

GSA TODAY

VOL. 20, No. 1

A PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA

JANUARY 2010

Impact of erosion, sedimentation, and structural heritage on the structure and kinematics of orogenic wedges: Analog models and case studies



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Jacques Malavieille



Cover: Sandbox model of orogenic wedge submitted to erosion illustrating the impact of décollements. Deformation partitioning is characterized from right to left by a frontal imbricate of thrust sheets; a synformal stack of thrust units (resting above the décollement); and an antiformal stack of underplated thrust units (image by E. Konstantinovskaia and J. Malavieille). See "Impact of erosion, sedimentation, and structural heritage on the structure and kinematics of orogenic wedges: Analog models and case studies," by J. Malavieille, p. 4–10.

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Impact of erosion, sedimentation, and structural heritage on the structure and kinematics of orogenic wedges: Analog models and case studies

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ABSTRACT

Interaction between surface and tectonic processes plays a key role in the structural evolution, kinematics, and exhumation of rocks in orogenic wedges. The deformation patterns observed in analog models show that strain partitioning has a strong impact on the vertical component of displacement of tectonic units, which in return favors erosion in domains of important uplift. Partitioning is controlled by tectonic processes and by climate-dependent surface processes, including erosion and sedimentation. The effects of partitioning include localization of deformed domains, exhumation above areas of deep underplating, and steady-state maintenance of wedges for long time periods. Simple models illustrate well how the morphostructural evolution of mountain belts is determined by these complex interactions.

INTRODUCTION

Orogenic wedges record the tectonic evolution and the coupled deep geological (rheology and kinematics, metamorphism, magmatism) and surface (climate-dependent erosion and sedimentation) processes active along convergent margins. Their role is highlighted in studies dealing with the evolution of orogens at different time and space scales (see part I of supplemental information, GSA data repository¹). The role of erosion and sedimentation on fault growth, exhumation, and deformation in accretionary orogens is widely studied through geological, experimental, and numerical approaches (e.g., Bonnet et al., 2007; Stockmal et al., 2007). Here, insights from simple sandbox models are used to show how interactions between surface processes and the mechanical behavior of the orogenic wedge influence its structures, deformation kinematics, exhumation mechanisms, and evolution. Case studies (Taiwan, the Alps, and the Variscan belt) characterizing several first-order tectonic processes are discussed in light of the experiments.

ANALOG MODELS

Analog experiments dealing with the growth of thrust wedges have been performed over many years at the Geosciences Montpellier Laboratory, providing insights for the ideas discussed here. Analog experiments present significant advantages. They help

account for tectonic instabilities and provide complementary information on accretion processes and deformation at the scale of discrete tectonic structures. Large-scale convergence can be tested, which is a necessary step when studying the role of subduction in the growth of mountain belts. Experiments can integrate erosion and sedimentation, allowing us to characterize the impact of surface processes on the structure and evolution of accretionary wedges (see part II of supplemental information, GSA data repository [see footnote 1]).

Modes of Accretion

Experiments without erosion (Fig. 1) show the geometry, structure, and kinematics of end-member thrust wedges formed by accretion only. They illustrate two main modes of accretion, depending on boundary conditions and rheology of incoming layers. (1) Frontal accretion: Wedges with a high basal friction are characterized by a high taper angle and by growth through imbrication of long tectonic units bounded by low-angle thrusts. Backthrusts are minor and develop within the body of the wedge. Wedges with a low basal friction are characterized by a low taper angle and by growth through frontal accretion of new tectonic units involving forward propagation of a basal décollement (Lallemand et al., 1994). Because the stress field in the wedge is symmetric (sigma one is close to horizontal; Stockmal, 1983), deformation involves conjugate thrust faults forming pop-up structures. As new thrusts propagate the deformation forward, former thrusts or newly formed thrusts can be activated out of sequence inside the wedge to allow the wedge to maintain an ideal "accretionary" (critical) taper (e.g., Dahlen et al., 1984). (2) Basal accretion (or underplating): Wedges with multiple décollements are complex (Fig. 1C). Two main growth mechanisms act simultaneously in different parts of the wedge: (i) frontal accretion above the upper décollement located within the incoming material, and (ii) deep underplating of thrust slices (basal accretion) at the rear due to duplex formation above a basal lower detachment (Gutscher et al., 1998). The resulting low-angle slope of the frontal part of the wedge reflects the low-friction upper décollement, whereas higher slope angles are a consequence of the higher basal friction that controls domains of underplating.

Experiments with Simulated Erosion and Sedimentation

Erosion and sedimentation involve material transfer, which modifies wedge dynamics (supplemental information, part II [see footnote 1]). Two models, based on accretion of a homogeneous material sequence, illustrate the direct effect of erosion

¹GSA supplemental data item 2010039, additional information on geological background and modeling method, is available at www.geosociety.org/pubs/ft2010.htm; copies can also be obtained by e-mail to GSAToday@geosociety.org.

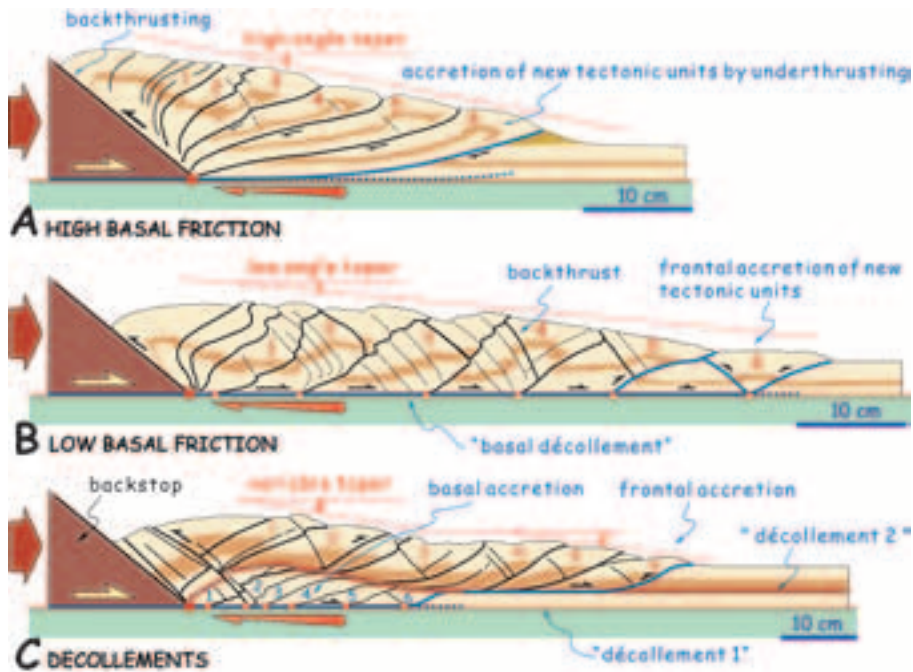


Figure 1. Models without erosion showing the main mechanisms of wedge growth and corresponding critical taper. (A) High basal friction model. (B) Low friction. (C) Multiple décollements.

on structure and material transfer (Figs. 2A and 2B); these can then be compared to similar experiments without erosion. The diversity of exhumation patterns is controlled by the mode of fault propagation, which is influenced by basal friction (high or low). For an equivalent amount of shortening, the vertical component of exhumation is higher for wedges with high basal friction. Uplift of material occurs along subvertical thrusts in the middle of low-friction wedges, versus on inclined (20–50°) thrusts in the rear of high-friction wedges. The vertical exhumation rate increases with time, and the material accreted later is rapidly transferred to the main exhumation zone, compared to the material accreted earlier.

