Continental-scale links between the mantle and groundwater systems of the western United States: Evidence from travertine springs and regional He isotope data

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SCIENCE ARTICLE

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Continental-scale links between the mantle and groundwater systems of the western United States: Evidence from travertine springs and regional He isotope data

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ABSTRACT
To understand regional mantle degassing, we compiled new and existing helium isotope data measured in hot springs, gas fields, and travertine-depositing cool springs and compared these geochemical data with mantle velocity structure determined from tomographic studies. These data suggest heterogeneous mantle degassing, with regions of highest \(^{3}\text{He}/^{4}\text{He}\) in groundwater (hence, highest mantle helium contribution) corresponding to regions of lowest mantle velocity, a reflection of tectonically active and partially molten mantle. New He isotope and water chemistry data from travertine-depositing cool springs of the western United States show marked variability consistent with mixing between surface water recharge and inputs from deep crustal and mantle sources. The deeply sourced end-member fluids of these mixing trends have high \(^{3}\text{He}/^{4}\text{He}\), high dissolved \(\text{CO}_2\), and high salinity compared to shallow recharge waters, and commonly have elevated trace element concentrations. Consequently, these fluids cause degradation of water quality in western U.S. aquifers. Our conclusions highlight a connection between neotectonics (e.g., mantle degassing) and water quality in the western United States.

INTRODUCTION
Distributed deformation associated with the western North American plate margin extends >1000 km inboard from the San Andreas fault zone to the Rocky Mountain and western Great Plains regions. This region forms an orogenic plateau with high average heat flow and is characterized by relatively low upper mantle P-wave velocities with marked heterogeneity (Gody et al., 2003; Humphreys et al., 2003). Progressive geochemical depletion of the upper mantle during generation of basaltic melt likely occurred in several episodes since the Proterozoic (Karlstrom et al., 2005). The mantle was hydrated by flat-slab subduction during the Laramide orogeny (Humphreys et al., 2003) and now is partially molten, leading to small-scale convective exchange between an upwelling asthenosphere (Gao et al., 2004) and compositionally variable lithosphere (Dueker et al., 2001; Karlstrom et al., 2005). The mantle underlying western North America is marked by one of the largest known shear wave velocity contrasts on Earth (van der Lee and Nolet, 1997). At the continental scale, this transition reflects the heterogeneous thinning and warming of North America’s lithospheric keel as the plate moved southwest in absolute plate motion in the Cenozoic into a wide zone of warm asthenosphere (CD-ROM Working Group, 2002).

We hypothesize that \(\text{CO}_2\)-rich mineral springs and related travertine deposits in the western United States are a manifestation of this mantle tectonism, and hence the geochemistry of spring waters and gases can be used in conjunction with geophysical data sets to understand mantle heterogeneity and the processes of lithosphere-asthenosphere interaction. We report new water and gas chemistry with associated carbon and helium isotope data in the context of a synthesis of the existing noble gas isotope chemistry database for western North America. Our literature synthesis (Table DR1) builds on previous work in the area, with the regional helium isotope data presented in the context of a tomographic image of today’s mantle. We also show that travertine-depositing cool springs contain mantle-derived volatiles in a variety of locations and tectonic settings throughout the western United States, such that many aquifer systems are influenced by mixing of deeply sourced and circulated waters.

HE ISOTOPES—BACKGROUND
The isotope geochemistry of noble gases is a sensitive tracer of mantle-derived volatiles even with a large input of volatiles derived from Earth’s crust. This is because the mantle has retained a significant fraction of the terrestrial inventory of the primordial isotope \(^{3}\text{He}\) acquired during Earth formation (Clarke et al., 1969), and it is still leaking to Earth’s surface. In contrast, the crust has been extensively reworked over geological time and has retained very little \(^{3}\text{He}\): its helium inventory is dominated by radiogenic \(^{4}\text{He}\) produced from the decay of U- and Th-series nuclides. Consequently, helium presently emanating from regions of mantle melting, such as mid-oceanic ridges or helium trapped in glass and phenocrysts in mid-oceanic-ridge basalts (MORB), is characterized by a relatively high \(^{3}\text{He}/^{4}\text{He}\) ratio (R) of \(8 \pm 1\) times that of air (R\(_{50}\)) which has a \(^{4}\text{He}/^{3}\text{He}\) ratio of \(1.4 \times 10^{-4}\) (Graham, 2002). Indeed, values as high as \(37 \times R_{50}\) have been observed in some ocean island basalts (Hilton et al., 1999) and are thought to be related to deep plumes tapping less degassed mantle reservoirs. When mantle-derived fluids are injected into the crust, mantle helium becomes progressively diluted by crustal helium characterized by low \(^{3}\text{He}/^{4}\text{He}\) ratios of \(<0.02 \times R_{50}\). Therefore, any value higher than 0.1

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1GSA Data Repository Item 2005199, a description of sampling and analytical methods and geochemical data tables DR1–DR3, is available online at www.geosociety.org/pubs/ft2005.htm or on request from Documents Secretary, GSA, PO. Box 9140, Boulder, CO 80301-9140, USA, or editing@geosociety.org.

R, which lies above the range typical of various crustal lithologies, is considered to have a significant mantle He component (Ballentine et al., 2002). Conversely, areas like the Canadian Shield that have a thick, cool lithosphere and are tectonically quiescent have \(^{3}\He/\He\) ratios ~0.02 R, implying that groundwater and gas reservoirs have been insulated for long periods from mantle volatile additions.

Across western North America, mantle-derived helium and elevated CO levels have long been identified in fluids and gases at major volcanic centers, faults, and hydrothermal systems associated with mantle partial melting and high heat flow (Ballentine et al., 2002; Craig et al., 1978; Hilton et al., 2002; Kennedy et al., 1987, 2002; Welhan et al., 1988, and references therein). Helium-3 flux has also been used to understand magmatism in extensional tectonic settings (e.g., Oxburgh and O’Nions, 1987; Torgersen, 1993). Natural gas fields have been the focus of noble gas research and clearly show the presence of mantle-derived volatiles (Ballentine et al., 2000, 2001; Caffee et al., 1999; Hiyagon and Kennedy, 1992; Jenden et al., 1988; Kennedy et al., 2002; Poreda et al., 1986; Torgersen and Kennedy, 1999). Mantle-derived helium has been identified in the San Andreas and Walker Lane fault zones of California and Nevada (Kennedy et al., 1997; Kulonogski et al., 2005; Sorey et al., 1993; Welhan et al., 1988), suggesting that faults can serve as conduits for mantle volatiles without active magmatism.

UNDERSTANDING THE FLUX OF MANTLE VOLATILES THROUGH THE CRUST

Interpretation of the variation in helium isotopic ratios measured in groundwaters and gases is complicated by the factors that can affect the ratio during volatile movement from the mantle through the crust. Assuming the MORB value for the mantle end-member under the western United States (e.g., Ballentine et al., 2005), the factors that can lower the isotopic value below 8 R include alpha recoil addition of \(^{3}\He\) from uranium-series radioactive decay during movement through the crust, dilution by stored crustal helium (0.02 R.), and addition from old magmatic systems that have been diluted by the same processes (Ballentine and Burnard, 2002; Torgersen, 1995). Thus, one must understand not only the initial mantle helium isotope input but the residence time, fluid flow rate, and mixing history through the crust, as well as the distribution and age of magmatic intrusions and variation in U and Th in the crust (Kennedy et al., 1997; Torgersen, 1993; Torgersen et al., 1995).

Helium does not move alone from the mantle, but travels with CO and other components. Helium is a trace gas in spring gases, whereas CO can comprise over 99% of the gas phase in some springs. Quantifying the CO flux from the mantle is not simple, due to mixing of CO from other sources such as metamorphic decarbonation of carbonate bedrock, CO gas reservoirs, organically derived CO, and atmospheric CO (Polyak et al., 2000; Sano and Marty, 1995; Sherwood Lollar et al., 1997). MORB has a narrow range of CO/He ratios (2–7 × 10\(^{-4}\)), whereas crustal fluids are characterized by higher CO/He ratios (10\(^{-3}\)–10\(^{-5}\)) (O’Nions and Oxburgh, 1987; Sherwood Lollar et al., 1997). The combination of \(\delta^{13}\CO\) measurements and the CO/He ratio has been used successfully to resolve the relative contribution of mantle CO to fluids and gases (e.g., Sano and Marty, 1995).

TRAVERTINE SPRINGS OF THE WESTERN UNITED STATES

Travertine deposition is driven by the degassing of CO\(_2\)-charged groundwater as it emerges at springs. Although it is commonly suggested in the literature that CO\(_2\) is derived from meteoric or near-surface biological sources (e.g., Szabo, 1990), the models of Liu et al. (2003), Siegel et al. (2004) and Crossley et al. (2006) suggest that travertine-depositing springs often contain deep geological or endogenic sources of CO\(_2\).

Worldwide, there is recognition that travertine deposits are associated with faulting and extensional settings (Hancock et al., 1999). In the western United States, active travertine-depositing hot and cool springs (Fig. 1) are associated with basement-penetrating normal faults and lavas associated with extensional tectonics. The association of travertine deposits with hot springs and lavas suggests a link to high crustal heat flow. However, cool travertine springs are

Figure 1. \(^{3}\He/\He\) values (R/R, notation) for hot springs, cool mineral springs, gas fields, and groundwater for the western United States and Canada. Helium isotopic values are overlain on P-wave velocity mantle tomography at 100 km depth (modified from: Humphreys et al., 2003). Blue: interpreted as high velocity, old, and cold lithosphere at 100 km depths. Yellow to red: lower velocity and warmer lithosphere and/or asthenosphere at 100 km depths, interpreted to be locally partially molten (Humphreys and Dueker, 1994). Tectonic provinces outlined in black (e.g., Rio Grande rift); white dashed line depicts our interpretation of the eastward transition from the tectonically active western U.S. mantle to the tectonically quiescent mantle. Dots show locations of western U.S. travertine deposits (Buchanan and Swain, 1998; Feth and Barnes, 1979; Heimuller and Reece, 2003; Johnson and McCormick, 2003; Love and Chaitetz, 1988).
also found in these settings, and they have similar water chemis-
tries to hot springs. Hot springs have been sampled extensively
for He isotopes as part of geothermal exploration in the western
United States, especially in the Great Basin (e.g., Kennedy et
al., 1996). Our work focuses on characterizing cool springs and
expanding the geochemical database on travertine-depositing
systems of the southwestern United States, and it highlights a
direct link between neotectonics and gas and water chemistry in
western U.S. aquifers.

RESULTS

New $^{3}$He/$^{4}$He data from springs in the Arizona Transition
zone, the Colorado Plateau, and the Rio Grande rift have $R_{A}$
values that range from 0.08 to 1.16 $R_{A}$ (Table 1). These data are
merged with published values from hot springs, cool springs,
geochemical wells, and gas field wells of western North America
(Table DR1; see footnote 1) and are overlain on an image of the
mantle velocity field at 100 km depth (Fig. 1) (Humphreys et al.,
2003). Our new data are important in reinforcing the regional
extent of mantle degassing and in reemphasizing that mantle
helium is present in a wide variety of both thermal and nonther-
mal springs.

Water-free gases measured in spring waters range up to 99%
by volume CO$_{2}$ and average 45%. In contrast, typical shallow
groundwaters containing dissolved gases from a meteoric or
soil-gas origin have <1% by volume CO$_{2}$. A plot of nitrogen,
argon, and helium shows our data in terms of potential gas
source based on tectonic setting (Giggenbach, 1992). These
data show a trend in source ranging from air-saturated ground-
water to an end member composition dominated by crustal or
mantle-derived volatiles (Fig. 2; Table DR2 [see footnote 1]). The
CO$_{2}/^{3}$He ratios for these springs range from 2.02 $\times$ 10$^{-4}$ to 5.1 $\times$
10$^{-2}$ (Table 1; Table DR1 [see footnote 1]), falling within both
the mantle and crustal ranges. Their $\delta^{13}$CO$_{2}$ values range from
−12.7 to −1.0‰ Peedee belemnite (table 1), spanning the range
of carbonates (0 ± 2‰) and the mantle (−6 ±
3‰) (Hoesf., 1987; Sano and Marty, 1995; Trull et al., 1993),
with the more negative values indicating some influence by organic
carbon sources (−20 to −30‰). While these analyses cannot
quantitatively determine the source of the CO$_{2}$ present, they
support the hypothesis that some of the CO$_{2}$ is mantle-derived.

Water analyses from these springs indicate that they are gener-
ally <30 °C, range in pH between 6 and 7, have alkalinites
between 300 and 3000 mg/l, and have total dissolved solids
up to 23,000 ppm. Chemistry for selected springs found in the
Rio Grande rift is provided in Table DR3 (these springs are
representative for travertine-springs of the southwestern United
States). Major ion chemistry shows trends between Ca-Mg-
HCO$_{3}$ and Na-Cl-SO$_{4}$ type waters (Fig. 3) that range from
dilute to saline. Springs have arsenic contents ranging from <5 ppb
to >5000 ppb. Similar mixing trends are present in the Grand
Canyon and lead to the inference that there are different endo-
genic water end members that mix with the more dilute waters
from surface recharge to explain the observed wide range of
water compositions (Crossey et al., 2006).

CORRELATION OF HELIUM ISOTOPIC VARIATIONS
WITH TECTONIC PROVINCE

Although the distribution of $^{3}$He/$^{4}$He data is highly vari-
able among tectonic provinces, in general the highest mantle
helium contributions correlate to the youngest and most
active tectonic regions and the domains of lowest mantle
velocity (Fig. 1). Exceptions to this exist because of mixing
that can affect helium isotopic value during movement
through the crust. In Yellowstone National Park, $^{3}$He/$^{4}$He
ratios as high as 16 $R_{A}$ are observed (Craig et al., 1978;
Kennedy et al., 1987); these values suggest that Yellowstone
represents a high-$^{3}$He plume end member such as is found in
Hawaii and Iceland (see review by Graham, 2002). All other
localities in the western United States show $^{3}$He/$^{4}$He values $\leq$
$R_{A}$. Therefore, we assume that helium in the western United
States is a mixture between a mantle end member with a

<table>
<thead>
<tr>
<th>Table 1. New $^{3}$He/$^{4}$He and $^{13}$CO$_{2}$ Values for Springs and Groundwater of Southwest U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Montezuma Hot Spring</td>
</tr>
<tr>
<td>(BM 290 1957)$^*$</td>
</tr>
<tr>
<td>Upper Owl Spring</td>
</tr>
<tr>
<td>Manby Hot Spr Pool—near bathhouse</td>
</tr>
<tr>
<td>Manby Hot Spr Pool—S of bathhouse</td>
</tr>
<tr>
<td>Ponce de Leon Hot Spr—hottest in concrete</td>
</tr>
<tr>
<td>No Name Spring—S of John Dunn Bridge</td>
</tr>
<tr>
<td>Tierra Amarilla Anticline—Grassy Spring</td>
</tr>
<tr>
<td>La Madera Spring</td>
</tr>
<tr>
<td>Salt Spr—Jemez Pueblo</td>
</tr>
<tr>
<td>Salado Arroyo Spring</td>
</tr>
<tr>
<td>Lucero Uplift unnamed mineral spring</td>
</tr>
<tr>
<td>Truth or Consequences—Artesian Well</td>
</tr>
<tr>
<td>Geronimo Hot Spring—Truth or Consequences1—Artesian Well</td>
</tr>
<tr>
<td>Well #10 Burgette Greenhouse Lightening Dock1</td>
</tr>
<tr>
<td>Well #1 Burgette Greenhouse Lightening Dock1</td>
</tr>
<tr>
<td>Well #10 Burgette Greenhouse Lightening Dock1</td>
</tr>
<tr>
<td>Well #4 Doc Cambell’s Gila Hot Springs1</td>
</tr>
<tr>
<td>Lightfeather Hot Spring1</td>
</tr>
<tr>
<td>Turkey Creek Hot Spr—Upper Spring</td>
</tr>
<tr>
<td>Bubbles Spring Lower Frisco Area</td>
</tr>
<tr>
<td>Lower Frisco Hot Spring2</td>
</tr>
<tr>
<td>Upper Frisco Hot Spring3</td>
</tr>
<tr>
<td>Sedillo Spring Socorro4</td>
</tr>
<tr>
<td>Pagosa Hot Spring—hottest in concrete</td>
</tr>
<tr>
<td>Pagosa Hot Spring—S of main terrace</td>
</tr>
<tr>
<td>Fossil Creek, upper orifice</td>
</tr>
<tr>
<td>Fossil Creek, downstream</td>
</tr>
<tr>
<td>Montezuma Well</td>
</tr>
</tbody>
</table>

Note: nr—not reported; Spr—Spring.

*Rc/Ra*—Air corrected Rc/Ra; $Ra = He/He$ in air (1.4 E-6).

$X = (\text{He}/^{3}Ne)/(\text{He}/^{4}He) \times [\text{Ne}/^{3}He]$. B—Bunsen coefficients, assuming a groundwater recharge temperature of 15 °C (Weiss, 1970).

$^*$Unpublished data provided by M. Kennedy and M. van Soest.
MORB-like helium isotopic composition and the crustal, radiogenic helium (0.02 $R_a$) reservoir (Table 2).

Table 2 summarizes $R_a$ variations in key areas of western North America, calculated in terms of percent mantle contribution. In active tectonic areas such as the Salton Trough, San Andreas fault, Walker Lane, Cascadia, and the Canadian Cordillera, maximum $R_a$ values are consistently high and imply at least 50% mantle contribution to the helium inventory. Lower values reported in these regions are generally interpreted to be diluted by the crustal He reservoir. Most areas of the east of Walker Lane have much lower $R_a$ values, implying up to 14% mantle-derived helium (notable exception: the Valles Caldera). Somewhat enigmatic are areas of tectonically quiescent sedimentary basins flanking the Cordillera (Alberta basin, Kansas-Hugoton basin, and Bravo Dome) that have elevated $R_a$ values perhaps indicative of long-term storage of mantle-derived helium.

In order to test for a direct relationship between helium isotopic composition and underlying mantle velocity, we plotted all regional helium isotopic values reported herein versus the relative P-wave mantle velocity (Fig. 4). The velocity structure used is a compilation of P-wave tomographic studies and a shear-wave velocity model for the western United States at 100 km (Dueker et al., 2001; Humphreys et al., 2003). The highest $R_a$ values show a good correlation with mantle velocity ($r^2 = 0.83$). The correlation omits points from Cascadia, where the velocity model reflects subduction of the oceanic slab, not the state of the North American lithosphere. Points with lower $R_a$ in each velocity domain (resolved to 0.25%) are also not included in the correlation because these data can be explained by admixture of mantle and crustal He.

MOVEMENT OF MANTLE-VOLATILES THROUGH MAGMATISM AND ACTIVE FAULTING

There is evidence that mantle volatiles can be precursors to more obvious tectonic or magmatic activity. For example, cold springs at Three Sisters, Oregon, show anomalously high CO$_2$ and $R_a$ values (Evans et al., 2004), and forest kills at Mammoth Mountain were correlated with increased CO$_2$ emissions linked to changes in magmatic activity (Evans et al., 2002; Farrar et al., 1995). Several lines of evidence can also be used to infer that volatiles are conveyed from the middle crust to the surface via seismogenic processes: the association of travertine and travertine-depositing springs with basement-penetrating faults suggests that the faults serve as fluid conduits and that spikes in mantle helium exist in active springs along fault zones (e.g., San Andreas, Walker Lane); monitoring at tectonically active areas shows that the movement of CO$_2$ and mantle helium correlate with seismicity. Helium isotopes showed a rapid response to earthquake swarms at Mammoth Mountain; increases in mantle contribution correlate to magmatically driven seismic swarms (e.g., Sorey et al., 1993). Also, Kulonogoski et al. (2005) concluded that mantle helium found in groundwaters of the Morongo Basin east of the San Andreas fault moved via deeply penetrating faults. They cite no evidence for active magmatism in the area and speculate that episodic seismicity and associated hydrofracturing drive volatile transfer from the mantle to the crust.

Table 2. Summary of Helium Isotopic Ratios and Percent Mantle Contribution for Key Tectonic Provinces of Western North America

<table>
<thead>
<tr>
<th>Tectonic region</th>
<th>$R_a$ range</th>
<th>Mantle contribution</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascade volcanoes</td>
<td>2.2–8.1</td>
<td>28–100%</td>
<td>Craig et al., 1978; Evans et al., 2004; Welhan et al., 1988</td>
</tr>
<tr>
<td>Canadian Cordillera</td>
<td>0.06–6.5</td>
<td>0.5–80%</td>
<td>Clark and Phillips, 2000; Hyagon and Kennedy, 1992</td>
</tr>
<tr>
<td>San Andreas fault zone</td>
<td>0.1–4.0</td>
<td>1–50%</td>
<td>Jenden et al., 1988; Kennedy et al., 1997; Kulonogoski et al., 2005; Poreda et al., 1986; Torgersen and Kennedy, 1999</td>
</tr>
<tr>
<td>Salton Trough</td>
<td>6.3</td>
<td>75%</td>
<td>Welhan et al., 1988</td>
</tr>
<tr>
<td>Walker Lane</td>
<td>0.4–7.0</td>
<td>5–88%</td>
<td>Hilton, 1996; Sorey et al., 1993; Welhan et al., 1988</td>
</tr>
<tr>
<td>Great Basin</td>
<td>0.14–0.25</td>
<td>1–3%</td>
<td>Welhan et al., 1988</td>
</tr>
<tr>
<td>Colorado Plateau/Rocky Mountains</td>
<td>0.07–0.80</td>
<td>0.5–10%</td>
<td>Caffee et al., 1999; Crossey et al., 2006</td>
</tr>
<tr>
<td>Arizona Transition Zone</td>
<td>0.1–1.2</td>
<td>1–14%</td>
<td>Kennedy and van Soest (unpub.); this study</td>
</tr>
<tr>
<td>Valles Caldera</td>
<td>0.8–6.0</td>
<td>10–75%</td>
<td>Golf and Janik, 2002</td>
</tr>
<tr>
<td>Rio Grande rift</td>
<td>0.09–0.65</td>
<td>1–7%</td>
<td>Kennedy and van Soest (unpub.); this study</td>
</tr>
<tr>
<td>Bravo Dome gas (NE New Mexico)</td>
<td>0.3–4.3</td>
<td>3–53%</td>
<td>Ballentine et al., 2005; Caffee et al., 1999</td>
</tr>
<tr>
<td>Great Plains gas fields</td>
<td>0.06–0.69</td>
<td>0.5–8%</td>
<td>Ballentine et al., 2000, 2001; Ballentine and Sherwood Lollar, 2002; Hyagon and Kennedy, 1999</td>
</tr>
</tbody>
</table>

Figure 2. He-Ar$_N$ plot (after Giggenbach, 1992) for travertine-spring gases from the Rio Grande rift, Arizona Transition zone, and the Grand Canyon (Crossey et al., 2006). He values are multiplied by 10 and $N_a$ is divided by 100 to allow for better viewing of the data, whereas the true gas ratios are preserved on the axes. Fields for crustal and/or mantle-derived gases, air, and air-saturated groundwater (asw) are from Giggenbach (1992).

LINKING MANTLE HELIUM TO TECTONICS

It is generally agreed that helium flux from the mantle is most pronounced during partial melting (Ballentine and Burnard, 2002) and that movement through the crust is aided by fracturing (e.g., Torgersen and O’Donnell, 1991), which is supported by the existence of mantle helium up to MORB values at volcanic centers and the association of mantle helium with travertine springs and faults (e.g., Kulonogoski et al., 2005). However, the presence of mantle helium in the Great Plains and Alberta Basin (Fig. 1), areas without recent
tectonism and with mantle seismic velocities that preclude significant partial melt in the mantle (Humphreys and Dueker, 1994), is enigmatic. This observation has led to the interpretation that mantle volatiles trapped in some gas reservoirs are millions of years old (e.g., Ballentine et al., 2001). Ballentine et al. (2001) argue that mantle helium and CO\textsubscript{2} present in parts of the Permian Basin were stored for ~300 m.y. and were derived from magma degassing associated with foreland extensional basins related to the Marathon thrust belt. However, the elevated R\textsubscript{A} values in other basins of the Great Plains do not correlate to nearby areas of magmatism nor to present-day partially molten mantle. Hiyagon and Kennedy (1992) suggest that fluids enriched in mantle volatiles entered these basins due to Laramide-to-recent compressional tectonics, a hypothesis supported by paleomagnetic studies (Enkin et al., 2000). Another explanation for the presence of mantle helium is that hydration above the Farallon slab during the Laramide orogeny may have introduced mantle volatiles that were stored in the lithosphere (Humphreys et al., 2003).

