmental and climate sciences, geology, geophysics, and geochemistry (further information is available at: <http://www.geosc.psu.edu>). The Department and College also host research centers with foci on climate, environment, energy, and policy, including the Shale Hills Critical Zone Observatory; the Earth System Science Center; the Penn State Ice and Climate Research Center; the Riparia Center; and the Center for Geomechanics, Geofluids, and Geohazards. There are wide-ranging opportunities for collaboration in research and education in the College's Department of Energy and Mineral Engineering and Energy Institute, and in departments within the Colleges of Engineering and Agricultural Sciences.

Candidates should send a complete curriculum vita, statements of research and teaching interests, and contact information for four references to: Search Committee Chair (please specify Hydrogeology or Geomorphology), 503 Deike Building, The Pennsylvania State University, University Park, PA 16802; application materials can also be sent electronically to: <http://apptrkr.com/386688>. Appointment could begin as early as July 1, 2014. Review of applications will begin immediately and continue until the positions are filled. For further information or questions, please contact Stacie Hugney, slg9@psu.edu.

Penn State is committed to affirmative action, equal opportunity and the diversity of its workforce. Women and members of underrepresented groups are encouraged to apply.

a letter of application, curriculum vitae, a statement of teaching and research interest, names and contact information (including e-mail addresses) of at least 3 professional references. These documents should be uploaded to the employment website and we request that copies be e-mailed or sent directly to Dr. Calvin Barnes, Pevehouse Chair Search Committee, Dept. of Geosciences, Texas Tech University, MS 1053, Lubbock, TX 79409-1053.

Additional information on the department can be found at www.depts.ttu.edu/gesc/. E-mail questions regarding the position are received at cal.barnes@ttu.edu. Review of applicants will begin immediately and continue until the position is filled.

Texas Tech University is an affirmative action/equal opportunity employer, committed to excellence through diversity. Texas Tech welcomes applications from minorities, women, veterans and persons with disabilities.

TENURE-TRACK COASTAL SYSTEMS GEOCHEMISTRY

UNIVERSITY OF MASSACHUSETTS BOSTON
The School for the Environment at the University of Massachusetts Boston invites applications for a junior rank tenure-track position in coastal systems geochemistry, to begin 1 Sept. 2014. We especially welcome candidates with research expertise across a breadth of temporal scales, modern and ancient systems, and spatial scales, freshwater to marine. Particular attention will be given to candidates who combine a focus on understanding fundamental processes with state-of-the-art laboratory and/or field research programs that leverage the School's Environmental Analytical Core Facility and Nantucket Field Station. For more information on the University and the School for the Environment visit www.umb.edu/environment.

Applications must be submitted online at <http://umb.interviewexchange.com/candapply.jsp?JOBID=43079> and will include a letter of application, current CV, statement of research interest, statement of teaching philosophy, and up to 3 reprints/pre-prints. Three letters of recommendation should be emailed directly to paula.cameron@umb.edu.

UMass Boston is an Affirmative Action, Equal Opportunity, Title IX employer.

TENURE-TRACK POSITION SEISMIC STRATIGRAPHY SAN DIEGO STATE UNIVERSITY

The Dept. of Geological Sciences at San Diego State University (SDSU) invites applications for a tenure-track faculty position in seismic stratigraphy or a related field. Candidates who specialize in imaging techniques applied to sedimentary systems are of particular interest, but we seek applicants from any relevant area of focus who will complement our strengths in geological and geophysical modeling as well as neotectonics, hydrology, and petroleum geology. The successful candidate will demonstrate the ability to develop an innovative and robust externally-funded research program, and to effectively teach and mentor students at the undergraduate, master, and doctoral level through our Joint Doctoral Program (JDP) in Earthquake Science and

Applied Geophysics with the University of California at San Diego (UCSD). He/she will be expected to teach an undergraduate sedimentology and stratigraphy course, general-education courses, as well as advanced graduate courses in his/her area of specialization. This position is expected to be filled at the Assistant Professor level. A Ph.D. in Earth Sciences or a related field is required at the time of appointment; post-doctoral experience is preferred.

Applications should be submitted to Search Committee, Dept. of Geological Sciences, San Diego State University, 5500 Campanile, San Diego CA 92182-1020, or alternatively to geosearch@mail.sdsu.edu; the materials should include curriculum vitae, descriptions of future research plans, teaching statements, and the names and contact information of three references. Review of applications will begin on 1 Nov. 2013, and will continue until the position is filled.

SDSU is a Title IX, equal opportunity employer and does not discriminate against persons on the basis of race, religion, national origin, sexual orientation, gender, gender identity and expression, marital status, age, disability, pregnancy, medical condition, or covered veteran status.