“Décollement”-type models are designed with a low-friction layer of glass microbeads within the incoming sand layer and a high-friction basal detachment (Konstantinovskaia and Malavieille, 2005). The material below the weak layer is underplated under the rear part of the wedge, while above the décollement, the wedge front deforms by frontal accretion. From the frontal part of the wedge to the backstop, respectively, we have (Fig. 2C) (1) a frontal imbricate of thrust sheets; (2) a synformal stack of thrust units (resting above the décollement) previously accreted to the front and progressively deformed; and (3) an antiformal stack of underplated thrust units that refold the upper décollement surface. During continuous shortening, the kinematics of deformation reflects the interaction between wedge mechanics and erosion. Basal accretion and erosion favor the growth of an antiformal stack in the rear of the wedge. Uplift and subsequent exhumation of the underplated units occur along low-angle thrusts that progressively steepen due to subvertical shearing at the back of the wedge. An upper thrust wedge develops above the décollement, leading to progressive frontal imbrication of thrust sheets. When incorporated into the wedge, the thrust units are steepened to near vertical due to continued shortening and surface erosion. The former thrust units of the upper wedge are preserved, between the rear antiformal stack and the frontal imbricate, within a synformal “klippe.” Frontal and

basal accretion are interdependent. During the final stages of shortening, high-angle backthrusts can develop at the rear of the wedge, favoring the upward transfer and exhumation of accreted basal units.

CASE STUDIES

Here we focus on three mountain belts, each chosen to highlight specific processes revealed by analog models. The Taiwan case shows well the strong partitioning of active deformation that develops during rapid convergence. The Western Alps illustrate the impact of Mesozoic extensional structural heritage and the role of sedimentation in the foreland. The Variscan Montagne Noire shows how normal and thrust faults can be linked kinematically.

Taiwan

Taiwan is a good place to study mountain building during the transition from oceanic to continental subduction. The obliquity of plate convergence involves the progressive subduction of the continental margin of China, inducing the fast growth of the mountains (Suppe, 1981). Due to the high convergence rate (~8 cm/yr) of the Eurasian and Philippine Sea plates, deformation and erosion rates are extreme (horizontal shortening >2 cm/yr on seismogenic faults, with vertical motions up to 3 cm/yr). Catastrophic erosion involving landslides induced by typhoons and earthquakes have sculpted in a few million years the sharp relief of the island. Today, most of the shortening is accounted for by a few major faults on the western foreland side of the wedge and along its backside hinterland against the Philippine Sea upper-plate (Fig. 3). Middle-term shortening estimates show that ~4 cm/yr is absorbed across the frontal faults (Simoès and Avouac, 2006), whereas, on the backside, ~3 cm/yr of shortening occurs on the Longitudinal Valley faults (Angelier et al., 2000; Shyu, et al., 2006) and ~2 cm/yr offshore within the Philippine Sea plate (Malavieille et al., 2002). Little horizontal shortening occurs within the hinterland, and there is a strong partitioning of deformation. Such a

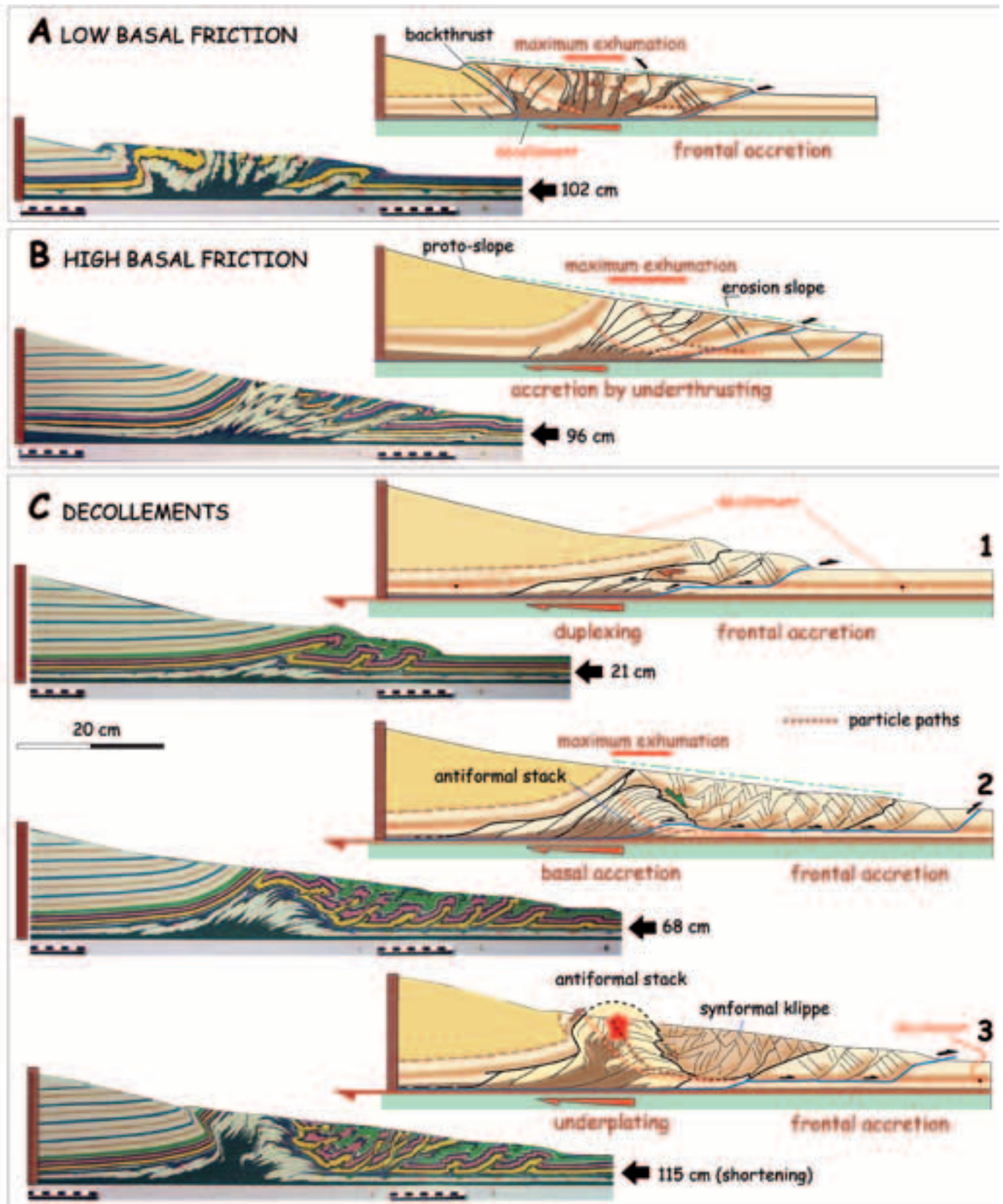


Figure 2. Models with erosion (flux steady state) showing particle paths (dotted lines) and domains of maximum exhumation. (A) Low basal friction model. (B) High friction. (C) Impact of décollements: 1—frontal accretion and basal duplex formation, 2—basal accretion (underplating), and 3—growth of an antiformal stack, wide amplitude folding of former imbricate thrusts (synformal klippe), and backthrusting.