Abrupt (km- to 10-km-scale) mantle velocity transitions between velocity domains have been imaged by recent detailed tomographic studies (Dueker et al., 2001; Gao et al., 2004). The extent to which these transitions represent old compositional provinces, such as across paleosuture zones (Dueker et al., 2001; Karlstrom et al., 2005) versus active small scale asthenospheric convection (e.g., Gao et al., 2004), remains a first-order problem in understanding the western U.S. mantle and lithosphere-asthenosphere interactions. Perhaps the velocity transition beneath the western Great Plains (Fig. 1, light blues to greens, marked by white dashed line) is linked to the presence of mantle volatiles in basins, reflecting convective heat loss as the mantle starts to heat but before it melts. Mantle-derived helium may be a harbinger of mantle tectonism, hinting at slow eastward warming and subsequent dismemberment of the old, cold keel of the North American plate.

**LINKS BETWEEN MANTLE DEGASSING AND WATER QUALITY**

During the ascent of fluids carrying mantle-derived volatiles, rock-fluid interaction occurs, as does mixing between shallow groundwater, basement fluids, and sedimentary basin brines. Evidence for mixing along flow-paths exists in the geochemical data from travertine-depositing springs in the Rio Grande rift and Colorado Plateau. Data show mixing of saline and dilute end members that potentially relates to local tectonic province (Fig. 2). In the Grand Canyon, radiogenic \(^{87}\text{Sr}/^{86}\text{Sr}\) ratios derived from Precambrian basement show simi-
lar mixing trends between deep and shallow waters (Crossey et al., 2006). Thus, these springs are the surface expression of groundwaters altered by complicated mixing pathways as well as the introduction of mantle-derived fluids, and we argue that these processes are occurring within groundwaters throughout the western United States. Our data show that CO$_2$-charged groundwaters carrying mantle volatiles are saline, of poor quality, and are elevated in trace metals, such as arsenic (Tables DR2 and DR3 [see footnote 1]).Arsenic contents were found to exceed the U.S. drinking water standard of 10 ppb in some springs (EPA, 2004). These results are similar to travertine-spring data reported from the Grand Canyon, where springs are often saline and have arsenic and uranium contents of several parts per million (Crossey et al., 2006; Monroe et al., 2005). Rio Grande surface water quality degrades from north to south, as traced by increasing salinity, a trend often attributed to effects of agriculture and evapotranspiration. But based on water chemistry and conservative tracers, it has been suggested that the upwelling of deep sedimentary basin brines at the terminus of Rio Grande rift basins is degrading downstream water quality (Phillips et al., 2003). However, our findings show that the mixing of basin brines alone cannot explain the spring geochemistry. Groundwater in the Albuquerque basin varies widely in composition and quality (Plummer et al., 2004), and travertine-depositing springs, we show that mantle degassing may be associated with a diffuse degrada- tion of water quality in western U.S. aquifers. Understanding the controls on water quality in this region will continue to be a priority because of increasing population, periodic drought, and rapidly depleting high-quality groundwater resources.

**ACKNOWLEDGMENTS**

We thank Mack Kennedy and Matthijs van Soest from the Center for Isotope Geochemistry, Lawrence Berkeley National Laboratory, for releasing to us their unpublished helium isotopic data for springs in New Mexico and southern Colorado, which are reported herein. Viorel Atudorei, University of New Mexico (UNM) Department of Earth and Planetary Sciences, provided invaluable support in measuring carbon isotopic values in our spring gases. Funding for this research was partially provided by National Science Foundation grant EAR-0301232 (to Crosskey and Fischer) from the Hydrologic Sciences Program, by the National Science Foundation Integrative Graduate Education and Research Traineeship program (to Newell), and a grant from the New Mexico Water Resources Research Institute (to Newell). Reviews from Ken Duerer and three anonymous reviewers, and editorial assistance from Gerry Roos, greatly improved this manuscript. We also thank UNM undergraduates April Lyons, Eileen Embir, and Christopher Cox for their assistance in data compilation and GIS support.

**REFERENCES CITED**


The 2005 GSA Annual Meeting in Salt Lake City provided a large and diverse terrain for field trips—from the Basin and Range to the Rocky Mountains, from the Snake River Plain, across the Colorado Plateau, to the Mojave Desert. This volume contains 22 field trip articles. All combine the latest research with useful road logs to spectacular and often classic geologic settings. The regional tour has a core of structure and stratigraphy-paleontology contributions, and is rounded off with volcanic, glacial, lacustrine, fluvial geomorphology, neotectonic, geologic hazard, and geoarchaeology articles.

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GSA Field Guide 6

Edited by Joel L. Pederson and Carol M. Dehler

The 2005 GSA Annual Meeting in Salt Lake City provided a large and diverse terrain for field trips—from the Basin and Range to the Rocky Mountains, from the Snake River Plain, across the Colorado Plateau, to the Mojave Desert. This volume contains 22 field trip articles. All combine the latest research with useful road logs to spectacular and often classic geologic settings. The regional tour has a core of structure and stratigraphy-paleontology contributions, and is rounded off with volcanic, glacial, lacustrine, fluvial geomorphology, neotectonic, geologic hazard, and geoarchaeology articles.

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www.geosociety.org
Call for Proposals

Keynote Symposia and Topical Sessions

The 2006 GSA Annual Meeting in Philadelphia, Pennsylvania, comes at a time when energy shortages and recent catastrophic earthquakes, tsunamis, and hurricanes have dramatically demonstrated the importance of earth science in everyday life. Increased recognition by society of the immediacy of earth processes adds incentive to the obligation of the earth science profession to communicate our perspective to policymakers and the general public. How can we utilize new technologies and approaches to meet the increasing demands on earth scientists? What information gaps need to be addressed to advance our understanding of earth systems? How can new advances and interdisciplinary synthesis help our understanding of complex earth systems and their interplay with society?

You can play a key role in answering these and many other questions by proposing a topical session or Pardee Symposium for the 2006 meeting. Help make this a dynamic meeting where we grow and meet the increasing demands on earth science by exchanging a wide range of ideas through topical sessions.

Proposal deadline: 10 January 2006
Submit proposals at www.geosociety.org

Have you ever been frustrated to find that none of the topical sessions at a GSA meeting represents your own current area of research and excitement? If so, there is an easy answer: propose a session yourself! The topical sessions and Pardee Symposia at GSA meetings are planned entirely by your friends and colleagues. If these sessions do not adequately reflect your own interests, your voice is needed. Please plan to participate in the design of the meeting by submitting a session proposal. The reward is great: you play a direct role in attracting key people to the meeting and in formulating part of the program that will be of direct benefit to you. Yours might even be the session that leaves everyone talking in the corridors and the bars or even on the evening news! You may also be well on your way to producing the next GSA Special Paper.

Program Opportunities

The annual meeting program structure offers opportunities for effective and dynamic program building, allowing a mixture of invited and volunteered papers and different session formats. Joint Technical Program Committee (JTPC) representatives from GSA Divisions play a sizeable role in decisions. Please read the various program options and guidelines at www.geosociety.org carefully before submitting a proposal of one of two types:

Pardee Keynote Symposia, made possible by a grant from the Joseph T. Pardee Memorial Fund, are special events of broad interest to the geoscience community. Topics appropriate for these symposia are those that are on the leading edge in a scientific discipline or area of public policy, address broad, fundamental problems, are interdisciplinary, or focus on global problems. The primary criterion for selection is excellence; selection is on a competitive basis. All speakers will be invited, and each convener is provided with a budget of US$2,000. We strive for a good mix of Pardee Keynote Symposia of interest to GSA and Associated Society members. Topical sessions promote the exchange of timely or state-of-the-art information with respect to a focused topic and allow scheduling of interdisciplinary talks that bear on a specific topic. Organizers (advocates) may invite specific papers to ensure an excellent and successful session and are encour-
Building on a Foundation of Discovery

aged to solicit volunteered contributions. A maximum of four invited speakers may be allowed. Sessions will include a mix of invited and volunteered abstracts. All approved topical sessions will be promoted in *GSA Today*. Topical sessions must receive a minimum of 12 abstracts to be part of the technical program. Advocates are encouraged to submit their proposals as poster sessions to accommodate the growing technical program. All session proposals are reviewed by the JTPC.

**Oral and Poster General Sessions**

Consisting entirely of volunteered papers, these sessions are an important component of the GSA Annual Meeting. The number of abstracts received determines the number of general sessions in each discipline. The goal of the technical program chair and JTPC representatives is to provide presenters the best possible opportunity for communicating new scientific information rather than to dictate what can or will be presented. To allow for well-attended, dynamic sessions, an effort will be made in scheduling to avoid overlap of poster and oral sessions in the same discipline.

**Hot Topics**

The focus of these popular lunchtime forums, held Sun.–Wed., is on discussion, with plenty of audience participation. Depending on the subject, a debate format is recommended, and panels are discouraged. Each session must have a moderator. Titles should be catchy and provocative. If you are interested in organizing a session, contact Nancy Carlson, ncarlson@geosociety.org.

**Public Forum**

The GSA Public Forum is an educational outreach program that extends the value of geoscience research into the GSA Annual Meeting host community. An evening presentation is promoted locally and is free to the public. Topics are of interest to the general science-reading community and are presented in nontechnical terms for the broadest level of scientific understanding. If you have an idea for a Public Forum, please contact Christa Stratton, cstratton@geosociety.org.

**Make Yours the Session Everyone Talks About**

Topical session organizers have the ability to ensure program excellence and success through topical sessions, with their combination of invited speakers and volunteered papers, and through Pardee Keynote Symposia, which expand the opportunity for high-profile sessions on important developments that have an impact on our science.

We look forward to working with you to make the 2006 GSA Annual Meeting dynamic and stimulating for all GSA and Associated Society members, as well as appealing to a wide audience. If you have any questions or concerns regarding the program, please call or e-mail.

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gieg@sas.upenn.edu

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fns@sas.upenn.edu

**Technical Program Chair**

Rob Young  
+1-828-227-3822  
ryoung@wcu.edu

We welcome proposals for Pardee Keynote Symposia and topical sessions. Submit proposals electronically on or before **10 January 2006**, via the link at [www.geosociety.org](http://www.geosociety.org).

**Propose a Session: Who Knows Where It Could Lead?**

When you organize a session, you can help ensure that your area of expertise gets exposure through meeting attendees, the widely cited *Abstracts with Programs* volume, media attention, or even a resulting GSA Special Paper. Propose a session. Then watch your efforts unfold as abstracts are submitted and your initiative becomes part of science history.

**PHILADELPHIA 2006 DATES AND DEADLINES**

**10 Jan. 2006**  
• Proposals due by midnight (PST).  
**Electronic submission required.**

**April 2006**  
• Electronic abstract form posted at [www.geosociety.org](http://www.geosociety.org).  
• First announcement in April *GSA Today*.  
• 2nd announcement in June *GSA Today*.  

**12 July 2006**  
• Abstracts due by midnight (PST).  
• Technical program schedule finalized.

Accepted abstracts will be posted at [www.geosociety.org](http://www.geosociety.org) in mid-August, with links to speakers and titles.
NORTHEASTERN

41st Annual Meeting
Northeastern Section, GSA
Radisson Penn Harris Hotel and Conference Center
Camp Hill/Harrisburg, Pennsylvania

20–22 March 2006
www.geosociety.org/sectdiv/northe/06nemtg.htm

The 2006 meeting of the GSA Northeastern Section will be joined by the Association for Women Geoscientists, the Pander Society, the Northeastern Section of the Paleontological Society, and the Eastern Section of the Society for Sedimentary Geology. Hosts are geoscientists from Dickinson College, Bloomsburg University, Franklin and Marshall College, Harrisburg Area Community College, Harrisburg Area Geological Society, Pennsylvania Geological Survey, Susquehanna University, and the U.S. Geological Survey. The meeting will be at the Radisson Penn Harris Hotel and Convention Center in Camp Hill, Pennsylvania, just across the Susquehanna River from downtown Harrisburg. We will meet in the heart of the classic Appalachian Ridge and Valley Province, in proximity to the Mesozoic basins and Piedmont in Pennsylvania.

MEETING REGISTRATION

Standard registration deadline: 13 February 2006
Cancellation deadline: 20 February 2006

GSA Headquarters will handle all registration. Please REGISTER ONLINE (www.geosociety.org/sectdiv/northe/06nemtg.htm), or you can download the paper registration form (PDF format). If you are unable to register this way, please contact GSA Sales and Service at +1-888-443-4472 or +1-303-357-1000, option 3. On-site registration will be in the Radisson Penn Harris Conference Center Lobby.

Registration Fees

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<th>Standard</th>
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On-site Registration and Standard Registration Badge

Pickup Schedule

Radisson Penn Harris Conference Center Lobby

Sunday, 19 March 4–8 p.m.
Monday, 20 March 7 a.m.–5 p.m.
Tuesday, 21 March 7 a.m.–5 p.m.
Wednesday, 22 March 7–11 a.m.

Register early to qualify for lower registration fees. Costs will increase after 13 Feb. 2006. Full payment MUST accompany the registration form. Members of GSA and the GSA Associated Societies listed on the registration form (see www.geosociety.org/sectdiv/northe/06nemtg.htm) receive registration discounts. Registration is required for those attending technical sessions, field trips, short courses, and the exhibits hall. Guest registration is intended for nongeologist spouses or friends and does not include attendance at technical sessions, field trips, or short courses. Students and K–12 teachers must show a current ID at check-in to obtain special rates.

Register only one person per form and retain a copy for your records. GSA will be distributing all badges at the meeting registration desk, so badges will NOT be mailed to you prior to the meeting.

CANCELLATIONS, CHANGES, AND REFUNDS

All requests for additions, changes, and cancellations must be made in writing to GSA Headquarters and received by 20 Feb. 2006. There will be no refunds for cancellations received after this date, and no refunds for on-site registration, the Abstracts with Programs book, and on-site ticket sales.

ACCOMMODATIONS

A large block of rooms at a special rate of US$102 per night, excluding tax, has been reserved at the Radisson Penn Harris Hotel and Conference Center, 1150 Camp Hill Bypass, Camp Hill, PA 17011-3734, USA. This rate is the same for up to four persons per room. Attendees are responsible for making their own room reservations, which can be made by calling the Radisson Penn Harris Hotel at +1-717-765-7117 or +1-800-333-3333. You MUST identify yourself as attending the Northeastern GSA meeting to get the discounted room rates.

Conference organizers have attempted to keep costs as low as possible. In doing so, we have anticipated filling our reserved room block at the Radisson Penn Harris Hotel as a way of minimizing meeting room costs. Please help us meet our budget, and make your own stay less hectic, by staying at the Radisson Hotel. If you stay at the Radisson Hotel, but do not reserve a room through the Radisson reservation phone numbers above, please make this known to Noel Potter so that we may count your room toward the room quota.

Accommodations for Registrants with Special Needs

GSA is committed to ensuring full participation for conference attendees with disabilities at all events. Every attempt is made for full compliance with the Americans with Disabilities Act. If you have special requirements, please check the appropriate box on the meeting registration form. For more information, please contact Noel Potter (pottern@dickinson.edu) or the Radisson Penn Harris Hotel. A limited number of especially accessible hotel rooms are available and can be reserved when making your reservation, but this is best done early. Requests for special accommodations should be received by 13 Feb. 2006.
DIRECTIONS
The Radisson Penn Harris Hotel and Convention Center is located at 1150 Camp Hill Bypass in Camp Hill, just across the Susquehanna River from downtown Harrisburg via the Harvey Taylor Bridge: exit at Erford Road and turn south to the hotel. From the Pennsylvania Turnpike, use Exit 236 and follow US-15 north to the hotel; from the south on I-81, use Exit 59 to PA-581, and then exit north to Camp Hill via US-15 to the hotel; from the northeast on I-81, use Exit 65 south (Enola), and follow US-15 through four lights (~4 miles), turn right at the fifth light (Walnut Street), and go straight through two more lights to the hotel, which will be on the right.

Harrisburg is served by long-distance bus lines (Trailways and Greyhound) and Amtrak rail. Harrisburg International Airport is 10 miles (16 km) south of Harrisburg, and rental cars and taxis are available there. The Radisson provides complimentary van service to and from Harrisburg International Airport and the Harrisburg Amtrak station.

ABSTRACTS
Abstract submission deadline: 13 December 2005
Abstracts can be submitted for theme and general discipline sessions in both oral and poster format. Volunteered papers are considered for any general discipline or theme session as listed on the GSA abstracts form. An individual may be presenter for only one volunteered paper (except for symposia and invited papers for theme sessions) but may be co-author on any number of abstracts. Those invited for symposia may present an additional paper. If you have questions regarding your abstract, please contact Nancy Carlson, ncarlson@geosociety.org. Papers based on undergraduate research will be identified as such in the program, and both oral and poster papers by undergraduates will be merged with other papers on related topics.

ORAL SESSIONS
Except in special sessions, speakers will have 15 minutes for presentation and 5 minutes for discussion. One laptop computer using Windows XP (no Macs available) and PowerPoint 2003, one LCD projector, and one screen will be provided for all oral sessions. Speakers may not use their own laptop computers for presentations. If a Mac was used to produce the presentation, the speaker should run it on one of the ready-room laptops to see if it works properly. Slide projectors, overhead projectors, and multiple screens will not be available. If you have any special requests you MUST contact the AV coordinator, Duane Braun, dbraun@bloomu.edu, by 20 Feb. 2006. PowerPoint presentations may be e-mailed in before or during the meeting or brought on CD or USB memory stick to the AV technician in the speaker ready room, Radisson Penn Harris Convention Center, Keystone Room A. Detailed instructions on how to load a presentation will be e-mailed to presenters with abstract acceptance notices.

POSTER SESSIONS
Poster sessions allow at least three hours of display time. Presenters must be present for two hours of that time. All posters must fit on a single 8' × 4' display board. Electrical and network connections will not be available. Display boards will accommodate either Velcro or push pins.

TECHNICAL PROGRAM SCHEDULE
Symposium
3. Foraminiferal Relevance in Marine Geology. Sponsored by SEPM. Jennifer E. Newcomb, senewcomb@earthlink.net, +1-301-622-0177; William R. Brice, University of Pittsburgh at Johnstown, wbrace@pitt.edu, +1-814-269-2942.
4. History of Geology: Evolution of Thought Regarding the Appalachians. Sarah E. Newcomb, senewcomb@earthlink.net, +1-301-622-0177; William R. Brice, University of Pittsburgh at Johnstown, wbrace@pitt.edu, +1-814-269-2942.
5. Forensic Geology: Practical Geologic Experiences that Helped CSIs. Susan D. Halsey, Admiral Coastal Consulting, dru.dunenj@aol.com, +1-609-731-6380.
6. Palaeosol Environments from Across the Landscape. Sponsored by Eastern Section, Society for Sedimentary Geology (SEPM). Jennifer Elick, Susquehanna University, elick@susqu.edu, +1-570-372-4214; Todd D. Grote, Shippensburg University, tdgrot@ship.edu, +1-717-477-1509.
7. From Pleistocene to Present: Landscape Dynamics of the Susquehanna River Basin and Chesapeake Bay. Chris Williams, Franklin and Marshall College, chris.williams@fandm.edu, +1-717-291-3814.
8. Seismology of the Northeastern United States and Eastern Canada. John E. Ebel, Weston Observatory, Boston College, ebel@bc.edu, +1-617-552-3399; Frank A. Revetta, State University of New York at Potsdam, revettfa@potsdam.edu, +1-315-267-2289.
9. **Bringing Geoscience to the Community.** Laura Guertin, Pennsylvania State University–Delaware County, uxp3@psu.edu, +1-610-892-1427.

10. **New Developments in the Late Quaternary History and Climate of the Northeastern United States and Eastern Canada.** Robert Dineen, Pennsylvania Department of Transportation, eskers@aol.com, +1-610-286-2888.

11. **Time Slices Across the Appalachians: Tectonic and Depositional Settings of Cambro-Ordovician Rocks in the Appalachian Orogen.** Craig Dietsch, University of Cincinnati, craig.dietsch@uc.edu, +1-513-556-2547.

12. **Time Slices Across the Appalachians: Tectonic Settings of Silurian-Devonian Igneous Rocks in the Appalachian Orogen.** Sandra Barr, Acadia University, sandra.barr@acadiau.ca, +1-902-585-1340; Cees van Staal, Geological Survey of Canada, Ottawa, cvanstaa@nrcan.gc.ca; David Gibson, University of Maine–Farmington, dgibson@maine.edu, +1-207-778-7402; John Hogan, University of Missouri–Rolla, jhogan@unr.edu, +1-573-341-6935; David West, Jr., Middlebury College, dwest@middlebury.edu, +1-802-443-3476.

13. **Time Slices Across the Appalachians: Role of the Rhei Ocean in the Development of the Appalachian Orogen.** Damian Nance, Ohio University, nance@ohio. edu, +1-740-593-1107; Duncan Keppie, Universidad Nacional Autónoma de México, duncan@servidor.unam.mx, +1-525-622-4288.


16. **Applied Hydrogeology and Environmental Geology for the 21st Century.** Martin Helmke, West Chester University, mhelmke@wcupa.edu, +1-610-436-2727.

17. **Successes in K–16 Geoscience Education (POSTERS ONLY).** Jeb Baxter, Harrisburg Area Community College, jebaxter@hacc.edu, +1-717-780-2395; Ron Dowey, Harrisburg Area Community College, radowey@hacc.edu, +1-717-780-2393.


19. **Metamorphic Rocks and Shear Zones: Stitching Together Appalachian Terranes.** Gary Solar, Buffalo State University, solargs@bscmail.buffalostate.edu, +1-716-878-4900; David Valentino, State University of New York at Oswego, dvalenti@oswego.edu, +1-315-312-2798.

20. **Issues with Acid Mine Drainage in the Appalachians.** Ryan Mathur, Juniata College, mathur@juniata.edu, +1-814-641-3725; Duff Gold, Pennsylvania State University, gold@ems.psu.edu, +1-814-865-7261.


22. **Contaminants in Groundwater and Surface Water of the Northeast: From Arsenic to Xylene.** Steve Peters, Lehigh University, scp2@lehigh.edu, +1-610-758-3957.


**SHORT COURSES AND WORKSHOPS**

Attention is limited at the short courses and workshops listed below, so please register early to assure a space. For more information, contact the short course leader or short course coordinator, Noel Potter, pottern@dickinson.edu.

1. **Measurement of Indoor Radon.** Sat.–Sun., 18–19 Mar., 9 a.m.–5 p.m., Radisson Penn Harris Convention Center. Douglas Mose, George Mason University, dje42@aol.com, +1-703-273-2282; George Mushrush, George Mason University, Optional exam to earn a Radon Measurement Specialist Certificate: US$150.

   This course provides hands-on training to understand, anticipate, and measure geologically dependent indoor radon and waterborne radon. The course is for teachers and researchers, and an optional end-of-course exam earns a Radon Measurement Specialist Certification (National Radon Safety Board, www.nrsb.org). The certificate is required by federal and state regulatory agencies to list individuals authorized for employment as home inspectors in the real estate market. Min.: 5; max.: 25. Prerequisite: general knowledge of soil and hydrology. Fee: US$350, includes course manual and lunches.

2. **Making Digital Movies for Earth Science Classes.** Sat., 18 Mar., 9 a.m.–noon, Radisson Penn Harris Convention Center. Jennifer Elick, Susquehanna University, elick@susqu.edu, +1-570-372-4214.

   Have you ever wanted to use video from geologic field trips to illustrate important concepts, principles, or to highlight interesting features for your earth science classes? This short course will help you organize and edit new and old video into geoscientific movies using Macintosh computers. You will learn how to add text, voice-over, and sound, capture underwater video, add video microscopy, and provide useful illustrations that help explain geologic features in your video. Bring a video camera if you own one. Min.: 10; max.: 20. Cost: US$12.

3. **Academic Careers and Academic Job Searches in the Geosciences: A Workshop for Graduate Students and Post-Docs.** Sat., 18 Mar., 1–5 p.m., Radisson Penn Harris Convention Center. R. Heather Macdonald, College of Williams and Mary, rhmcd@wm.edu, +1-757-221-2443;
This workshop is designed for graduate students and post-doctoral fellows interested in academic careers. We will discuss characteristics of academic careers in different types of institutions, the academic job search process (including applications, interviews, and teaching statements), and strategies for preparing for the next career stage. This workshop is part of the professional development program, On the Cutting Edge: http://serc.carleton.edu/NAGTWorkshops/, which is sponsored by the National Association of Geoscience Teachers. Min.: 15. Cost: US$15.

