Why did the Southern Gulf of California rupture so rapidly?
—Oblique divergence across hot, weak lithosphere along a tectonically active margin

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Cover: Oblique view northwest up the Gulf of California with the Baja California peninsula on the left and mainland Mexico and Southwestern United States on the right. Note the WNW-trending transform faults and short spreading centers in the southern Gulf of California and the shallow northern Gulf of California and low elevation Salton trough regions through which faults link to the San Andreas fault. Mountains on the mainland are the Sierra Madre Occidental and smaller ranges of the Basin and Range province. Image courtesy geomapapp.org. See related article, p. 4–10.
Why did the Southern Gulf of California rupture so rapidly?—Oblique divergence across hot, weak lithosphere along a tectonically active margin

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ABSTRACT

Rifts in the interior of continents that evolve to form large oceans typically last for 30 to 80 m.y. and longer before complete rupture of the continent and onset of sea-floor spreading. A distinct style of riffs form along the active tectonic margins of continents, and these rifts more commonly form marginal seas and terranes or continental blocks or slivers that are ruptured away from their home continent. The Gulf of California and the Baja California microplate make up one of the best examples of the latter setting and processes. In the southern Gulf of California, sea-floor spreading commenced only ~6–10 m.y. after the formation of the oblique-divergent plate boundary at ca. 12.5 Ma. Three main factors caused this rapid rupture: (1) an inherited long, narrow belt of hot, weak crust from a volcanic arc that was active immediately before formation of the oblique-divergent plate boundary and that lay between two strong batholith belts; (2) relatively rapid plate motion resulting in high strain rates; and (3) a dominant role of strike-slip faulting in the highly oblique-divergent setting that formed large pull-apart basins with rapid and focused crustal thinning in a linked en-echelon system. Accentuating factor 1 is that the formation of slab windows associated with microplate capture west of the Baja California peninsula may have further weakened the crust. These causes of rapid rupture of continental lithosphere are mostly linked to the fact that the Gulf of California developed along a long-lived tectonically active margin of a continent with a convergent or oblique-convergent setting since at least the Jurassic, but not a margin that was thickened in a major contractional orogen. This combination of causes and factors suggests that riffs that form at active margins are fundamentally different than continental interior riffs, and that these differences can produce vastly different rifting histories. The formation and northwestward motion of the Baja California microplate also show that “terranes” formed in an oblique-divergent setting can form and move long distances over relatively short geologic time intervals.

INTRODUCTION

The rupture of continental lithosphere is one of the most fundamental tectonic processes. Complete rupture of a continent requires the familiar progression from early rifting to extreme continental lithosphere thinning to continental breakup that forms oceanic spreading in a nascent ocean (e.g., Veevers, 1981). The development of a rift, and whether it progresses to breakup, is mainly dependent on the thermal structure, crustal thickness, and crustal strength of the lithosphere when rifting begins (e.g., Buck, 2007), as well as forces at the base of the lithosphere and far-field plate interactions (Ziegler and Cloetingh, 2004).

Continental rupture at its two extremes creates either large ocean basins or small and narrow marginal seas depending largely on the tectonic setting of the rift. Rupture of a continent that creates large oceans most commonly initiates as riffs in old, cold continental lithosphere or within former large collisional belts in the interior of large continents, part of the process known as the Wilson Cycle (Wilson, 1966). Rupture to create narrow marginal seas commonly occurs in active continental margins and results in the formation of micro-continents or continental terranes. Examples of these marginal sea settings are the modern Andaman Sea and Gulf of California and the Mesozoic of the Alps (Kelts, 1981; Weissert and Bernoulli, 1985; Channell and Kozur, 1997). The creation and later translation and accretion of terranes is one of the processes that leads to the formation of so-called accretionary or Cordilleran-type orogens (Helwig, 1974; Coney et al., 1980; Moores and Twiss, 1995).

The process of rifting active continental margins can occur in two distinctly different settings that create vastly different results. Most attention and research has been done in rifts within active margins that were previously contractional orogens, such as the Basin and Range or Aegean Sea, in which the crust was thickened before rifting. In the western United States, before the Basin and Range extensional event, the crust was ~70 km thick in the Sierra Nevada arc (Ducea, 2001) and 50 km thick in the hinterland of the thrust belt (Coney and Harms, 1984). In both of these examples, after tens of millions of years of extension, continental crust has not fully ruptured, but it has thinned appreciably to 20–30 km (Thompson and Burke, 1974; Wernicke, 1992; Klemperer and Ernst, 2003; Sodoudi et al., 2006).

The Aegean Sea is also an example of slab rollback that drove extension in the backarc but has not resulted in continental rupture after a few tens of millions of years. Slab rollback in the Tyrrenhian Sea did produce continental rupture and formation of oceanic crust (Nicolosi et al., 2006), but only after extension occurred for ~30 m.y. (Malinverno and Ryan, 1986). Therefore, from the Mediterranean region, it appears that slab rollback is an alternative process to the oblique divergence explored in this paper, which may produce rupture of continental lithosphere—but in these examples rupture was a slow process. However, there may be conditions in which slab rollback produces more rapid rupture of continental lithosphere.
In contrast to these rifts formed on ancient contractional orogens, other rifts along active continental margins form on volcanic arcs in regions with previous neutral or extensional tectonics, such as the Gulf of California. The Gulf of California is an example of a region in which a young oblique rift formed on a volcanic arc with an extensional backarc. The Pacific–North America plate boundary in the Gulf of California (Fig. 1) is one of the best modern examples of rupture of continental lithosphere to form a narrow continental fragment or terrane outboard of a narrow sea (Wilson, 1966; Lonsdale, 1989; Umhoefer and Dorsey, 1997). Among rifts and passive margins worldwide, one of the distinguishing traits of the Gulf of California is how rapidly it evolved to active sea-floor spreading and formation of oceanic crust. In the past decade, new research has started to quantify the style and the timing of that rupture process (e.g., Lizarralde et al., 2007). In the southern Gulf of California, sea-floor spreading commenced ~6–10 m.y. after the formation of the oblique-divergent plate boundary at 12–12.5 Ma (Lonsdale, 1989; Stock and Hodges, 1989; Stock and Lee, 1994). This contrasts greatly to rifts in the interior of continents that develop into large oceans and have a typical duration of 30–80 m.y. and longer.

This paper summarizes recent advances in understanding when and where the southern Gulf of California plate boundary developed to the stage of sea-floor spreading and explores possible reasons for this rapid rupture of the continental lithosphere. This example of continental rupture and formation of a terrane (the Baja California microplate; Fig. 1) shows the critical role of the history of the inherited lithosphere upon which a rift develops, rapid plate divergence, and strike-slip faulting in the rapid rupture of continents. This paper also highlights the stark difference between rifting of continent interiors versus rifting of tectonically active continental margins. The formation of the Baja California microplate also demonstrates how rapidly terranes or microplates can form and translate long distances along their mother continent; in 20–25 m.y., Baja California will likely have translated 1000 km.

**TECTONIC SETTING AND RAPID RUPTURE OF SOUTHERN GULF OF CALIFORNIA**

The Gulf of California and the Salton Trough form the oblique-divergent boundary between the Pacific and North America plates from 22° to 34°N latitude (Fig. 1). Most of the plate motion in the southern Gulf of California is accommodated in the gulf axis system by linked transform faults and short spreading centers (Lonsdale, 1989). Relative plate motion between the Baja California microplate and North America in the southern gulf is ~45–47 mm/yr (Plattner et al., 2007). An additional 4–6 mm/yr is accommodated on the offshore Tosco-Abreojos fault zone (borderland fault system) southwest of the Baja California peninsula (Fig. 1) (Dixon et al., 2000; Plattner et al., 2007). Regional transtensional faulting has rifted Baja California obliquely away from mainland Mexico over the past ~12.5 m.y. (e.g., Atwater and Stock, 1998). Pacific–North America plate motion became localized along the axis of the present-day plate boundary by at least 6 Ma (Oskin et al., 2001; Oskin and Stock, 2003a and 2003b), but the distribution of plate-boundary deformation between 12.5 and 6 Ma is uncertain and debated. In one model, Miocene plate motion was partitioned into strike-slip faulting in the borderland system and east-west extension in the Gulf of California (Spencer and Normark, 1979; Stock and Hodges, 1989); Pliocene to Recent faulting became more transtensional as the main oblique-divergent plate boundary moved into the Gulf of California. This
model results in ~300 km of northwesterly motion of the Baja California microplate relative to North America mainly since 6 Ma (Oskin et al., 2001). A second model proposes that Miocene dextral-oblique shear has separated the Baja California microplate from mainland Mexico since ca. 12.5 Ma, producing a total of ~450–500 km offset across the Gulf of California between the Baja California microplate and North America (= mainland Mexico) (Gans, 1997; Fletcher et al., 2007). This model results in the same ~300 km of northwesterly motion of the Baja California microplate relative to North America mainly since 6 Ma, but requires an additional northwest-directed offset of ~150–200 km before 6 Ma. These contradictory models remain unresolved, but evidence from a crustal scale seismic survey in the southern gulf favors the larger offset model for that region (Sutherland, 2006; Lizarralde et al., 2007).

The spreading centers in the southern gulf (Fig. 1) formed at variable times from ca. 6 Ma to ca. 2 Ma. The Guaymas spreading center in the central gulf formed ca. 6 Ma based on the width of the new igneous crust as determined from a seismic refraction profile from Lizarralde et al. (2007). In the mouth of the gulf, the northern East Pacific Rise has a more complex history in which part of that system formed a spreading center ca. 5.5 Ma (Lonsdale, 1989; Brown, 2007). The Alarcon spreading center began forming proto-oceanic crust ca. 3–3.5 Ma (DeMets, 1995), and true sea-floor spreading at present rates started at 2.4 Ma (Sutherland, 2006; Umhoefer et al., 2008). The East Pacific Rise and Alarcon Rise both have magnetic anomalies on the oceanic crust (Lonsdale, 1989; DeMets, 1995), while the Guaymas basin is a complex of sills and sediment cover that obscures simple magnetic anomalies (Lizarralde et al., 2007). The Pescador, Farallon, and Carmen(? ) spreading centers may have formed ca. 2 Ma based on a proposed link to the Loreto basin (Dorsey and Umhoefer, 2000; Mortimer et al., 2005) and the width of the bathymetrically low basin surrounding the spreading centers (Lonsdale, 1989). By comparing these ages of initiation of sea-floor spreading to the estimate of 12.5 Ma for commencement of the Pacific–North America oblique-divergent plate boundary in this region (Stock and Lee, 1994; Atwater and Stock, 1998), it is clear that the time from onset of rifting to complete rupture of continental lithosphere (referred to below as “time-to-rupture”) in the southern gulf was only ~6–10 m.y.