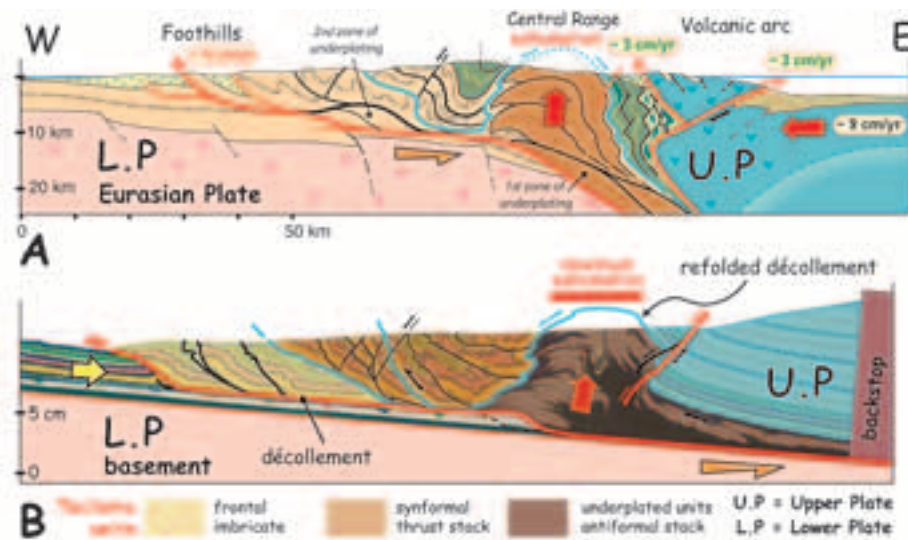


Figure 3. (A) Interpretive geological section of Taiwan orogenic wedge inspired by (B) experiment with décollement and erosion. Medium-term shortening rates on main active faults are indicated.

kinematic pattern closely matches the behavior of experimental erosional wedges with décollements (Fig. 3B). This suggests that the main mechanisms of growth can be described by frontal accretion in the foreland foothills and underplating of tectonic units at depth under the hinterland, involving strong uplift and exhumation. Intracrustal décollements localized within the subducting continental margin of Eurasia favor this style of deformation partitioning and wedge growth. Together with new constraints on the thermal evolution and exhumation of the Central Range (Beyssac et al., 2007), analog models and thermokinematic numerical models (Simoès et al., 2007) involving erosion, in which underplating at depth sustains the growth of the orogenic wedge, account well for the growth of the Taiwan orogenic wedge.

The Alps

Geologic sections across the Swiss Alps (e.g., Escher et al., 1997) reveal the significance of the Mesozoic extensional structural heritage and underscore the importance of surface

processes in the structural evolution of a mountain belt. To characterize deformation mechanisms involving a prestructured continental margin, a series of experimental models were designed (Bonnet et al., 2007) using data from a restored section across the western Alps proposed by Burkhard and Sommaruga (1998). The aim was to (1) better understand the impact of erosion and sedimentation on the tectonic structure and evolution of the Alpine wedge, and (2) analyze the role played by structural heritage. The first model is run without erosion (Fig. 4A) and the second with erosion and sedimentation (Fig. 4B). Without erosion, a high-friction wedge develops. In response to shortening, basement imbricates overthrust each other using inherited weaknesses. The unstructured part of the basement is then accreted. With simulated erosion and sedimentation, frontal accretion occurs in the foreland, and basal accretion and subsequent underplating occur in the hinterland. The combined effect of tectonics, erosion, and sedimentation focuses exhumation in the domain of underplating. Subsequent uplift isolates a synformal klippen nappe composed of

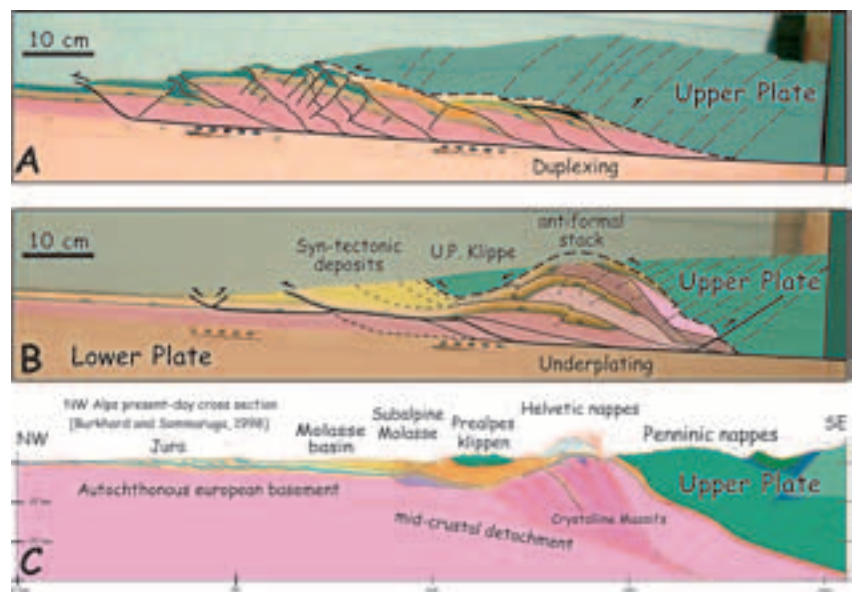


Figure 4. (A) Model simulating impact of structural heritage of a continental margin without erosion to be compared to (B), the same model with erosion and syntectonic sedimentation applied to the Alps (Bonnet et al., 2007), and (C), geologic section across the Swiss Alps (after Burkhard and Sommaruga, 1998).