4. Effective and Innovative Course Design in the Geosciences. Sun., 19 Mar., 9 a.m.–4 p.m., Radisson Penn Harris Convention Center. Barbara J. Tewksbury, Hamilton College, btewksbu@hamilton.edu, +1-315-659-4713; R. Heather Macdonald, College of William and Mary, rhmacd@wm.edu, +1-757-221-2443.

This one-day workshop will focus on a goals-based approach to course design. The workshop will guide participants through the goal-setting phase with an emphasis on goals that promote higher order thinking skills on the part of students. The workshop will also help participants begin the process of choosing content, selecting teaching strategies, and designing student activities, assignments, and assessments to insure that students meet those goals. This workshop is part of the professional development program, On the Cutting Edge: http://serc.carleton.edu/NAGTWorkshops/, which is sponsored by the National Association of Geoscience Teachers. Min.: 15. Cost: US$30. Lunch on your own.

OTHER SHORT COURSES/WORKSHOPS


In this two-day course, a panel of experts selected by PCPG will provide a focused review of the subjects most strongly emphasized on the Pennsylvania Professional Geologist Licensing Examination and those most applicable in practice of the science. This course is independent of the GSA Northeastern Section short courses listed above, but is offered concurrently. Registration and logistics are being handled by PCPG. See course details at www.pcpg.org.

K–12 TEACHERS PROGRAM

In addition to the special K–12 teachers field trip to a quarry (trip 5: “From Rocks to Roads”), the following workshops will be offered on Sat., 18 Mar. (two in the morning and two in the afternoon), on the Harrisburg Area Community College (HACC) campus and at Penn Center, about a mile away from HACC. Location details will be sent to registrants. The K–12 teachers program is supported in part by a grant from the HACC Foundation. The cost for two workshops (one morning, one afternoon) is US$20. Lunch will be on your own at locations suggested by workshop instructors.

Note: K–12 teachers are urged to submit papers and participate in Theme Session 17: Successes in K–16 Geoscience Education (POSTERS ONLY).

5. Caught in the Web of Geospatial Technology. Sat., 18 Mar., 9–11 a.m. Jeb Baxter, jebaxter@hacc.edu, +1-717-780-2395; Nicole Ernst, nlernst@hacc.edu, +1-717-780-2395. Penn Center. Min.: 5; max.: 18.

Teachers will be introduced to basic geospatial technology concepts, learn where to find Web-based geospatial resources, and use the existing Web-based global information system.


Teachers will be shown Web-sourced geologic maps and be taught how to interpret and use these resources in their classrooms.

7. Introduction to ArcGIS. Sat., 18 Mar., 1–3 p.m. Jeb Baxter, jebaxter@hacc.edu, +1-717-780-2395; Nicole Ernst, nlernst@hacc.edu, +1-717-780-2395. Penn Center. Min.: 5; max.: 18.

This workshop will introduce teachers to basic global information system (GIS) principles and acquaint them with ArcGIS and ArcExplorer software packages.

8. Web-Based Laboratory Exercises. Sat., 18 Mar., 1–3 p.m., Jeb Baxter, jebaxter@hacc.edu, +1-717-780-2395; Ron Dowey, radowey@hacc.edu, +1-717-780-2393. Harrisburg Area Community College. Min.: 10; max.: 20.

Teachers will be introduced to various Web-based laboratory exercises such as Virtual Earthquake and virtual field trips.

FIELD TRIPS

All field trips will depart from and return to the front of the Radisson Penn Harris Convention Center. Field trip coordinators are Andy DeWet, andy.dewet@fandm.edu, and Zeshan Ismat, zeshan.ismat@fandm.edu, of Franklin and Marshall College, but for detailed information, please contact individual field trip leaders. Fees include transportation, guidebook, and, for all-day field trips, lunch.


Much of the central Appalachian region’s Cambro-Ordovician carbonate section is dolomitized or structurally deformed, but in York County, Pennsylvania, an exceptionally well-preserved microbial reef complex retains its original calcite mineralogy, revealing bedded microbial strata,stromatolites, and fibrous submarine cements filling a network of primary depositional cavities. Numerous features indicative of deposition on an active subtidal shelf margin will be shown (slump structures, truncation features, intraclast and breccia beds), and new mechanisms will be proposed to help interpret the formation and infill of the meter-scale cavities. Limit: 20. Cost: US$20 for professionals; US$15 for students.
Northeastern

2. **Pleistocene to Present Landscape and Stream Evolution in Lancaster County, Pennsylvania, and Implications for Restoring Streams.**
   Sun., 19 Mar., 8:30 a.m.–5 p.m. Dorothy Merritts; Bob Walter; Chris Williams; Andy de Wet, Franklin and Marshall College, andy.dewet@fandm.edu, +1-717-291-3815.

   We will explore the difference in magnitude between pre- and post-settlement landscape-forming processes and examine how they relate to stream evolution, modern sediment sources, and the long-term success of stream restoration efforts in Lancaster County. Limit: 40. Cost: US$50 for professionals; US$40 for students.

3. **Nappe Mechanics and Changing Tectonic Patterns in Lancaster County, Pennsylvania.**
   Sun., 19 Mar., 8:30 a.m.–5 p.m. Don Wise, University of Massachusetts at Amherst; dwise@geo.umass.edu, +1-423-253-5342; G. Robert Ganis, Consulting Geologist.

   This field trip will examine the tectonic style, transport, and development of Taconic nappe structures from central Lancaster County northwestward into Dauphin County. Excellent exposures in three quarries (Prospect, Rheems, and Steelton) will be visited as well as several classic localities, including Chickies Rock. Limit: 80. Cost: US$50 for professionals; US$40 for students.

4. **Karst Subsidence Problems along Bushkill Creek, Northampton County, Pennsylvania.**
   Sun., 19 Mar., 8:30 a.m.–5 p.m. Bill Kochanov, Pennsylvania Geological Survey, wkochanov@state.pa.us, +1-717-702-2033.

   This field trip will examine the karst geology of the area around the Bushkill and Schoeneck Creeks and discuss the incredible series of events starting in fall 2000 that resulted in the failure of two bridges as well as damage to the Bushkill and Schoeneck creeks and the local community of Brookwood; a classic case history. There will also be a stop in Hershey to examine an excellent exposure of Ordovician-aged carbonates and to visit Chocolate World. Limit: 40. Cost: US$50 for professionals; US$40 for students.

5. **From Rocks to Roads: The Geology of a Mineral Aggregates Quarry, Rohrer’s Quarry, Lancaster County, Pennsylvania (for K–12 Teachers).**
   Sponsored by Rohrer’s Quarry Inc. Sun., 19 Mar., 11:30 a.m.–4:30 p.m. Ron Dowey, Harrisburg Area Community College, radowey@hacc.edu, +1-717-780-2393.

   Teachers will travel to a limestone quarry, see its operation, learn about the many products of quarries, and learn the geologic processes that occurred to form the rocks as they are found today. We suggest that you bring a camera along on this trip; there will be plenty to photograph and take back to your students. Limit: 60. Cost: US$30, including lunch.

6. **A Sampling of Conodont-Bearing Strata in the Central Appalachians.**

   This trip will visit stops in the folded Appalachians, about a two-hour drive west of Harrisburg, in the following intervals: (A) upper Lower to Upper Ordovician, (B) Upper Silurian and Lower Devonian, and (C) upper Mississippian, with an opportunity to examine a broad variety of Laurentian carbonate lithofacies and collect conodont samples from these strata. Limit: 20. Cost: US$50 for professionals; US$40 for students.

7. **Acid Drainage Problems at Skytop, Pennsylvania.**
   Sun., 19 Mar., 8:30 a.m.–5 p.m. Duff Gold, Pennsylvania State University; Ryan Mathur, mathur@juniata.edu; Larry Mutti, Juniata College, Pennsylvania; Arnold Doden, GMRE, Inc., State College, Pennsylvania, +1-814-641-3725.

   On this trip, we will visit outcrops containing epigenetic and syngenetic pyrite (along with other sulfide minerals) in Paleozoic rocks between Lewistown and State College. The leaders will discuss how mineralization may have occurred and the current problems of and possible resolutions for these acid-generating rocks. Limit: 40. Cost: US$50 for professionals; US$40 for students.

SPECIAL EVENTS

**Northeastern Section GSA, Management Board Meeting.**
Sun., 19 Mar., 4–6 p.m.

**Opening Reception.**
Sun., 19 Mar., 6–8:30 p.m., Radisson Penn Harris Conference Center Ballroom South. The opening reception and nearby open exhibits will help start off the meeting. Snacks and cash bar; a ticket for your first beverage comes with registration. Come visit with friends and colleagues. The registration desk will be open until 8 p.m.

**Paleontological Society Luncheon and Business Meeting.**

**Plenary Session: Special Hot Topic Lecture—Mars Exploration Rovers: Latest Geology, Geochemistry, and Mineralogy Results.**
Mon., 20 Mar., 4–5 p.m., Ballroom North. Jim Bell of Cornell University will bring us the latest results from the NASA Mars Exploration Rover (Spirit and Opportunity) mission.

**Society for Sedimentary Geology (SEPM) Northeast Section Business Meeting.**
Mon., 20 Mar., 5–6:30 p.m. Free.

**GSA Northeastern Section Map Blast VIII.**
Mon., 20 Mar., 7–9:30 p.m. Informal session for display of newly published, unpublished, or in-progress geologic maps of any sort. All attendees are welcome to bring, post, and discuss ancient, recent, or planned mapping efforts. Radisson Hotel Ballroom South; cash bar.

**Association of Women Geoscientists Career Development Workshop Breakfast.**

**Conference Banquet.**
Tues., 21 Mar., 7–9 p.m., Radisson Hotel Ballroom North. All attendees invited! The meal will be a buffet; a cash bar will be open 6–7 p.m. in the ballroom foyer. Cost: US$30.

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THE GEOLOGICAL SOCIETY OF AMERICA
ACTIVITIES FOR STUDENTS

Roy J. Shlemon Mentor Program in Applied Geoscience. Sponsored by GSA Foundation. Mon.–Tues., 20–21 Mar., 11:30 a.m.–1 p.m.; Veranda Room, Radisson Penn Harris Hotel and Convention Center. Karlon Blythe, kblythe@geosociety.org. This is a chance for students to discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Plan to attend both free luncheons to hear different presenters each day. Students will receive FREE LUNCH tickets in their registration packet to attend both Shlemon Programs. However, space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

John Mann Mentors in Applied Hydrogeology Program. Sponsored by GSA Foundation. Mon., 20 Mar., 5–6:30 p.m. Veranda Room, Radisson Penn Harris Hotel and Convention Center. Karlon Blythe, kblythe@geosociety.org. This early evening event presents mentoring opportunities for undergraduate and graduate students and recent graduates with interest in applied hydrogeology or hydrology as a career to interact and network with practicing hydrogeologic professionals. This program is a focused, small-scale event that features a free pizza dinner for participants. Students will receive a ticket to attend the Mann Program event in their registration packets, but space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

STUDENT TRAVEL GRANTS

Application deadline: 1 March 2006

Travel grants are available from GSA’s Northeastern Section in cooperation with the GSA Foundation. Grants are available to undergraduate and graduate students who are GSA Members, currently enrolled in Northeastern Section schools, and are presenting oral or poster papers at this meeting. Applications are available online at www.geosociety.org or through Stephen Pollock, secretary-treasurer of GSA’s Northeastern Section, pollock@usm.maine.edu.

GUEST ACTIVITIES

Click on “Area Information” on the Radisson Penn Harris Web site, www.radisson.com/camphillpa, to view a wide variety of Web links to area attractions, including Harrisburg, Hershey, Lancaster County, and Gettysburg.

EXHIBITS

Reservation and payment deadline: 20 February 2006

Exhibits will be located in the Radisson Penn Harris Hotel and Conference Center Ballroom South. This space is centrally located with considerable exposure to meeting crowds. Exhibit rates are US$100 for nonprofit organizations and US$200 for others. Booth space will include an 8’ × 10’ space with draped framing, one table, one chair, and a header sign. Electricity is US$60 extra for the meeting. To reserve booth space and to make other arrangements, contact the exhibits coordinators: Michelle Curry, meshale13@netzero.net, or Anne Lutz, anlutz@state.pa.us.

SPONSORSHIP

The organizing committee is actively seeking sponsorship for this conference from government and corporate agencies. Sponsors will be recognized during the meeting and acknowledged in the printed program and on meeting Web sites. Those interested in sponsoring an event, AV equipment, coffee breaks, or making a donation to the general fund of the conference should contact Bob Ganis, treasurer, bobganis@aol.com.

CONTACT INFORMATION

More information can be found at the Dickinson College Department of Geology’s meeting Web site, www.dickinson.edu/public/geodept/departments/geol/negsa2006.htm, or by contacting the general meeting chair, Noel Potter, pottern@dickinson.edu.
Final Announcement and Call for Papers

SOUTHEASTERN

55th Annual Meeting
Southeastern Section, GSA
Knoxville, Tennessee

23–24 March 2006
www.geosociety.org/section/southe/06semtg.htm

LOCATION

Knoxville is situated in the Appalachian Valley and Ridge of east Tennessee, in a region that has been the cradle of geoscience research for over a century. Several fundamental concepts have resulted from local and regional research, but the southern Appalachians remains an area where fundamental contributions continue to be made. Knoxville is no more than an hour from sites of classic stratigraphic-sedimentologic, paleontologic, petrologic, and structural contributions. The region is one of the world’s former major zinc producers and is an area of active oil and gas exploration. There is a large geoscience community in the Knoxville–Oak Ridge area, with geoscientists employed by the University of Tennessee, Tennessee Division of Geology, Oak Ridge National Laboratory, Tennessee Department of Transportation, Tennessee Valley Authority (TVA), Tennessee Board of Regents community colleges, numerous environmental engineering companies, and small independent oil and gas producers.

The Knoxville metro area has a population of ~500,000, and the Department of Energy facilities in Oak Ridge, the TVA, and the university are the largest employers. A short driving distance from Knoxville are the Great Smoky Mountains National Park, Big South Fork National Recreation Area, the Cherokee National Forest, the Joyce Kilmer–Slickrock Wilderness Area, numerous state parks, and TVA reservoirs.

Weather in Knoxville in late March could be spring-like, or it could be more like late winter. We have already put in a request for good weather for all of the field trips so that everything goes well for the meeting.

CALL FOR PAPERS

Abstract Deadline: 5 January 2006

Papers are invited from students and professionals for oral and poster presentations in general discipline sessions, theme sessions, and symposia. Abstracts must be submitted online at the GSA Web site, www.geosociety.org. An abstract submission fee of US$10 will be charged. Only one volunteered paper may be presented by an individual; however, a person may be a co-author on other papers. Individuals invited to participate in symposia may present an additional volunteered paper.

REGISTRATION

Standard registration deadline: 20 February 2006
Cancellation deadline: 27 February 2006

Register online at the GSA Web site, www.geosociety.org. On-site registration will be available at the Marriott Hotel during the meeting.

Registration Fees

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CANCELLATIONS, CHANGES, AND REFUNDS

All requests for additions, changes, and cancellations must be received at GSA Headquarters by 27 February 2006. No refunds will be made on cancellation notices received after this date. Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card will be credited to the card identified on the registration form. No refunds will be available for on-site registration and ticket sales.

ACCOMMODATIONS

Hotel registration deadline: 28 February 2006

A block of rooms has been reserved at the Marriott Hotel at US$99 per night for 1–4 occupants. For reservations, please call the Marriott reservation line at +1-800-836-8031 and request a reservation under SEGSA 2006. The Marriott Hotel is located at 500 Hill Avenue SE, Knoxville, TN 37915. It is 20 minutes from McGhee-Tyson Airport, 45 minutes from Great Smoky Mountains National Park, and a short walk to the University of Tennessee, the Women’s Basketball Hall of Fame, and the Tennessee River riverfront walk. The Marriott has high-speed Internet capabilities, an on-site fitness center, an outdoor swimming pool, and two restaurants. Additional restaurants are located a short walk from the hotel.

TRANSPORTATION

Knoxville is located at the intersection of Interstates 75 and 40 in eastern Tennessee and has air transport through the McGhee-Tyson Airport. McGhee-Tyson receives more than 75 incoming flights a day and is served by Delta, American Eagle, United, Northwest Airlines, Continental, US Airways, and Independence Air. Car rental is available through Alamo, Avis, Budget, Enterprise, Hertz, National, and Thrifty. Taxi service is also available.

TECHNICAL PROGRAM

Oral Sessions: Oral presentations will be given in the convention headquarters Marriott Hotel. Conveners of all oral sessions are requested to keep their sessions on schedule. Each speaker will be allowed 20 minutes, which includes ~15 min for presentation and 5 min for questions.
Computer projectors will be provided for oral presentations. Personal laptops cannot be used for presentations. Authors should bring PowerPoint presentations on a CD-ROM or memory stick to the Speaker Ready Room at least 12 hours before their presentation. Zip drives will not be available.

**Poster Sessions:** Poster presenters have one 4-ft by 7-ft 5-inch horizontal (‘landscape’ view) display. Posters will be scheduled for half-day sessions. The use of tables is not encouraged, but can be arranged upon advance request at author cost. Electrical hookups will not be available; all computer equipment must be battery powered.

**Technical Sessions:** Symposia, theme sessions, and field trips scheduled as of 28 September are listed herein. Additional events may be accommodated. If you wish to propose an additional session, please contact technical and field trip program co-chairs Robert D. Hatcher, Jr., bobmap@utk.edu; William A. Thomas, University of Tennessee at Knoxville, wthomas@utk.edu; James C. Cobb, Kentucky Geological Survey, jamec.cobb@uky.edu; and Theodore C. Labotka, tlabotka@utk.edu. Updated session listings will be posted on the GSA Web site, www.geosociety.org.

**SYMPOSIAS**

1. **New Geochronologic and Isotopic Approaches to Constraining Appalachian Tectonics.** Sponsored by GSA Structural Geology Division. Bob Tracy, Virginia Tech, rtracy@vt.edu; Calvin Miller, Vanderbilt University, calvin.miller@vanderbilt.edu; Brent Miller, Texas A&M University, bvmiller@geo.tamu.edu.

   The development of focused geochronologic techniques, particularly in situ isotopic and non-isotopic methods and of new methodologies and approaches using isotopic tracers, has created new opportunities for constraining ages of deformatonal and thermal events and the origins of enigmatic terranes. This symposium will examine application of these methods to Appalachian tectonic problems.

2. **Frontiers of Appalachian Tectonics.** Sponsored by GSA Structural Geology and Tectonics Division. Robert D. Hatcher, Jr., University of Tennessee at Knoxville, bobmap@utk.edu; William A. Thomas, University of Kentucky, geowat@uky.edu.

   This symposium is intended to present state-of-the-art concepts related to both Appalachian foreland fold-thrust belt development and that of the more internal parts of the mountain chain. Several contrasting ideas have evolved recently about the timing of assembly of different components of the orogen. We hope to have all points of view represented to encourage discussion.

3. **Grenville Terranes of the Appalachians and Their Boundaries.** Sponsored by GSA Structural Geology Division. Mervin J. Bartholomew, University of Memphis, jbthlm1@memphis.edu; Carl E. Merschat, North Carolina Geological Survey, Carl.Merschat@ncmail.net.

   The theme of this symposium is to define and characterize dismembered terranes and their boundaries in the Grenville orogen, which are now found in the Appalachian orogen.

4. **Impacts in the Field.** Cosponsored by Planetary Geoscience Institute; GSA Planetary Geoscience Division. Keith A. Milam, University of Tennessee at Knoxville, kmilam@utk.edu.

   This symposium will focus on field investigations of impact craters in the south and elsewhere. Presentations that include discoveries, observations, sample analyses, and field techniques of terrestrial (and even nonterrestrial) impact craters are welcome.

5. **Paleontological Perspectives: A Symposium in Honor of Frank K. McKinney.** Sponsored by Paleontological Society. Steven J. Hageman, Appalachian State University, hagemans@appstate.edu.

   This symposium will consist of talks that deal with observations of modern living organisms and ecology that are applied to Paleozoic taxa-faunas (and vice versa). Traditionally, most invertebrate paleontologists who work on Paleozoic faunas are trained in geology programs where their introduction to Phanerozoic diversity is from a paleozoological perspective. When these workers are eventually exposed to living organisms in modern faunas (marine laboratories or on research cruises), they bring a perspective of morphology and ecology that is not necessarily shared by neobiologists observing paleontological data. The epiphany of bringing modern insights to Paleozoic organisms (and vice versa) by classically trained paleontologists has led to great advances in our understanding of changing ecosystems through the Phanerozoic.

6. **Symposium in Honor of Donald C. Haney.** John D. Kiefer, Kentucky Geological Survey, kiefer@uky.edu; James C. Cobb, Kentucky Geological Survey, cobb@uky.edu.

   This symposium will highlight two of the favorite endeavors of Don Haney: the role of geology in public policy and the National Cooperative Geologic Mapping Program.

7. **Magmatism in the Eastern U.S. and Beyond: A Symposium in Honor of Paul C. Ragland.** James S. Beard, Virginia Natural History Museum, james@vmnh.net; Harry Y. McSween, University of Tennessee–Knoxville, mcsween@utk.edu.

   This symposium is intended to honor the memory and career of Paul C. Ragland, whose research spanned the range of mafic and granitic rocks, petrology, and geochemistry. Papers will be welcome on any related topic suitable to honor Paul’s work and life.

**THEME SESSIONS**

**Oral Sessions**


   The goal of this session is to bring together research focused on the burial, uplift, and thermal history of the Appalachian basin. Tools used to determine these histories include fluid inclusions, apatite, and zircon fission tracks, and indicators of thermal maturity (e.g., vitrinite reflectance and CAD), as well as regional structure and
Southeastern stratigraphy. This fundamental knowledge of basin history provides a framework within which to study relations between tectonic activity, diagenesis, fluid flow, and hydrocarbon and mineral occurrences.

2. **Recent Advances in Western Blue Ridge Geology.** Sponsored by **GSA Structural and Tectonics Geology Division.** C. Scott Southworth, U.S. Geological Survey, ssouthwo@usgs.gov.

   This session will highlight new research on the stratigraphy, structure, metamorphism, paleontology, geochronology, and surficial processes of the western Blue Ridge province of Georgia, Tennessee, North Carolina, and Virginia.

3. **The Brevard Fault Zone: Physical Characteristics and New Perspectives.** Sponsored by **GSA Structural and Tectonics Geology Division.** Randy Kath, University of West Georgia, rkath@westga.edu; John Costello, Georgia Department of Natural Resources, john_costello@dnr.state.ga.us.

   Goals of this session are to define various characteristics within the Brevard fault zone from Alabama to North Carolina to better comprehend internal lithostratigraphy, structure, and the role of this conspicuous element in southern Appalachian orogen tectonic evolution. Topics including lithologic and mineralogic assemblages, morphologic and macro- to micro-scale structural characteristics, topographic-physiographic characteristics, and hydrogeologic and mineral-resource potential are welcome. Additionally, data from three new metro Atlanta-area tunnels (Nancy Creek—strike-parallel to the Brevard; Chattahoochee—nearly strike-perpendicular to the north; and Atlanta West Combined Sewer Overflow—nearly strike-perpendicular to the south) will be presented.

4. **Metamorphic Framework of the Southern Appalachians** Theodore C. Labotka, University of Tennessee at Knoxville, tlabotka@utk.edu.

   The emerging picture of metamorphism in the southern Appalachians is one of superposed events formed in high- to medium-pressure environments. Evidence for the metamorphic history is gathered from elemental and isotopic compositions of porphyroblasts and inclusions in porphyroblasts. The various data are to be assembled into a coherent framework of the metamorphic development of the Appalachians.

5. **Geology of the Cambro-Ordovician Section of the Southern Appalachian Basin.** Gary G. Bible, Miller Petroleum, tamia@nxs.net; Jeff Bailey, Tengasco Inc., jbailey@tengasco.com.

   The purpose of the session will be to discuss the structure, stratigraphy, reservoir characteristics, source rocks, and facies distribution of the Cambro-Ordovician carbonate section in the southern Appalachian basin. Presentations are sought that cover either the present development of oil and gas fields or exploration trends within the Cambro-Ordovician section.