**DURATION OF TYPICAL RIFT STAGES FOR LARGE OCEANS**

The time-to-rupture for the Gulf of California was much more rapid than rupture of continent interiors to form large oceans. Rifts in the interior of continents that evolve to form oceans typically last for 30 to 80 m.y. before complete rupture of the continent and onset of sea-floor spreading, and some rift stages last much longer (Ziegler and Cloetingh, 2004). For example, the Newark rift basin in the eastern United States records >30 m.y. of sedimentation that began rifting before ca. 230 Ma (Olsen et al., 1996, 2004) and has the Central Atlantic Magmatic Province basalts dated at 201 Ma (Schoene et al., 2010) in its upper parts. The oldest documented true oceanic crust and sea-floor spreading in the east-central Atlantic is ca. 185 Ma (Withjack et al., 1998; Bird et al., 2007), while there was a proto-Atlantic stage from 200–185 Ma, during which sea-floor spreading may have initiated (Schettino and Turco, 2011). Therefore, the rift stage in the central Atlantic lasted ~35–45 m.y. The southern Atlantic had a rift stage that lasted for ~30 m.y. Rifting in the southernmost ocean north of the Falkland plateau and Scotia Sea started ca. 155 Ma (Jokat et al., 2003), whereas

![Figure 2. A simple cartoon of the narrow corridor (gray) between the Baja California peninsula and the Sierra Madre Occidental middle Cenozoic volcanic belt that results if there was a total of ~450 km offset across the Gulf of California since 12–14 Ma (Gans, 1997; Sutherland, 2006; Fletcher et al., 2007; Lizarralde et al., 2007). Note that with that 450 km of offset the lower to middle Miocene volcanic arc of the Comondú Group, and the early oblique-divergent plate boundary, formed along the reconstructed gray corridor. The dashed gray line is the width of the Gulf of California–Salton trough corridor if the total offset was the more modest 300 km as indicated by the shorter arrow across the northern Gulf (Stock and Hodges, 1989; Oskin and Stock, 2003b). Smaller granite exposures in mainland Mexico, on the islands in the Gulf, and in the gap between the northern and southern Baja California granites are not shown.](image-url)
sea-floor spreading started ca. 125 Ma (Müller et al., 1997). The rifting stage between Africa and Antarctica lasted at least 30 m.y. before breakup (Jokat et al., 2003). Likewise, the Australian margins have rift stages that lasted 30–40 m.y. (Brown et al., 2003). Rifting in the southern Red Sea occurred over 20–25 m.y.; extension in Yemen and Ethiopia started ca. 28–26 Ma (Menzies et al., 1997; Garfunkel and Beyth, 2006), and the oldest ocean crust is 4–6 Ma (Gochrane, 1983). The eastern Gulf of Aden had a shorter rifting stage of 17 m.y.; rifting started at 35 Ma, and initial sea-floor spreading occurred at 18 Ma (d’Acremont et al., 2006).

WHY DID THE SOUTHERN GULF OF CALIFORNIA RUPTURE RAPIDLY?

The factors that affect rift localization and the subsequent rupture of continental lithosphere include the thermal structure, crustal thickness, and strength of the lithosphere (e.g., Buck, 2007), as well as forces near the asthenosphere-lithosphere boundary and far-field plate interactions (Ziegler and Cloetingh, 2004). These factors have been investigated largely from numerical and analog modeling. Here I will explore the main factors that may have created rapid rupture in the Gulf of California, and in the following section, I will discuss a paradox of this history compared to recent modeling results.

It is clear that the southern Gulf of California developed from initial rifting to sea-floor spreading much more rapidly than typical continental rifts. There appear to be three major factors that caused this rapid time-to-rupture: (1) the presence of a narrow zone of hot, weak crust between belts of strong crust because of the long history as an active tectonic margin; (2) moderately rapid relative plate motion; and (3) obliquity of plate motion with a major role of strike-slip faulting.

The first factor that favors rapid rupture is the inherited crustal structure when oblique divergence commenced. An older arc with presumed hot, weak crust formed between two strong, older batholith belts. When Baja California is reconstructed in a simple fashion 450 km back to the southeast (the large-offset model), there remains a long, narrow belt (1800 × 150 km) that was occupied by the pre-gulf volcanic arc from ca. 20–12 Ma (gray belt, Fig. 2) (Hausbeck, 1984; Sawlan, 1991; Ferrari et al., 2007). The eastern part of this belt west of the Sierra Madre Occidental underwent widespread extension during this time before the oblique-divergent plate boundary formed in the future Gulf of California (Henry, 1989; Gans, 1997; Ferrari et al., 2007) and arguably thinned the crust. Arc volcanism was active in the southern gulf until immediately before the change to oblique divergence at 12.5 Ma (Umhoefer et al., 2001). The volcanic arc and extension formed between two provinces underlain by strong batholithic crust. In the west, a Cretaceous batholith occupies the length of the Baja California peninsula (Fig. 2; small exposures are discontinuous between the large northern and southern belts). In the east, the Sierra Madre Occidental is a vast 34–27 Ma rhylhotic caldera province with an axial zone that has a thick crust of 55 km and is likely underlain by a silicic batholith and mafic lower crust (Ferrari et al., 2007). These initial conditions of a thermally weak arc crust of normal thickness would greatly promote rifting, but the weak crust may also delay localization and rupture (after Buck, 2007). Intuitively, the two relatively strong batholith belts on either side of the narrow arc would work against the rift widening past the batholith margins, and indeed the present boundaries of the gulf extensional province lie along the edges of the batholiths (Figs. 1 and 2). Therefore, I suggest it is the combination of the narrow, weak arc crust between the strong batholiths that was the first key factor in rapid rupture.

McCrorry et al. (2009) suggested another factor that may have further thermally weakened the arc crust in the few million years before oblique convergence. They proposed that the slab window related to the capture of microplates west of southern Baja California during the volcanic arc (Stock and Lee, 1994) would have heated the region from the accretionary prism to the arc, further decreasing the strength of the crust within the arc.

The second cause of rapid rupture is suggested to be the moderately rapid relative motion across this plate boundary. The Pacific and North America plates have moved 630 km since 12.5 Ma at a rate of 51 km/m.y. (Atwater and Stock, 1998; Plattner et al., 2007). The Late Cenozoic history of separation across the gulf itself is debated as summarized in the “Tectonic Setting” section. Using the model for 450 km offset across the southern gulf and a rate of 47 mm/yr since 6 Ma (present rate between the southernmost Baja California microplate and North America [Plattner et al., 2007] extrapolated back to 6 Ma [Oskin et al., 2001]) gives 282 km of offset since 6 Ma. That yields a remainder of 170 km of offset from 12.5 to 6 Ma at a rate of 26 mm/yr of plate motion across the gulf. Much is uncertain in these estimates of plate motion for the early gulf, but most viable options result in moderately fast rates of relative plate motion, and a substantial increase in across-gulf offset rates at ca. 6 Ma. These rates of plate motion compare to rates of 3 to 6 mm/yr across the East Africa Rift system (Stamps et al., 2008). The key second conclusion is that these rates of motion across the Gulf of California are much higher than those across most active rifts and may have promoted efficient magma generation and strain localization in the axial region of the plate boundary.

The third cause of rapid rupture is suggested to be the obliquity of motion across the plate boundary. Highly oblique divergence can be defined in terms of the rift angle, or the angle between the azimuth of the axis of the plate boundary and the azimuth of the relative plate motion. The southern gulf has a rift angle of ~20°, which results in a transtensional deformation style and means that strike-slip faulting played a major role in divergence before the modern plate boundary formed with its long transform faults and short spreading centers (e.g., Lonsdale, 1989; Umhoefer et al., 2007). The large-offset (450–500 km) and long-lived transtensional model suggests that strike-slip and transtensional faulting were dominant for the whole history of the gulf. The smaller-offset (300 km) model suggests that there was little or no strike-slip faulting from 12.5 to 6 Ma and then an abrupt change to dominantly strike-slip faulting at 6 to 0 Ma.

In the large-offset model, the likely pre-seafloor spreading fault patterns were dominated by en-echelon strike-slip faults that were linked to transtensional systems of normal and strike-slip faults at the gulf margin (Dorsey and Umhoefer, 2000; Umhoefer et al., 2007). Along the gulf axis, the en-echelon strike-slip faults likely produced large pull-apart
basins (Lonsdale, 1989). These fault and basin patterns are locally known along the margin; the patterns are hypothetical in the gulf axis, but modern bathymetry supports rhomboid shaped basins (Figs. 1 and 2), and limited seismic lines support rift and transtensional basins (Sutherland, 2006). The key point for the causes of rapid rupture of lithosphere is that pull-apart basins are the most efficient basin type at localizing rapid thinning of the crust and the most rapidly subsiding basins (Christie-Blick and Biddle, 1985; Pitman and Andrews, 1985; Allen and Allen, 2005; Xie and Heller, 2009).

DISCUSSION AND CONCLUSIONS

Gulf of California as an End-Member Example

The oblique-divergent plate boundary in the southern Gulf of California localized ~90% of plate motion to develop seafloor spreading by 6–2.4 Ma. This produced an unusually rapid rupture of continental lithosphere that took only 6–10 m.y. Evidence summarized in this paper suggests that three main factors caused this rapid rupture: (1) an inherited long, narrow belt of hot, weak crust from a volcanic arc that was active immediately before formation of the oblique-divergent plate boundary and formed between two strong batholith belts (Fig. 2); (2) relatively rapid plate motion resulting in high strain rates; and (3) a dominant role of strike-slip faulting with highly oblique divergence that likely formed large pull-apart basins with rapid crustal thinning in a linked en-echelon system.

These causes of rapid rupture are mostly linked to the fact that the Gulf of California developed along the tectonically active margin of a continent that experienced multiple episodes of magmatism (and deformation) through much of Phanerzoic time. The precursor volcanic arc clearly demonstrates this case, and the two batholiths on either side of the Gulf of California are products of earlier Tertiary and Cretaceous convergent margin episodes. Moreover, relatively rapid plate motion as seen in this example is unlikely for a rift in a continental interior. This combination of causes and factors suggests that rifts that form at active margins are fundamentally different than continental interior rifts, and that these differences produce vastly different rifting histories. The difference in rifts in these two settings is not just in the setting itself, but in the series of processes that occur in each setting before and during rifting, and the rates of extension across the rift. I suggest that the Gulf of California represents the end member along an active margin where a previous arc existed with an extensional backarc and along which many features developed before the rift started that led to the key factors that favor a short time to rupture. The rifting of active margins in which the previous tectonics were a long-lived contractional orogen (Basin and Range or Aegean Sea) that produced thickened continental crust have many factors that work against rapid localization and rupturing of continental lithosphere, especially the initially thick crust across a wide zone.

Gulf of California and Modeling Results

One apparent paradox arises when comparing recent models for extension at the crustal scale and the Gulf of California. As one example, Huismans and Beaumont (2007) used finite-element modeling to explore the effects of the strength of the crust and fate of extension on the symmetry and mode (narrow versus wide) of the rift. At high rifting velocities it was found that strong viscous coupling in the lower crust suppresses localization and produces a distributed, symmetric style of extension. In addition, weak lower crust appears to result in delayed rupture. These results appear to contradict the observations from the Gulf of California for rapid rupture. But it is important to note that modeling to date involves extension of uniform layers across a relatively wide region as the initial condition. The initial conditions in the Gulf of California were much different than these models. I would suggest that it was this narrow, weak arc lying between strong batholiths, together with the moderately rapid plate motion and strike-slip faulting, that was the critical combination of factors that led to the rapid lithosphere rupture in the Gulf of California.