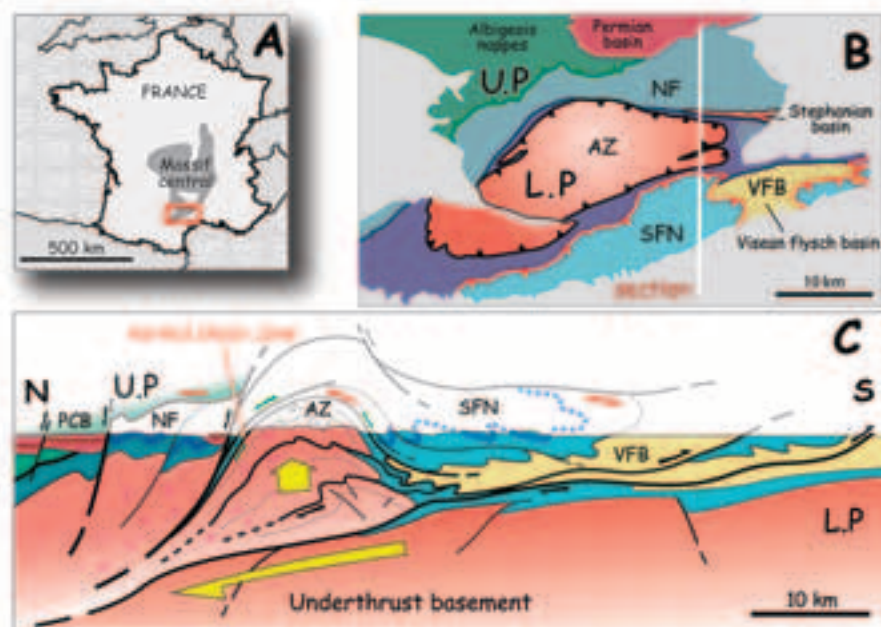


Figure 5. (A) Location of the Montagne Noire. (B) Structural map. (C) Interpretive cross section showing an alternative hypothesis for dome formation and enigmatic normal shear zones and faults observed on its northern flank (NF). The southern recumbent fold nappes (SFN) emplaced on the foreland basin are passively deformed during development of the Axial Zone (AZ) antiformal stack. PCB—Permian and Upper-Carboniferous basins; VFB—Visean Foreland Basin; L.P.—lower plate; U.P.—upper plate.

imbricated thrust units. Frontal accretion therefore leads to cyclic syndeformational removal of a substantial volume of foreland sediments. At the end of shortening, the different units have been largely eroded. The foreland basin and the orogenic lid, including its frontal klippe, come to rest upon syntectonic deposits. Underplated duplexes formed an antiformal stack that localized rapid synconvergence exhumation and that ultimately reached the surface, appearing as a tectonic window.

Models suggest that for natural orogenic wedges, when convergence can no longer be mechanically accommodated by subduction of lower-plate basement units at depth, deformation is taken up by underplating. This mechanism allows the tectonic units detached from the subducting lower plate to be accreted to the upper plate, contributing to wedge growth. It requires intracrustal décollement zones, the location of which are controlled by the kinematics of subduction, the thermomechanical conditions in the wedge, the structural heritage, and by erosion. In the experiments, the structural heritage of the lower plate (weak levels of glass beads) defines the size of thrust units and favors the initiation of underplating. The process continues spontaneously in the homogeneous part of the basement due to burial and increasing stress with depth. Thus, underplating develops through different structural levels in a thrust wedge and can simultaneously or successively affect different parts of the subducted crust.

Models that combine erosion and sedimentation show that if the erosion/sedimentation budget is not balanced, in the sense that more material is removed from the system than is deposited in the foreland basin (i.e., output is greater than input), an important record of the tectonic history of the orogenic wedge will be missing. This is the case in the Alpine foreland basin, where more than half of the sediments have been carried out of the system by large rivers into neighboring sinks (Kuhle-mann et al., 2002). In addition, as parts of the foreland basin are incorporated into the orogenic prism, and then cannibalized by erosion, section balancing may lead to a significant underestimation of global shortening.

Variscan Montagne Noire

The Variscan orogen developed during the Gondwana-Laurasia collision, with progressive migration of crustal thickening to external parts of the belt from Devonian to middle Carboniferous times accompanied by Barrovian-type metamorphism and progressive southward thrusting (Matte, 2007). The Montagne Noire forms the southernmost part of the Variscan French Massif Central (Figs. 5A and 5B). The area is divisible into three tectonostratigraphic units from the internal hinterland domains to the foreland, respectively: (1) the Northern Flank upper-plate with a southward tectonic vergence, consisting of low-grade lower Paleozoic folded and faulted metasedimentary units; (2) the Axial Zone lower-plate, which is a high-grade metamorphic antiform of gneiss, migmatite, and micaschist of Proterozoic to Ordovician age; and (3) the kilometer-scale recumbent fold nappes of the Southern Slope (upper-plate) composed of low-grade Paleozoic sequences. Foreland basin Visean flysch sediments include synorogenic olistolites and are deformed, forming south-verging nappes. The upper-plate nappes are separated from high-grade lower-plate basement units by major fault zones that record a complex pattern of deformation (Aerden and Malavielle, 1999). The steep north-dipping fault zone bounding the Axial Zone–Northern Flank tectonic units is characterized by polyphase deformation, including late normal-sense shearing. Upper Carboniferous molasse-type sediments are exposed in a narrow strip north of this boundary. Two end-member models have been proposed to explain these relationships. The first is that the development of normal shear zones and intermontane basins was caused by late-orogenic extension (Echtler and Malavielle, 1990) involving the growth of a metamorphic core complex (Van den Driessche and Brun, 1992), the Axial Zone. The second postulate is that all large-scale structures were acquired in a compressional setting (e.g., Matte, 2007). However, neither of these end-member models takes into account the fundamental role of erosion. Experiments that involve erosion point to an alternative model (Fig. 5C) that combines simultaneous uplift

(induced by local underplating of basement units) and erosion during convergence. This synconvergence mechanism accounts well for the geometry of tectonic units, fault kinematics (development of normal sense shear zones), and metamorphic relationships between the high-grade core zone and the surrounding low-grade fold nappes. Other mountain belts, such as the Alps (Mosar, 1999), the Himalaya (Bollinger et al., 2004), the Variscan belt of NW Spain (Pérez-Estaún et al., 1991), Oman (Michard et al., 1994), New Caledonia (Lagabrielle and Chauvet, 2008), and Alpine Corsica (Molli et al., 2006), where exhumed antiformal metamorphic domes bound by normal sense fault zones are exposed and where underplating is suspected, need to be revisited in light of the general mechanisms outlined here (see supplemental data Fig. B [see footnote 1]).

CONCLUSIONS

Our experiments show that thrust wedges behave in a complex manner, even for simple settings and model materials. Internal deformation mechanisms and faulting control the shape, topography, taper variability, and structural evolution of the wedge. Models show that two main modes of accretion characterize wedge growth: frontal accretion and basal accretion (underplating). Erosion and sedimentation control material transfer from the surface and directly influence the internal dynamics of wedges. Surface erosion allows long-term localization of domains of basal accretion, promoting the development of large basement nappes, favoring rapid exhumation of deep rocks, and, when combined with sedimentation in the foreland, can contribute to maintain a wedge in a steady-state for long periods of time.