TENURE-TRACK FACULTY POSITION SEDIMENTOLOGY/STRATIGRAPHY THE UNIVERSITY OF ALABAMA

The Dept. of Geological Sciences at The University of Alabama invites applications for a tenure-track faculty position in sedimentology and stratigraphy, beginning August 2014. The position will be filled at the Assistant Professor level. Candidates must have a strong record of research and teaching, and must have received their Ph.D. in Geology, or a related field, at the time of appointment. The successful candidate will be expected to teach introductory geology courses and undergraduate and graduate courses in sedimentology and stratigraphy, attract and supervise graduate students, and establish a vigorous externally-funded research program in sedimentology and/or stratigraphy. The department has a broad range of geophysical, modeling, isotopic and geochemical research facilities available, in addition to University shared facilities at CAF (www.caf.ua.edu). Details regarding existing research programs, equipment and facilities, and departmental activities can be found at www.geo.ua.edu. Questions should be directed to Dr. Alberto Pérez-Huerta (aphuerta@as.ua.edu). Applicants should go to facultyjobs.ua.edu to electronically apply for this position. When submitting an application, candidates must provide a cover letter, CV, research and teaching statements, and a list with the contact information for at least three referees. Applications will be reviewed beginning 1 Jan. 2014, and will continue until the position is filled. The University of Alabama is an Equal Opportunity Affirmative Action Employer. Women and minorities are encouraged to apply.

Opportunities for Students

Graduate Fellowships at the University of Kentucky. Pioneer Natural Resources Fellowships are available at the Univ. of Kentucky. Pioneer

Fellowships are open to M.S. and Ph.D. candidates with research interests in stratigraphy, sedimentology, and petroleum geology. These positions include salary, tuition, research support and health insurance. Field sites for research include the western United States and the East African Rift Valley. Students with interdisciplinary geoscience backgrounds (including coursework/research in sedimentary geology, exploration seismology, petroleum geochemistry, and micropaleontology) are particularly encouraged to apply. Experience in conducting remote fieldwork is a plus. Please contact Prof. Michael McGlue (michael.mcglue@uky.edu) for more information. Further details on the Dept. of Earth and Environmental Sciences at the Univ. of Kentucky can be found at <http://ees.as.uky.edu/>. The department maintains world-class facilities and an active, student-centered research program. Review of applications for Fall 2014 admission will begin 1 Feb. 2014.

Lindahl Ph.D. Scholarships. The University of Alabama Dept. of Geological Sciences (DGS) seeks highly qualified Ph.D. students with specializations in topics that complement faculty research interests. Exceptional students will receive Research or Teaching Assistantships and a Lindahl Scholarship totaling \$22,000 for a nine month appointment. The Univ. of Alabama covers the cost of non-resident tuition and fee waivers, and health insurance. Funding is renewable for at least 4 years if expectations are met. Other fellowships are available from the graduate school on a competitive basis. Further details on the DGS and the faculty members can be found at www.geo.ua.edu/. Applicants should contact Dr. Delores Robinson (dmr@ua.edu) to express interest. Review of applications for Fall 2014 admission will begin 15 Jan. 2014.

Graduate Student Opportunities, Case Western Reserve University. Students with backgrounds in geology, physics, chemistry, biology, engineering and related fields are encouraged to apply for our Ph.D. and MS programs in Earth, environmental, and planetary sciences. Areas of active research in the department include planetary geology and geophysics, igneous geochemistry, mineral physics, sediment transport, aqueous geochemistry and carbon sequestration. For more information, see <http://geology.case.edu> or write to ees-gradinfo@case.edu. Financial assistance is available. Application deadline: 1/15/2014.

Graduate Research Assistantship in Geoscience Education, North Carolina State University. A 12-month research assistantship (RA) is available for Ph.D. candidates in the Dept. of Marine, Earth and Atmospheric Sciences (MEAS) at North Carolina State Univ. (NCSU). The successful applicant will work on a funded-research project in geoscience education with a focus on the use of video to support learning in "flipped" classroom environments. The position includes a monthly stipend, tuition, fees and health insurance. NCSU has a successful geoscience education program that includes two full-time faculty and approximately a dozen student researchers and postdocs. Students have access to departmental and on-campus research laboratories

dedicated to the collection of qualitative and quantitative data for discipline-based STEM education research. Additional support is available for potential graduate students interested in other aspects of geoscience education. Please contact Dr. David McConnell (david_mcconnell@ncsu.edu) for more information. Further details on MEAS can be found at www.meas.ncsu.edu/. Review of applications for Fall 2014 admission will begin 1 Jan. 2014.