6. **Origin, Evolution, and Resource Utilization of Planets and Planetesimals.** Cosponsored by **Planetary Geoscience Institute; GSA Planetary Geoscience Division.** James Day, University of Tennessee at Knoxville, jday13@utk.edu; Eddy Hill, University of Tennessee at Knoxville, ehill10@utk.edu; Yang Liu, University of Tennessee at Knoxville, yangl@utk.edu.

   This session will explore various approaches and techniques used in studies of carbonate sediment and rocks over the years. Modern investigations will be placed in their historical context to highlight recent advancements in carbonate sedimentology, stratigraphy, and diagenesis.

7. **New Views on Old Rocks: Insights on Biospheric Evolution from the Precambrian Sedimentary Record.** Cosponsored by **GSA Sedimentary Geology Division; Eastern Section, Society for Sedimentary Geology (SEPM).** Linda C. Kah, University of Tennessee at Knoxville, lckah@utk.edu; Chris Fedo, University of Tennessee at Knoxville, cfedo@utk.edu.

   This session will focus on both existing and emerging data sets that integrate sedimentologic and stratigraphic analysis with biological, geochemical, and chronological information to explore the evolution of the Precambrian biosphere. We welcome submissions of both local and global geographic focus.

8. **Carbonates Then and Now: How Much Has Changed? A Session in Honor of Kenneth R. Walker.** Cosponsored by **GSA Sedimentary Geology Division; Eastern Section, Society for Sedimentary Geology (SEPM).** Bosiljka Glumac, Smith College, bglumac@email.smith.edu; Stan Dunagan, University of Tennessee at Martin, sdunagan@utm.edu.

   This session will explore various approaches and techniques used in studies of carbonate sediment and rocks over the years. Modern investigations will be placed in their historical context to highlight recent advancements in carbonate sedimentology, stratigraphy, and diagenesis.

9. **Developing Approaches to Terrestrial Paleoclimatology.** Sponsored by **GSA Sedimentary Geology Division.** Claudia I. Mora, University of Tennessee at Knoxville, cmora@ut.edu.

   This session will consider the development and application of terrestrial climate proxies, including isotopic, sedimentologic, and tree-ring studies. We are particularly interested in presentations that consider the complex climate issues of the southeastern region, but encourage all related submissions.

10. **Karst Feature Distribution in the Southeastern Region.** Yongli Gao, East Tennessee State University, gaoy@mail.etsu.edu.

    Many active karst areas are located in the southeastern United States. This session focuses on understanding controls of karst feature distribution, groundwater flow in carbonate aquifers, and karst hazard assessment.

11. **Surficial Geology and Geomorphology in the Appalachians: Progress and Applications.** Hugh Mills, Tennessee Tech University, hmills@tntech.edu; Mike Clark, University of Tennessee at Knoxville, clarkgmorph@utk.edu.

    This theme session seeks to highlight recent developments in surficial geology and geomorphology in the Appalachian region, in particular applications of these fields to practical problems, including landslide hazards.
12. **Landslides and Rock Falls—Investigation, Analysis, and Remedial Action.** Harry Moore, Tennessee Department of Transportation, harry.moore@state.tn.us; Vanessa Bateman, Tennessee Department of Transportation, vanessa.bateman@state.tn.us.

Presentations on landslides and rock fall events and their effects on highways and other man-made structures as well as the natural landscape are welcome. In addition, presentations on remedial projects that involve landslide and rock-fall events are encouraged. Unusual occurrences, innovative treatments, and inventory and rating methods of landslides and rock falls are also welcome.

13. **Coastal Management and Environmental Lessons from Recent Southeastern U.S. Hurricanes.** David M. Bush, University of West Georgia, dbush@westga.edu; Robert S. Young, Western Carolina University, ryoung@wcu.edu.

Recent (2003–2005) hurricanes affecting the southeastern Atlantic and Gulf of Mexico coasts include Isabel, Charley, Frances, Ivan, Dennis, Katrina, and Rita. Each hurricane affords the opportunity to better prepare for the next one. This session will address hurricane physical interaction with the coastal zone, property damage mitigation, improved public awareness, and better management of coastal resources. Discussions of any physical, social, and engineering aspect of hurricane-coastal interactions are welcome.

14. **Geology and Groundwater Resources in Carbonate and Crystalline Rocks of the Eastern U.S.: Methods, Geologic Controls, and Exploration Approaches.** Lester Williams, U.S. Geological Survey, lesterw@usgs.gov; Tom Crawford, University of West Georgia, tcrawfor@westga.edu.

Specialized methods and knowledge of geologic controls are needed for assessing the availability, quantity, and quality of groundwater in carbonate and crystalline rock aquifer systems. This session seeks presentations that highlight methods and/or exploration approaches used to study groundwater in complex aquifer systems, as well as studies highlighting geologically significant features that influence groundwater recharge, flow paths, and contamination.

15. **Groundwater Contamination: Transport, Fate and Remediation.** Sponsored by GSA Hydrogeology Division. Ed Perfect, University of Tennessee at Knoxville, eperfect@utk.edu; Larry McKay, University of Tennessee at Knoxville, lmckay@utk.edu.

This session will cover the behavior of inorganic, organic, and microbial contaminants in a variety of geologic settings, including coastal sand aquifers, fractured rocks, karst, saprolite, and soils. Both fully and partially saturated conditions will be considered. Papers can be based on the results of laboratory experimentation, field observations, model simulations, or experience at contaminated sites. We are particularly interested in studies that combine approaches from a variety of disciplines to deal with contaminant problems over a range of spatial and temporal scales.

16. **Applications and Innovations in Near-Surface Geophysics.** Sponsored by GSA Geophysics Division. Gregory S. Baker, University of Tennessee at Knoxville, gbaker@tennessee.edu; Edward W. Woolery, University of Kentucky, woolery@uky.edu.

The objective of this session is to bring together researchers who (1) are developing new techniques and new technology in near-surface geophysics, or (2) have applied examples of state-of-the-art technology used for constraining geologic, hydrologic, archaeologic, or other problems in the southeastern United States. Presentations may include innovations (in such areas as instrument development, survey design, data analysis, imaging, etc.) with or without associated case studies or specific near-surface geophysics case studies.

17. **Paleontology, Paleocology, and Paleoenvironments of the Gray Fossil Site, Gray, Tennessee.** Sponsored by Paleontological Society. Andrew K. Rindsberg, Geological Survey of Alabama, arindsberg@gsa.state.al.us; Steve Wallace, East Tennessee State University, wallaces@mail.etsu.edu; Blaine Schubert, East Tennessee State University, schubert@mail.etsu.edu.

The Gray Fossil Site was discovered in May 2000, during road construction in Washington County near Gray, Tennessee. The deposit provides a rare opportunity to study the Miocene paleoecology of southern Appalachia. This session will focus on emerging paleontological and paleoecological data from this extraordinary fossil site.

18. **Hands-on Ichnology and the Union Chapel Track Site.** Cosponsored by Paleontological Society, Eastern Section, Society for Sedimentary Geology (SEPM). Andrew K. Rindsberg, Geological Survey of Alabama, arindsberg@gsa.state.al.us; Ben Tanner, Western Carolina University, btanner@utk.edu.

The Carboniferous ichnology of the Union Chapel track site (Steven C. Minkin Paleozoic Footprint Site, Alabama) will be showcased, and talks on any aspect of ichnology are welcome. Attendees are invited to bring a specimen or image for general discussion.

19. **Bringing Research into the Undergraduate Classroom.** Sponsored by National Association of Geoscience Teachers, Southeast Section. Ben Tanner, Western Carolina University, btanner@utk.edu.

This session will focus on ways to integrate research experiences into the undergraduate classroom and to determine the value of research derived from undergraduate classes.

20. **Current Status of K–12 Science Standards and Earth Science Education in the Southeast.** Cosponsored by National Association of Geoscience Teachers, Southeast Section; GSA Southeastern Section Education Committee. Michael A. Gibson, University of Tennessee at Martin, mgibson@utm.edu; Doug Haywick, University of Southern Alabama, dhaywick@jaguar1.usouthal.edu.

Science standards for K–12 education in the southeast have undergone revision in response to test scores, national initiatives, and education reform movements over the past 20 years. What is the current status of earth science education in the southeast and what are the implications for higher education programs? State science
coordinators from the southeast will be invited to report on the status of standards-based science education in their states, areas still in need of attention, and expected trends in earth science education.

21. **Hydrology and Water Quality Issues in the Southeast.** Sponsored by **Southeastern Water Research Institute; GSA Hydrogeology Division.** Randy Gentry, University of Tennessee, rgentry@utk.edu; Larry McKay, University of Tennessee, lmckay@utk.edu.

This session invites papers dealing with a range of water supply, water quality, and aquatic habitat issues facing the rapidly growing populations of the southeastern United States. These include Total Maximum Daily Loads, wellhead protection, storm water discharges, water supply, water disputes, stream ecology and restoration, microbial contamination, etc. Papers can address these problems from a variety of perspectives and disciplines, including geology, engineering, microbiology, ecology, economics, and social policy.


This session will focus on how geoscientists are using technology to collect, manage, and distribute geological information. Presentations on topics such as global positioning system usage in the field, Internet mapping, the geographic information system and digital mapping techniques, and geological database management are welcome.

**POSTER SESSIONS**

22. **Geologic Maps, Digital Geologic Maps, and Derivatives from Geologic Maps.** Sponsored by GSA **Structural Geology and Tectonics Division.** Ralph F. Crawford, The Geologic Mapping Institute, crawford@sprintmail.com; Michael W. Higgins, The Geologic Mapping Institute, mhiggins@mindspring.com.

Geologic maps are the most fundamental tool of geological science. State-of-the-art geologic maps (both classical and GIS-based) are welcome.

23. **Undergraduate Research in Watershed Assessment.** Randa Harris, University of West Georgia, rharris@westga.edu; Curtis Hollenbaugh, University of West Georgia, chollaba@westga.edu; Julie Bartley, University of West Georgia, jbartley@westga.edu.

Watershed assessment is an important avenue for research in the southeast and provides many opportunities for undergraduate involvement. Frequently, such assessment is used as a training ground for undergraduate researchers and enables them to learn both field and laboratory techniques and to analyze complex interactions among water quality variables. This session will focus on both training methods and results of undergraduate research driven by watershed assessment programs.

24. **Undergraduate Research Poster Session.** Sponsored by **Council for Undergraduate Research.** Brannon Andersen, Furman University, brannon.andersen@furman.edu; Jeff Ryan, University of South Florida, ryan@chuma.cas.usf.edu.

The Council on Undergraduate Research will sponsor a poster session highlighting research performed by undergraduates in all areas of the earth sciences. First authors must be undergraduate students, and students must be responsible for the bulk of the research, preparation of posters, and presentation of results.

**FIELD TRIPS**

**Premeeting**


This field trip begins and ends in Asheville, North Carolina. Lodging must be purchased separately by each participant. A block of rooms is reserved at the Holiday Inn Biltmore-East (+1-828-298-5611; Oteen Exit 55 on I-40). Lodging is also available in other parts of Asheville. The field trip focuses on the middle Proterozoic basement map units of the Blue Ridge of western North Carolina, northwest of Asheville. It addresses their age, mappable characteristics, and relationships with the overlying Ashe-Tallulah Falls and Ooee Supergroup sequences. Evidence for high-grade Grenville metamorphism and subsequent Paleozoic overprints will be examined, with emphasis on the Alleghanian.

2. **Geologic Excursion across Part of the Southern Appalachian Foreland Fold-Thrust Belt in Northeastern Tennessee.** (One day) Peter J. Lemischki, Tennessee Division of Geology, +1-865-594-6200, peters.lemischki@state.tn.us; Martin S. Kohl, Tennessee Division of Geology, martin.kohl@state.tn.us. Wed., 22 Mar., 7 a.m.–5 p.m. Cost: US$70, including transportation, lunch and a guidebook. Min.: 8; max.: 20.

This one-day field trip will begin and end at the Marriott Hotel in Knoxville, Tennessee. The field trip will traverse the northeastern part of the Tennessee Valley and Ridge to examine results from recent STATEMAP-supported geologic quadrangle mapping. Stops will include exposures of the Copper Creek and Town Knobs thrusts, folding and fracturing in the Martinsburg Formation and Sevier Shale (Ordovician), unusual sedimentary features in the Nolichucky Shale (Cambrian), and a visit to a farm where participants can collect small quartz crystals we fondly refer to as Tennessee field diamonds. At each stop, we will discuss the local structure, stratigraphy, mineral resources, and geohazards in a regional context. The trip is a great opportunity for professional geolo-
gists, academics, and teachers looking for an overview of regional geology.

Postmeeting

This trip will originate and end at the Sugarland Visitor Center, Great Smoky Mountains National Park. Check out of your hotel and depart Knoxville by 8 a.m. to get to the Visitor Center by 9 a.m. Wear sturdy footwear, warm clothes, and bring rain gear. K–14 teachers, students, professionals, and guests are invited to participate. The trip will consist of four stops around Mount Le Conte: (1) Carlos Campbell Overlook; (2) a short, steep hike to Buckeye Cove; (3) lunch at the Chimneys picnic area; and (4) a moderate 4.5-mile round-trip hike to Alum Cave. We will highlight the origin of the rocks; the timing and conditions of deformation, metamorphism, and uplift; and erosion and surficial deposits that have contributed to the geomorphology.

4. Lessons from Limestone. (One day) Don Byerly, University of Tennessee at Knoxville, dbyerly@utk.edu; Michael A. Gibson, University of Tennessee at Martin, mgibson@utm.edu. Sat., 25 Mar., 8 a.m.–5 p.m. Cost: US$10 (the major costs of the trip are being funded by the Crushed Stone Producers of Tennessee–Rinker Materials, Inc., Rogers Group, Inc., and Vulcan Materials Corporation). Max.: 30.

This field trip begins and ends at the Marriott Hotel, Knoxville, Tennessee. The trip will feature limestone as an instrument for teaching National Science Education Content Standards, including chemical reactions (Standard B), biological evolution (Standard C), geochemical cycles (Standard D), and natural and human-induced hazards (Standard F). Some of the topics covered by the trip include using fossils to develop concepts of paleoclimates and evolution; using limestone to reconstruct ancient geography (including plate tectonics); the importance of limestone in our society as a natural resource; hazards associated with karst (caves and sinkholes); and where, how, and why limestone forms.

5. Diverse Mafic and Ultramafic Rock Sequences of the Central Blue Ridge, North Carolina–Georgia. (Two days) Jeff Ryan, University of South Florida, ryan@chuma.cas.usf.edu; Steve Yurkovich, Western Carolina University, yurkovich@wcu.edu; Virginia Peterson, Grand Valley State University, petersons@gsu.edu. Sat.–Sun., 25–26 Mar. Departs 8 a.m. and returns 2 p.m. Sunday. Cost: US$140, including transportation, two nights lodging (double occupancy) and continental breakfast, box lunches, and field trip guide. Max.: 20.

This field trip begins and ends at the Comfort Inn, Sylva, North Carolina. Participants are expected to arrange their own travel to and from the departure locality. The focus of the trip will be the varied mafic-ultramafic rock exposures in the south-central Blue Ridge, their likely origins, and tectonic implications. The trip will emphasize new mapping and petrologic results from the Buck Creek and Carroll Knob mafic-ultramafic complexes, and from rocks in the Webster–Addie–Balsam Gap area.

6. Geotraverse: Geology of Northeastern Tennessee and the Grandfather Mountain Region. (Two days) Robert D. Hatcher, Jr., University of Tennessee at Knoxville, +1-865-974-2366, bobmap@utk.edu. Sat.–Sun., 25–26 Mar. Departs 8 a.m.; returns 5 p.m. Sunday. Cost: US$275, includes two nights lodging, transportation, two lunches, and guidebook. Participants will be responsible for breakfasts and dinners. Min.: 10; max.: 32.

This field trip will start and end at the Marriott Hotel, Knoxville, Tennessee. The trip will consist of a traverse from the Johnson City–Elizabethton area in northeastern Tennessee, where the Shady Valley thrust sheet contains a complete section from Grenville basement through the Knox Group (Valley and Ridge or Blue Ridge), across the Mountain City window into the Stone Mountain thrust sheet and other Grenville and pre-Grenville (Mars Hill) terrane and rifted-margin igneous rocks (Bakersville complex) in western Blue Ridge thrust sheets, and across the Chattahoochee–Holland Mountain thrust sheet into eclogite-bearing Ashe Formation rocks. We will also examine Grandfather Mountain Formation rocks inside the Grandfather Mountain window and the Linville Falls fault.

7. Lower Pennsylvanian Siliciclastic Rocks of the Northern Cumberland Plateau, Including Marine Margin Sandstones Crawling with Life. (One day) Molly Miller, Vanderbilt University, molly.miller@vanderbilt.edu; Andrew Rindsberg, Geological Survey of Alabama, arindsberg@gsa.state.al.us. Sat., 25 Mar., 8 a.m.–5 p.m. Cost: US$60, including transportation and lunch.

This field trip will begin and end at the Marriott Hotel, Knoxville, Tennessee. Diverse trace fossils in a unique flagstone within the Fentress Formation in a small quarry near Jamestown, Tennessee, reflect deposition under marine conditions. In contrast, the overlying Rockcastle Conglomerate was deposited in braided streams. This trip affords an opportunity to observe biogenic structures in a well-exposed sedimentologic context, to discuss how and where the structures were produced and by what, to see the facies and facies relationships of the Rockcastle Conglomerate, to reconstruct the succession of depositional processes and environments, to consider tectonic-climatic scenarios reflected by the sequence, and to order rock for a lovely patio that will increase Earth awareness on your campus.

8. The Geology and Ecology of the Late Miocene to Early Pliocene Gray Fossil Site, Northeast Tennessee. (One day) Steven C. Wallace, +1-423-439-6085, wallsca@mail.etsu.edu; Blaine W. Schubert, +1-423-439-8419,
Southeastern

schubert@mail.etsu.edu, East Tennessee State University. Sat., 25 Mar., 8 a.m.–5 p.m. Cost: US$75, includes bus transportation, lunch, snacks, guide, and guidebook. Min.: 40; max: 50.

This one-day trip will originate and end at the Marriott Hotel in Knoxville, Tennessee. The field trip is an opportunity to examine one of the few late Miocene to early Pliocene vertebrate sites in the eastern United States. It will be in two parts, including a stop at the Gray site to see the excavations and examine the deposits, depositional setting, and geology. After lunch, the trip will proceed to East Tennessee State University to examine fossil finds and receive an overview of the fauna and the importance of the site.

WORKSHOPS

Measurement of Indoor Radon in Geologically Diverse Terranes. Sponsored by GSA Engineering Geology Division. Sat.–Sun., 25–26 Mar., 8 a.m.–5 p.m. Douglas Mose, George Mason University, djic42@aol.com; George Mushrush, George Mason University. Optional exam earning Radon Measurement Specialist Certificate: US$150. This course provides hands-on training to understand, anticipate, and measure geologically dependent indoor radon and waterborne radon. The course is designed for teachers and researchers. An optional exam earns a Radon Measurement Specialist Certificate (National Radon Safety Board, info@nrsb.org) for full- or part-time employment as a home inspector in the real estate market. A general knowledge of soil and hydrology is required. Limit: 40. Fee: US$360, includes course manual and lunches.

ACTIVITIES FOR STUDENTS

Roy J. Shlemon Mentor Program in Applied Geoscience. Sponsored by GSA Foundation. Thurs.–Fri., 23–24 Mar., 11:30 a.m.–1 p.m. Location information available at GSA’s on-site registration desk. Karlon Blythe, kblythe@geosociety.org. This is a chance for students to discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Plan to attend both free luncheons to hear different presenters each day. Students will receive FREE LUNCH tickets in their registration packet to attend both Shlemon Programs. However, space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

John Mann Mentors in Applied Hydrogeology Program. Sponsored by GSA Foundation. Thurs., 23 Mar., 5–6:30 p.m. Location information available at GSA’s on-site registration desk. Karlon Blythe, kblythe@geosociety.org. This early evening event presents mentoring opportunities for undergraduate and graduate students and recent graduates with interest in applied hydrogeology or hydrology as a career to interact and network with practicing hydrogeologic professionals. This program is a focused, small-scale event that features a radon pizza dinner for participants. Students will receive a ticket to attend the Mann Program event in their registration packets, but space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

MEETINGS AND SPECIAL EVENTS

Wednesday, 22 March

Southeast GSA Business Meeting. 4–6 p.m., Marriott Hotel Board Room.

Welcoming Reception. 7–9 p.m., Marriott Hotel.

Thursday, 23 March

Eastern Section, Society for Sedimentary Geology (SEPM). 5 p.m., Marriott Hotel.

Friday, 24 March


Business Meeting, Southeast Section of the Paleontological Society. 1:30 p.m., Marriott Hotel.

EXHIBITOR INFORMATION

Exhibit space will be available in a centrally located exhibit hall. For more information on exhibit rates and space reservations, contact Edmund Perfect, eperfect@utk.edu.

SPONSORSHIP INFORMATION

Corporate and government sponsorship are welcome. Sponsors will be recognized during the meeting and with an acknowledgment in the printed program. Sponsors may designate their gift for a specific event or technical session, with recognition during that event. For more information on sponsorship, please contact Edmund Perfect, eperfect@utk.edu.

STUDENT TRAVEL GRANTS

Travel grants are available from the GSA Southeastern Section and GSA Foundation to both undergraduate and graduate students who are presenting papers and are GSA Student Members. Information and applications are available at http://core.ecu.edu/geology/neal/segusa/travel.html or via link on the GSA Web site, www.geosociety.org.

ACCOMMODATIONS FOR REGISTRANTS WITH SPECIAL NEEDS

GSA’s Southeastern Section is committed to making every event at the 2006 meeting accessible to all people interested in attending. If you have special requirements, please contact the local committee chair, Claudia I. Mora, cmora@utk.edu.

ADDITIONAL INFORMATION

For further information, please contact the local committee chair: Claudia I. Mora, cmora@utk.edu. Additional meeting information will be available on the GSA Web site, www.geosociety.org. Visitor information for the city of Knoxville and the surrounding eastern Tennessee region can be found at www.ci.knoxville.tn.us/.

THE GEOLOGICAL SOCIETY OF AMERICA
**SOUTH-CENTRAL**

40th Annual Meeting
South-Central Section, GSA
School of Geology and Geophysics and
Oklahoma Geological Survey
University of Oklahoma, Norman, Oklahoma

6–7 March 2006
www.geosociety.org/sectdiv/southc/06scmtg.htm

The University of Oklahoma (OU) is the largest public university in Oklahoma, enrolling over 24,000 students from more than 100 countries. The South-Central Section meeting will include two days of technical presentations (oral and poster) and student activities, plus a very active premeeting program—six field trips and five workshops (two designed especially for teachers) are planned. Three “less”-technical tours of campus geoscience collections also will be held. In addition, GSA Members and guests will want to visit the Fred Jones Museum of Art, which houses the largest collection of French Impressionist paintings ever donated to a public university. The Sam Noble Oklahoma Museum of Natural History displays the largest dinosaur skull (Pentaceratops) ever found and the oldest piece of art found in North America. Bizzell Library houses a world-class history of science collection. The Geologic Gallery of the School of Geology and Geophysics and the Laurence S. Youngblood Energy Library in Sarkeys Energy Center contain superb mineral and fossil displays. Finally, no visit to Norman would be complete without visiting the Barry Switzer Center, celebrating the seven-time national football champion OU Sooners. For more information on what to see and do on the OU campus, visit www.visitou.edu/vc_vtstart.htm.

The school of geology and geophysics (SGG) currently has 15 academic faculty members, 78 undergraduate students, and 75 graduate students. The vision of the SGG is to be “a preeminent center of excellence for study and research in geology and geophysics, with emphasis in applied areas such as energy. Students shall be provided with a high quality education that stresses the fundamentals of science within a creative, interdisciplinary environment, and that prepares them for success in their professional careers by instilling knowledge, skills, confidence, pride, principled leadership, and the ability to contribute to the wise stewardship of the earth and its resources.”

The Oklahoma Geological Survey (OGS) is an applied research and public-service agency authorized by the state constitution. Its charter is to investigate the land, water, mineral, and energy resources of the state and to disseminate the results of those investigations. The OGS engages in a wide variety of field investigations throughout the state either independently or with other state and federal agencies.