ACKNOWLEDGMENTS

Thanks to the “sandbox colleagues and students” who shared my passion and greatly improved my knowledge of mountain belts during more than 25 years of analog modeling and field studies: S. Lallemand, S. Dominguez, E. Konstantinovskaya, M-A. Gutscher, C. Larroque, C-Y. Lu, K-J. Chang, A. Taboada, P. Tapponnier, A. Chemenda, M. Jolivet, S. Calassou, C. Bonnet, F. Graveleau, N. Kukowski, J. Mosar, C. Romano, and many others. I dedicate this paper to M. Mattauer, who died in April 2009, who communicated to me his enthusiasm for studying mountain belts. I thank editor S. Johnston and two reviewers, P. Cobbold and particularly G. Stockmal, for constructive comments. As mountain-building has been an area of extensive research for many years, the amount of literature in this field has been overwhelming; I apologize for not being able to cite all the relevant publications.

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Manuscript received 16 March 2009; accepted 21 September 2009. ○

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2009 GSA Annual Meeting & Exposition Wrap-Up

18-21 October 2009, Portland, Oregon, USA

Nearly 6,500 attendees from over 50 countries came to this year's annual meeting in Portland. Technical session rooms and poster sessions were full of enthusiastic geoscientists taking in the world-class research presented during this four-day meeting. More than 850 people engaged in our diverse array of field trips, and 438 people attended short courses.

Attendees enjoyed "Cruising the Geoscience Highway" in the Exhibit Hall, visiting over 230 exhibit booths as well as the 67 schools in the Graduate School Information Forum.

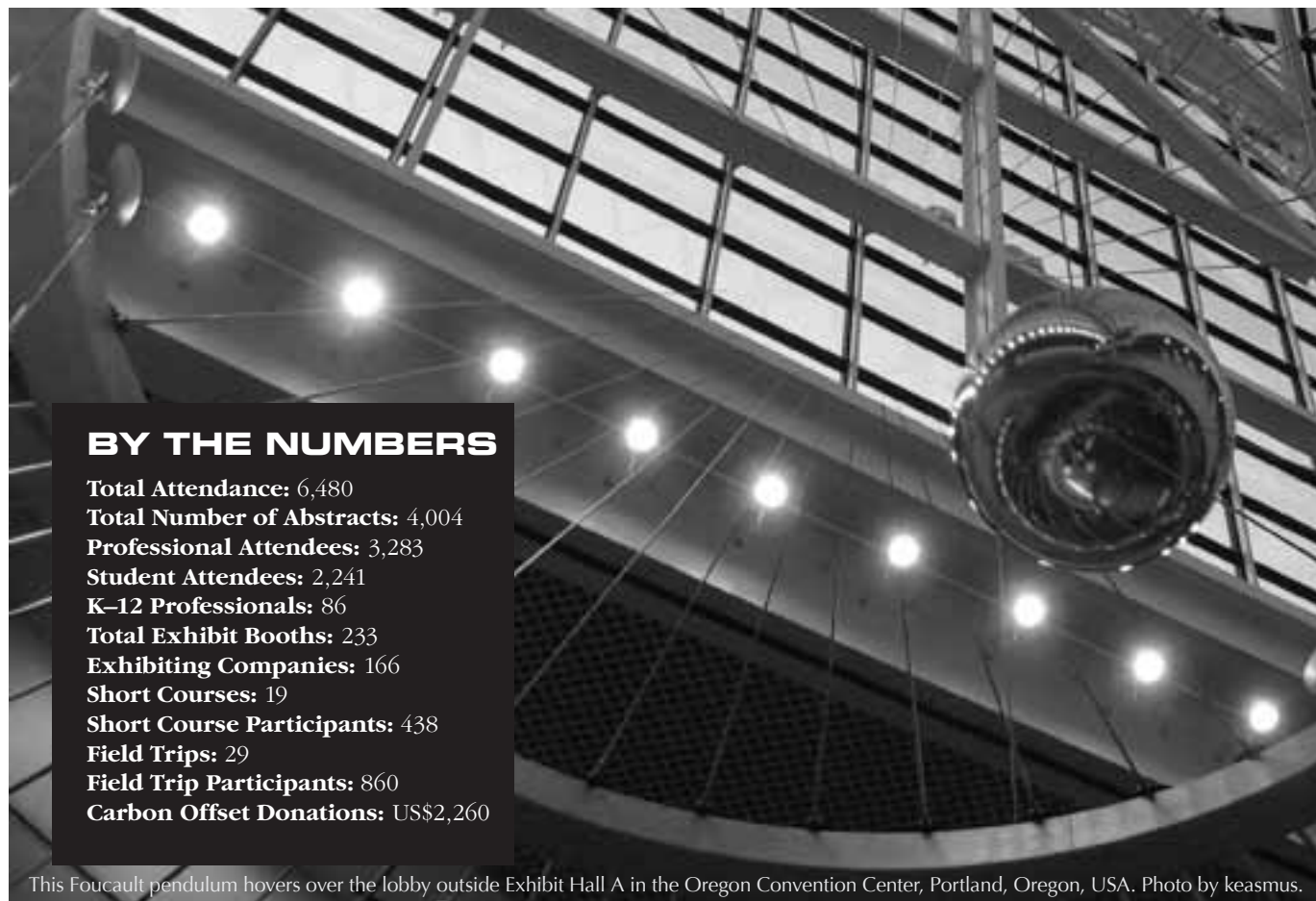
As always, a special emphasis of the meeting was recognizing excellence. Citations and responses for the 2009 GSA Awards & Medals and the 2009 GSA Division named awards are online at www.geosociety.org/awards/.

Social/Web media had a strong presence at the meeting, with 19 registered science bloggers and 17 tweeps (people using Twitter) adding their names to our dynamic blog and twitter rolls. The meeting generated more than 430 tweets under search topic #GeoPort, and the 50 meeting-related blogs are compiled at www.geosociety.org/meetings/2009/blogNews.htm.

The more traditional media were also at the meeting, with 25 science writers on-site. Science press included representatives from *Nature*, *Science News*, *Earth Magazine*, *Cosmos*, *Scientific American*, and *National Geographic News*. Several talks were also covered by local and regional news stations, and dozens of

presentations received widespread coverage. Topics reported included planetary geoscience, hydrogeology, climate change, environmental geology, geology and health, geomorphology, paleontology, geoarchaeology, and geochemistry.

Thanks to the 2009 Annual Meeting Sponsors for their continued support of this event (details on facing page), and thanks especially to Vicki McConnell, Dick Berg, and the entire Annual Meeting Organizing Committee, along with the Joint Technical Program Committee, for putting together a fantastic meeting.