Implications for Terrane Formation and Translation

The rapid rupture of the southern Gulf of California and formation of the Baja California microplate also has implications for terrane formation and translation. This young and modern example demonstrates that terranes composed of fragments of their former continent can form rapidly and translate long distances in relatively short geologic time spans. For the Baja California terrane, the large-offset model suggests it has moved 450–500 km northwest relative to stable North America in 12.5 m.y. Assuming that the Baja California terrane either continues to move at the present rate (47 km/m.y.) or Pacific–North America plate motion fully localizes in the Gulf of California (51 km/m.y.), the terrane will move a total of 1000 km in ~22–25 m.y. For the smaller-offset model with 300 km offset across the Gulf of California, the Baja California terrane will move 1000 km in ~27 m.y.

If this process of rapid rupture along highly oblique plate boundaries occurs along a plate boundary with rates of plate motion at the high end of current relative plate motions, one can reasonably suggest shorter times for terrane formation and translation of 1000 km. The modern Pacific basin has examples of Nazca–South American relative motion of ~70–75 km/m.y. and Pacific–Australia (north of Australia) highly oblique relative motion of 110–115 km/m.y. (DeMets et al., 2010). Given these rates, one could envision the formation and translation of a terrane like Baja California moving 1000 km in 10–15 m.y. For example, if a terrane formed in 5 m.y. at a rate of motion of about 80 km/m.y. (the same percentage of total relative motion that is localized in the Gulf of California since its inception), it would move 400 km. If the plate motion was then fully localized along the main plate boundary at 115 km/m.y., the terrane would move a total of 1000 km in ~10 m.y. This possibility of the formation and translation of terranes these large distances over relatively short time periods is a challenge for those studying ancient orogens because it demands understanding of the orogenic processes to a few-million-year resolution in order to detect large terrane translations.

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GSA Fellow Scott Burns has been named the 2011–2012 Richard H. Jahns Distinguished Lecturer in Engineering Geology. Burns is a professor of geology at Portland State University (PSU), where he specializes in engineering and environmental geology, soils, geomorphology, Quaternary geology, and terroir. He just finished his 21st year of teaching at PSU and his 41st year of teaching at the university level (including in Switzerland, New Zealand, Washington, Colorado, and Louisiana).

Burns received his B.S. and M.S. degrees from Stanford University, and earned his Ph.D. at the University of Colorado. He holds registrations in Oregon (RG & CEG) and a license in Washington (LG) and is a consultant and expert witness for legal cases. Burns has authored or co-authored more than 80 articles and 200 published abstracts as well as two books. His diverse research topics include landslide debris flows; radon and earthquake hazard mapping; heavy metals and trace elements in soils; loess stratigraphy; slope stability; the Missoula Floods; biogeomorphology; alpine soil development; and terroir.

Burns’ accolades include the 2011 GSA Public Service Award and the 2006 GSA Environmental and Engineering Geology Division Meritorious Service Award. He has served as chair of the Environmental and Engineering Geology Division and as treasurer for 12 years of GSA’s Quaternary Geology and Geomorphology Division. Burns was 2002–2003 president of AEG and vice president of IAEG (North America) from 2006 to 2010.

Burns has also won many awards for outstanding teaching, with the most significant being the Faculty Senate Chair Award at Louisiana Tech University in 1987; the Distinguished Faculty Award from the PSU Alumni Association in 2001; and the George Hoffmann Award from PSU in 2007. He actively helps local TV and radio stations and newspapers bring important geological news to the public.

The main talk being offered by Burns is “Urban Landslides—Challenges to Forensic Engineering Geologists.”

Other talks on the following topics can also be arranged: “Cataclysms on the Columbia, the Great Missoula Floods”; “Engineering Geology Challenges on the Cascadia Margin, Pacific Northwest, USA”; and “The Mystery of Terroir—The Relationship of Geology, Soils, and Climate to Wine.” All talks are suitable for technical/professional and general audiences.

To make arrangements for talks, please contact Scott Burns directly at burnss@pdx.edu or +1-503-725-3389. Descriptions of these talks are posted on the AEG website (www.aegweb.org) and the GSA Environmental and Engineering Geology Division website (http://rock.geosociety.org/egd/index.html).
UPCOMING AWARD, RECOGNITION & GRANT DEADLINES

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

2012 GSA MEDALS AND AWARDS
Nomination deadline: 1 Feb. 2012
- Penrose Medal
- Day Medal
- Young Scientist Award (Donath Medal)
- GSA Public Service Award
- The Bromery Award for the Minorities
- GSA Distinguished Service Award
- Subaru Outstanding Woman in Science Award

GSA FELLOWSHIP
Nomination deadline: 1 Feb. 2012
Elevation to GSA Fellowship is an honor bestowed on the best of our profession at each spring GSA Council meeting. 
GSA Fellows may support two nominees each year but only one as a primary nominator. 
GSA members who are not Fellows may be secondary nominators for up to two nominees.

AGI MEDAL IN MEMORY OF IAN CAMPBELL
Nomination deadline: 1 Feb. 2012
The AGI Medal in Memory of Ian Campbell recognizes singular performance in and contributions to the profession of geology. To submit a nomination, go to www.agiweb.org/direct/awards.html.

AGI MARCUS MILLING LEGENDARY GEOScientIST MEDAL
Nomination deadline: 1 Feb. 2012
This award recognizes consistent, high-quality scientific achievements and service to the Earth sciences of lasting, historic value. The recipient should be a senior scientist nearing completion or having completed full-time regular employment who has been recognized for accomplishments in his or her field(s) of expertise by professional societies, universities, or other organizations. To submit a nomination, go to www.agiweb.org/direct/awards.html.

2012 NATIONAL AWARDS

2012 STUDENT RESEARCH GRANTS
Applications will be accepted online only beginning in late November. Paper applications or letters will not be accepted.

2012 POST-DOCTORAL RESEARCH AWARDS
Application deadline: 1 Feb. 2012
The following post-doctoral research awards are managed by the GSA Foundation. Learn more at www.geosociety.org/grants/postdoc.htm.
- The Gladys W. Cole Memorial Research Award for research on the geomorphology of semiarid and arid terrains in the United States and Mexico is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology.
- The W. Storrs Cole Memorial Research Award for research on invertebrate micropaleontology is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD
In cooperation with the Association of American State Geologists and supported by endowment income from the GSA Foundation’s John C. Frye Memorial Fund, GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey.
CALL FOR PROPOSALS

TECHNICAL SESSIONS
Deadline: 10 Jan. 2012

Help ensure that your area of research and expertise is represented in next year’s technical program. Individuals, groups, and geosciences organization are welcome to suggest topics and submit proposals for both Topical Sessions and Pardee Keynote Symposia. Pardee Symposia are high-profile sessions on significant scientific developments, with invited speakers only. Topical Sessions are a combination of invited and volunteered papers. Unique formats are allowed, but they must be outlined in the proposal, along with the technical support needs. Sessions that promote discussion are encouraged.

FIELD TRIPS
Deadline: 1 Dec. 2011

Know of a great geoscience excursion near Charlotte, North Carolina, USA? Teach your colleagues and peers about the ground-breaking research in this region. Submit your idea for a fun, interesting, and educational field trip for the 2012 Annual Meeting online at http://gsa.confex.com/gsa/2012AM/fieldtrip.htm. Trips can be anywhere from a half day to 5 days long. Questions? Please contact Beth Engle, +1-303-357-1006, bengle@geosociety.org.

SHORT COURSES
Deadline: 1 Feb. 2012

Have something that your peers need to know? Then lead a Short Course at the 2012 GSA Annual Meeting in Charlotte! Proposals for Short Courses are now being accepted. Courses can be run to develop professional, teaching, and research skills at all levels. Proposal guidelines are available online or by contacting Jennifer Nocerino at jnocerino@geosociety.org.

Looking ahead to 2012
GSA SPECIALTY DIVISIONS

Keeping You Connected

GSA’s 17 Divisions help you stay connected with your colleagues worldwide and receive specific information related to your area of interest. Divisions also provide opportunities for leadership and service; sharing of pertinent information, including notices of specialty meetings; development of the technical program at GSA meetings; nomination and presentation of awards; and support of student initiatives. To learn more, go to www.geosociety.org and click on “Divisions & Associated Societies.”

- The Archaeological Geology Division (est. 1977) provides a forum for the presentation and discussion of papers on archaeological geology in order to stimulate and promote research and teaching within this field. Division awards include the Rip Rapp Archaeological Geology Award, the Richard Hay Student Paper/Poster Award, and the Claude C. Albritton, Jr., Award memorial fund.

- The purpose of the Coal Geology Division (est. 1954) is to encourage coal research and disseminate coal geology information to all interested parties by actively participating in thought-provoking symposia and technical sessions at GSA’s meetings and through scientifically pertinent publications. The Division sponsors a major award for outstanding contributions to the field of coal geology, the Gilbert H. Cady Award, and also recognizes the volunteered contributions of its members through its Distinguished Service Award. For students, the Division offers the Antoinette Lierman Medlin Scholarship, the Antoinette Lierman Medlin Laboratory and Field Awards and a Best Student Paper Award.

- The Environmental and Engineering Geology Division (est. 1947 as the Engineering Geology Division) promotes education, research, outreach, and application of engineering geologic knowledge to the betterment of society by adopting sound design of buildings, structures, and facilities that assure public safety and a healthy environment. Each year, this Division honors geologists with the E.B. Burwell, Jr., Award and, along with the Assoc. of Environmental and Engineering Geologists, commissions the Richard H. Jabns Distinguished Lecturer. Other Division awards include the Meritorious Service Award, the Distinguished Practice Award, and the Roy J. Shlemon Scholarship and Meeting Student Awards.

- The purpose of the Geobiology & Geomicrobiology Division (est. 2001) is to bring together scientists working at the interface of biology and geology and to encompass the integration of these disciplines by simultaneously promoting both the broad scope and detailed disciplinary work demanded of rigorous interdisciplinary research. Fields represented within this Division include biogeochemistry, biomineralogy, geochemical ecology, paleontology, micropaleontology, origins of life and co-evolution of planets and life, paleobiology and paleoecology, molecular paleontology and ecology, systems modeling and informatics, and astrobiology. This Division sponsors an Outstanding Contributions to Geobiology & Geomicrobiology Award and an Outstanding Student Research Poster Award.

- The mission of the Geoinformatics Division (est. 2006) is to advance “Data to Knowledge,” providing GSA members with an opportunity to participate in the emerging field of cyberinfrastructure. The Division actively promotes and sponsors short courses, symposia, and books that emphasize information technology–supported discovery and integration of geoscience data leading to a more comprehensive understanding of Earth and the planets as complex systems.

- The Geology and Health Division (est. 2005) focuses on the intersection of natural or anthropogenic geological conditions with health, disease, pathology, and death in modern and fossil humans, animals, and plants. This GSA Division fosters communication and collaboration among scientists and health practitioners with an emphasis on the interdisciplinary relationship of geology to medicine, biology, chemistry, and other sciences.

- The motto of the Geology and Society Division (est. 2003) is “Geology Working for Society.” By increasing the geoscience community’s knowledge of societal issues and improving the community’s overall communication skills, this Division works to ensure accurate and intelligent dissemination of geologic information to society. This Division sponsors a Best Student Presentation Award.

- The Geophysics Division (est. 1971) facilitates the presentation and discussion of the challenges and ideas of scientists interested in geophysics, fosters communication among geophysicists and other earth scientists, and promotes research and publication. This Division sponsors the George P. Woollard Award and lecture for outstanding contributions to geology through the application of the principles and techniques of geophysics. For students, the Division offers the Allan V. Cox Student Research Award and the GSA Geophysics Division Student Research Award.