**LOCATION AND TRAVEL INFORMATION**

Norman is 20 miles south of Oklahoma City (OKC) near the boundary between the Cherokee Shelf and the Anadarko Basin. Surface strata consist of Leonardian (Lower Permian) redbeds overlain by Quaternary deposits associated with the Canadian River. Outcrops of the Garber-Wellington aquifer, a principal source of water for the OKC metro area currently being studied because of its locally high arsenic content, occur on the east side of Norman.

OU is located just south of the center of Norman and is easily accessed by Interstate 35. The meeting will be held at the Oklahoma College of Continuing Education (OCCE), south of the main campus. Registration parking will be immediately south of the OCCE Forum building and north of Timberdell Avenue. A map of the OU campus is available at www.ou.edu/visitorcenter/vc_campus_map.htm.

**ACCOMMODATIONS**

A block of rooms has been reserved at the Sooner Hotel and Suites, located next to the OCCE. Rooms cost about US$55 per room (1–2 beds per room) per night at the hotel and about US$91 per cottage (2 rooms, 1 bed per room) per night. To obtain these rates, you must phone the hotel at +1-405-329-2270 or +1-888-777-0477 and state that you are affiliated with OU/GSA. The deadline for reserving rooms is 1 February 2006.

A complete list and a map of other Norman motels can be found at www.visitnorman.com/lodging.html. All of these require driving; none are within walking distance of campus.

**Accommodations for Registrants with Special Needs**

GSA is committed to making all events at the South-Central 2006 meeting accessible to all people interested in attending. Special requirements (wheelchair accessibility, dietary concerns, etc.) should be indicated on the registration form.

**REGISTRATION**

**Standard registration deadline:** 31 January 2006
**Cancellation deadline:** 6 February 2006

**Registration Fees**

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GSA Headquarters will handle meeting registration. Register online at www.geosociety.org. On-site registration will be available at Sarkeys Energy Center late afternoon and early evening on Sun., 5 Mar., and at OCCE during the meeting.

Admission to the Sam Noble Oklahoma Museum of Natural History is free to registrants with their OU/GSA name tags. The museum will conduct a limited number of small-group, behind-the-scenes tours on a first-come, first-served, sign-up basis. Registrants will also be able to tour the History of
South-Central

Science Collections at Bizzell Library on a small-group basis. Reservations for these tours can be made at the registration desk during the meeting.

CALL FOR PAPERS
Abstract deadline: 6 December 2005
Papers are invited for symposia, theme sessions, and general sessions, in oral and/or poster formats. Abstracts not included in symposia will be scheduled for appropriate theme or general sessions. All abstracts must be submitted online to www.geosociety.org. There is an abstract submission fee of US$10.

SYMPOSIA AND THEME SESSIONS
For more information, or to propose additional symposia or theme sessions, contact Neil Suneson, nsuneson@ou.edu, +1-405-325-3031.

Symposia
1. Sequence Stratigraphy and Paleontology of Carboniferous and Permian Strata of the Northern and Southern Mid-Continent. Darwin Boardman, Oklahoma State University, amm0001@okstate.edu, +1-405-744-6358, fax +1-405-744-7841.
   This symposium will focus on the stratigraphic, sequence stratigraphic, biostratigraphic, and paleoecologic aspects of the mid-continent and north-central Texas Carboniferous and Permian succession. Of particular interest, this session will focus on Upper Mississippian Barnett and Caney Formations, as well as sequence stratigraphy of the Cherokee, Council Grove, and Chase Groups of Oklahoma and Kansas.

   This half-day session will focus on the many challenges and issues that are associated with the Tar Creek Superfund Site in northeastern Oklahoma. Some of these challenges and issues include size (>41 mi²), land ownership, legal issues, elevated blood-lead levels, data availability, a large number of mine and mill-waste sites, ongoing subsidence, and oversight and accountability.

Theme Sessions
1. Drivers of Regional Water Management: Who’s Stopping to Ask Directions? Todd Halihan, Oklahoma State University, halihan@okstate.edu, +1-405-744-6358, fax +1-405-744-7841.
   Sound water management requires an integration of scientific, political, and social expertise in order to derive long-term management plans. Most water management is reactive, based on lack of supply due to drought or population increases. This theme session examines ways that are being employed to make water management follow a coherent map toward sustainable supplies on a regional scale.

2. Geology and Public Policy. Melanie Barnes, Texas Tech University, melanie.barnes@ttu.edu, +1-806-742-3204, fax +1-806-742-0100.
   Over the last year, the Gulf of Mexico has weathered three major hurricanes (Ivan, Katrina, and Rita) that have had a direct impact on our energy infrastructure. With this theme session, we would like to initiate a dialogue about the role geologists have, can, and should play in the crafting of a sound energy policy. An integration of scientific, political, and social expertise is required in order to derive a sound long-term energy policy for our nation. Papers on all aspects of this issue are welcome. We plan to design the session to encourage interaction between the presenters and the audience.

3. Undergraduate Research Poster Session. Sponsored by Council on Undergraduate Research, Geosciences Division (www.cur.org); GSA Education Committee (www.geosociety.org/educate/). Wendi Williams, University of Arkansas–Little Rock, wjwilliams@ualr.edu, +1-501-569-3546.
   Undergraduate students are invited to submit abstracts for a special poster session highlighting activities by undergraduate researchers. Undergraduate students involved in independent, team, or class-related research are highly encouraged to submit abstracts regarding their research projects, activities, techniques, internship experiences, and/or preliminary results for this session. The presenter and first author must be an undergraduate student, but co-authors may include faculty sponsors and/or graduate students and/or high school students.

4. Addressing the Pseudoscience of Intelligent Design in the K–16 Classroom. Iris Totten, Kansas State University, itotten@ksu.edu, +1-785-532-6724, fax +1-785-532-5159.
   This session will focus on issues of educating the K–16 population on evolution and intelligent design (ID) in the classrooms and communities. States including Kansas and Georgia are experiencing great controversies in their schools regarding equal time for creationism and ID and evolution. In August 2005, the Kansas School Board of Education voted 6–4 to include greater criticism of evolution in its school science standards. This session is intended to engage the audience in a discussion regarding the consequence of these controversies to our K–16 science programs, to share strategies for promoting the understanding of evolution in our classrooms and communities, and to further define the role of the geosciences with respect to this controversial national issue.

5. Igneous Petrology: What the Rocks Are Telling Us. Charles Gilbert, School of Geology and Geophysics, University of Oklahoma, mcgilbert@ou.edu, +1-405-325-4501; David London, School of Geology and Geophysics, University of Oklahoma, dlondon@ou.edu, +1-405-325-7626, fax +1-405-325-3140.
   Papers on all aspects of igneous petrology are welcome, with especial emphasis on textures, descriptions of field sites, estimating conditions of crystallization, and on any general principles used in explicating igneous processes.
WORKSHOPS AND SHORT COURSES
See www.geosociety.org/sectdiv/southc/06scmtg.htm for updates and possible sponsorships.


   This workshop will focus on the importance of trace fossil analyses in recognizing ichnofacies, identifying key stratal surfaces, reconstructing depositional environments, and determining and using ichnofabric indices as an aid in reservoir characterization. Hands-on trace fossil exercises will be used to demonstrate important trace fossil applications in recognizing and interpreting depositional sequences. Min.: 10; max.: 25. Cost: US$80 (students: US$15), includes snacks, lunch, and workshop manual.


   This workshop will focus on deepwater depositional systems, including recent deepwater exploration and production history, architectural elements, and related reservoir performance. A written text will be provided for follow-on with lecture material. Min.: 5; max.: 25. Cost: US$870, includes lunch and a copy of “Petroleum Systems of Deep-Water Settings” by P. Weimer and R.M. Slatt (2004).

3. Hands-on Geology Projects for Group Learning. Sat. morning, 4 Mar., in Norman. Vince Cronin, Vince_Cronin@baylor.edu, assisted by Rena Bonem, Rena_Bonem@baylor.edu, Baylor University, +1-254-710-2361, fax +1-254-710-2673.

   Teachers will participate in a series of short (5–10 min) projects that illustrate important geological processes, generally involving materials and devices that are readily available. The workshop will show the participants how to reproduce these projects for individual classroom use. Min.: 8; max.: 21. Cost: US$825.

4. Earth and Space at Your Fingertips: Infusing Technology-Rich Resources into Your Lessons. Sat. afternoon, 4 Mar., in Norman. Wendi Williams, University of Arkansas–Little Rock, wjwilliams@ualr.edu, +1-501-569-3546; Keith Harris, krharris@ualr.edu, University of Arkansas–Little Rock, +1-501-569-3546.

   Participants will explore technology-rich resources aligned to meet National Science Education Standards, as well as begin mapping participants’ state standards. Example resources of products included are from GSA, the National Aeronautics and Space Administration, the American Geological Institute, the Incorporated Research Institutions for Seismology (IRIS) Consortium, the Digital Library for Earth System Education (DLESE), the National Science Teachers Association, and National Science Foundation–funded resources. Earth and Mars will be emphasized. Min.: 5; max.: 21. Cost: US$35 K–16; US$20 pre-service.


   This course provides hands-on training to understand, anticipate, and measure geologically dependent indoor radon and waterborne radon. The course is for teachers and researchers, and an optional end-of-course exam earns a Radon Measurement Specialist Certification (National Radon Safety Board, www.nrsb.org). The certificate is required by federal and state regulatory agencies to list individuals authorized for employment as home inspectors in the real estate market. Min.: 5; max.: 25. Prerequisite: general knowledge of soil and hydrology. Fee: US$350, includes course manual and lunches.

FIELD TRIPS


   The Arbuckle-Simpson aquifer, which underlies more than 500 mi² in south-central Oklahoma, is the source of several springs and streams, including those in the Chickasaw National Recreation Area and Blue River, Pennington Creek, and Honey Creek. The field trip will examine the geologic histories of the Arbuckle and Hunton anticlines, and how the different structural and geologic frameworks can affect aquifer characteristics and groundwater flow. A multidisciplinary team of researchers from various agencies and universities will discuss the techniques they are employing to understand the highly fractured carbonate aquifer and associated springs and streams. Field stops will include outcrops, streams, a climatic station, an artesian well, and scenic Turner Falls. Field trip stops will include outcrops, streams, a climatic station, an artesian well, and scenic Turner Falls. Min.: 10; max.: 40. Cost: US$50, includes transportation, water, soft drinks, and a field guide. Lunch will be at a restaurant; participants are responsible for their own lunch expenses.


   The purpose of this trip is to demonstrate that prudent development of both groundwater and the landscape can be enhanced by a working knowledge of the origin, distribution, and burial history of Oklahoma’s Permian red beds. Field trip stops will enable participants to examine lines of evidence for the proposed depositional setting of these stratigraphic units and the role that provenance and lithofacies play in the distribution of naturally occurring arsenic in the region’s drinking water. Susceptibility of the landscape to erosion will also be observed and discussed. Min.: 10; max.: 22. Cost: US$50, includes transportation, water, soft drinks, lunch, and field trip guide.
3. **Tar Creek Superfund Site and its Many Challenges.**

The Tar Creek Superfund Site is located in northeastern Oklahoma near the Oklahoma-Kansas border in Ottawa County. The site consists of ~41 mi² (26,000 acres) and is part of the Tri-State Mining District (Okla., Kans., and Mo.). The Mississippian rock units, principally the Boone Formation, are the host for most of the ore deposits. Zinc and lead ores (principally sphalerite and galena) were mined in the Picher Field in northeastern Oklahoma and southeastern Kansas for more than 60 years. The Superfund site contains over 2,500 acres that are underlain by underground lead-zinc mines and 1,150 mine shafts. Significant quantities of mill-waste material were generated by milling of the lead-zinc ores. Approximately 5,000 acres in Oklahoma were overlain by mine and/or mill byproducts. On this field trip, we will visit mine and mill-waste sites, locations where ongoing ground failure is occurring, a reclamation and restoration project, sites where mine water is discharging from mine shafts and boreholes, and a mill-waste reprocessing plant. We will discuss the many challenges and issues that are associated with the Tar Creek Superfund Site. Min.: 10; max.: 22. Cost: US$100, includes transportation, lodging (double-occupancy), soft drinks, two lunches, and a field trip guide. Participants are responsible for their own breakfast and dinner expenses.

4. **Interpreting Textures of Granitic and Gabbroic Rocks, Wichita Mountains, Oklahoma.** Sun., 5 Mar.
Charles Gilbert, School of Geology and Geophysics, University of Oklahoma, mcgilbert@ou.edu, +1-405-325-4501; David London, School of Geology and Geophysics, University of Oklahoma, dlondon@ou.edu, +1-405-325-7626, fax +1-405-325-3140.

Petrologists utilize or sometimes rely on texture to infer the conditions and history of crystallization in igneous rocks, but our knowledge of textural interpretation comes mostly from two sources: (1) what we were taught as students, and (2) intuition. A third source of understanding is available from a rather small number of important experimental studies on the crystallization of silicate melts at compositions and conditions relevant to natural igneous systems.

The purpose of this one-day trip is to view a variety of textures in granitic and gabbroic rocks exposed in the Wichita Igneous Province, southwest Oklahoma, and as individuals, to evaluate the geologic history of each texture based on (1) our existing knowledge base, and then (2) on the basis of several pertinent experimental summaries that will be distributed at the beginning of the field trip. Each participant will be encouraged to develop and present his or her own interpretation of the rock texture, which may include the history of crystallization, the structural environment or rheology of the melt, qualitative estimates of intensive (e.g., \( P, T, dH/\Delta O, \alpha O_2 \)) and extensive variables, and so forth. Some of the textures we will see and evaluate in granite include hypidiomorphic granular, linear or cusptate patterns of quartz and feldspar, orbicicular, pegmatitic, granophyric, spherulitic, miarolitic. Those in gabbro include lamination (trachytic/compaction) and ophitic and heteradcumulate textures. Min.: 5; max.: 20. Cost: US$60, includes transportation, lunch, snacks, and a field guide.

5. **Stratigraphy and Paleontology of the Upper Mississippian Barnett Shale of Texas and the Caney Shale of Southern Oklahoma.** Fri.–Sun., 3–5 Mar. (three-day field trip). Darwin Boardman, Oklahoma State University, amm0001@okstate.edu, +1-405-744-6358, fax +1-405-744-7841.

The purpose of this field trip is to examine the stratigraphy and paleontology of the Upper Mississippian shale formations of the southern mid-continent (Barnett Shale of Texas, Caney Shale of Oklahoma). The Barnett Shale has become the largest nontraditional gas play in the United States yet detailed lithologic and paleo-logic analysis remains to be completed. Additionally, the Caney Shale (roughly Barnett equivalent) is equally lacking in detailed analysis. This field trip will focus on lithic analysis along with ammonoid and conodont biostatigraphy. Min: 10; max.: 40. Cost: US$500, includes transportation, two nights lodging, two breakfasts, and guidebook. Participants are responsible for lunches and dinners.

6. **Facies Architecture of a Middle Pennsylvanian Incised Valley Fill: The Bluejacket (Bartlesville) Sandstone of Eastern Oklahoma.** Fri.–Sun., 3–5 Mar. (3-day trip). Dennis Kerr, University of Tulsa, dennis-kerr@utulsa.edu, +1-918-631-3020, fax +1-918-631-2091.

Participants will examine Bluejacket lowstand and transgressive systems tract facies architecture in a distal to proximal outcrop traverse through the fill of an ancient incised valley. Outcrop observations will be related to the important Bartlesville petroleum reservoir in terms of petrophysical properties and improved reservoir exploitation strategies. Min.: 20; max.: 30. Cost: US$125, includes transportation, two lunches, snacks, and guidebook. Participants are responsible for other meals and motel reservations; student sponsorships are being sought. Contact Dennis Kerr for further information.

**During Meeting**

7. **OU Campus Walking Tour.** Mon., 6 Mar., ~4:30 p.m.
Stan Krukowski, Oklahoma Geological Survey, skrukowski@ou.edu, +1-405-325-3031, fax +1-405-325-7069.

This walking tour will focus on earth resources materials used to build structures on the University of Oklahoma (OU) campus and showcase the various classical architectural styles. The campus tour is designed as an example of an educational or outreach activity on college campuses, city centers, or historical sites. Free; no participant number limit.
STUDENT ACTIVITIES

Roy J. Shlemon Mentor Programs in Applied Geoscience. Sponsored by GSA Foundation. Mon., 6 Mar., 11:30 a.m.–1 p.m.; location available at GSA’s on-site registration desk. Karlon Blythe, GSA, kblythe@geosociety.org. This is a chance for students to discuss career opportunities and challenges with professional geoscientists from multiple disciplines. Students will receive a FREE LUNCH ticket in their registration packet to attend the Shlemon program. However, space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

John Mann Mentors in Applied Hydrogeology Program. Sponsored by GSA Foundation. Mon., 6 Mar., 5–6:30 p.m.; location available at GSA’s on-site registration desk. Karlon Blythe, GSA, kblythe@geosociety.org; Todd Halihan, Oklahoma State University, halihan@okstate.edu. This early evening event presents mentoring opportunities for undergraduate and graduate students and recent graduates with interest in applied hydrogeology or hydrology as a career to interact and network with practicing hydrogeologic professionals. This program is a focused, small-scale event that features a free pizza dinner for participants. Students will receive a ticket to attend the Mann Program event in their registration packets, but space is limited: first come, first served. For further information, contact kblythe@geosociety.org.

STUDENT SUPPORT

Travel grants are available from the South-Central Section in cooperation with the GSA Foundation for students who are presenting oral or poster papers. To be eligible, students must be GSA Student Members or Student Associates. Please visit www.geosociety.org/sectdiv/southc/index.htm#travel for details regarding application instructions. For more information, contact Matthew W. Totten, Sr., mtotten@ksu.edu.

SOCIAL ACTIVITIES

Welcoming Party and Registration. Sun., 5 Mar., 5:30–7 p.m. East Atrium, Sarkeys Energy Center, OU Campus.

Sam Noble Oklahoma Museum of Natural History. “Behind-the-scenes” tours. Limited number, small group; sign-up required at registration desk.

Bizzell Library History of Science Collections. Tours. Limited number, small group; sign-up required at registration desk.

EXHIBITORS

Exhibit booths will be available for universities, government agencies, and companies at the meeting. Those providing information on graduate school or employment opportunities are especially encouraged to attend and exhibit.

BUSINESS MEETINGS

South-Central Section Management Board Meeting. Mon., 6 Mar., 5 p.m. Location: TBA.

South-Central Section GSA Business Meeting. Mon., 6 Mar., 6:30 p.m. Location: TBA.

CONTACT INFORMATION

Local organizing committee co-chairs: Neil Suneson, nsuneson@ou.edu, +1-405-325-3031; Rick Lupia, rlupia@ou.edu, +1-405-325-7229.
STUDENTS—Mark Your Calendars!

Plan now to attend a Shlemon Mentor Program in Applied Geoscience and/or a Mann Mentor Program in Applied Hydrogeology at your 2006 Section Meeting to chat one-on-one with practicing geoscientists. These volunteers will answer your questions and share insights on how to get a job after graduation. When programs are scheduled for multiple days, each day’s program will offer a different set of mentors.

FREE lunches will be served (students only) at the Shlemon Mentor Programs. Students will receive a free lunch ticket with their registration badge to attend each Shlemon Program. However, space is limited: first come, first served.

FREE pizza suppers will be served (students only) at the Mann Mentor Programs. Students will receive a free pizza supper ticket with their registration badge to attend the Mann Program. The Mann Program is geared toward careers in hydrogeology or hydrology. Whether you’ve already decided to head down the hydro career path or whether you just would like to know more about these career options, this meeting is for you! However, space is limited: first come, first served.

Mentor Programs for 2006 Section Meetings

For program locations, ask at the Section Meeting registration desk.

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<td>Mann Mentors in Applied Hydrogeology Program:</td>
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<th>NORTHEASTERN SECTION MEETING</th>
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<td>Mon.–Tues., 20–21 March, 11:30 a.m.–1 p.m.</td>
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<td>Mann Mentors in Applied Hydrogeology Program:</td>
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<th>SOUTHEASTERN SECTION MEETING</th>
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<td><strong>Shlemon Mentor Program Luncheons:</strong></td>
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<td>Thurs.–Fri., 23–24 March, 11:30 a.m.–1 p.m.</td>
<td>Wed.–Thurs., 17–18 May, 11:30 a.m.–1 p.m.</td>
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<td>Mann Mentors in Applied Hydrogeology Program:</td>
<td>Mann Mentors in Applied Hydrogeology Program:</td>
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<td>Thurs., 23 May, 5–6:30 p.m.</td>
<td>Wed., 17 May, 5–6:30 p.m.</td>
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**Upcoming Deadlines**

**Medals and Awards**
**Nominations Due 1 February 2006**
Nominations of candidates are requested for the following medals and awards: Penrose Medal, Day Medal, Honorary Fellows, Young Scientist Award (Donath Medal), GSA Public Service Award, and GSA Distinguished Service Award. For details on the awards and nomination procedures, see the October 2005 issue of *GSA Today*. For the new online nomination form, go to www.geosociety.org/aboutus/awards/, or call +1-303-357-1028. Materials and supporting information for any of the nominations may be sent to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

**GSA Fellows**
**Nominations Due 1 February 2006**
The Committee on Membership requests nominations of members to be elevated to GSA Fellow status. Any GSA Fellow may nominate up to two members per election cycle for this honor. Two other supporting letters in addition to the online nomination form are needed. For details on nomination procedures, see the October 2005 issue of *GSA Today*, visit www.geosociety.org/members/fellow.htm, call +1-303-357-1028, or e-mail awards@geosociety.org.

**2006 Subaru Outstanding Woman in Science Award** *(Sponsored by Subaru of America, Inc.)*
**Nominations Due 1 February 2006**
This award is given to a woman who has made a major impact on the field of the geosciences, based on her Ph.D. research. For details on the award and nomination procedures, see the October 2005 issue of *GSA Today*. For the new online nomination form, go to www.geosociety.org/aboutus/awards/, or call +1-303-357-1028. Send nominations and supporting material to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

**John C. Frye Environmental Geology Award**
**Nominations Due 31 March 2006**
In cooperation with the Association of American State Geologists, GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. For details, see the October 2005 issue of *GSA Today*, visit www.geosociety.org, or call +1-303-357-1028. Nominations must be sent to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

**Student Research Grants 2006**
**Online submission must be completed by Wednesday, 1 February 2006, at 11:59 p.m. (MST).**
The GSA student research grant application process is available only online. No paper applications or letters will be accepted.
In an effort to fund more GSA Student Members, students may now only receive GSA graduate student research grant money once at the master's level and once at the Ph.D. level. This policy affects all GSA research grantees retroactively. Those who have applied for grant funding but who did not receive a grant are welcome to apply again.
For further information on the 2006 Research Grant Program, see the October 2005 issue of *GSA Today*, visit www.geosociety.org/aboutus/awards/, or call +1-303-357-1028, or e-mail awards@geosociety.org.

**Congressional Science Fellowship**
**Applications Due 1 February 2006**

**National Awards**
**Nominations Due 30 April 2006**
Candidate nominations are needed for the following national awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, and Alan T. Waterman Award. For details, see the October 2005 issue of *GSA Today*. Nominations should be sent to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.
CALL FOR APPLICATIONS:

Planetary Geology Division’s Stephen E. Dwornik Student Paper Award

THE AWARD

Planetary geologist Stephen E. Dwornik established this award in 1991 to provide encouragement, motivation, and recognition to outstanding future scientists. Two awards are given annually, one for the best oral presentation, the other for the best poster presentation; each winner receives a citation and US$500. The program is administered through the Planetary Geology Division of the Geological Society of America. The GSA Foundation manages the award fund.

CRITERIA

The Dwornik Student Paper Award applies to papers presented at the annual Lunar and Planetary Science Conference held each March in Houston. Student applicants must be (1) the senior author of the abstract (the paper may be presented orally or in a poster session); (2) a U.S. citizen; and (3) enrolled in a college or university, at any level of their education, in the field of planetary geosciences. Papers will be judged on the quality of the scientific contributions, including methods and results; clarity of material presented; and methods of delivery, oral or display.

TO APPLY

The application form and instructions are found in the call for papers for the 37th Lunar and Planetary Science Conference, to be held 13–17 March 2006 at the South Shore Resort and Conference Center, League City, Texas.

Please visit www.lpi.usra.edu/meetings/upcomingmeetings.shtml for more information.