BY THE NUMBERS

Total Attendance: 6,480
Total Number of Abstracts: 4,004
Professional Attendees: 3,283
Student Attendees: 2,241
K-12 Professionals: 86
Total Exhibit Booths: 233
Exhibiting Companies: 166
Short Courses: 19
Short Course Participants: 438
Field Trips: 29
Field Trip Participants: 860
Carbon Offset Donations: US\$2,260

This Foucault pendulum hovers over the lobby outside Exhibit Hall A in the Oregon Convention Center, Portland, Oregon, USA. Photo by keasmus.

2009 GSA Annual Meeting Presidential Address

O brave new world: Geoscientists in an emerging green economy

Jean M. Bahr, Dept. of Geoscience, University of Wisconsin, 1215 W. Dayton Street, Madison, Wisconsin 53706-1692, USA; jmbahr@geology.wisc.edu

The phrase “O brave new world” hearkens back to Shakespeare’s romantic comedy “The Tempest,” written almost 400 years ago. In that play, the maiden, Miranda, has been raised on a remote island with only her aging father, Prospero, and the deformed slave, Caliban, for company. A shipwreck brings the King of Naples, his son, Ferdinand, and others in their party to the island. When confronted with these newcomers in the final act of the play, Miranda exclaims with genuine, albeit somewhat naïve, delight “O wonder! How many goodly creatures are there here! How beauteous mankind is! O brave new world, that has such people in’t!” Some 300 years later, Aldous Huxley appropriated Miranda’s line as the title of a novel; however, in contrast to the delightful new world envisioned by Shakespeare’s character, Huxley’s brave new world was a dystopian nightmare of society and technology run amok. Which of these senses of the phrase should apply to an emerging green economy?

We all recall the nightmare of the market crash in the fall of 2008, followed by a financial crisis that we are still facing in the fall of 2009. On the heels of the crash, the United Nations Environment Programme (UNEP, 2008a) launched a “Green Economy Initiative” to communicate global plans for a green industrial revolution (UNEP, 2008a). In describing the motivations for this initiative, UNEP noted that “[a] crisis is a terrible thing to waste.”

In the United States, President Barack Obama made greening of the economy a priority during his campaign. He has remained committed to that goal through support of green job training provisions in the American Recovery and Reinvestment Act and in his stated plans to invest US\$150 billion over the next ten years for energy research and a transition to a clean energy economy (www.whitehouse.gov, 2009).

President Obama is not the only world leader who has been advocating this type of transition. Based on environmental concerns, UK Prime Minister Gordon Brown was a strong proponent of greening measures prior to the economic crisis, and he now also sees “building a greener Britain” as a route to economic recovery (BBC News, 8 Apr. 2009). Like

Britain, Spain sees green technology as a solution to unemployment and a path toward future prosperity (Faiola, 2009). And even in countries like Australia that have fared better than others in the current economic climate there are calls for greening of jobs not only from environmental groups but also from Australian Council of Trade Unions President Sharan Burrow (Xinhua, 2009).



Jean M. Bahr

The emerging green economy pre-dates the current economic crisis. For example, a Canadian Broadcasting Company (CBC) News special report from March of 2008 (Kelly, 2008) noted that green technologies have become hot commodities for investors in light of anticipated cuts in carbon emissions. Germany has been slowly but steadily going green “by design” for the last two decades, with the government working in tandem with industry to create markets and businesses that profit from higher environmental standards (Theil, 2008). Numerous books (e.g., Milani, 2000; Danaher et al., 2007) as well as a document titled “Moving towards a green economy,” issued by the Canadian government (Dept. of Finance Canada, 2005) in conjunction with release of its 2005 budget plan, provide additional evidence of the build-

ing interest in a green economy over the last decade. Groups exploring ways to build green jobs and businesses for sustainable development are also active in the emerging economic giants India (<http://www.greeneconomyindia.com/>) and China (<http://www.efg2009.org/>).

In March of 2009, the United Nations (UN) Green Economy Initiative formed a global task force with the goal of developing a variety of practical projects and policy proposals. As part of this overall initiative, the UN generated reports on a “Global Green New Deal” (UNEP, 2009) and on green jobs (UNEP, 2008b). As might be expected, there has not been universal enthusiasm for going green. In fact, some see these developments as a move toward a “brave new world” closer to Huxley’s vision than to Shakespeare’s, suggesting that green initiatives will kill jobs and the economy overall.

Examining the UN report on green jobs (UNEP, 2008b) may shed some light on some of the sources of apprehension. First of all, the report defines green jobs as “work that contributes to preserving or restoring the quality of the environment.” To me, that sounds like a good fit for many geoscientists. Our research to elucidate the history and workings of our planet contributes directly and indirectly to improved understanding of the processes that shape the environment. Thus, I see geoscience as

an essential foundation for preserving and restoring environmental quality.

The UN report anticipates four effects on employment during a transition to a green economy: (1) additional jobs will be created; (2) some employment will be substituted; (3) certain jobs will be eliminated without direct replacement; and (4) existing jobs will be transformed and redefined. Creation of new jobs is certainly a good thing, but jobs that might be eliminated without direct replacement is a cause for concern.

The discussion within the green jobs document that is most likely a source for apprehension among geoscientists is the following paragraph: “As the move towards a low-carbon and more sustainable economy gathers momentum, growing numbers of green jobs will be created. Although winners are likely to far outnumber losers, some workers may be hurt in the economic restructuring toward sustainability. Companies and regions that become leaders in green innovation, design and technology development are more likely to retain and create new green jobs. But workers and communities dependent on mining, fossil fuels and smokestack industries—or on companies that are slow to rise to the environmental challenge—will confront a substantial challenge to diversify their economies” (p. 4).

As an aside, it is heartening to note that a number of large geoscience employers are already rising to the environmental challenge, as evidenced by strong rankings of several energy and geotechnical firms in a 2009 *Newsweek* assessment of green practices in major U.S. companies.

But more to the point, where do geoscientists fit into a green jobs future? The American Geological Institute’s (AGI) recent report on the “Status of the Geoscience Workforce” (AGI, 2009) gives us a picture of current employment trends. It is probably no surprise that the AGI data show the vast majority of recent Ph.D.’s finding positions in academic institutions (67%) or government research (14%). That employment mix is likely to remain stable in the transition to a green economy. In fact, the job picture for geoscientists in research and teaching positions should strengthen if the current trends toward increase federal investments in science and education are sustained.

At the M.S. level, the AGI data indicate that jobs in the environmental sector already account for ~20% of recent grads, and those opportunities are likely to be enhanced in a green economy. For example, an article published in *Science* (Coontz, 2008) highlights the strong career opportunities in hydrogeology. A more recent *New York Times* article (Zimmerman, 2009), which cited an employment forecast from the Bureau of Labor Statistics, ran with the headline “Hiring in Hydrology Resists the Slump.”