- The purpose of the Geoscience Education Division (est. 1991) is to foster the active participation of GSA members in all aspects of earth-science education. The Division complements and expands on the contributions of GSA’s Education & Outreach group, the National Earth Science Teachers Assoc. (NESTA), the National Assoc. of Geology Teachers (NAGT), and other similar organizations. This Division sponsors the Biggs Earth Science Teaching Award and a Distinguished Service Award.

- The History and Philosophy of Geology Division (est. in 1976 as the History of Geology Division) works to encourage the study and communication of the history and philosophy of geology. The Division sponsors technical sessions at GSA meetings and honors geologists for their research, writing, and historical work through the Mary C. Rabbitt History of Geology...
Award, the Gerald M. and Sue T. Friedman Distinguished Service Award, and the History & Philosophy of Geology Student Award. The Division provides “Rock Stars” articles to GSA Today, highlighting the life and work of “giants in geology.”

The Hydrogeology Division (est. 1959) focuses on the geologic aspects of hydrogeology, the role of geology in the hydrologic cycle, and the importance of hydrogeology to society and science. The Division has a well-established mentor program for students looking at careers in hydrology or hydrogeology through the John Mann Mentors in Applied Hydrogeology Program. The Birdsall-Dress Distinguished Lecturer honorees are named by this Division, along with the O.E. Meinzer Award, the Division’s Distinguished Service Award, the Hydrogeology Division Student Research Grant Awards, and the Diodato Student Travel Grants.

The Limnogeology Division (est. 2002) encourages research on both ancient and modern lakes around the world, the collaboration of scientists from all disciplines on lake research, and the fostering of student research and careers in lake studies. The Division sponsors the Israel C. Russell Award and the Kerry Kelts Student Research Award.

GSA’s newest Division (est. 2009), Mineralogy, Geochemistry, Petrology, Volcanology (MGPV), provides a mechanism whereby GSA members who share these common interests can organize to partner with adhering Associated Societies with the same interests; promotes awareness, teaching, study, and research of the relevant areas; stimulates and facilitates the presentation and discussion of problems, ideas, knowledge, and results of work and research in the relevant areas; and cooperates with other GSA Divisions and Sections and with GSA’s Associated Societies and other scientific organizations to foster, aid, and promote the relevant areas. The Division sponsors the Distinguished Geologic Career Award and the MGPV Student Research Grant Awards.

The two mottos of the Planetary Geology Division (est. 1981) are “One planet just isn’t enough!” and “The GSA Division with the biggest field area!” Awards sponsored by the Division include the G.K. Gilbert Award, the Distinguished Service Award, the Eugene M. Shoemaker Impact Cratering Award for students, the Stephen E. Dvornik Student Awards, and (jointly with the Meteoritical Society) the Pelliss-Ryder Award for the best student paper in planetary science.

The Quaternary Geology and Geomorphology Division (est. 1955) facilitates communication among scientists in these fields and the presentation of their research and ideas to the wider scientific community. Several awards are given by this Division: the Distinguished Career Award, the Kirk Bryan Award, the Gladys W. Cole Memorial Award, the Farouk El-Baz Award for Desert Research, and the J. Hoover Mackin, Arthur D. Hotard, and Marie Morisawa student research awards.

The Sedimentary Geology Division (est. 1985) works to ensure the presentation of sedimentary-related topics and sessions at GSA meetings and actively nurtures the work of students by offering the Sedimentary Geology Division Student Research Grant Award, Student Poster Awards, and by providing financial aid for students to attend Division-sponsored short courses and field trips. Additionally, the Division sponsors the Stephen E. Laubach Research in Structural Diagenesis Award (alternating with the Structural Geology and Tectonics Division) and the Laurence L. Sloss Award for outstanding accomplishments in sedimentary geology and contributions to GSA.

The Structural Geology and Tectonics Division (est. 1980) focuses on the geometry and mechanisms of natural and experimental deformation at all scales and works to promote the research of scientists in these fields and facilitate communication and discussion at all levels of the earth sciences. This Division offers a Career Contribution Award for advancement of the science of structural geology and tectonics, an Outstanding Publication Award, and the Division Student Research Grant Awards. Additionally, the Division sponsors the Stephen E. Laubach Research in Structural Diagenesis Award (alternating with the Sedimentary Geology Division).
Thank You 2011 GeoCorps™ America Participants, Partners, and Donors!

Katherine Jepson, Bureau of Land Management, Craters of the Moon National Monument.

**GeoCorps™ America** places geoscientists of all levels—university students, teachers, professionals, and retirees—in short-term geoscience projects on public lands throughout the United States. GeoCorps projects are hosted by three major federal partners—the National Park Service (NPS), the U.S. Dept. of Agriculture (USDA) Forest Service, and the Bureau of Land Management (BLM). Projects cover a wide variety of subjects related to the geosciences, including geology, hydrology, paleontology, soils, geohazards, mapping, GIS, education, and interpretation. GeoCorps positions funded by GSA, its federal partners, the GSA Foundation, and the organizations and individuals listed herein.

Most GeoCorps jobs are during the spring and summer, but we now have some in the fall and winter, and the program now includes diversity and American Indian internships.

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

- Badlands Natural History Association
- Bryce Canyon Natural History Association
- Canyonlands Natural History Association
- Discover Your Northwest
- Friends of the Florissant Fossil Beds
- Glacier Natural History Association
- Grand Canyon Association
- Pinchot Institute for Conservation
- Rocky Mountain Nature Association

**Federal Partners and Major Donors to the GeoCorp Program**

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<th>Federal Partners</th>
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<td>National Park Service (NPS)</td>
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<td>U.S. Dept. of Agriculture (USDA) Forest Service</td>
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<td>Bureau of Land Management (BLM)</td>
<td>Association for Women Geoscientists (AWG)</td>
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**Special thanks to Sally Newcomb** for supporting multiple GeoCorps positions in Alaska's parks, and to **Liz Lovelock** for supporting GeoCorps work at John Day Fossil Beds National Monument in memory of Christopher Lovelock.
FALL/WINTER 2010–2011 GEOCORPS PARTICIPANTS

Bureau of Land Management
Jason Frels, BLM Public Lands, Washington D.C. Office

National Park Service
Kate Dallas, NPS Geologic Resources Division
Liz Dengler, Rocky Mountain National Park
Kim Elson, Big Thicket National Preserve
David Santaniello, Yosemite National Park
Elena Sipe, Mount Rainier National Park
Zoe Vulgaropulos, Catoctin Mountain Park
Laura Walkup, Mount Rainier National Park

SPRING/SUMMER 2011 GEOCORPS PARTICIPANTS

Bureau of Land Management
Victoria Barnsbee, National Historic Oregon Trail Interpretive Center
Vanessa Calder, McInnis Canyons National Conservation Area
Gayle Eissner, Upper Missouri River Breaks National Monument
David Eitelberg, National Landscape Conservation System (NLCS)
Bryan Escamilla, Fairbanks (Alaska) District Office
Kathryn Estes-Smargiassi, Price (Utah) Field Office

National Park Service
Hani Al-Twaijri, Oregon Caves National Monument
Jane Barnes, Cape Cod National Seashore
Eleanor Bash, Glacier National Park
Diane Butler, Craters of the Moon National Monument and Preserve
Ruben Cano, Delaware Water Gap National Recreation Area
Molly Chamberlin, Grand Teton National Park
Scott Cherba, Grand Canyon National Park (North Rim)
Devin Cherry, Fossil Butte National Monument
Laura Clarke, Florissant Fossil Beds National Monument
Ryan Doucette, Mammoth Cave National Park
Andrew Farrar, Delaware Water Gap National Recreation Area
Lee Finley-Blasi, Grand Teton National Park
Corrie Floyd, Mount Rainier National Park

Positions for spring/summer 2012 will be posted 1 Dec. 2011.
Positions for fall/winter 2012 will be posted 1 May 2012.

www.geosociety.org/geocorps/
GeoCorps participants continued from p. 17

John Gagnon, Statue of Liberty National Monument, Governors Island National Monument, and Ellis Island
Drew Gentry, White Sands National Monument
John Ghist, NPS Geologic Resources Division
Leah Hall, Oregon Caves National Monument
William Hudacek, Fire Island National Seashore, Sagamore Hill National Historic Site, and Gateway National Recreation Area
Christopher Hughes, Bryce Canyon National Park
Jamie Kendall, Oregon Caves National Monument
Rachel King, Oregon Caves National Monument
Brandin Krempasky, Death Valley National Park
Taormina Lepore, Fossil Butte National Monument
Katharine Loughney, Chesapeake and Ohio Canal National Historical Park
Eva Lyon, NPS/AGI offices (Alexandria, Va.)
Kaitlin Maguire, John Day Fossil Beds National Monument
Pamela Marsh, Gulf Islands National Seashore
Adrian Maxwell, Florissant Fossil Beds National Monument
Jacob McDermott, Gateway National Recreation Area
Kelly McElwaine, NPS Natural Resource Program Center
Win McLaughlin, John Day Fossil Beds National Monument
Keegan Melstrom, Dinosaur National Monument
Allison Mills, Oregon Caves National Monument
Levi Moxness, Badlands National Park
Jonathan Munnikhuis, Bryce Canyon National Park
Chelsea Neill, Mount Rainier National Park
Karen Neumaier, Valley Forge National Historical Park
John Niles, Craters of the Moon National Monument and Preserve
Joanna Panosky, Dinosaur National Monument
Heather Parker, Mount Rainier National Park
Nancy Parker, Denali National Park
Rebecca Port, NPS Geologic Resources Division
Mariah Richards, Denali National Park
Janelle Rohweller, Grand Canyon National Park
Jeffrey Rosenthal, Grand Portage National Monument and Pipestone National Monument

Julie Rozen, Dinosaur National Monument
Nikole Rutters, Mount Rainier National Park
Julia Schwarz, Chesapeake and Ohio Canal National Historical Park
Alisa Scott, Mount Rainier National Park
Carolyn Sexton, Canyonlands National Park
Mandy Toong, Katmai National Park and Preserve
Jennifer Trout, Guadalupe Mountains National Park
Cynthia Valle, Grand Canyon National Park
Phil Varela, Chaco Culture National Historical Park
Lindsay Walker, Florissant Fossil Beds National Monument
Jeremy Wei, Glacier National Park
Delphine Woodman, Assateague Island National Seashore

USDA Forest Service
Kathryn Carlson, Huron-Manistee National Forest
Taylor Crist, Beaverhead-Deerlodge National Forest
Paul Doss, Huron-Manistee National Forest
Edgar Gelabert, Gila National Forest
Sarra Guisse, Shasta-Trinity National Forest
Joel Harrington, Klamath National Forest
Bethany Ladd, Medicine Bow-Routt National Forests
Erik Larson, Hiawatha National Forest
Erin Lynch, Tongass National Forest
Kelly McElwaine, Fraser Experimental Forest, Arapaho-Roosevelt and Medicine Bow National Forests
Natalie Rossington, Sierra National Forest
Elizabeth Rozar, Plumas National Forest
Jon Sanfilippo, Willamette National Forest
Brittany Smith, Fraser Experimental Forest, Arapaho-Roosevelt and Medicine Bow National Forests
Daniel Solway, Custer, Shoshone, and Gallatin National Forests
Brynne Storsved, Huron-Manistee National Forest
Abeje Temesgen, Shasta-Trinity National Forest
Paul Wilcox, Tongass National Forest

Paul Wilcox, USDA Forest Service, Tongass National Forest.
STUDENTS
Are you interested in a career in the applied geosciences?