GSA Offers Awards in Geomorphology and Micropaleontology

Two of GSA’s most prestigious awards supporting research are made possible by the generosity of the late W. Storrs Cole. Qualified GSA Members and Fellows are urged to apply. The Gladys W. and W. Storrs Cole Award funds are managed by the GSA Foundation.

The Gladys W. Cole Memorial Research Award provides support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. GSA Members and Fellows between the ages of 30 and 65 who have published one or more significant papers on geomorphology are eligible for the award. While the funds may not be used for work that is already finished, recipients of previous awards may reapply if they need additional support to complete their work. The 2006 award is for US$8,200.

The W. Storrs Cole Memorial Research Award supports research in invertebrate micropaleontology. For 2006, this award carries a stipend of US$7,500 and will go to a GSA Member or Fellow between the ages of 30 and 65 who has published one or more significant papers on micropaleontology.

2006 application forms are available at www.geosociety.org/grants/postdoc.htm. For more information, contact Grants, Awards, and Recognition, GSA, P.O. Box 9140, Boulder, CO 80301-9140, awards@geosociety.org, or call +1-303-357-1023.

Applications must be received via post on or before 1 February 2006.
GSA's Coal Geology Division announces the availability of the Antoinette Lierman Medlin Scholarship in Coal Geology for the 2006–2007 academic year. The scholarship provides full-time students who are involved in research in coal geology (origin, occurrence, geologic characteristics, or economic implications of coal and associated rocks) with financial support for their project for one year.

Scholarship funding can be used for field or laboratory expenses, sample analyses, instrumentation, supplies, or other expenses essential to the successful completion of the research project. Approximately US$2,000 will be available for the 2006–2007 scholarship award. In addition, the recipient of the scholarship may be provided with a stipend to present the results of the research at the 2007 GSA Annual Meeting.

For the academic year 2006–2007, the Coal Geology Division is also offering a field study award of approximately $1,500. The recipient of this award will also be eligible to receive travel funds to present results of his or her study at the 2007 GSA Annual Meeting.

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

Interested students should submit five copies of the following: (1) a cover letter indicating which award(s) is(are) sought; (2) a concise statement of objectives and methods and a statement of how the scholarship funds will be used to enhance the project (the proposal should be no more than five double-spaced pages in length, including references); and (3) a letter of recommendation from the student's immediate advisor that includes a statement of financial need and the amount and nature of other available funding for the research project.

Send the material to: Gretchen Hoffman, New Mexico Bureau of Geology, 801 Leroy Place, Socorro, NM 87801, USA, gretchen@gis.nmt.edu, fax +1-505-835-6333.

The proposal and letter of recommendation must arrive no later than 15 February 2006. Applicants will be notified of the scholarship committee's decision by 1 April 2006.

The scholarship was established as a memorial to Antoinette "Toni" Medlin, who for many years dedicated her efforts toward the advancement of coal geoscience and to the encouragement of students in coal geology. Monies for the scholarships are derived from the annual interest income of the Antoinette Lierman Medlin Scholarship fund, which is managed by the GSA Foundation.

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Changes to GSA Graduate Student Research Grant Eligibility Beginning 2006

In an effort to fund more GSA Student Members, students may now only receive GSA graduate student research grant money once at the master’s level and once at the Ph.D. level. This policy affects all GSA research grantees retroactively.

Those who have applied for grant funding but who did not receive a grant are welcome to apply again.

To apply, please go to www.geosociety.org/grants/gradgrants.htm. Online applications are due by Wed., 1 February 2006, at 11:59 p.m. (MST).
2004–2005 Congressional Science Fellow Report:

A Category 5 Adventure


It has been quite a year working with the House Science Committee’s Space Subcommittee, one that seems to have both started and ended amidst hurricanes. In fact, maybe that’s a good symbol for the whirlwind adventure that was my past year as Congressional Science Fellow.

Stormy Weather

The first storm I encountered on this journey was the remnants of a hurricane whose name I can no longer remember. It reached Rhode Island just as I was loading the last of my belongings into the moving-truck; I was lucky that almost everything stayed dry. I arrived at my new home in Washington, D.C., just as the remnants of another storm (that I also can’t remember the name of) hit. For the second time in a week, I lucked out and managed to get almost everything inside just as the rain started to fall.

A few weeks later, I was reminded just how lucky I was when I tried to interview in the office of Senator Bill Nelson (Dem.-Fla.). I was asked to call back in a few months when they would have time to deal with something besides hurricane relief. Clearly, my experience of the hurricane season of 2004 was mild compared to that of the citizens of Florida. Of course, now even those devastating hurricanes have been overshadowed by Hurricane Katrina. Katrina is a name I am not likely to forget, and neither is Rita.

It’s interesting how in this town everything happening in New Orleans and along the Gulf Coast seems to be both closer and farther away. Closer, because it affects members of Congress like Rep. Charlie Melancon, a member of my committee, whose southeastern Louisiana district was devastated by Katrina and hit again by Rita. I spent a good portion of my Labor Day weekend volunteering in Melancon’s office, where I got a close-up view of the situation. As personal as that experience was, in some ways the whole tragedy seemed so far away because everything here is distorted through a weird political lens. From the minute Katrina made landfall, I could hear the buzz in this town: How will this affect my poll numbers? Can we use this to push for higher fuel efficiency standards? In D.C., everything is political, all the time.

I have even found myself looking through that political lens, trying to figure out how Katrina will affect the Space Subcommittee. How much damage was there at the two National Aeronautics and Space Administration (NASA) facilities in Katrina’s path? How will that affect the launch schedule for the next shuttle? Where will the money for repairs come from? How long will this distract the Senate from finding time to pass that NASA bill? I guess it’s an occupational hazard.

Shouting into the Wind

In the wake of Katrina, I cringed to hear President Bush and others say that they had been caught off guard, that they were surprised the levees broke. How is that possible? Scientists and engineers had been warning for years that New Orleans was in danger, and yet it appears that their warnings fell on deaf ears. Why weren’t they listened to? Indeed, it often feels like scientists are shouting into the wind.

In my last article, I talked about how useful it can be to establish and maintain a relationship with your Congress members and their staff, providing your opinion and expertise when appropriate. However, it has become increasingly clear to me this year that simply having access to experts isn’t enough.

Here is where I think sometimes we as scientists fail to have an impact: we are, by nature, logical. We assume that all we have to do is explain things to people and they will see the logic, jump on board, and do the logical thing. Things don’t work that way in D.C. Logic isn’t the only driver in this town. In fact, logic is pretty far down the list. Politics, economics, and a million other factors go into every decision that our lawmakers consider.

I have witnessed the phenomenon of the logical scientist firsthand many times this year when scientists have come in to talk about various projects. They bring in cool pictures. They talk about the exciting science results they are hoping to find. And they think that’s enough. But it’s only the start. They need to go further, to put the science into context, to justify it.

Congress members want to know what’s in it for them and their constituents. Will it provide jobs? Bring money or prestige to a university or facility in their district? Is there an outreach program or some sort of student involvement? Will there be technology spinoffs? These are the kinds of considerations that can make your science relevant. No matter how fabulous your project is, without context, you’re just one more person asking for money.

In The Eye of the Storm

Despite that advice, I don’t think that anyone could argue that lack of relevance can account for the lack of action to secure New Orleans. I really don’t have an answer for that. I wish I did. Perhaps our government officials just closed their eyes, crossed their fingers, and hoped that New Orleans would continue to be lucky. Or maybe the 14-billion-dollar price tag on the proposed Louisiana Coastal Area Ecosystem Restoration Project gave them sticker shock. (Isn’t it funny how suddenly $14 billion over 30 years seems like chump change when compared to cleanup and rebuilding costs?) There are numerous investigations under way in Congress and the rest of the government to search for those answers; maybe they’ll even find some.
Whatever the excuses, my sincere hope is that we can all learn from this tragedy. I hope, in particular, that our government understands that ignoring the scientific community doesn’t make the problem go away. The optimist in me would like to think that we can learn from our mistakes and that, next time, the voices of the scientists will be heard. So, ultimately, my advice is: keep shouting.

After the Rain

The Gulf Coast will forever be changed by the hurricanes. Homes and lives will be rebuilt, but things will never be exactly the way they were before. For so many, a line has been drawn across the timeline of their lives. Their memories will now be filed as either before Katrina and Rita or after.

In some small measure, I feel the same way about my time in Washington. My life will forever be changed by this fellowship. Part of that change is the friendships and connections that I have made here, but a lot of it is because “Congress” and “The Government” are no longer black boxes to me. I understand much more clearly now how it all works (or doesn’t, as the case may be). That understanding has changed my perspective. I no longer feel helpless. You won’t ever catch me sitting around wondering why “someone doesn’t do something about that,” but rather, I’ll be thinking, “What can I do about that?” As scientists, we all know that knowledge is empowering, and I have gained an unbelievable amount of knowledge this year.

Public Service Message

Speaking of empowering knowledge: One of the projects that I worked on this year, and that I’m very proud of, is our brand new committee Web site, http://sciencedems.house.gov. There you can find all kinds of information about what is happening in the science committee, information on bills and investigations, transcripts from hearings, member speeches, and more. The resources on this site can keep you informed and educated about the complex goings on of science policy.

In addition to science committee information, there is also a section titled “Science Education & You.” This is my main contribution to the site. These pages are designed as a clearinghouse of federal educational resources for K–16 math and science teachers. By providing access to science and math lesson plans, internship information, summer program opportunities, and countless other resources, our hope is that this site will become a valuable tool for students and educators across the country.

I hope that you will find some time to explore the site and send your comments and suggestions to the committee staff. If you find the site useful, please pass it on to your friends and colleagues.

Apply for the GSA-USGS Congressional Science Fellowship for 2006–2007

Opportunities to serve as a Congressional Science Fellow are rare, unique experiences. This position may be a good fit for you. It will enable you to work directly with national leaders and put your expertise and experience to work helping shape science and technology policy on Capitol Hill.

The Congressional Science Fellow will be selected from top competitors early in 2006. Prospective candidates should be GSA Members with a broad geoscience background and excellent written and oral communication skills. Minimum requirements are a master’s degree with at least five years professional experience or a Ph.D. at the time of appointment.

If you possess this professional background, have experience in applying scientific knowledge to societal challenges, and share a passion for helping shape the future of the geoscience profession, GSA invites your application. The fellowship is open to U.S. citizens or permanent U.S. residents.

Deadline to apply: 1 February 2006

For application information, visit www.geosociety.org/science/csf/ or contact Ginger Williams, GSA Headquarters +1-303-357-1040, gwilliams@geosociety.org.
Planned Giving Options Give Donors the Ability to Give Generously Today and in the Future

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

Planned Giving Options and Benefits

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

**Gifts of Stocks, Bonds, Mutual Funds, and Real Estate** that have appreciated in value and have been owned for more than one year can result in triple tax savings. You may receive an income tax deduction on the market value, not the original price, of the securities or real estate, and you bypass any capital gains tax on the gain or growth since the time of purchase. Opportunities for state capital gains tax savings may also exist.

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

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

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

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

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

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

To receive a complimentary copy of *A Guide to Creative Planned Giving*, please contact Donna Russell, director of operations, GSA Foundation, drussell@geosociety.org, +1-303-357-1054.

Don’t Forget!

Make sure your 2005 contributions to the Foundation are postmarked by 31 December 2005.

Most memorable early geologic experience:

I was fortunate to have been mentored by the late Vincent C. Kelley at the University of New Mexico in the early 1960s. He stressed the importance of field mapping, a quality that I have tried to imprint on my own students. He accompanied me during the early phases (1963) of mapping on my dissertation project, the Sierra Blanca Volcanic Field in South-Central New Mexico. Rather than answering directly, he asked questions that made me arrive at plausible interpretations to field sites. That approach to field work is critical in training young geologists.

—Tommy Thompson

Enclosed is my contribution in the amount of $___________.
Please credit my contribution for the:
☐ Greatest need  ☐ Other: __________________________ Fund
☐ I have named GSA Foundation in my will.
☐ I want to support and celebrate the Foundation’s 25th Anniversary with a gift of:
  ☐ $2,500  ☐ $1,000  ☐ $500  ☐ Other: $___________.
☐ Complimentary copy of *A Guide to Creative Planned Giving*

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Call for Field Trip Proposals

The Pursuit of Science

Geological Society of America
Annual Meeting & Exposition • Philadelphia, Pennsylvania
Technical Program • 22–25 October 2006

FIELD TRIP CHAIR
Frank J. Pazzaglia,
Dept. of Earth
and Environmental Sciences
Lehigh University
31 Williams Drive, Bethlehem, PA 18015
+1-610-758-3667, fax: +1-610-758-3677, fjp3@lehigh.edu

The GSA Annual Meeting’s return to the east brings with it many opportunities for great field trips throughout the area. We are interested in proposals for half-day, single-day, and multi-day field trips beginning or ending in or near Philadelphia and dealing with all aspects of the geosciences. While the planning for some trips is already under way, many more areas and topics are still open; we are looking for leaders to take these trips and give them a personal touch.

Take a look at the suggested topics and areas below (or propose a different one) and let Field Trip Chair Frank Pazzaglia (+1-610-758-3667, fjp3@lehigh.edu) know you are interested.

Due Date for Field Trip Proposals: 15 January 2006.

LEAD ONE OF THESE TRIPS AT THE 2006 GSA ANNUAL MEETING:

☐ The K-T Boundary in New Jersey
☐ Coastal Processes and Beach Communities
☐ Quaternary Geochronology of the Middle Atlantic Coastal Plain
☐ Urban Geology Walking Tours of Fall Zone Cities—New York, Philadelphia, Baltimore, and Washington, D.C.
☐ History and Geology of Revolutionary and Civil War Battlefields

2006 PROPOSED FIELD TRIPS

Watch for more information on the following trips in upcoming issues of GSA Today.

Devonian Fossil Fish of Central Pennsylvania
One day; Ted Deschler, Philadelphia Academy of Science
Proposed to be held in conjunction with a technical session.

Haddonfield Dinosaur Site
One day; Jan Twitchell, Hatch Dinosaur Sculpture Committee

Historical Geology of the American Philosophical Society, Academy of Natural Sciences, and Franklin Institute
One day; Sally Newcomb and Gary Rosenberg, History of Geology Division

Metamorphic Rocks in the Philadelphia Area
One to three days; Hal Bosybehl, West Chester University

Metamorphic History of the Honey Brook Upland and its Paleozoic Cover
One day; Joe Pyle, Rensselaer Polytechnic Institute

A Tour of the Peach Bottom Slate—Once the Best Building Slate in the World
One day; Jeri Jones, Jones Geological Services

Building on a Foundation of Discovery
### MEETINGS CALENDAR

#### 2006

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<tr>
<th>Date</th>
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<tr>
<td>5–8 March</td>
<td>Earth &amp; Space 2006, 10th International Conference on Engineering, Construction and Operations in Challenging Environments, League City, Texas, USA. American Society of Civil Engineers, Aerospace Division. <a href="http://www.asce.org/conferences/space06">Information</a>.</td>
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<td>2–7 April</td>
<td>EGU 2006, General Assembly of the European Geosciences Union, Vienna, Austria. <a href="http://meetings.copernicus.org/egu2006/">Information</a>.</td>
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<td>3–7 April</td>
<td>Backbone of the Americas—Patagonia to Alaska, Mendoza, Argentina. Co-convened by Asociación Geológica Argentina and GSA. [Information](<a href="mailto:dnelson@geosociety.org">mailto:dnelson@geosociety.org</a>, +1.303.357.1014, <a href="http://www.geosociety.org/meetings/06boa/">www.geosociety.org/meetings/06boa/</a>).</td>
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<td>8–12 May</td>
<td>First International Conference on Impact Cratering in the Solar System, Noordwijk, The Netherlands. [Information](<a href="mailto:agustin.chicarro@esa.int">mailto:agustin.chicarro@esa.int</a>, <a href="http://www.rssd.esa.int/">www.rssd.esa.int/</a>).</td>
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<td>16–21 July</td>
<td>Zeolite'06: The 7th International Conference on the Occurrence, Properties, and Utilization of Natural Zeolites, Socorro, New Mexico, USA. [Information](<a href="mailto:bowman@nmt.edu">mailto:bowman@nmt.edu</a>, <a href="http://www.ees.nmt.edu/Zeolite06">www.ees.nmt.edu/Zeolite06</a>).</td>
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<td>26–27 August</td>
<td>4th International Gemological Symposium, GIA Gemological Research Conference, San Diego, California, USA. [Information](<a href="mailto:jigemconference@gia.edu">mailto:jigemconference@gia.edu</a>, <a href="http://www.symposium.gia.edu/">www.symposium.gia.edu/</a>).</td>
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#### 2007

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Visit [www.geosociety.org/calendar/](http://www.geosociety.org/calendar/) for a complete list of upcoming geoscience meetings.

### About People

The Antarctic geological drilling program (ANDRILL), led in the U.S. by GSA Fellow [Ross Powell](mailto:rospow@geosociety.org) and GSA Member [David Harwood](mailto:harwood@geosociety.org), has received nearly $12 million in funding from the National Science Foundation. Harwood is the director of the ANDRILL Science Management Office; Powell serves as co-chief scientist for ANDRILL and fellow U.S. co-leader with Harwood.

GSA Fellow [Molly F. Miller](mailto:molly@geosociety.org) has been awarded the 2005 Association for Women Geoscientists Foundation Outstanding Educator Award. The award was bestowed at the AWG breakfast on 17 Oct. 2005 at the GSA Annual Meeting in Salt Lake City, Utah.

GSA Senior Fellow [Gerald M. Friedman](mailto:gerald@geosociety.org) is the recipient of the American Geological Institute’s 2005 Legendary Geoscientist Award. This award is presented to scientists who demonstrate a long history of scientific achievement and exceptional service to the geoscience profession. Friedman is also GSA’s 2005 Mary C. Rabbitt History of Geology Awardee.

GSA Honorary Fellow Sir [Nicholas Shackleton](mailto:nicholas@geosociety.org) has been awarded the Founders Medal of the Royal Geographical Society (London, UK) for advancing international understanding of pale-oceanographic and Quaternary environmental change.
AGI Names New Officers

GSA Fellow Ernest A. Mancini has been named president of the American Geological Institute (AGI). He was inducted into office on 18 October 2005 at the Friends of AGI reception at the GSA Annual Meeting in Salt Lake City, Utah. AGI also appointed three new officers: GSA Senior Fellow Gail M. Ashley will serve as president-elect to AGI; GSA Member Richard M. Powers is AGI's new member-at-large, and GSA Fellow James C. Cobb will serve as AGI's treasurer.

Publication Pipeline to Aid Hurricane Area Universities

In the November issue of GSA Today (p. 23), an article by GSA Fellow George D. Klein (gdkgeo@earthlink.net) on the AAPG Publication Pipeline Committee solicited donations of books and journals for educational use in developing countries. The committee is now working with GSA to donate needed books and journals to geology departments that were in the paths of Hurricanes Katrina and Rita. The committee is awaiting word from the universities affected (Tulane University, University of New Orleans, University of Southern Mississippi, and Lamar University), which will come once the university faculty are able to return to campus and can assess the damage to their collections. For more information, contact the AAPG Publication Pipeline Committee Chairman, Rick Wall, at rwall@sampson.com or rwall1@hotmail.com.

Dr. A.H. Heineken Prize for Environmental Sciences 2006: Nominations Requested

These international prizes reward outstanding scientific achievement in various fields, including environmental science. The Royal Netherlands Academy of Arts and Sciences (KNAW) selects the winners of the Heineken Prizes on the basis of nominations received from both institutes and individual researchers. For more information, go to www.knaw.nl/. The deadline for nomination is 1 January 2006; laureates will be announced in April 2006.

Call for Proposals:

Professional Development Short Courses and K–12 Education Workshops

The GSA Committee on Professional Development invites those interested in proposing a short course or workshop to contact GSA Headquarters for proposal guidelines. This invitation is extended to K–12 teachers, teacher trainers, preservice educators, and undergraduate educators to submit proposals for K–12 education workshops. Committee members are interested in receiving course proposals for the 2006 GSA Annual Meeting in Philadelphia or the 2007 GSA Annual Meeting in Denver.

Proposals must be received by 1 January 2006. Selection of courses for 2006 will be made by 1 March 2006. We will also consider courses for 2007 during this time.

For proposal guidelines or information, contact Edna Collis, Program Officer, GSA Headquarters, +1-800-472-1988, ext. 1034, ecollis@geosociety.org.
Forensic Geomorphology

Stanley A. Schumm, Mussetter Engineering, Inc., Fort Collins, Colorado, stans@mussei.com

According to Tank (1983, p. 12), geologists have testified as expert witnesses in litigation involving landslides, subsidence, erosion, ground and surface water problems, mineral discovery, mine safety, oil and gas discovery and ownership, environmental disputes, soil conditions, and criminal cases. Engineers are also involved in geomorphic-type forensic activity, especially with regard to the causes and effects of mass movement, river hydraulics, and flooding (Shuimran and Slosson, 1992; Rens, 1997). During the past 35 years, I have been involved as an expert witness in hearings, depositions, and trials that were related to channel incision, river boundaries, bank erosion, island ownership, water rights, and river navigability. This type of activity is considered to be part of the work of forensic geomorphology.

The term forensic brings to mind experts testifying during a criminal trial. This is understandable because of the popular mystery novels by Sarah Andrews that involve a criminal forensic geologist and books describing how forensic geologists use mineralogy and sedimentology to locate the sites of criminal activity (Murray, 2004). However, these limit the meaning of forensic, which is much broader. Forensic pertains to legal proceedings or argumentation (Morris, 1981). Black (1979) states that forensic medicine involves the “application of every branch of medical knowledge to the purpose of the law.” If we substitute geomorphic knowledge for medical knowledge, we have a definition of forensic geomorphology that applies to both criminal and civil litigation.

The purpose of this commentary is to encourage my friends and colleagues to become involved as experts in geomorphic litigation (Coates, 1976). In several instances, I have found highly qualified geomorphologists reluctant to be involved in cases in which they clearly could contribute to an appropriate outcome. For example, boundary disputes, where a river forms the boundary, require geomorphic input. Perhaps my fellow geomorphologists are deterred by examples of television program cross-examinations. In reality, a judge would never allow the speechifying that occurs during television trials, and in my experience, cross-examination has always been professional and reasonably civil.

An individual can be qualified as an expert “by knowledge, skill, experience, or education.” The expert may testify in the form of an opinion if “(1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case” (Federal Rules of Evidence, 2004). There are three phases of litigation that involve expert witnesses. The first is the pretrial deposition, during which opposing counsel questions the expert witness in order to determine what was done and what the expert’s conclusions are. The purpose is to allow the opposition to learn as much as possible about the expert’s activities and opinions and what he or she will testify to in court. In this procedure, the questions are designed to elicit information, and the situation can be informal. Next is direct testimony, during the trial, when the expert’s opinions are expressed during questioning by the expert’s attorney. This is straightforward and professional. The final phase is cross-examination, when opposing counsel attempts to weaken the previous testimony and perhaps to show conflict between testimony in the deposition and testimony during direct examination, which is often referred to somewhat dauntingly as impeachment. This, of course, is the most stressful part of the expert’s involvement. However, if the expert is convinced that his or her testimony is accurate, the response to cross-examination will essentially be a repeat of the deposition and direct testimony.

The following is some helpful advice provided to me by attorneys with whom I have worked:

1. Be truthful—if you lie or are less than straightforward with an answer to a question, you will appear to be biased, and you will lose credibility. If your reputation is damaged, not only will you be damaged, but so will your client.

2. Listen carefully—Answer only the questions asked, and do not guess or speculate. “I do not know” is an appropriate answer. Remember, you can only be questioned in your area of expertise.

3. Provide short answers—Answer as briefly as possible, and do not volunteer information that was not requested.

4. Short but not too short—Do not answer yes or no to a complex question. You can always explain your answer.

5. You can always request a time-out if you are tired or require a break.

6. An appropriate response to an “isn’t it possible” question is “yes, but it is improbable.”

7. Do not joke or be flippant or sarcastic, and do not lose your temper.

8. Avoid jargon and keep explanations simple, especially before a jury.

The reason people hesitate to act as expert witnesses is that they feel that they will be made to appear incompetent or even foolish under cross-examination. That is, they are afraid that some fast-talking, know-it-all lawyer is going to make fools of them. However, most trial lawyers are afraid that some fast-talking, know-it-all witness is going to make
fools of them—or worse, is going to destroy their cases. A seasoned trial lawyer may not appear nervous—but most live with butterflies in their stomachs (Baker, 1983).