Publications produced as part of the Year of Planet Earth (IYPE; <http://yearofplanetearth.org/content/downloads.html>), of which GSA is a sponsor, highlight other environmental geoscience opportunities related to natural hazards, sustainable resource development and management, and human health. The 2009 GSA Annual Meeting program showcased many of the exciting scientific developments in environmental geoscience, as well advances in applying those developments to societal needs. As it celebrated its 50th anniversary, GSA’s Hydrogeology Division sponsored more than 40 technical sessions. The Tuesday “Lunchtime Keynote” lecture by Lucy Jones described a unique experiment in geohazard communication that took

place in California in 2008 as well as just a week before the meeting. The Pardee Symposium “Hazards and Health” brought together geoscientists, health professionals, and emergency managers.

The AGI workforce data also indicate that 21% of recent M.S. grads have found employment in the petroleum industry. This is one of the employment sectors that the UN report suggested might be a loser in the transition to the green economy. But I think that is not necessarily the case. Projections of world fuel use through 2030 are available from the most recent assessment by the U.S. Energy Information Administration (Fig. 2 in EIA, 2009). While these projections are based on a reference scenario in which there are no substantial changes to current laws and policies, they do nevertheless forecast a significant increase in the use of renewables. However, fossil fuel use also continues to increase—particularly coal and natural gas. (The liquid petroleum picture is complicated by the fact that the EIA projections lump biofuels with oil.) How much will this picture change over the next 20 years in a transition to a green economy?

As one indication, we can consider the analyses that were undertaken by the Intergovernmental Panel on Climate Change (IPCC) working group on mitigation (IPCC, 2007). The IPCC developed two realistic upper- and lower-bound scenarios for which they estimated how greenhouse gas emissions in the electricity sector would change as a result of switching sources of energy, implementing carbon capture and storage, and increasing efficiency. While the more optimistic scenario projects greenhouse gas emissions stabilizing at nearly 2004 levels by 2030 (Fig. 4.29b in IPCC, 2007), renewables and nuclear still constitute only a relatively modest percentage of the total energy mix. Projections of potential changes in the transportation sector (Fig. 4.30 in IPCC, 2007) also show fossil fuels continuing to dominate in 2030. The bottom line is that even with aggressive moves to convert to green energy over the next two decades, fossil fuels are likely to continue to play a significant role in the global energy mix. As Scott Tinker emphasized in a number of talks and briefings during his term as American Association of Petroleum Geologists (AAPG) president last year (e.g., Tinker, 2008), fossil fuels will be an important bridge to any alternative energy future.

Coupled with a likely need for continued oil and gas exploration and production are the rather skewed current age demographics of geoscience employees in that industry. The AGI workforce report (AGI, 2009) includes a figure showing a large peak of petroleum industry employees who may be approaching retirement in the coming decade. Thus, while new employment in oil and gas may not grow as much as environmental employment in a green economy, I do not expect it to be a big loser either.

In fact, geoscientists with training relevant to the petroleum industry might see growth in employment if geologic carbon storage becomes a major greenhouse gas mitigation strategy in the green economy. Skills and technologies for petroleum exploration and development, ranging from basin-scale seismic imaging to analysis of pore scale features, are important to the evaluation of sequestration targets. Successful large-scale sequestration also requires improved understanding of a variety of geochemical and geomechanical processes. Carbon

sequestration (both in subsurface formations and through other processes at or near Earth's surface) was a prominent theme at the 2009 GSA Annual Meeting, with more than 70 technical program abstracts and two lunchtime keynote talks, one on Sunday by the Geology and Society Division's Distinguished Lecturer, Patricia Woertz, CEO of Archer Daniels Midland, and one on Monday by the Halbouty Lecturer, Sally Benson, professor of Energy Resources Engineering at Stanford.

The other potential geoscience employment sector loser noted by the UN report is mining. Similar to the petroleum industry, data from the AGI workforce report indicate that mining has rather unfavorable age demographics. While recycling and improved processing may reduce some demand for new raw materials, a shift to clean energy technologies could actually increase the demand for rarer minerals, prompting new opportunities for geoscientists involved in mineral exploration as well as in development of strategies for more environmentally benign resource extraction and reclamation.

Expanding opportunities for geoscientists are expected in a green economy for development of low carbon energy sources, such as geothermal. If expanded use of nuclear power is part of the clean energy mix, geoscientists will also find expanding opportunities related to safe siting of reactors and safe management of radioactive waste.

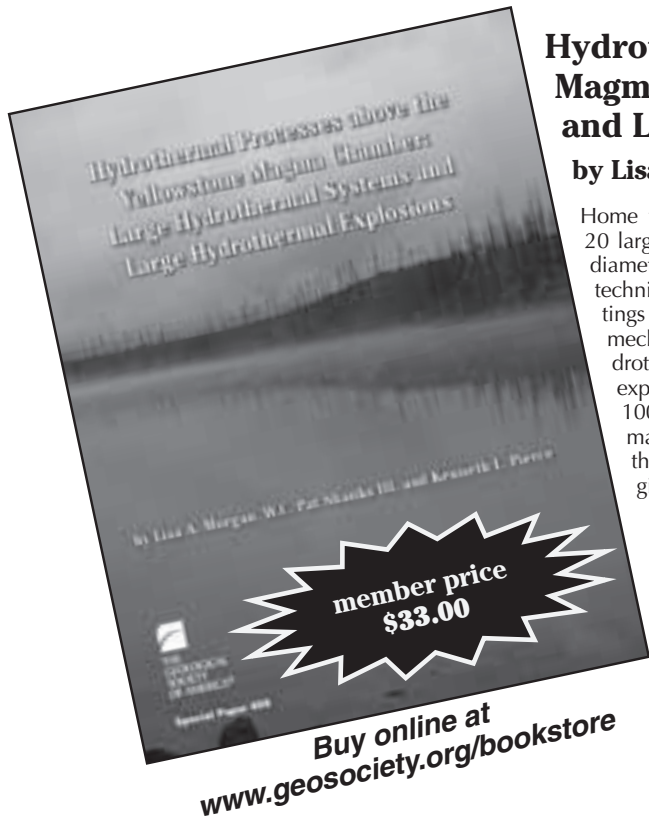
As noted in a feature article in a recent issue of *Earth* magazine (Wayman, 2009), water and energy are inextricably linked. Geoscientists are likely to play important roles in the assessment of water-energy issues related to biofuels and to energy technologies that require water for cooling.

Overall, I believe that geoscientists will be among the winners in the job market of an emerging green economy. However, we must address a number of challenges to make this a smooth transition. We must continue to educate the public and decision makers about the importance of geoscience to society. GSA's Geology and Society Division, its position statements developed through the Geology and Public Policy Committee, and the facilitation of interactions between GSA members and government decision makers through our Washington office all contribute to meeting that challenge. We must be creative in identifying new applications of our science to emerging energy technologies and strategies to maintain a habitable planet. And those of us in academia must carefully consider how best to train the next generation of geoscientists to adapt to a changing job market. I believe this will require depth in "traditional" areas of geoscience related to Earth and planetary systems processes, from the deep interior to the shallow crust at Earth's surface, and the history and complex evolution of the physical Earth, its climate, and the life it supports. At the same time, the next generation of geoscientists will need increasing breadth and interdisciplinary training to interact effectively with colleagues from other fields, including material science, various engineering specialties, and biological sciences such as microbiology, ecology, and evolutionary biology, as well as with social scientists.