Plan now to attend a Roy J. Shlemon Mentor Program in Applied Geoscience and/or a John Mann Mentors in Applied Hydrogeology Program at your 2012 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. Learn more at www.geosociety.org/mentors/.

PROFESSIONALS
Are you interested in sharing information about your applied geoscience career with students?

Being a mentor is a rewarding experience. If you are interested in serving as a mentor at one of the GSA Section Meetings, please contact Jennifer Nocerino at jnocerino@geosociety.org.
Renew your Membership for 2012

- Journal Subscriptions
- Division Memberships
- Section Affiliations
- GSA Foundation Support

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- Public Policy Updates
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Student, Recent Grads, and K-12 Teacher Extras

- FREE Online Access to Journals (more than US$190 annual value)
- Research Funding (geographic restrictions may apply)
- Mentor Programs and Employment Contacts

www.geosociety.org/members/
New from the GSA Bookstore!

- **Geological Criteria for Evaluating Seismicity Revisited: Forty Years of Paleoseismic Investigations and the Natural Record of Past Earthquakes**
  - Edited by Franck A. Audemard M., Alessandro Maria Michetti, and James P. McCalpin
  - SPE479, 204 p., ISBN 9780813724799
  - $80.00 | member price $56.00

- **Melanges: Processes of Formation and Societal Significance**
  - Edited by John Wakabayashi and Yildirim Dilek
  - SPE480, 277 p., ISBN 9780813724805
  - $90.00 | member price $63.00

- **A new geological map of the Island of Syros (Aegean Sea, Greece): Implications for lithostratigraphy and structural history of the Cycladic Blueschist Unit**
  - By Mark Keiter, Chris Ballhaus, and Frank Tomashchek
  - SPE481, 43 p. plus CD-ROM, ISBN 9780813724812
  - $40.00 | member price $32.00

- **Societal Challenges and Geoinformatics**
  - Edited by A. Krishna Sinha, David Arctur, Ian Jackson, and Linda Gundersen
  - SPE482, 191 p., ISBN 9780813724829
  - $90.00 | member price $63.00

- **Origin and Evolution of Precambrian High-Grade Gneiss Terranes, with Special Emphasis on the Limpopo Complex of Southern Africa**
  - Edited by Dirk D. van Reenen, Jan D. Kramers, Stephen McCourt, and Leonid L. Perchuk
  - MVIR207, 324 p., ISBN 9780813712079
  - $99.00 | member price $73.00

- **Field Guide to Samos and the Menderes Massif: Along-Strike Variations in the Mediterranean Tethyan Orogen**
  - By Klaus Gessner, Uwe Ring, and Talip Güngör
  - FLD023, 52 p., ISBN 9780813700236
  - $25.00 | member price $20.00

- **Geological Field Trips in Central Western Europe: Fragile Earth International Conference, Munich, September 2011**
  - Edited by Sara Carena, Anke M. Friedrich, and Bernd Lammerer
  - FLD022, 125 p., ISBN 9780813700229
  - $40.00 | member price $35.00

- **From the Outside Looking In**
  - Written and illustrated by Charles Ferguson Barker
  - OUTSIDE, 28 p., 9.75” x 7.75” paperback with black-and-white illustrations, ISBN 9780813760339
  - $9.95 (sorry, no additional discounts)

- **Archean to Anthropocene: Field Guides to the Geology of the Mid-Continent of North America**
  - Edited by James D. Miller, George J. Hudak, Chad Wittkop, and Patrick I. McLaughlin
  - SPE481, 43 p. plus CD-ROM, ISBN 9780813724812
  - $40.00 | member price $32.00

Visit www.geosociety.org/bookstore for more information and to purchase these titles.
Preliminary Announcement & Call for Papers

NORTH-CENTRAL
46th Annual Meeting of the North-Central Section, GSA
Dayton, Ohio, USA
23–24 April 2012
www.geosociety.org/Sections/nc/2012mtg/

Change through Time

LOCATION
Located centrally within the Cincinnati Arch, where I-75 meets I-70, Dayton, Ohio, USA, is surrounded by “world-class” late Ordovician strata and within driving distance of the famous Devonian Silica Shale, which has produced many prized trilobites, fish, and crinoids.

CALL FOR PAPERS
Please submit your abstract online at www.geosociety.org/sections/nc/2012mtg/. An abstract submission fee of US$12 for students and US$15 for all others will be charged. If you cannot submit an abstract online, please contact Nancy Wright, +1-303-357-1061, nwright@geosociety.org.

Theme Sessions
1. Applications of Remote Sensing to the Geological and Environmental Sciences. Doyle Watts, Wright State Univ., doyle.watts@wright.edu; Umesh Haritashya, Univ. of Dayton, Umesh.Haritashya@notes.udayton.edu.
2. Mercury Biogeochemistry. Chad R. Hammerschmidt, Wright State Univ., chad.hammerschmidt@wright.edu; Gary Conley, Ohio Univ., conleyg@ohio.edu.
3. Special Poster Session on Undergraduate Research. Cosponsored by the Council on Undergraduate Research Geoscience Division. Robert D. Shuster, Univ. of Nebraska, rshuster@unomaha.edu.
5. Geoscience Student Engagement: Innovations in Labs, Activities, Field Trips, and In-Class Pedagogy for K–16 Classrooms. Carrie L. Wright, Univ. of Southern Indiana, clwright@usi.edu.
6. Issues in Geoscience Education. Solomon Isiordo, Indiana Univ.–Purdue Univ. Fort Wayne, isiordo@ipfw.edu.
7. Geoscience Education and Outreach: Bringing Cutting Edge Science and Technology to Undergraduates, K–12 Teachers, and the Public. Cosponsored by National Assoc. of Geoscience Teachers North-Central Section. Katherine Johnson, Eastern Illinois Univ., kjohnsoni@eiu.edu; Shelley Judge, College of Wooster, sjudge@wooster.edu.
8. Vertebrate Paleontology. Jeremy L. Green, Kent State Univ. at Tuscarawas, jgreen72@kent.edu.
9. Bridging the Gap between the Great Ordovician Biodiversification Event and Late Carboniferous Life: Conodonts, Climate Change, and Biodiversity Patterns. Cosponsored by Pander Society and IGCP Projects 591 and 596. Mark Kleffner, The Ohio State Univ., mkleffner@lima.ohio-state.edu; Jeff Bauer, Shawnee State Univ., jbauer@shawnee.edu.
11. Dimensions of Biodiversity: A Paleontological Perspective. Alycia L Stigall, Ohio Univ., stigall@ohio.edu; Daniel I. Hembree, Ohio Univ., Hembree@ohio.edu.
15. Watersheds, Hydrogeology, and Environmental Site Investigation in the Midwest Basin and Arches Region. E. Scott Bair, The Ohio State Univ., bair.1@osu.edu; Robert W. Ritzi Jr., Wright State Univ., robert.ritzi@wright.edu.
16. **Climate Change: Past, Present and Future.** Shuang-Ye Wu, Univ. of Dayton, swu526@gmail.com.

17. **Issues in Geology and Public Policy: A Clash of Cultures/An Intersection of Interests.** Cosponsored by GSA Geology and Society Division; GSA Geology and Public Policy Committee. Mike Phillips, Illinois Valley Community College, mike_phillips@ivcc.edu.

18. **Economic Development and State Geological Surveys.** Larry Wickstrom, Ohio Geological Survey, larry.wickstrom@dnr.state.oh.us.

19. **Geothermal Resources of the Central United States—An Important Source of Renewable Energy.** Mike Angle, Ohio Division of Natural Resources Geologic Mapping & Industrial Minerals Section, mike.angle@dnr.state.oh.us.

20. **The Museum as Geological Muse: Outreach, Online Catalogs, Blogs, Student Internships, and More.** Joe Hannibal, Cleveland Museum of Natural History, jhanniba@cmnh.org; Brenda Hunda, Cincinnati Museum Center, BHunda@cincymuseum.org.

21. **Geoarchaeology and Cultural Geology: Exploring the Geological Aspects of Archaeological and Cultural Materials and Settings.** Andrew Bauer, DePauw Univ., andrewbaucer@depauw.edu; Joe Hannibal, Cleveland Museum of Natural History, jhanniba@cmnh.org.

22. **Shales during the Devonian: Facies Observed through New Stratigraphic, Sedimentologic, and Paleoenvironmental Perspectives.** Gordon Baird, SUNY Fredonia, baird@fredonia.edu; Jeff Over, SUNY Genesee, over@genesee.edu; Charles Ver Straeten, New York State Geological Survey, cverstra@mail.nysed.gov.

23. **Near-Surface Geophysics.** Ernie Hauser, Wright State Univ., ernest.hauser@wright.edu.

24. **Below the Mount Simon Sandstone of Ohio, Indiana, and Kentucky.** Ernie Hauser, Wright State Univ., ernest.hauser@wright.edu.

25. **Explorations in Mineralogy and Petrology: The View from the Midcontinent.** Andrea Koziol, Univ. of Dayton, Andrea.Koziol@notes.udayton.edu; Allen J. McGrew, Univ. of Dayton, Allen.McGrew@notes.udayton.edu.

26. **Constructed Wetlands: Boom or Bust?** Michael Enright, Five Rivers MetroParks, Michael.Enright@metroparks.org; Donald Geiger, Univ. of Dayton, Don.Geiger@notes.udayton.edu; James Amon, Wright State Univ.

27. **Biogeochemistry of Natural and Restored Wetlands and Their Role in Treatment of Contaminated Water and Wastewater.** Abinash Agrawal, Wright State Univ., abinash.agrawal@wright.edu.

28. **CO₂ Sequestration.** Neeraj Gupta, Battelle Labs, gupta@battelle.org.

**FIELD TRIPS**

**Premeeting**

1. **The Serpent Mound Impact Crater and Paleozoic Stratigraphy of Southern Ohio.** Two-day trip; departs Fri., 20 Apr., 5 p.m.; returns Sat., 21 Apr., 9 p.m. US$177. Max.: 22. Keith A. Milam, Ohio Univ.

2. **Lower Silurian of West-Central Ohio and the Case of the Disappearing Dayton.** One-day trip, Sat., 21 Apr.; departs 8 a.m.; returns 5 p.m. US$81. Max.: 16. Mark Kleffner, The Ohio State Univ. at Lima; Bradley Cramer, Kansas Geological Survey/Univ. of Kansas; Carlton Brett, Univ. of Cincinnati.

3. **Bourbon and Springs in the Bluegrass Region of Kentucky.** One-day trip, Sat., 21 Apr.; departs 6:45 a.m.; returns 6:45 p.m. US$81. Max.: 22. Alan Fryar, Univ. of Kentucky; Ashley Barton, Univ. of Kentucky.


5. **Upper Ordovician Strata of Southern Ohio-Indiana: Shales, Shell Beds, Storms, Sediment Starvation, and Cycles.** One-day trip, Sun., 22 Apr.; departs 9 a.m.; returns 8 p.m. (includes evening meal). US$83. Max.: 27. Benjamin Datillo, Indiana Univ.—Purdue Univ. Fort Wayne; Carlton Brett, Univ. of Cincinnati; Thomas Schramm, Louisiana State Univ.