Remember, you are on better ground than the questioner. He or she can only ask questions; if you know the answers, you are in control. Often, if the expert has done a thorough and professional job, the opposition will accept defeat, and the case is settled before trial.

Examples of litigation related to river boundary disputes, causes of bank erosion, and the effect of diversions on channel morphology are provided by Bowman (1923), Womack (2001), Schumm, (1994), and Gordon (1995).

A well-trained geoscientist who understands the argument advanced by the opponent and who has done all of the field work, literature review, and data analysis necessary has nothing to fear from cross-examination. Of course, if the expert’s investigations reveal that the case is weak or, in fact, the position of the expert’s employer is incorrect, it is the expert’s obligation to so inform his employer and his attorney so that a trial can be avoided. Finally, a major obligation of the expert is to educate the attorney regarding the technical aspects of the case and to assist in developing a plan for the presentation of evidence and cross-examination.

REFERENCES CITED
GSA Special Papers

Reconstruction of Pleistocene Ice-Dammed
Lake Outburst Floods in the Altai Mountains, Siberia
by Jürgen Herget

In the Altai Mountains, located in southern Siberia, some of the largest floods in Earth’s history occurred in Pleistocene times. The floods were caused by ice-dammed lake outburst floods comparable with glacial Lake Missoula events. In this volume, the remnants of the repeated jökulhlaups and key features of the local Pleistocene environment are described in review. The volume also focuses on the paleohydraulic interpretation of the traces of the floods to reconstruct their magnitudes and characteristics. Herget applied several established methods in the study as well as developed and applied new approaches (e.g., hydraulic interpretation of run-up sediments, fluvial gravel dunes and local scour around obstacles).

$65.00, member price $52.00

Coal Systems Analysis
edited by Peter D. Warwick

Coal is an important and required energy source for today’s world. Current rates of world coal consumption are projected to continue at approximately the same (or greater) levels well into the twenty-first century. This collection of papers provides an introduction to the concept of coal systems analysis and contains examples of how coal systems analysis can be used to understand, characterize, and evaluate coal and coal gas resources. Coal systems analysis incorporates the various disciplines of coal geology to provide a complete characterization of the resource.

$60.00, member price $48.00

Plates, Plumes, and Paradigms
edited by Gillian R. Foulger, James H. Natland, Dean C. Presnall, and Don L. Anderson

This beautiful compendium of work on hotspot volcanism documents the development, current state-of-play, and future prospects of all branches of the subject. It contains extensive and indispensable reference resources in the form of hotspot, tectonic, volcano and topographic maps and cross sections of Earth. Some chapters outline the history of the plume hypothesis and other theories for the genesis of hotspots, and several provide tutorials that will be valuable to students and cross-disciplinary scientists. Other chapters present innovative models and theories for individual localities, volcano genesis processes, and related global observations. Many of these include subject reviews, making them doubly valuable to specialists and non-specialists alike. The book is fully interdisciplinary, encompassing geophysics, geochemistry, noble gases, heat, temperature, tectonics, petrology, mantle dynamics, impacts, and syntheses reconciling several branches of earth science. Included are chapters that advocate the plume model and ones that advocate alternative models. The book will enjoy a long lifetime of usefulness and functions as a reference work for students, scholars, and informed lay people. It is equally valuable for supporting advanced undergraduate or post-graduate courses and research scientists working at the forefront of hotspot science. It is an essential addition to the bookshelves of every science library, earth science teacher, and research scientist who aspires to understand the frontiers of this exciting subject. With over 150 color plates, it makes a beautiful addition to the library of anyone fascinated by volcanoes—one of nature’s most exciting and extraordinary phenomena.

$180.00, member price $144.00

Fifth Hutton Symposium: The Origin of Granites and Related Rocks

Granitic rocks are the most important component of Earth’s upper continental crust, but their origin remains a topic of considerable debate. Recent developments have underscored the importance of modeling physical and chemical processes as well as the application of field techniques. The Fifth Hutton Symposium on the Origin of Granites and Related Rocks was held in Toyohashi, Japan, in September 2003 to review current thinking on this age-old debate. Some 27 invited papers are collected in this volume and represent all principal areas of research activity. The volume includes papers describing unifying models and new paradigms consistent with recent research, and contributions span the range from anatexis to emplacement and late-stage mineralization. A significant feature of this particular volume is the major contribution by scientists from the Far East both to generic aspects of granite magmatism and to studies of regional importance.

$95.00, member price $76.00

Stone Decay in the Architectural Environment
edited by Alice V. Turkington

Some structures are constantly under threat from natural and human-induced decay processes, yet stone buildings, structures, and works of art remain a permanent feature in our cultural heritage. This volume presents recent research by an international group of geologists and geomorphologists on stone decay in the architectural environment, and it updates the latest theoretical and methodological advances in this field. The volume will be informative to earth scientists concerned with rock weathering in natural and urban locales, and it will be of benefit to those conservators, practitioners, scientists, and students whose interest lies at the interface between research and its application.

$45.00, member price $36.00

Net Dextral Slip, Neogene San Gregorio–Hosgri Fault Zone, Coastal California: Geologic Evidence and Tectonic Implications

The San Gregorio–Hosgri fault is the major subsidiary strand of the San Andreas fault system in coastal California, where its course is partly onshore and partly offshore. Understanding the path and amount of San Gregorio–Hosgri fault displacements is important for understanding the geologic history of California and seismic hazard along the California coast. This Special Paper summarizes evidence for 156 km of net San Gregorio–Hosgri fault slip based on an analysis of onshore and offshore geologic mapping supplemented by reappraisal of key geologic features offset by San Gregorio–Hosgri fault movements.

$40.00, member price $32.00

A Typology of Sculpted Forms in Open Bedrock Channels
by Keith Richardson and Paul Anthony Carling

Bedrock channels are important agents of erosion in mountainous areas, and understanding them is vital to the development of models of landscape evolution. Despite this, erosional sculpted forms in bedrock channels are a neglected area of research and are at present poorly described. This heavily illustrated book provides a comprehensive description and classification of bedforms in bedrock channels over a range of spatial scales and develops a consistent terminology, placing the study of sculpted forms in bedrock on a more rational footing alongside that of depositional bedforms. The authors then use the descriptions to define general principles governing the development of sculpted forms. They also show that erosional features in bedrock provide a wealth of information regarding flow structures, erosion processes and the origins of bedforms.

$55.00, member price $44.00
This volume provides a comprehensive overview of the idea that a great fault, the Mojave-Sonora megashear, served as the plate boundary of southwestern North America in the Late Jurassic. The volume is organized into three parts to illuminate separate aspects of the megashear controversy. For the first time, the original U-Pb analyses and field observations that led to development of the megashear hypothesis are presented (three articles) along with their detailed geologic context. Seventeen papers included in the assessment section document significant efforts by numerous geoscientists to tackle various aspects of the problem. Finally, to provide a balanced perspective, we include five articles in the alternatives section that argue against existence of the megashear as originally proposed and provide alternative interpretations to explain geologic relations in northern Mexico and the southwestern United States. The volume includes diverse studies that consider the stratigraphy, structure, geochronology, geochemistry, and paleontology of relevant geologic units.

$140.00, member price $112.00

Caribbean–South American Plate Interactions, Venezuela
edited by Hans G. Avé Lallemant and Virginia B. Sisson, 2005
Rocks in plate boundary zones are generally strongly deformed. Rocks in the Mesozoic–Cenozoic Caribbean–South American plate boundary zone in Venezuela are no exception. The first of four major deformation events occurred in Jurassic to Early Cretaceous time and is expressed by normal faults recognized in seismic reflection lines and by extensional mylonites in the Tinaquillo alpine-type peridotite. Subsequently, Early Cretaceous subduction created high-pressure–low temperature mélanges that were exhumed in the Late Cretaceous to Eocene. Next, north-south contraction resulted in an Eocene fold and thrust belt. The final event from Eocene to Recent resulted in west to east diachronous, right-oblique convergence and collision of the Leeward Antilles arc. All of this is documented with new geochronology, geochemistry, petrology, sequence stratigraphy, structural geology, and reflection seismology.

$80.00, member price $64.00

Isotopic and Elemental Tracers of Cenozoic Climate Change
edited by Germán Mora and Donna Surge
This volume contains a series of papers focusing on the utilization of isotopic and bulk-chemical techniques to interpret past changes in climate. Chapters cover marine, coastal, and terrestrial settings, thus providing a broad range of ideas in terms of the versatility of these techniques. The authors are all experts in the field of geochemistry, with diverse backgrounds and wide-ranging expertise. Consequently, their contributions provide illustrative examples of the applicability of geochemical techniques to paleoclimatology by exploring theoretical and practical frameworks used to analyze and interpret isotopic and elemental data from marine and terrestrial materials. This publication also contains innovative interpretations that improve proxy records in the fields of oceanography, limnology, hydrology, aquatic ecology, and pedology.

$35.00, member price $28.00

Kinematics and Dynamics of Lava Flows
edited by Michael Manga and Guido Venture
The vast majority of erupted magmas are emplaced as lava flows. Although not as devastating as large explosive eruptions, lava flows may cause significant damage. Understanding the physical and thermal processes that govern the flow and emplacement of lava (the dynamics) and the inference of the emplacement and flow history from features preserved in flows (the kinematics) are the subjects of this compilation of papers. The volume provides an overview of the current understanding of the physical, thermal, and chemical processes that govern the flow of lavas and the interpretation of prehistoric flows. The chapters encompass volcanological, petrological, and structural studies; approaches include numerical and experimental modeling, field studies, remote sensing, and hazard assessment using geographic information systems. An outstanding feature of this volume is the multidisciplinary content of the presented topics.

$70.00, member price $56.00
COAL GEOLOGY
SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE
The Department of Geology at Southern Illinois University Carbondale is a medium-sized, public university in the heart of southern Illinois, where faculty and students work and learn in a beautiful karst landscape. The department offers a B.S. in Geology and a minor in Geology. The Geology department at SIUC has energy programs and facilities that provide opportunities for collaborative research, including the Coal Research Center, the Center for Advanced Friction Studies, and the Mining and Mineral Resources Program. The Department of Geology at SIUC is the only department in the region that offers a program in Coal Science and Engineering. The Geology department at SIUC is the only department in the region that offers a program in Coal Science and Engineering.

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URBAN GEOGRAPHY: A human geographer whose research interests include urban geography and urban environmental issues.

BIogeography: A biogeographer or geologist whose research interests include landscape ecology, long-term biological responses to environmental change, and biological community dynamics.

SEDIMENTOLOGY: A sedimentologist or geologist whose research interests include the development and evolution of coastal ecosystems. Specific research areas could include hydrological linkages with biogeoclimatic, vegetation dynamics, and geology. Regardless of specialization, the ideal candidate will have a significant field research component in their work and an interest in and capacity for interdisciplinary research.

The successful candidate will be expected to develop outstanding research programs in relation to the ongoing research efforts at both the undergraduate and graduate levels. Applicants must show demonstrated excellence in their research and a strong commitment to quality teaching. Candidates should have a Ph.D. in the hydrological sciences or closely related discipline.

Applications for research and teaching interests, curriculum vitae, and the names and addresses of three referees to: Joseph C. Zieman, Professor and Chair, Department of Environmental Sciences, University of Georgia, 291 McCormick Road, PO Box 400123, Charlottesville, VA 22901-4123.

For immediate review, applications must be received by June 1, 2006; however, the position may remain open until filled. We especially encourage applications from underrepresented groups. For additional information see the department web site at http://www.evsirci. virginia.edu/.

The University of Virginia is an Equal Opportunity/Affirmative Action Employer.

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
DIRECTOR OF CAVE & KARST
The Director will serve as manager and chief executive officer of the Cave & Karst Research Institute. The Director will be responsible for the strategic planning and development of the Institute, including the development of new initiatives and maximizing the Institute’s impact in the fields of cave and karst science.

The Director will be responsible for developing and implementing a long-term strategic plan for the Institute, including the identification and prioritization of key research areas, the development of new partnerships, and the cultivation of new funding opportunities.

The Director will also be responsible for the financial management of the Institute, including the development and implementation of a comprehensive financial plan, the management of the Institute’s budget, and the development of new revenue streams.

The Director will be responsible for the development and implementation of a comprehensive marketing and communication plan, including the development of new marketing materials, the management of the Institute’s social media presence, and the development of new partnerships with other organizations.

The Director will be responsible for the oversight of the Institute’s operations, including the management of the Institute’s facilities and the implementation of new policies and procedures.

The Director will be responsible for the development and implementation of a comprehensive human resources plan, including the recruitment and retention of new staff members, the development of new training and development programs, and the implementation of new policies and procedures.

The Director will be responsible for the development and implementation of a comprehensive community engagement plan, including the development of new partnerships with other organizations, the development of new outreach materials, and the implementation of new community engagement initiatives.

The Director will be responsible for the development and implementation of a comprehensive sustainability plan, including the development of new sustainability initiatives, the implementation of new sustainability policies and procedures, and the monitoring and reporting of the Institute’s sustainability performance.

The Director will be responsible for the development and implementation of a comprehensive quality assurance plan, including the development of new quality assurance initiatives, the implementation of new quality assurance policies and procedures, and the monitoring and reporting of the Institute’s quality assurance performance.

The Director will be responsible for the development and implementation of a comprehensive compliance plan, including the development of new compliance initiatives, the implementation of new compliance policies and procedures, and the monitoring and reporting of the Institute’s compliance performance.

The Director will be responsible for the development and implementation of a comprehensive governance plan, including the development of new governance initiatives, the implementation of new governance policies and procedures, and the monitoring and reporting of the Institute’s governance performance.

The Director will be responsible for the development and implementation of a comprehensive risk management plan, including the development of new risk management initiatives, the implementation of new risk management policies and procedures, and the monitoring and reporting of the Institute’s risk management performance.

The Director will be responsible for the development and implementation of a comprehensive legal plan, including the development of new legal initiatives, the implementation of new legal policies and procedures, and the monitoring and reporting of the Institute’s legal performance.

The Director will be responsible for the development and implementation of a comprehensive research plan, including the development of new research initiatives, the implementation of new research policies and procedures, and the monitoring and reporting of the Institute’s research performance.

The Director will be responsible for the development and implementation of a comprehensive educational plan, including the development of new educational initiatives, the implementation of new educational policies and procedures, and the monitoring and reporting of the Institute’s educational performance.

The Director will be responsible for the development and implementation of a comprehensive public relations plan, including the development of new public relations initiatives, the implementation of new public relations policies and procedures, and the monitoring and reporting of the Institute’s public relations performance.

The Director will be responsible for the development and implementation of a comprehensive marketing plan, including the development of new marketing initiatives, the implementation of new marketing policies and procedures, and the monitoring and reporting of the Institute’s marketing performance.

The Director will be responsible for the development and implementation of a comprehensive communications plan, including the development of new communications initiatives, the implementation of new communications policies and procedures, and the monitoring and reporting of the Institute’s communications performance.

The Director will be responsible for the development and implementation of a comprehensive public affairs plan, including the development of new public affairs initiatives, the implementation of new public affairs policies and procedures, and the monitoring and reporting of the Institute’s public affairs performance.

The Director will be responsible for the development and implementation of a comprehensive strategic plan, including the development of new strategic initiatives, the implementation of new strategic policies and procedures, and the monitoring and reporting of the Institute’s strategic performance.

The Director will be responsible for the development and implementation of a comprehensive planning and budgeting plan, including the development of new planning and budgeting initiatives, the implementation of new planning and budgeting policies and procedures, and the monitoring and reporting of the Institute’s planning and budgeting performance.

The Director will be responsible for the development and implementation of a comprehensive program planning and management plan, including the development of new program planning and management initiatives, the implementation of new program planning and management policies and procedures, and the monitoring and reporting of the Institute’s program planning and management performance.

The Director will be responsible for the development and implementation of a comprehensive program evaluation plan, including the development of new program evaluation initiatives, the implementation of new program evaluation policies and procedures, and the monitoring and reporting of the Institute’s program evaluation performance.

The Director will be responsible for the development and implementation of a comprehensive program management plan, including the development of new program management initiatives, the implementation of new program management policies and procedures, and the monitoring and reporting of the Institute’s program management performance.

The Director will be responsible for the development and implementation of a comprehensive program administration plan, including the development of new program administration initiatives, the implementation of new program administration policies and procedures, and the monitoring and reporting of the Institute’s program administration performance.

The Director will be responsible for the development and implementation of a comprehensive program communication plan, including the development of new program communication initiatives, the implementation of new program communication policies and procedures, and the monitoring and reporting of the Institute’s program communication performance.

The Director will be responsible for the development and implementation of a comprehensive program marketing plan, including the development of new program marketing initiatives, the implementation of new program marketing policies and procedures, and the monitoring and reporting of the Institute’s program marketing performance.

The Director will be responsible for the development and implementation of a comprehensive program public relations plan, including the development of new program public relations initiatives, the implementation of new program public relations policies and procedures, and the monitoring and reporting of the Institute’s program public relations performance.

The Director will be responsible for the development and implementation of a comprehensive program public affairs plan, including the development of new program public affairs initiatives, the implementation of new program public affairs policies and procedures, and the monitoring and reporting of the Institute’s program public affairs performance.

The Director will be responsible for the development and implementation of a comprehensive program strategic plan, including the development of new program strategic initiatives, the implementation of new program strategic policies and procedures, and the monitoring and reporting of the Institute’s program strategic performance.

The Director will be responsible for the development and implementation of a comprehensive program planning and budgeting plan, including the development of new program planning and budgeting initiatives, the implementation of new program planning and budgeting policies and procedures, and the monitoring and reporting of the Institute’s program planning and budgeting performance.

The Director will be responsible for the development and implementation of a comprehensive program program planning and management plan, including the development of new program program planning and management initiatives, the implementation of new program program planning and management policies and procedures, and the monitoring and reporting of the Institute’s program program planning and management performance.

The Director will be responsible for the development and implementation of a comprehensive program program evaluation plan, including the development of new program program evaluation initiatives, the implementation of new program program evaluation policies and procedures, and the monitoring and reporting of the Institute’s program program evaluation performance.

The Director will be responsible for the development and implementation of a comprehensive program program management plan, including the development of new program program management initiatives, the implementation of new program program management policies and procedures, and the monitoring and reporting of the Institute’s program program management performance.

The Director will be responsible for the development and implementation of a comprehensive program program communication plan, including the development of new program program communication initiatives, the implementation of new program program communication policies and procedures, and the monitoring and reporting of the Institute’s program program communication performance.

The Director will be responsible for the development and implementation of a comprehensive program program marketing plan, including the development of new program program marketing initiatives, the implementation of new program program marketing policies and procedures, and the monitoring and reporting of the Institute’s program program marketing performance.
Trinity University, One Trinity Place, San Antonio, offers a tenure-track assistant rank of assistant or associate scientist, depending on qualifications, for an opening in the Department of Geosciences with tracks in geology, geospatial sciences, and hydrogeology. Applicants must have a Ph.D. degree (or equivalent) and demonstrate an ability to apply, Trinity University is an Equal Opportunity, Affirmative Action employer.

HYDROGEOLOGY AND GEOPHYSICS
SECTION–KANSAS

GEOLGICAL SURVEY
THE UNIVERSITY OF KANSAS, LAWRENCE

Full-time tenure-track position in geology to begin in 2006. Candidates must have a Ph.D. and have or be very close to completion of their Ph.D. Candidates should have a research specialization in igneous petrology, and a demonstrated interest in teaching and in research. A cover letter, curriculum vitae, a detailed statement of undergraduate teaching experience and philosophy, evidence of teaching effectiveness, a description of research plans, and the names and contact information of four professional references are required. Applications and supporting documents must be submitted by December 1, 2005. For more information, contact Dr. Glenn Kroeger, Department of Geosciences, Trinity University, One Trinity Place, San Antonio, TX 78212. Review of applications will begin January 4, 2006. Submit applications to: Chair, Geology Search Committee, Department of Geosciences, Trinity University, One Trinity Place, San Antonio, TX 78212. Applications are especially encouraged to apply. Trinity University is an Equal Opportunity Employer.

THE UNIVERSITY OF KANSAS, LAWRENCE

The Department of Geological Sciences at Brown University invites applications for a tenure track position in the general area of physics and chemistry of magmatic processes. Preference will be given to those technologies where research interests might include, but are not limited to, melt generation, segregation, and transport; magma chamber and volcanic eruption processes; diffusion, phase equilibria, and mass transfer processes in minerals and at grain boundaries. Analytical, experimental, and theoretical/computational approaches, preferably some combination of the three, to describing geological observations and processes are of interest. Candidates with research interests in Earth and planetary problems are encouraged to apply. Preference will be given to candidates who propose an active research program that complements existing research at Brown University. Candidates will be expected to commit to teaching excellence and graduate education. A Ph.D. degree or equivalent is required, and postdoctoral experience is preferred. A Ph.D. is expected to be completed by the time of appointment. Applicants should forward a curriculum vitae, research interests, and potential for collaboration with existing research groups at Brown as well as a statement of teaching interest to: Professor of Geosciences, Chair, Geology Search Committee, Department of Geological Sciences, Brown University, Box 1917, Providence, RI 02912. Review of applications will begin January 4, 2006. Applications are especially encouraged to apply. Trinity University is an Equal Opportunity Employer.

THE UNIVERSITY OF KANSAS, LAWRENCE

The University of Arkansas is a nationally competitive research university and has 16,900 students, the majority of whom are of Hispanic origin. UTPA is an Affirmative Action/Equal Opportunity employer. Applications will be accepted until the position is filled. Interested candidates should submit a letter of application, curriculum vitae, statement of research interests, evidence of teaching effectiveness (if available), and full contact information for three or more references to: Dr. Ralph K. Davis, Search Committee Chair, Department of Geosciences, 113 Ozark Hall, Fayetteville, AR 72701. The University of Arkansas is a nationally competitive student-centered research university located in

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Fayetteville, Arkansas. The Department of Geosciences offers bachelor’s degrees in Geology and Geography, and is a primary participant in two interdisciplinary graduate programs, Space and Planetary Exploration and Dynamic Earth, providing opportunity for supervision of PhD and MS students. Fayetteville, nestled in the Ozarks of Northwest Arkansas, offers a unique environment for a student to interact with professors and peers that retains its small college town atmosphere. It is the sixth fastest growing metropolitan area in the U.S., spurred by opportunities with national companies, including Walmart, Tyson, Inc., and J.B. Hunt trucking. The quality of life is high and it’s a great place to work, play and raise a family.

The University of Arkansas is an Affirmative Action/Equal Opportunity Employer and applications will be accepted from anyone, regardless of age, race, color, national origin. Applicants have proof of legal authority to work in the United States at the time of the appointment. Women and minorities are encouraged to apply.

**STABLE ISOTOPE GEOCHEMISTRY UNIVERSITY OF MANITOBA**

The Department of Geological Sciences at the University of Manitoba invites applications for a full-time tenure-track faculty position in stable isotope geochemistry at the rank of Assistant Professor. This position, which is subject to final budgetary approval, is to commence July 1, 2006, or as soon thereafter as is mutually agreeable. Minimum qualifications are a Ph.D. in Geology and evidence of research potential. Search committees believe that all ideal candidates will have experience in stable isotope geochemistry and analysis; complementary experience in geology, biology, or environmental sciences in the stated specialty would be considered an asset. Closing date for applications is January 9, 2006. Further information may be obtained from the following:

Visit our website at: http://www.umanitoba.ca/faculties/science/geological_sciences/

**DEPARTMENT OF EARTH AND PLANETARY SCIENCES HARCOURT UNIVERSITY**

The Department of Earth & Planetary Sciences at Harvard University seeks to fill a faculty position at the Assistant Professor level (untenured) in a broad, interdisciplinary area of the broadly defined area of Geobiology. The ideal candidate would have experience in stable isotope geochemistry and analysis; complementary experience in geology, biology, or environmental sciences in the stated specialty would be considered an asset. Closing date for applications is September 15, 2005. Further information may be obtained from the following:

Visit our website at: http://www.harvard.edu/geo/
**UNIVERSITY OF MASSACHUSETTS BOSTON**

**EEOS Search, Dean’s Office, College of Science and Technology**

Applications are invited for a full-time, tenured-track assistant professor position in environmental earth and marine sciences. The successful applicant will have a strong background in environmental earth sciences. The University of Massachusetts Boston (UMB) is a relatively new, highly focused, teaching and research institute that is dedicated to developing and delivering high-quality, research-based undergraduate and graduate education programs. The candidate will have the opportunity to contribute to the development of a nascent undergraduate and graduate research program, and to participate in the development of new courses. The successful candidate will have a strong background in environmental earth sciences, and will be expected to develop a viable research program that aligns with the mission of the new university. This position will begin on or about September 1, 2006. All classes are in English.