Presidential Doctoral Research Fellowship, Dept. of Geology, Utah State University. The Dept. of Geology at Utah State Univ. invites applications for a Presidential Doctoral Research Fellowship starting during the 2014–2105 academic year. This 4-year Ph.D. fellowship will pay all tuition and a stipend of ~\$20,000/year. Collaborative research will integrate fieldwork and a variety of geochemical and geo- and thermochronologic techniques to understanding processes in brittle fault zones and continental tectonics. Advisors and committee will consist of some combination of Drs. Alexis Ault, James Evans, Susanne Janecke, and Dennis Newell. Potential projects include use of new and existing labs both at USU and other universities to date paleoearthquakes in iron-bearing fault zones. We seek a motivated student with an M.S., but will consider outstanding candidates with B.S. or B.A. degrees. The Dept. of Geology at USU is field oriented with a dynamic and growing faculty and graduate program. We are located in Logan, Utah, with close proximity to a wide variety of recreational and cultural opportunities. Interested candidates should contact the aforementioned

faculty at james.evans@usu.edu; aault@email.arizona.edu; susanne.janecke@usu.edu, and dennis.newell@usu.edu. All faculty will be at the GSA Annual Meeting in Denver to talk with prospective applicants. Please visit <http://geology.usu.edu> for more information about our program, and www.usu.edu/graduateschool/apply/ to apply before 15 Jan. 2014.

NEW GSA BOOKS

Neogene Deformation between Central Utah and the Mojave Desert

Edited by R. Ernest Anderson

Rethinking the Fabric of Geology

Edited by Victor R. Baker

The Impact of the Geological Sciences on Society

Edited by Marion E. Bickford

The Web of Geological Sciences: Advances, Impacts, and Interactions

Edited Marion E. Bickford

The Columbia River Flood Basalt Province

Edited by Stephen P. Reidel, Victor E. Camp, Martin E. Ross, John A. Wolff, Barton S. Martin, Terry L. Tolan, and Ray E. Wells

<http://rock.geosociety.org/store/>

Call for Applications



2014–2015 GSA–USGS Congressional Science Fellowship

Deadline: 1 Feb. 2014

Bring your science and technology expertise to Capitol Hill to work directly with national leaders at the interface between geoscience and public policy. The GSA-USGS Congressional Science Fellowship provides a rare opportunity for a geoscientist to spend a year working for a Member of Congress or congressional committee. If you are an earth scientist with a broad geologic background, experience applying scientific knowledge to societal challenges, and a passion for helping shape the future of the geoscience profession, GSA and the USGS invite your application. The fellowship is open to GSA members who are U.S. citizens or permanent residents, with a minimum requirement of a master's degree with at least five years professional experience or a Ph.D. at the time of appointment. Learn more at www.geosociety.org/csf or by contacting Susan Lofton, +1-303-357-1040, slofton@geosociety.org.

Apply today!



39th International Commission on the History of Geological Sciences (INHIGEO) Symposium

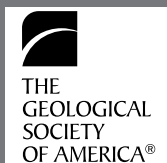
Asilomar Conference Grounds, Pacific Grove,
California, USA

Sun.–Thurs., 6–10 July 2014

CONFERENCE THEMES

- Doing the History of the Earth Sciences: What, Why, and How?
- *Plus:* California's Place in the History of the Earth Sciences
- Mid-week and Post-Meeting Field Trips are being planned.

[http://community.geosociety.org/
INHIGEO2014/Home/](http://community.geosociety.org/INHIGEO2014/Home/)





A new editorial policy for Comptes Rendus Geoscience

Comptes Rendus Geoscience ranks as a prominent international journal for the geosciences. A new editorial team has been in charge since January 2013. The team wishes to encourage even better quality and more innovative science, to promote a simpler review process and to ensure very rapid publication.

An important experimental feature is that authors will have their papers reviewed prior to submission. Reviewers will be proposed by the authors and will have to be accepted by the editors following published rules. Since their names will be published, reviewers will commit themselves, a guarantee of quality. In case they feel it is needed, associate editors can of course invite additional, anonymous reviewers. Upon receiving the papers and the reviews, an associate editor will decide on accepting or rejecting the paper in less than a month. The paper should be published less than a month after acceptance.

Review and frontier papers and thematic issues based on workshop presentations are welcome.

In order to attain these goals, a compact team of associate editors that cover a broad range of disciplines of the geosciences has been assembled, with **Vincent Courtillot** as the new Chief Editor, and Associate Editors **James Badro** (geomaterials), **Sylvie Bourquin** (sedimentology), **Michel Campillo** (seismology), **Philippe Cardin** (geo- and paleomagnetism), **François Chabaux** (surface geochemistry), **Marc Chaussidon** (geo- and cosmochemistry), **Marguerite Godard** (petrology), **Amaëlle Landais** (stable isotopes and paleoclimates) and **Isabelle Manighetti** (tectonics). Guest associate editors may be invited when the field of geosciences appears too remote from the spectrum covered by the editorial team.