6. **Scalps of Stream Study in West-Central Ohio.** One-day trip, Sun., 22 Apr.; departs 8 a.m.; returns 5 p.m. US$76. Max.: 18. John Ritter, Wittenberg Univ.

7. **Dayton Region Geology in Core and Outcrop—A Field Guide for Citizens, Environmental Investigators, Geologists, and Educators.** One-day trip (morning workshop and afternoon field trip), Sun., 22 Apr.; begins 9 a.m.; returns 5 p.m. US$71. Max.: 22. Gregory A. Schumacher, Michael P. Angle, Douglas J. Aden, Ohio Dept. of Natural Resources Division of Geological Survey; Brian E. Mott, DLZ Ohio Inc.
8. **The First Fossil-Vertebrate Locality in North America—“Big Bone Lick,” Kentucky.** One-day trip, Sun., 22 Apr.; departs 8 a.m.; returns 6 p.m. US$134. Max.: 20. Richard Arnold Davis, College of Mount St. Joseph; Stanley Hedeen, Xavier Univ.; H. Gregory McDonald, National Park Service; Kenneth B. Tankersley, Univ. of Cincinnati.

9. **Fossil Collecting from the Middle Devonian Silica Shale, West-Central Ohio.** One-day trip, Sun., 22 Apr.; departs 9 a.m.; returns 5 p.m. US$90. Max.: 20. Dave Mielke, Botkins, Ohio; Alex Fabian, Michigan; Michael R. Sandy, Univ. of Dayton.

During the Meeting


**REGISTRATION**

Early registration deadline: 19 Mar. 2012
Cancellation deadline: 26 Mar. 2012

Online registration opens Dec. 2011. For further information, or if you need special accommodations, please contact the general chair, Chuck Ciampaglio, at chuck.ciampaglio@wright.edu.

**ACCOMMODATIONS**

Hotel registration deadline: 30 Mar. 2012

The meeting will take place at the Dayton Convention Center. A block of rooms has been reserved at the Crowne Plaza Hotel, directly across from the convention center at 33 East Fifth Street, Dayton, Ohio 45402, USA. The group rate is US$104/night +13% tax. Please make your reservations by calling +1-888-233-9527 and requesting the 2012 GSA North-Central Section Meeting group rate.

**Contact Us Location**

To know more about benefitting from the expertise of the GNS Science Stable Isotope Laboratory and Rafter Radiocarbon Laboratory please visit

- [www.gns.cri.nz/nic/stableisotopes](http://www.gns.cri.nz/nic/stableisotopes)
- [www.rafterradiocarbon.co.nz](http://www.rafterradiocarbon.co.nz)

or Email us at:

- [stableisotopes@gns.cri.nz](mailto:stableisotopes@gns.cri.nz)
- [radiocarbon@gns.cri.nz](mailto:radiocarbon@gns.cri.nz)

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- [www.rafterradiocarbon.co.nz](http://www.rafterradiocarbon.co.nz)

or Email us at:

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Readers from age 14 to adult will enjoy learning about the creative forces of volcanoes.
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Call for papers: GSA TODAY
Publish your hot-topic science to a wide readership* with free color, no page charges, and open access online. Upload your article via the GSA Today online manuscript tracking system at www.geosociety.org/pubs/gsatguid.htm.

Did you know? The latest report from SCImago Journal & Country Rank (www.scimagojr.com/journalrank.php?category=1907) shows that for 2010, GSA Today was the third most influential geology journal in the world in terms of how many times its articles were cited in other journals (Geology is still no. 1).

*GSA Today is distributed to more than 24,000 readers and is available online from 1995 through today.
If GSA & GSAF Had All the Money in the World…

Several years ago the Foundation asked several GSA members what they would do “If GSA/GSAF had all the money in the world.” The following are some of the comments the Foundation (GSAF) has received over the years.

• “Spend our ill-gotten gains on education, for every level but mostly for the young (primary and secondary students) and lay people (via museums perhaps) to let them know about geology and the ‘new’ look of the field as the base on which we have to conduct our lives from personal to global health and for all those ‘things’ we enjoy.”

• “I would suggest that we help students, particularly those making presentations at the meetings, to go to the meetings, with a travel subsidy for both annual and section meetings. I would also increase the amount of money available for research grants and fund several more mentor meetings for students.”

• “To build a facility and provide service at minimal fees in training in ‘field geology’ and to establish a GSA sponsored Field Geology Institute!”

• “Create a national repository for all core, rock, and mineral samples that no longer have available storage space. This facility should be able to accept material as well as loan it out to researchers. So, it will need a ‘rock librarian.’”

• “Set up a nationwide program to help train and retrain elementary, middle school, and high school teachers in geology and geophysics to be able to raise the awareness of our science. An integral part of this program should incorporate either an abbreviated field camp or field trip to famous geologic sites. This will allow those teachers to teach to the National Science Standards. It may also help train them to be able to teach an Advanced Placement test level geology course.”

• “Provide funds for undergraduate field and laboratory research similar to the current program available for graduate thesis research.”

• “Be able to publish and make accessible all maps that are done for student research. This should include funds to make them accessible digitally as well as print versions.”

• “Be able to subsidize the costs for all participants in Penrose and field conferences.”

• “Enable the GSA to develop much more ‘outreach,’ particularly to other geological professionals who are not now members. For example, provide funds to non-Ph.D. professionals working in the applied sciences. Set up sabbaticals for them, either at major universities, or at a series of seminars, preferably hosted by the GSA.”

• “Permit full-time academic members to take jobs in industry, at least for a short time, and not jeopardize their tenure or academic standing. How wonderful for them to return to the classroom and describe ‘real world’ problems to students. Both academia and industry will greatly benefit.”

• “I would increase the student grants program to make more available, increase stipends available to bring more foreign scholars to GSA meetings, including Penrose Conferences, and make sure that there are adequate funds for operation of the Foundation.”

What would be your suggestion? You can e-mail the GSA Foundation at drussell@geosociety.org, or go to our website at gsafweb.org.
Most memorable early geologic experience:

Growing up on the shores of Lake Erie, I marveled at the storm waves that thundered against the shale cliffs yet painted intricate patterns in the heavy mineral sands on the beach. I think this is the reason I became a geologist!

—James Ebert

About People

Learn more about these accomplished GSA members and Fellows and find more member news at www.geosociety.org/news/memberNews.htm.

15 Sept.: GSA Fellow Paul Hsieh, a research hydrologist for the U.S. Geological Survey, has earned the Federal Employee of the Year medal for providing critical scientific information during the Deepwater Horizon oil spill.

14 Sept.: GSA Member Joan Kleypas, a marine ecologist and geologist at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, USA, has been named the 2011 recipient of the Heinz Award for her work studying the effects of climate change on coral reefs. The Heinz Award recognizes excellence in “individuals creating and implementing workable solutions to the problems the world faces through invention, research, and education, while inspiring the next generation of modern thinkers.”

31 Aug.: GSA Fellow Philip Christensen, principal investigator for numerous instruments of Mars exploration carried on NASA spacecraft, has been named the 2011 Eugene Shoemaker Memorial Award recipient by Arizona State University in honor of his life’s work on “Unlocking the Mysteries of the Red Planet.”

30 June: GSA member Alfred McEwen, professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, has been awarded NASA’s Distinguished Public Service Medal for his work as principal investigator on the High Resolution Imaging Science Experiment (HiRISE) for the Mars Reconnaissance Orbiter.

In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 26 May and 28 July 2011).

Carey Brent Miller
Oklahoma City, Oklahoma, USA
Notified 26 May 2011

Russell R. Dutcher
Carbondale, Illinois, USA
Notified 3 June 2011

W.N. McKinney Jr.
Spring, Texas, USA
1 Aug. 2010

George R. Harlow
Paoli, Pennsylvania, USA
27 Apr. 2011

James V. Taranik
Reno, Nevada, USA
21 June 2011

David W. McDonald
Plano, Texas, USA
15 Mar. 2011

Edward J. Combs
Newburgh, Indiana, USA
1 Sept. 2009

To honor one of these colleagues with a memorial, please go to www.geosociety.org/pubs/memorials/. This page also lists completed memorials, some of which are available for download.

If you would like to contribute to the GSA Memorial Fund, please contact the GSA Foundation at drussell@geosociety.org, +1-303-357-1054, gsafweb.org.
Deformation Localization in Rocks: New Advances
Cadaqués and Cap de Creus Peninsula, Catalonia, Spain
27 June–2 July 2011

CONVENERS

Elena Druguet, Depto. de Geologia, Universitat Autònoma de Barcelona, Spain; Elena.druguet@uab.cat

Jordi Carreras, Depto. de Geologia, Universitat Autònoma de Barcelona, Spain; jordi.carreras@uab.cat

G. Ian Alsop, Dept. of Geology & Petroleum Geology, School of Geosciences, University of Aberdeen, UK; ian.alsop@abdn.ac.uk

Paul D. Bons, Institut für Geowissenschaften, Eberhard Karls Universität Tübingen, Germany; paul.bons@uni-tuebingen.de

Dyanna M. Czech, Dept. of Geosciences, University of Wisconsin, Milwaukee, Wisconsin 53201, USA; dyanna@uwm.edu

Peter J. Hudleston, Dept. of Geology and Geophysics, University of Minnesota, Minneapolis, Minnesota 55455-0213, USA; hudletoff@umn.edu

Christine S. Siddoway, Geology Dept., Colorado College, Colorado Springs, Colorado 80903, USA; csiddoway@coloradocollege.edu

OVERVIEW

The past few decades have seen an intense interest in the localization of deformation in rocks, and the conference on “Shear Zones in Rocks” held in Barcelona in 1979 was a milestone marking this interest. A key part of that conference was the field trip to the extraordinary outcrops at the Cap de Creus peninsula. The interest in shear zones and localization of deformation has not abated since 1979 and perhaps has even intensified. There has been significant increase in our knowledge of the processes associated with deformation localization, from field and laboratory study, from physical and computer modeling, and from theoretical considerations. We know more about the chemical and physical influence of fluids on deformation, and we recognize that deformation in many shear zones departs significantly from simple shear and that flow may be channeled in the crust. Criteria have been developed to establish the degree of non-coaxiality or vorticity of deformation.

The ability to determine the pressure, temperature, and timing of flow in various tectonic settings has improved dramatically. It was highly appropriate to return to Cadaqués for this conference, which allowed the participants to discuss new ideas on deformation localization in the lecture room and poster hall, and in the field in the wonderful natural laboratory at Cap de Creus.

Field Trips and Presentations

The papers presented at this conference reflected the multifaceted work being carried out on deformation localization and do not lend themselves to easy characterization.

The conference began with a field trip on Monday, 27 June, to visit classic outcrops of shear zones in granitoids and the complex high-temperature–high strain zone at Puig de Culip. This set the stage for the first lecture sessions on Tuesday in Cadaqués on the geometry and kinematics of shear zones. Keynote lectures were given by Jordi Carreras, who discussed some problems of coupling strain, kinematics, and tectonic regimes; and Cees Passchier, who presented a typology of complex shear zones. An afternoon session was dedicated to further aspects of shear zone initiation and development, starting with a keynote lecture by Laurel B. Goodwin on the controls on deformation localization. Wednesday was spent examining the classic outstanding outcrops along the Cala Serena–Cala Prona shear zone, which encouraged active discussion among participants. On Thursday, the topic switched to strain localization with regard to fluids, melts, and metamorphism. Neil Mancktelow presented a keynote lecture on brittle precursors, fluid-rock interaction, and the localization or spreading of shear zones. The topic moved to structures and fabrics that are found in shear zones, beginning with a talk by John W. Cosgrove on rock anisotropy, buckling, and strain localization. In the evening, a boat cruise highlighted the magnificent outcrops along the rocky coastal cliffs of Cap de Creus.