Applicants should submit a cover letter, a curriculum vitae, a description of research plans, and a list of publications, to:

Professor Charles McFadden, Chair, Department of Earth Sciences, University of Massachusetts Boston, 100 Morrissey Blvd., Boston, MA 02125-3393. Applications and nominations will be accepted until the position is filled. UMass Boston is an Affirmative Action, Equal Opportunity Title IX employer.

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**FLUVIAL GEOMORPHOLOGY OR HYDROGEOLOGY UNIVERSITY OF MASSACHUSETTS BOSTON**

The Department of Environmental, Earth and Marine Sciences at the University of Massachusetts Boston invites applications for a tenure-track Assistant Professor position (beginning September 1, 2006) in Fluvial Geomorphology or Hydrogeology. The University of Massachusetts Boston (UMB) is an urban university located in the heart of the city of Boston, one of the most vibrant and diverse cities in the United States. The city is a modern, cosmopolitan center of more than 650,000. UMB is an urban research university with a strong commitment to undergraduate education and research. The city is rich in cultural and recreational opportunities, and the university is supported by a strong and supportive community. The successful candidate will join a dynamic and collegial department of earth sciences and will be expected to develop a viable research program that aligns with the mission of the new university. This position will begin on or about September 1, 2006. All classes are in English.

Applicants should submit a cover letter, a curriculum vitae, a description of research plans, and a list of publications, to:

Professor Charles McFadden, Chair, Department of Earth Sciences, University of Massachusetts Boston, 100 Morrissey Blvd., Boston, MA 02125-3393. Applications and nominations will be accepted until the position is filled. UMass Boston is an Affirmative Action, Equal Opportunity Title IX employer.
Interested candidates should send an application to: Faculty Recruitment, Marshall University, 13 Oak Drive, Hamilton, NY 13346. Applications from qualified females are particularly invited. Please submit a hardcopy application only if unable to submit electronically. For more information, contact: Dr. E. Gates, Chair, Department of Earth and Environmental Sciences, Rutgers University, 101 Warren Street, New Brunswick, NJ 08901 or agates@andromeda.rutgers.edu. For a full description, visit http://geology.newark.rutgers.edu. Rutgers University is an equal opportunity/affirmative action employer.

NEW PH.D. PROGRAM ENVIRONMENTAL AND HEALTH GEOCHEMISTRY

Our goal is to train Ph.D. scientists with a passion for understanding the interactions of the geosphere, hydrosphere, biosphere and atmosphere. We are particularly interested in finding candidates with strong interdisciplinary focus who are also intrigued by the practical challenges that stem from urban development in a bio-national and region. The Department of Geological Sciences supports undergraduate, M.S., and Ph.D. degrees in Geological Sciences as well as interdisciplinary undergraduate, M.S., and Ph.D. programs in Environmental Geochemistry and Engineering. The candidates are expected to teach introductory courses as well as upper division and graduate classes that serve both the Environmental and Geological Sciences. The Department is in a spacious building that contains extensive analytical and computing facilities. Applications are encouraged to apply to a superb variety of analytical equipment in other departments. For more information about activities and facilities, visit our website at http://www.geom.uptep.edu.

QUALIFICATIONS REQUIRED: The candidates must have a Ph.D. degree at the time of appointment. We are seeking candidates capable of building active research programs who and enjoy collaborative research.

APPLIED GEOL OGY

Applicants should send a letter of application, curriculum vitae, description of teaching and research interests, and the names of three people willing to provide professional references, to: Diane Doser, Chair, Department of Geological Sciences, The University of Texas at El Paso, El Paso, TX 79968, doser@geo.utep.edu. All materials will be reviewed beginning January 10, 2006, to be completed by March 21, 2006.

ENVI RONMENTAL SCIENCE

The Department of Earth and Environmental Sciences at the University of Rochester invites applications for a tenure-track Assistant Professor position beginning August 2006, in Environmental Geology. Experience with GIS is essential. The successful candidate will expand undergraduate and graduate curriculum and teach courses related to surficial processes, including Geomorphology, Depositional Environments, and GIS. The University supports undergraduate, M.S., and Ph.D. research and teaching. We seek a broadly trained geologist who can integrate classroom, field, and laboratory approaches to teaching at a small institution in a rural setting. The teaching load is 12 hours per semester. The successful candidate will share in the delivery of introductory geology classes and develop a student-involved research program that focuses in part on New Mexico geology.

Enrollment completion of the Ph.D. is required. Review of applications will begin on January 15 and continue until the position is filled. Applicants must submit a letter of interest, vita, three letters of recommendation, transcripts, and a copy of a research statement detailing research interests and equipment needs, and a one-page statement describing your teaching philosophy and your commitment to diversity. Applications must be received by March 1, 2006. University of New Mexico. Women and minorities are encouraged to apply. For additional access or services, call (505) 454-3311 or TDD#(505) 454-3003.

STRUCTURAL GEOL OGY AND ENVIRONMENTAL GEOLOGY FACULTY POSITIONS

At THE UNIVERSITY OF TENNESSEE—KNOXVILLE the Department of Earth and Environmental Sciences in the College of Arts and Sciences invites applications for two tenure-track faculty positions starting fall 2006. Successful candidates are expected to develop strong, externally funded research programs involving graduate and undergraduate student supervision and publication. Post-doctoral experience and the ability to complement or in existing departmental strengths (crustal structure and seismology, Earth systems history, geochemistry, hydrogeology, and environmental science, and planetary geology) are desirable.

STRUCTURAL GEOLOGY: Assistant Professor—open to candidates with research and teaching expertise in structural geology. This position is intended to enhance the Department's educational and research program in structural geology. The successful candidate is expected to develop and teach courses in structural geology and related topics. Duties also include regular participation in undergraduate education. The University supports the development of new and innovative teaching methods and the use of new technologies in the classroom. The University is also interested in candidates who can contribute to New Mexico's strengths in biotechnology. This position comes with the Boyce Fellowship, which is intended to attract a candidate whose background hopes to attract a candidate whose background is expected to strengthen the Department and to begin working in the fall of 2006.

ANALYTICAL GEOCHEMISTRY: Open to candidates with research and teaching expertise in inorganic and/or organic analytical geochemistry. Duties include the development of new advanced analytical methods and the application of these methods to study problems in the earth and environment, and the ability to contribute to New Mexico’s strengths in biotechnology. This position is intended to enhance the Department's educational and research program in analytical geochemistry.

The University of New Mexico is an Equal Opportunity/Affirmative Action/Title VI/Title IX employer and is committed to diversity. Women and minorities are encouraged to apply.

PLANT PHYSIOLOGY AND HOMEOPATHY FACULTY POSITION

New Mexico Highlands University, 101 Warren Street, New Brunswick, NJ 08901 or agates@andromeda.rutgers.edu. For a full description, visit http://geology.newark.rutgers.edu. Rutgers University is an equal opportunity/affirmative action employer.

NEW PH.D. PROGRAM ENVIRONMENTAL AND HEALTH GEOCHEMISTRY

Our goal is to train Ph.D. scientists with a passion for understanding the interface between the geological and human environment, with an emphasis on the generation of Climate Change and Public Health issues in academic, policy and international spheres. See http://www.ihu.uptep.edu/geology/geochem/ for information regarding the program. Applications are encouraged to apply to a superb variety of analytical equipment in other departments. For more information about activities and facilities, visit our website at http://www.geom.uptep.edu.

QUALIFICATIONS REQUIRED: The candidates must have a Ph.D. degree at the time of appointment. We are seeking candidates capable of building active research programs and who enjoy collaborative research.

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ANALYTICAL GEOCHEMISTRY: Open to candidates with research and teaching expertise in inorganic and/or organic analytical geochemistry. Duties include the development of new advanced analytical methods and the application of these methods to study problems in the earth and environment, and the ability to contribute to New Mexico’s strengths in biotechnology. This position is intended to enhance the Department's educational and research program in analytical geochemistry.

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PLANT PHYSIOLOGY AND HOMEOPATHY FACULTY POSITION

New Mexico Highlands University, 101 Warren Street, New Brunswick, NJ 08901 or agates@andromeda.rutgers.edu. For a full description, visit http://geology.newark.rutgers.edu. Rutgers University is an equal opportunity/affirmative action employer.
facilities. The university welcomes and honors people of all races, cultures, sexual orientations, and values intellectual curiosity, pursuit of knowledge, and academic freedom and integrity. Applicants should e-mail the Chair a letter describing research and teaching interests, and list of 3 references in .pdf format to Dr. Chris Fedo, Search Committee Chair, Dept. of Earth & Environmental Sciences, University of Tennessee, Knoxville, TN 37996-1410; Phone 865-974-6002; Fax 865-974-2388; E-mail: cledo@utk.edu. Supplementary materials and all copies of refereed publications, can be e-mailed or mailed to Dr. Fedo at the above address. Review of applications will begin on December 15, 2005, and continue until both positions are filled.

The University of Tennessee is an EEO/AA/Title VI/ Title IX/Section 504/ADA/ADAIDEA institution in the provision of its education and employment programs and services.

FACULTY POSITION IN EARTH SURFACE PROCESSES UNIVERSITY OF WISCONSIN—MADISON

The Department of Geology and Geophysics at the University of Wisconsin–Madison seeks an Earth Surface Processes geoscientist for an assistant professor, tenure-track position. A starting date of August 2006 is anticipated. We are seeking an individual interested in the physical aspects of Earth Surface Processes, in the modern to recent geological record. We are particularly interested in a quantitative and field-oriented geologist. Specialties may include fluvial, glacial geomorphology, Quaternary geology, tectonic geomorphology, submarine geology, and geologic hazards. A Ph.D. is required at the time of the appointment. The successful candidate is expected to develop an active research program, including supervision of graduate students. Responsibilities include courses at the undergraduate and graduate levels. Applicants should submit a resume, a statement of research and teaching interests, and the names and addresses of at least three references to Dr. Basil Tikoff, Earth Surface Processes Search Chair, Dept. of Geology & Geophysics, University of Wisconsin-Madison, 1215 W. Dayton St., Madison, WI 53706-1692. To ensure full consideration, applications must be received by January 15, 2006. For additional information, please visit: www.geology.wisc.edu. UW-Madison is an equal opportunity/affirmative action employer and encourages applications from women and minorities. Applications for a tenure-track Assistant Professor position in Environmental Geochemistry beginning in August 2006. We are seeking a person with interdisciplinary interests in GIS/Remote Sensing as applied to areas such as natural resource exploration/management/protection, environmental impact assessment, remote sensing & management, and/or economic development. The appointment will be made in one or more of the three units, depending on the candidate's area(s) of expertise. The candidate will be expected to develop and maintain an active, externally-funded research program that emphasizes interdisciplinary work in GIS/Remote Sensing. The successful candidate will also be expected to teach undergraduate and graduate courses in one or more of the three units. Salary for the position is competitive and commensurate with peer institution levels for rank and position and in keeping with candidate experience and credentials. The three units have a combined faculty of 22. We are in the process of formalizing an academic structure that will facilitate collaboration in the area of Geospatial Science. Extensive facilities to support research and teaching in GIS/Remote Sensing include: three teaching laboratories, over 60 workstations, ACD, IMS servers, large format color plotters, large and small digitizers and scanners, color printers, laser rangefinders, sub-meter GPS receivers, ruggedized tablet and pocket PCs for mobile GIS, portable field spectrometers (300-3500 nanometer and 2-15 micrometer wavelength ranges), and ESRI, ENVI, ERDAS, PCI, and ERMapper site licenses.

Applicants are required to have a Ph.D. at the time of employment. Candidates should send a letter of application, curriculum vitae, statements of research and teaching interests and goals, and three letters of recommendation to: Chair, Search Committee, Department of Geography, Bowling Green State University, Bowling Green, OH 43403. Finalists are required to provide a transcript for the highest degree. Applications must be postmarked by January 2, 2006. Bowling Green State University is an Equal Employment Opportunity/Affirmative Action employer and encourages applications from women, minorities, veterans, and persons with disabilities.

HIGH-TEMPERATURE GEOCHEMIST UNIVERSITY OF COLORADO AT BOULDER

The Department of Geological Sciences, University of Colorado at Boulder, invites applications for a tenure-track position in high-temperature geochemistry. We anticipate hiring at the assistant professor level, but applications at other levels will be considered from those who would strengthen the Department's diversity. We seek applicants with a demonstrated potential for independent research that is beneficial. Any applicant specializing in the study of high-temperature Earth processes and whose work complements existing research programs in the Department will be considered. However, applicants in igneous and metamorphic rock geochemistry, or geochemistry of water resources who will contribute to our interdisciplinary program leading to a Master's degree in Environmental Geochemistry beginning in August 2006. A Ph.D. is required. The successful candidate will develop a strong research program including collaboration with undergraduates and will contribute to the undergraduate teaching program, including non-major course offerings, and provide graduate level courses in his/her specialty.

For additional information, please visit: www.geology.unl.edu/GeoSci/. Applicants should send a current CV, statements of teaching and research interests, and the names of at least three potential references to Chair, Geochemist Search, Department of Geological Sciences, University of Colorado, 389 UCB, Boulder, CO 80309-0389. Inquiries for additional information should be directed to Dr. G. Lang Farmer (farmer@colorado.edu). Review of applications will begin on December 15, 2005. Applications will be accepted until the position is filled. The University of Colorado at Boulder is committed to diversity and equality in education and employment.

ANALYTICAL/FORENSIC/ENVIRONMENTAL CHEMISTRY ARKANSAS STATE UNIVERSITY

Arkansas State University is an Equal Opportunity/ Affirmative Action Employer with a strong institutional commitment to the achievement of excellence and diversity among its faculty and staff.

In support of this commitment, the Department of Chemistry and Physics at Arkansas State University invites applications for a tenure track Assistant Professorship in analytical/forensic/environmental chemistry commencing August 2006. A Ph.D. is required. For more information see http://chemistryandphysics.astate.edu/facopenings.htm

TENURE TRACK GEOLOGY WASHINGTON & LEE UNIVERSITY

The Department of Geology at Washington and Lee University (geology.wlu.edu) seeks applicants for a tenure track Assistant Professor position to begin fall 2006. Ph.D. is required. The successful candidate must have a strong interest in teaching and research. Department strengths include paleontology, geology of the Appalachian Mountains, and geology of the southeastern United States. Candidates should have completed all requirements for the Ph.D. by Fall 2006. The Department of Geology consists of 12 faculty and is comfortably small, inviting, and innovative. Applicants are encouraged to review the Department’s website before applying.

Applications should be postmarked by January 1, 2006. Washington & Lee University is an Equal Opportunity/AA institution.

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methods, interests, and experience will enhance your program of study. Interested students are encouraged to inquire of David Harbor (habord@wlu.edu), Geology Department, Washington and Lee University, Lexington, VA 24450. Review of applications begins immediately and will continue until the position is filled. Washington and Lee University is committed to the development of a campus climate that embraces diversity and encourages all applicants and members of its community to apply. U.S. citizens or permanent residents are encouraged to apply. Equal Opportunity Employer.

PLANEY GEOLGIST IN OHIO UNIVERSITY

The Department of Geological Sciences at Ohio University invites applicants for a tenure-track appointment at the rank of Assistant Professor in planetary geology to begin September 2006. We are seeking a qualified individual with expertise in the geological processes operating on extraterrestrial planets and active interest in planet and solar system evolution. This position will expand and complement the department's existing strengths in earth and environmental systems and tectonics and allows for collaboration within Ohio University's Astrophysical Institute. Candidates should be able to teach mineralogy, petrology, and planetary geology and be familiar with geologic field methods. Excellence in teaching at both the undergraduate and graduate level and supervision of graduate student research must be accompanied by the establishment of a strong research program supported by external funding. The successful applicant will possess a Ph.D. in Geologic Sciences or a related discipline.

Applicants should send vitae, a description of research interests, a statement regarding teaching philosophy, and the names and addresses of three referees to: Search Committee Chair, Department of Geological Sciences, Ohio University, Athens, OH 45701-2979. Applications should be received by December 1, 2005. Women and minorities are especially encouraged to apply. Ohio University is an Affirmative Action/Equal Employment Opportunity Institution, enrolling 19,500 students on the Athens campus and more than 8,000 students on five regional campuses. For further information concerning the College of Arts and Sciences, the Department of Geological Sciences and the Astrophysical Institute, visit www.cas.ohiou.edu, www.ohiou.edu/geology and www.phy.ohiou.edu/~astro.

ASSISTANT RESEARCH PROFESSOR
ENVIRONMENTAL HYDROGEOPHYSICS

The Desert Research Institute’s (DRI) Division of Hydrologic Sciences seeks an Assistant Research Professor of Environmental Hydrogeophysics. This position is designed to be an integral part of an ongoing effort to build strong cross-disciplinary programs linking hydrological, geophysical, and near-surface environmental fields. Successful candidates will be expected to develop and lead multidisciplinary, collaborative projects on the use of geophysical techniques for environmental processes at different spatial scales, potentially up to and beyond the ecosystem level, or down to the micrometer level. Emphasis for this position can be on groundwater contamination, but we are not currently excluding deep-hole geophysics. Applicants are expected to possess appropriate professional experience, including a Ph.D. with a focus on near surface hydrogeology, hydrology, soil science, or high resolution imaging. This position will be filled at DRI’s Las Vegas Campus. Review of applications will begin in late fall 2005. Specific requirements and application instructions are available at http://jobs.dri.edu/2005/DHMS_hydrogeophysics.html or visit www.dri.edu.

Opportunities for Students

Ph.D. Student Assistantships. Oregon State and Portland State University are offering ten Ph.D. Student Assistantships in the Geology Department at Portland State University, beginning in fall 2006. Review of applications starts 1/15/06. Oregon State and Portland State Universities are committed to equality in education.

Graduate Fellowships at Indiana University. The Department of Geological Sciences at Indiana University is offering ten Ph.D. Graduate Fellowships in the following areas: Geobiology/Stratigraphy, Geophysics, Geomorphology, Petroleum Geology, and Climatic Change. Fellowships offer up to $18,000 per year plus tuition waiver. The duration of the fellowship varies but Ph.D. and M.Sc. students usually remain in the program for five years. Interested students must apply to the Department, respectively. Applicants for the 2006–2007 academic year should contact: Dr. Mark Person, Director of Graduate Studies, Department of Geological Sciences, maperson@indiana.edu, 812-855-4044.

Jonathan O. Davis Scholarship. Division of Earth and Ecosystem Sciences. Desert Research Institute. The family and friends of Jonathan O. Davis, a prominent U.S. geologist and geoarchaeologist and a DRI faculty member, have established an endowment that provides a yearly rental of a Jonathan O. Davis Scholarship, as well as a stipend for a University of Nevada, Reno student. Jonathan was tragically killed in an automobile accident in December 1990. It is the wish of his family and friends to support graduate students working on the Quaternary geology of the Great Basin, research closely related to Jonathan's efforts or research at DRI. The stipend is $4,000 and the University of Nevada, Reno stipend is $1,500. The national scholarship, administered by the Division of Earth and Ecosystem Sciences at the Desert Research Institute, is open to graduate students enrolled in an M.S. or Ph.D. program in Quaternary geology, geophysics, and paleoecology as used here, encompasses a wide range of topics normally considered as part of the Quaternary sciences. Research, however, must have a substantial geophysical component or demonstrate a strong reliance on geological techniques and must be conducted on or related to the Great Basin.

Applications should include:
A cover letter explaining how the individual qualifies for the award. Please include your social security number and state whether you are applying for the national scholarship or for the UNR stipend.
A current résumé or vitae.
A two-page, single spaced description of the thesis/dissertation research, which also clearly documents the geological orientation and research significance. Figures, tables, and references do not count against the two-page limit.
A letter of recommendation from the thesis/dissertation supervisor, which emphasizes the student’s ability and potential as a Quaternary scientist.

Applications should be postmarked by February 2, 2006. Proposal reviews will not be returned to applicants. Applications should be addressed to: Executive Director, Jonathan O. Davis Scholarship. Division of Earth and Ecosystem Sciences, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512.

The Department of Geological Sciences at Case Western Reserve University invites applications from students with a Ph.D. in any area of geological science for its graduate program. Current research strengths in the department include: surface processes, soil erosion, sediment transport, geochemical sequestration of carbon, geochemistry, planetary materials, planetary geology and geochemistry, and high-pressure mineral physics and chemistry. Financial assistance may be available for qualified applicants interested in pursuing Ph.D. or M.S. degrees in any area of research at the university. For further information, contact the department at geo-gradinfo@case.edu.

Graduate Student Opportunities at Case Western Reserve University (http://www.case.edu) is seeking qualified students for its graduate program. Current research strengths in the department include: surface processes, soil erosion, sediment transport, geochemical sequestration of carbon, geochemistry, planetary materials, planetary geology and geochemistry, and high-pressure mineral physics and chemistry. Financial assistance may be available for qualified applicants interested in pursuing Ph.D. or M.S. degrees in any area of research at the university. For further information, contact the department at geo-gradinfo@case.edu.

Applications for graduate study at Case are accepted on a rolling basis, though students requesting financial assistance in fall 2006 are encouraged to apply by February 1, 2006. Case is committed to diversity and equality. Students from all backgrounds are encouraged to apply.

NASA Planetary Biology Internships. The Marine Biological Laboratory, Woods Hole, Massachusetts, invites applications from graduate students and seniors accepted to graduate programs for rewards of $2800 plus travel to participate in research in NASA centers and collaborating institutions for approximately 8 weeks. Typical intern programs include: global ecology, remote sensing, microbial ecology, biomineralization, and origin and early evolution of life. Application deadline: March 1, 2006. For information/applications, contact: Michael Dolan, Planetary Biology, Department of Geosciences, Box 3-5820, University of Massachusetts, Amherst, MA 01003-5820. E-mail: pdb@geo.umass.edu.

NASA will have numerous opportunities for students wishing to begin graduate work in fall 2006. Research topics include: earthquake and wave propagation seismology, chemistry, climate change, structural geology, active tectonics, igneous geochemistry, paleoclimatology, geology and hydrogeology, glaciology, paleomagnetism, geodynamics, and planetary formation and dynamics. The Earth Sciences Department at UCSC has an outstanding reputation; our students are guaranteed 4 and 2 years of support within the first-round funding offers is February 1, 2006. First-year funding offers are extended to undergraduate students and may be renewed annually until the student begins work in graduate school. If you have further questions regarding the awards or are interested in applying, contact: Dr. Mark Person, Director of Graduate Studies, Department of Geological Sciences, maperson@indiana.edu, 812-855-4404.

Support for Students

numerous grant-funded Research Assistantships and university-funded Teaching Assistantships are available for students starting fall 2006. The Department maintains active field and laboratory based research projects in planetary geology, geophysics, geophysics, geophysics, hydrogeology, igneous petrology, isotope geochemistry (stable and radiogenic), low-temperature geochemistry, mineralogy and crystallography, mineral surface geochemistry, sedimentology and stratigraphy, seismology, structural geology, tectonics, and volcanology. For more information about the application process and graduate student research opportunities, please visit our departmental web site (http://www.muohio.edu/geology) or contact Cathy Edwards (cathy.edwards@muohio.edu). Prospective students are also encouraged to contact faculty directly to discuss potential research projects.

The application deadline for consideration in first-round funding offers is February 1, 2006.

Graduate Student Opportunities: The Department of Geological Sciences at Case Western Reserve University (http://www.case.edu) is seeking qualified students for its graduate program. Current research strengths in the department include: surface processes, soil erosion, sediment transport, geochemical sequestration of carbon, geochemistry, planetary materials, planetary geology and geochemistry, and high-pressure mineral physics and chemistry. Financial assistance may be available for qualified applicants interested in pursuing Ph.D. or M.S. degrees in any area of research at the university. For further information, contact the department at geo-gradinfo@case.edu.

Applications for graduate study at Case are accepted on a rolling basis, though students requesting financial assistance in fall 2006 are encouraged to apply by February 1, 2006. Case is committed to diversity and equality. Students from all backgrounds are encouraged to apply.
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