Submit your next paper to *Comptes Rendus Geoscience* now!

For more information on editorial policy and ways to submit go to: <http://ees.elsevier.com/geoscience/>

GSA Today is Open Access Online

Go to www.geosociety.org/pubs/ and click on the *GSA Today* cover.



THE GEOLOGICAL SOCIETY OF AMERICA®

Publications Highlights



New Online Store Expands Offerings

GSA has launched a new online store. Similar to the old interface where you can purchase print books, Rite in the Rain products, education materials, photo time scales, and EarthCache coins, the new site gives you a number of options, including the ability to purchase and download e-books. The site also can suggest similar titles to those you view or purchase.

Many out-of-print titles are now available as e-books, and we plan on adding more in the future, including the Decade of North American Geology products.

The site uses the same login credentials that you use for GSA's Connected Community, meaning that you only need to remember one username and password for your GSA access.

Start shopping at <http://rock.geosociety.org/store/>

GSA Annual Meeting & Exposition VANCOUVER 2014

19-22 October 2014

Now Accepting Technical Session, Field Trip, and Short Course Proposals

The 2014 GSA Annual Meeting will take place in beautiful Vancouver, British Columbia, Canada. The primary host of the 2010 Winter Olympics, this green city is very walkable and offers many bike rentals and paths. A short train or bus/taxi ride takes you from Vancouver International Airport into town. The convention center, on the edge of Coal Harbor, is an architectural masterpiece, with Canada's largest living roof. This geologically active area will make for some unique field trips. Venture outside the city to visit the mountain town of Whistler or Capilano Suspension Bridge Park, where you can hike around a West Coast rainforest. We hope you will join us 19-22 October 2014 for this first annual meeting outside the United States in sixteen years. *And make sure your passport is up to date!*

TECHNICAL SESSIONS

Proposals deadline: 14 Jan. 2014

Abstracts deadline: 29 July 2014

Help ensure that your area of research and expertise is represented in next year's technical program. Any individual or geoscience organization is welcome to suggest topics and submit proposals for both Topical Sessions and Pardee Keynote Symposia. Pardee Symposia are high-profile sessions on significant scientific developments, with invited speakers only. Topical Sessions are a combination of invited and volunteered papers. Unique formats are allowed, but they must be outlined in the proposal along with the technical support needs. Sessions that promote discussion are encouraged. <https://gsa.confex.com/gsa/2014AM/sessionproposals.epl>

FIELD TRIPS

Deadline: 2 Dec. 2013

Know of a great geoscience excursion in the Vancouver, British Columbia, Canada, area? Teach your colleagues and peers about the wondrous scenery and ground-breaking research in this region. Trips can be a half-day to 5 days long. *Questions?* Please contact Beth Engle, bengle@geosociety.org.

<https://gsa.confex.com/gsa/2014AM/fieldtrip.htm>

SHORT COURSES

Deadline: 1 Feb. 2014

Enjoy Teaching? Lead a Short Course at the GSA Annual Meeting in Vancouver in 2014! Extend your expertise to your peers and to the next generation. GSA Short Courses help develop professional, teaching, and research skills at all levels. *Questions?* Please contact Jennifer Nocerino, jnocerino@geosociety.org.

www.geosociety.org/meetings/2014/scProposals/



THE
GEOLOGICAL
SOCIETY
OF AMERICA®

www.geosociety.org/meetings/2014/

Unlock a moment in time

Rafter Radiocarbon dating services

When you seek knowledge of "a moment in time" Rafter Radiocarbon, the world's oldest continuously operating radiocarbon lab, can provide the answers.

For over 50 years we have been providing services to clients throughout the world.

As a department within a scientific research institute, our facility retains all analyses within our own site; is staffed with experienced and dedicated technicians operating modern equipment with our own scientists to provide stringent quality assurance; and has a tradition of scientific excellence and innovative thinking.

Regular size samples (> 0.2mg graphite) have a target precision of 2.5 ‰.

Talk to us about "small" samples (> 0.05mg) or higher precision services.

We are a regular participant in the International Radiocarbon Intercomparisons, price competitively, and we deliver quality analysis to deadlines.



Contact Us

To know more about benefitting from the expertise of the GNS Science Rafter Radiocarbon Laboratory please visit:
www.rafferradiocarbon.co.nz

or Email us at:
radiocarbon@gns.cri.nz

Location

National Isotope Centre
30 Gracefield Road
Lower Hutt 5010
PO Box 31312
Lower Hutt 5040
New Zealand
T +64-4-570 1444
F +64-4-570 4657