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The total number of oral presentations during the conference was 44; 25 posters covering the range of topics presented in the lectures were the focus of attention in the evenings and during breaks between lecture sessions.

Concluding Remarks

Ideas and discussions resulting from the field trips and presentations were significant, and the outcome of the conference will likely have great repercussions on the fields of structural geology and tectonics as well as on the importance of linking multiple research approaches to understand the processes that lead to strain localization in rocks. A special issue of papers on the conference topics is being prepared in Journal of Structural Geology.

Penrose Conference and Field Forum Proposals Encouraged

PENROSE CONFERENCES
GSA’s Penrose Conferences were established in 1969 to provide opportunities for the exchange of current information and exciting ideas in geology and related fields and to stimulate and enhance individual and collaborative research. Go to www.geosociety.org/Penrose/ for guidelines and a proposal form.

FIELD FORUMS
Have a great idea for a Penrose Conference that would be much more effective in a field setting or a field trip idea that captures the essence of new discoveries or a controversial topic? Then submit a Field Forum proposal! Field Forums provide an opportunity for the exchange of current knowledge and ideas that are well expressed by the geology of a specific area. Go to www.geosociety.org/fieldforums/ for proposal guidelines and more information.

QUESTIONS? Contact Becky Sundeen, +1-303-357-1041, bsundeen@geosociety.org.
Positions Open

ENVIROMENTAL STUDIES PROGRAM

TENURE-TRACK FACULTY POSITION
LOW-TEMPERATURE/ ENVIRONMENTAL GEOCHEMISTRY
GEORGIA SOUTHERN UNIVERSITY

Georgia Southern University’s Dept. of Geology and Earth Sciences invites applications for an Assistant Professor of Geology in with expertise in low-temperature and environmental geochemistry. The full text advertisement information is available at http://cost.georgiasouthern.edu/geo/. Screening of applications will begin 21 Nov. 2011 and continue until the position is filled. Georgia is an open records state. Georgia Southern is an AA/EO institution. Individuals who need reasonable accommodations under the Americans with Disabilities Act should contact the Georgia Southern University’s ADA/Tenure Track Committee, Dept. of Geological Sciences, University of Georgia, Athens, GA 30602-7222. Candidates interested in applying should submit their curriculum vitae, a letter of application, a research statement, a teaching statement, and three letters of recommendation. Applications will be accepted until the position is filled. Review of applications will begin on 15 Dec. 2011. The University of Georgia is an Affirmative Action Employment Opportunity Program. Potential candidates who might be contacted for letters of recommendation. The University of Florida is an Equal Opportunity Institution. University of Florida is an Equal Opportunity Institution. University of Florida is an Equal Employment Opportunity employer.

The Geology Dept. includes 11 tenure-track faculty and ~100 majors (Geology, Geology-Chemistry, Earth Sciences) and serves ~600+ support students. The department values field experiences and collegial faculty-student interactions (see www.psu.edu/geology and www.gwu.edu/geo/). Applicants for the position should have a strong educational and research record and be prepared to begin their careers immediately. The successful candidate will join the Environmental Studies research group currently working on anthropogenic changes to the South Shore Estuary Reserve, and in collaboration with other Adelphi faculty, lead undergraduate and graduate research projects. The successful candidate is expected to develop a strongly externally funded research program at the undergraduate and graduate levels. The successful candidate will also be expected to teach introductory and advanced geology courses, and conduct research in the area of expertise. This is a nine-month, 9-month, tenure-track, assistant professor, position.

Applications are due 15 Nov. 2011. Marshall University is an Affirmative Action/Equal Opportunity employer.

ASSOCIATE PROFESSOR OF GEOLOGY
WILLIAM M. THOMPSON CHAIR OF GEOLOGICAL SCIENCES
DEPARTMENT OF GEOLOGICAL SCIENCES
UNIVERSITY OF WISCONSIN–MILWAUKEE

The Dept. of Geosciences at the University of Wisconsin–Milwaukee welcomes applications for a tenure-track faculty position in geophysics at the assistant professor level. Applications from geophysicists in related fields or related fields at the time of appointment, and have demonstrated research experience in geophysics. Post-doctoral research experience (TA and/or lecturer) experience are preferred. The successful candidate is expected to conduct an active, internationally recognized, externally funded research program. The successful candidate will teach a required introductory survey course in geosciences and majors, as an upper level graduate and advanced level courses in his/her area of expertise, and related fields in his/her field of expertise, introductory student thesis projects. A standard teaching load is 3-credit courses per academic year. Applications are available online with information regarding the Dept. of Geosciences and the College of Letters and Sciences, http://www.uwm.edu/cola/colaeo/. Review of applications will begin 21 Jan. 2012. Priority will be given to applications received by that date, but the position will remain open until filled. To apply, please go to http://jobs.uwm.edu/postings/7022. Candidates should upload a cover letter, curriculum vitae, statement of teaching philosophy, research interests, and examples of published works with the online application. Published works may be uploaded with the application. Candidates are encouraged to upload a letter of recommendation from at least one familiar with your teaching philosophy, and the names and contact information of five references. Three letters of recommendation are required and should be mailed to: Lisa Alizadeh, Search & Screen Support, Dept. of Geosciences, University of Wisconsin–Milwaukee, P.O. Box 413, Milwaukee, WI 53201 or emailed to geoscience@uwm.edu.

The University of Wisconsin-Milwaukee is a large, research-oriented institution located on the northeast side of Milwaukee, five blocks from Lake Michigan. The Dept. of Geosciences offers B.S./B.A., M.S., and Ph.D. degrees and is staffed by 12 full-time faculty. UWM is an AA/EO/ADA employer.

THE UNIVERSITY OF FLORIDA

DEPARTMENT OF GEOLOGICAL SCIENCES
THOMPSON CHAIR OF GEOLOGICAL SCIENCES
UNIVERSITY OF FLORIDA

The Dept. of Geological Sciences, University of Florida, invites applications for the Thompson Chair of Geologic Sciences, an endowed, senior level position. The successful candidate will have demonstrated ability and the commitment to expand and maintain an international reputation in public engagement, teaching, and publishing in one or more areas of geoscience major. The University of Florida is an Equal Opportunity Institution. University of Florida is an Equal Employment Opportunity Program. Potential candidates who might be contacted for letters of recommendation. The University of Florida is an Equal Employment Opportunity employer.

ASSISTANT PROFESSOR, GEOLOGY
WILLIAM KENTUCKY STATE UNIVERSITY

The Dept. of Geography and Geology at Western Kentucky University is seeking applicants for a tenure-track position at the Assistant Professor rank in November 2011, GSA Today
the general areas of structural geology, tectonics, geophysics, or related discipline, effective August 2012. An earned Ph.D. in geophysics is required. The successful applicant is expected to develop a strong externally funded research program, teach high-quality undergraduate courses, encourage and supervise undergraduate and graduate research projects, and contribute to the growth of the department’s M.S. program in Geosciences. Teaching duties include general education courses, structural geology, as well as upper-level undergraduate and graduate courses in the specialization. Other responsibilities include scholarly research leading to publication, university and public services, and attention to professional development. For more information about the Geology program can be found at www.wku.edu/geology. Information about the department can be found at www.wku.edu/ geoweb.

Interested candidates must submit a letter of application, curriculum vita, unofficial transcripts, three letters of recommendation, a statement addressing (1) teaching and (2) research philosophy to: Natural Sciences Search Committee, Western Kentucky University, 1906 College Heights Blvd #3106, Bowling Green, KY 42101-1066, aaron.celestan@wku.edu.


Western Kentucky University does not discriminate on the basis of race, color, national origin, sex, sexual orientation, gender identity, age, religion, or marital status in admission to and/or activities, or employment practices in accordance with Title VI and VII of the Civil Rights Act of 1964, Title IX of the Educational Amendments of 1972, Section 504 of the Rehabilitation Act of 1973, Revised 1992, and the Americans with Disabilities Act of 1990.

ASSISTANT PROFESSOR OF EARTH SCIENCE
CARROLL COLLEGE

Carroll College, a Catholic, coeducational and comprehensive liberal arts college in Helena, Montana, invites applications for a full-time, tenure-track ASSISTANT PROFESSOR, to begin in August 2012. We seek a candidate with a strong commitment to teaching at an undergraduate institution. Primary responsibilities include teaching a one-semester course in earth science, a one-semester course in physical geography, and an upper-level geology or related course in an area of interest, and participation in advising/administration of the Environmental Studies Program. Area of specialization is open, but degrees and demonstrated knowledge and ability to teach physical or environmental geology and physical geography are essential. The ability to develop an externally funded undergraduate research program is expected; a Ph.D. by August 2012 is required. Applicants should submit curriculum vitae, three letters of recommendation, a statement responding to Carroll’s mission, and a statement of teaching and scholarly philosophy to: Natural Sciences Search Committee, Office of Human Resources, Carroll College, 1601 North College Rd., Helena, MT 59602, USA, or electronically submitted to employment@carroll.edu. Priority will be given to application materials received by 15 Dec. 2011. To learn more about Carroll College, please visit our web site: www.carroll.edu. EOE. Women and minorities are encouraged to apply.

TWO TENURE-TRACK ASSISTANT PROFESSOR POSITIONS IN MARINE GEOLOGY
VIRGINIA INSTITUTE OF MARINE SCIENCE
THE COLLEGE OF WILLIAM & MARY

The Dept. of Physical Sciences at the Virginia Institute of Marine Science at the College of William & Mary, located in Gloucester Point, Virginia, seeks applicants for tenure-track faculty positions to begin July 2012. Successful candidates will join a department that includes faculty working in geological and physical oceanography, a union which facilitates the synergy needed to address today’s interdisciplinary research problems, environmental issues, and challenges. These hires are part of a larger strategic expansion within the institute. Applicants should submit an application letter, curriculum vitae, a statement of research interests and goals, and a teaching statement that describes a personal philosophy of teaching, an essay describing significant teaching experiences, and three letters of recommendation to: Search Committee, Virginia Institute of Marine Science, 1000 Wiebo Circle, Gloucester Point, VA 23062. Review of applications will begin November 15, 2011. Questions about this position may be addressed to: Dr. David Straus, dstraus@vims.edu, 703-993-5857.

EOE

TENURE-TRACK PIONEER NATURAL RESOURCES PROFESSOR IN STRATIGRAPHY
UNIVERSITY OF KENTUCKY

The Dept. of Earth and Environmental Sciences at the University of Kentucky invites applications for the Pioneer Natural Resources Professor in Stratigraphy beginning August 2012. We are seeking to hire at the assistant professor level (tenure-track), but candidates at a more senior level will be considered. Applicants are expected to complement our existing programs in tectonics, geophysics, geochemistry and hydrogeology. We seek a field- and modeling-oriented candidate with expertise in basin analysis, and who is capable of using a variety of methods such as seismic stratigraphy, sequence stratigraphy, sedimentology, sedimentary geochemistry, organic petrology, scanning electron microscopy, X-ray diffraction, and geostatistics. Multiple opportunities exist for cooperation with other academic units, including the Kentucky Geological Survey, the UK Center for Applied Energy Research, the Tracy Farmer Institute for Sustainability and the Environment, and the Kentucky Water Resources Research Institute. In addition to maintaining a productive externally funded research program, the new faculty member will teach courses at the introductory, major, and graduate levels, as well as mentor and direct graduate students. The successful candidate will have demonstrated a track record of publication and potential for developing an externally funded, nationally recognized research

GEORGE MASON UNIVERSITY

ASSISTANT PROFESSOR

The George Mason University, Department of Atmospheric, Oceanic and Earth Sciences (AOES) invites applications for a full-time, tenure-track faculty position. The position is at the level of Assistant Professor to begin in the fall of 2012. We seek a dynamic person with broad expertise in the areas of structural geology, tectonics and/or seismology. Experience with field-based research and incorporation of Appalachian geology into future teaching and research are a plus. Preference will be given to candidates whose expertise complements existing departmental teaching and research areas. The successful candidate will be expected to pursue a vigorous externally-funded research program, aspire to teaching excellence, and engage in inter-disciplinary collaboration. Teaching will be primarily at the undergraduate level including structural geology. A Ph.D. is required for this position. AOES offers undergraduate degrees in Geology and Earth Science, and a Ph.D. in Climate Dynamics. Faculty includes geologists, atmospheric scientists and oceanographers. Additional information about the department may be found at http://aoes.gmu.edu/.

For full consideration, applicants must apply online at http://jobs.gmu.edu for position FE8552; complete the faculty application, and upload a cover letter/letter of intent, curriculum vitae, list of publications, contact information (including e-mail address) of three professional references, and teaching evaluations (if available).

Review of applications will begin November 15, 2011. Questions about this position may be addressed to: Dr. David Straus, dstraus@vims.edu, 703-993-5857.

EOE

For full consideration, applicants must apply online at http://jobs.gmu.edu for position FE8552; complete the faculty application, and upload a cover letter/letter of intent, curriculum vitae, list of publications, contact information (including e-mail address) of three professional references, and teaching evaluations (if available).

Review of applications will begin November 15, 2011. Questions about this position may be addressed to: Dr. David Straus, dstraus@vims.edu, 703-993-5857.

EOE

The successful candidate is expected to teach at all levels and develop a vigorous externally funded research program supporting graduate students. Teaching assignments include an undergraduate course in structural geology, graduate courses in the hire’s specialty, team-teaching undergraduate field course(s), and, on a rotational basis, an introductory geology course. To apply and view a complete position description, please visit: http://warnercnr.colostate.edu/employment-opportunities.html by 5 p.m. on 1 Dec. 2011. CSU is an EO/EA/AA employer. CSU conducts background checks on all final candidates.
Ohio University is an affirmative action/equal opportunity employer and applications will be accepted without regard to race, color, sex or national origin. Applicants must have proof of legal authority to work in the United States as well as Ph.D. requirements completed at the time of the appointment. Women and minorities are encouraged to apply.

Ohio University is a Research-Extensive institution, and a land-grant institution and Kentucky’s flagship university, UK is committed to being one of the top public institutions in the country. Women, persons with disabilities, and members of other under-represented groups are encouraged to apply. The University also supports the development of a diverse, culturally rich faculty. Additional details of the Dept. of Earth and Environmental Sciences (faculty, research clusters, facilities) and University of Kentucky may be viewed at our web pages: www.as.uky.edu/ees and www.uky.edu.

The University of Kentucky is an Equal Opportunity/Affirmative Action institution, and is committed to the principles of diversity and is committed to equal opportunity in employment, education, programs, services, activities and access. Women and minorities are encouraged to apply.

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should be sent to: Chair, Search Committee, Dept. of Geological Sciences, S-388 ESC, Brigham Young University, Provo, UT 84602. The application deadline is 31 Jan. 2012. You may obtain instructions for completing the online faculty application from Kris at kris.mortenson@byu.edu.

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Killer waves on the airwaves: New media, traditional media, and student conceptualization of tsunamis

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INTRODUCTION
This paper addresses the hypothesis that, after 26 Dec. 2004, media coverage, and more specifically “new media,” affected students’ understanding of, and interest in, tsunamis. To test this hypothesis, 13 years of media reports on tsunamis were reviewed and 146 students surveyed regarding their knowledge of the phenomenon in the aftermath of the 11 March 2011 Japan earthquake and tsunami.

BACKGROUND
The overarching goal of science educators is the achievement of scientific literacy (National Research Council, 1996). The means for achieving it vary, but it has been suggested that covering material relevant to students’ lives (Cervato et al., 2009, and references therein) and leveraging students’ fascination about natural disasters help them develop deeper understandings of these phenomena (e.g., Welch, 2006). Lee (1999) studied Florida children’s conception of hurricanes after they experienced Hurricane Andrew in 1992. She argued that since learning through personal experience may lead to understanding that is not compatible with the nature of science or scientific knowledge, it is important to be aware of students’ ways of knowing and thinking about science.

Students who do not live in areas impacted by natural disasters learn about these events through news media, movies, or in school (e.g., Parham et al., 2011). A study of the impact of news media on students’ understanding of earthquakes (Barrow and Haskins, 1996) suggests that while mass media expose them to the cause and effects of earthquakes more than direct experience, the focus of media on large, devastating events can fuel the misconception that tectonic plates move only rarely.

Since Barrow and Haskins’ (1996) study, the spectrum of mass media has expanded from print and TV and radio broadcasting to include “new media,” such as YouTube and other Internet sources. Houston et al. (2008) found that while reports of Hurricane Katrina and other disasters represent teachable moments for youth, their portrayal in the media has been so influential as to cause post-traumatic stress symptoms in younger viewers.

TSUNAMI IN NEW AND TRADITIONAL MEDIA
To test whether the media deserve credit for the sudden increase in worldwide concern regarding tsunami, the occurrence of the term “tsunami” in major world publications since December 1997 using the LexisNexis Academic news database was collected. The major world publications file of LexisNexis includes more than 700 news sources known for their content reliability. The search protocol for this study approximates the method used in a more general study of occurrences of geoscience terms in the news (Cervato et al., 2009), though the search was restricted to the topic “natural disasters” to exclude non-geologic usages of “tsunami.” Out of 399 occurrences in a random 14-day period in February 2011, 87 (22%) were categorized under “natural disasters”; others were in categories as varied as “elections” and “health and medicine.”

Pre–December 2004 data were collected for one-year intervals. Beyond 26 Dec. 2004, daily averages were computed within three-month bins (Fig. 1). To capture the effect of the 11 Mar. 2011 tsunami, the data from 2004 were split into two periods: one from 11 Dec. 2010 to 10 Mar. 2011 and once from 29 Dec. 2010 to 28 Mar. 2011.

Prior to 2004, the most recent significant tsunami event occurred on 17 July 1998 in Papua New Guinea, sparking 1.38 average daily news reports over one year. Afterward, tsunami reports averaged <1 per day until 26 Dec. 2004. In the two weeks thereafter, the term occurred 12,530 times (835 daily average occurrences). The daily occurrence until Mar. 2005 was 161. In the following year, this gradually declined to ~30. After the one-year anniversary of the Sumatra event, coverage stayed at ~15 reports per day, rising slightly when three other tsunamis hit the news. The M9.0 earthquake near Japan on 11 Mar. 2011 generated a tsunami wave across the Pacific Ocean and a wave of media interest comparable yet smaller than the one at the end of 2004: 9194 news reports in the 14 days following the event—an average of 656 daily reports.

The 2004 event coincided with the birth of YouTube, which made its official debut in November 2004, meaning dozens of amateur videos taken by tourists who witnessed the event were suddenly readily available on the Internet.

Google Earth, another new media source released in 2005, allows people to visualize the effects of natural disasters with unprecedented speed and detail. While “before and after” satellite images of areas affected by the 2004 tsunami were posted on the NASA site 15 days after the event (http://tinyurl.com/3sxhwg), Google Earth released higher resolution pre- and post-event images of the 2011 Japan tsunami less than two days after the event (http://tinyurl.com/49arhxg).

Widespread coverage of tsunamis in the media coincided with deeper coverage of tsunamis in many introductory geoscience curricula, as suggested by the jump from two pages in the first edition of an introductory geology textbook (Marshak, 2001) to five pages in the third edition (Marshak, 2008).
The impacts of the 2004 Indian Ocean tsunami go beyond the huge loss in human lives and the far-reaching environmental and economic consequences. The event initiated a “lexical shift” in media reports from the incorrect popular term “tidal wave” to the scientifically accepted “tsunami” (Clark, 2010). Further, media have also popularized the term “tsunami” beyond its original scientific usage: the political “tsunami” sweeping through North African countries this winter (J. Githongo, The East African, 14 Feb. 2011) causing a potential “human tsunami” to hit Italy (Italian PM Berlusconi quoted in Corriere della Sera, 2 Apr. 2011).

**TSUNAMIS AND STUDENTS’ CONCEPTIONS**

Given the intensity of coverage from multiple media sources, one might expect students’ understanding of tsunamis to be better now than prior to 2004. However, a 14-question survey (http://tinyurl.com/6g7jxlp) of 146 students (73% of the class) enrolled in an introductory meteorology course taught by the author and administered online between 29 March and 2 April 2011 shows that significant misconceptions remain. Tsunamis were not part of the course curriculum, and students received a small amount of extra credit for completing the survey.

The vast majority of students surveyed were between 18 and 22 years old. While 77.4% had taken an Earth science class in middle or high school and 44.5% had taken one in college, 47.3% declared that they first heard of tsunamis in the news, 40.4% in school, and 12.3% from a Hollywood movie. Most students surveyed (84.9%) knew the correct possible causes of tsunami. However, 54.8% believed that tsunamis are affected by climate change. Two thirds of students surveyed identified a tsunami as a single wall of water (28.8%) or several long waves in the ocean (35.6%); 28.1% believed they are related to tides. On the other hand, 32.9% of them identified “harbor wave” as the correct meaning of the Japanese word “tsunami.” Finally, 23.3% of students thought that tsunamis are about as frequent now as in the geologic past, while the majority (73.6%) thought that tsunamis are somewhat or much more frequent now.

These results suggest that most students know a lot about tsunamis, perhaps due to heavy media coverage. However, there are no data to prove this beyond the perception of a marked difference in students’ interest before and after 2004 as suggested by their questions in class.

Many students hold two significant misconceptions: (1) that tsunamis are affected by climate change, and (2) that tsunamis are becoming more frequent. This suggests that the true causal mechanism of tsunamis remains unclear, and that students may be erroneously assuming, in reaction to the increased visibility of tsunamis in the media, that their rate of occurrence has increased.

**CONCLUSIONS**

New visual media, such as YouTube and Google Earth, present geoscience educators with an opportunity to engage students in the understanding of dynamic Earth processes in powerful new ways. However, after 2004, traditional and new media have transformed the term “tsunami” into a household word that is now commonly used by people all over the world and in a broad range of non-geologic contexts. In spite of this popularity, students still hold challenging misconceptions about why, and how often, tsunamis occur.

**REFERENCES CITED**


Manuscript received 8 Apr. 2011; accepted 20 July 2011.

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