If we are able to meet these challenges, then I am confident that a future Miranda, finding herself suddenly facing a group of twenty-first-century geoscientists, will exclaim without irony, "O wonder! How many goodly creatures are there here! O brave new world, that has such [geoscientists] in't!"

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Hydrothermal Processes above the Yellowstone Magma Chamber: Large Hydrothermal Systems and Large Hydrothermal Explosions

by Lisa A. Morgan, W.C. Pat Shanks III, and Kenneth L. Pierce

Home to more than 10,000 thermal features, Yellowstone has experienced over 20 large hydrothermal explosions producing craters from 100 to >2500 meters in diameter during the past 16,000 years. Using new mapping, sampling, and analysis techniques, this volume documents a broad spectrum of ages and geologic settings for these events and considers additional processes and alternative triggering mechanisms that have not been explored in previous studies. Although large hydrothermal explosions are rare on the human time scale, the potential for future explosions in Yellowstone is not insignificant, and events large enough to create a 100-m-wide crater might be expected every 200 years. This work presents information useful for determining the timing, distribution, and possible causes of these events in Yellowstone, which will aid in the planning of monitoring strategies and the anticipation of hydrothermal explosions.

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GSA ELECTIONS

GSA's success depends on its members and the work of the officers serving on GSA's Executive Committee and Council. In late February, you will receive a postcard with instructions for accessing your electronic ballot via our secure Web site, and biographical information on the

nominees will be online for you to review at that time. Paper versions of both the ballot and candidate information will also be available. Please help continue to shape GSA's future by voting on the nominees listed here.

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Fifty-four positions are open again this year, to be filled on a first-come, first-served basis. Volunteers will receive a sign-up packet with scout applications (you have to be a scout, at least for the summer!), medical forms, and brochures in May 2010. Students who would like to volunteer must show proof of enrollment in a graduate-level program.

The 2010 season begins on Sunday, 13 June; 8 August begins the last week of the program.

For more information and to sign up, contact Ed Warner, P.O. Box 480046, Denver, CO 80248-0046, USA, +1-720-904-0560, ewarn@ix.netcom.com. Alternate contact: Bob Horning, P.O. Box 460, Tesuque, NM 87575, USA, +1-505-820-9290, rhorning@grappawireless.com.

Learn more about the geology of the area at http://pubs.usgs.gov/pp/pp_505/html/pdf.html.

New GSA Division! Mineralogy, Petrology, Volcanology, and Geochemistry (MPVG)

Jim Beard, MPVG Division Chair

On 21 Oct. 2009, GSA Council approved the organization of a new Division for Mineralogy, Petrology, Volcanology, and Geochemistry (MPVG). The Division will serve to promote these disciplines by sponsoring meeting theme sessions, conferences, and symposia (working closely with interested GSA Associated Societies) and serving as the voice of mineralogy, geochemistry, volcanology, and petrology within GSA.

The Division differs slightly in makeup from other GSA Divisions in that Associated Societies are represented in the Division's governance. To date, the Division is formally working with the Geochemical Society (GS) and the Mineralogical Society of America (MSA), and additional invitations for other societies are planned. We look forward to working closely with the Associated Societies and are certain that this new arrangement will benefit everyone involved, especially each discipline.

We have set the ambitious goal of organizing or cosponsoring (with the Associated Societies) at least 20 theme sessions for the 2010 GSA Annual Meeting & Exposition in Denver, Colorado, USA. Russ Harmon, second vice-chair, will be coordinating this effort. Please let Russ know if you are interested in organizing a special theme session in one of the Division disciplines or, better yet, a multidisciplinary session. Remember that the GSA deadline for submitting a 50-word theme session proposal is 12 January (at www.geosociety.org/meetings/2010/).

We have received overwhelming support from the community for this effort. Please help us continue our strong start by joining the Division and by volunteering. Dues are US\$10 for professionals and US\$5 for students.

A provisional Division Management Board of Division Officers and Associated Society representatives has been set up and will be organizing formal elections:

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JOINT MEETING

45th Annual Meeting of the Northeastern
Section, GSA

59th Annual Meeting of the Southeastern
Section, GSA

Baltimore, Maryland, USA

13–16 March 2010



*Linking North and South: Exploring
the Connections between Continent and Sea*

www.geosociety.org/sectdiv/northe/2010mtg/

Meeting Co-Chairs: Chuck Bailey, cmbail@wm.edu;
Noel Potter, pottern@dickinson.edu

Technical Program Co-Chairs: Katie Farnsworth,
katie.farnsworth@iup.edu; Wright Horton, whorton@usgs.gov

Location: Sheraton Baltimore City Center Hotel

REGISTRATION

Early registration deadline: 8 February 2010

Cancellation deadline: 16 February 2010

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

	Early		Standard	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	\$160	\$110	\$190	\$130
Professional Member 70+	\$90	\$70	\$120	\$90
Professional Nonmember	\$180	\$130	\$210	\$160
Student Member	\$55	\$45	\$75	\$65
Student Nonmember	\$65	\$55	\$85	\$75
K–12 Professional	\$65	\$50	\$75	\$60
Guest or Spouse	\$40	\$30	\$40	\$30
Field Trip or Workshop Only	\$30	\$30	\$30	\$30

ACCOMMODATIONS

Hotel registration deadline: 20 February 2010

Sheraton Baltimore City Center Hotel: 101 West Fayette
Street, Baltimore, MD 21201, USA; +1-866-837-5182; request a
reservation under “Geological Society of America.”

Rates: US\$139 single or double; US\$159 triple; US\$179 quad
(per night, plus tax).

Requests for special accommodations should be made by
16 February.

TECHNICAL PROGRAM

Symposia

1. It All Starts In the Field: In Honor of
Wallace A. Bothner.
2. The New Bedrock Geologic Map of Vermont: New
Answers, New Problems, and New Uses of Bedrock
Geologic Data.
3. Asbestos: Past, Present, and Future.

Theme Sessions

1. The Iapetan Rifted Margin and Rift History of Eastern
Laurentia.
2. Laurentian-Gondwanan Interactions in the Paleozoic.
3. Tectonic Significance of Buried Terranes of the Atlantic
and Gulf Coastal Plains.
4. Strike-Slip and Transpressional Tectonics in the
Appalachians and Beyond.
5. Vorticity and Strain in Shear Zones.
6. Geologic Maps, Geophysical Maps, and Derivatives from
Geologic and Geophysical Maps (Posters).

7. Landscape Evolution in the Appalachians: Rates, Dates, and Models.
8. Recent Advances in Understanding the Geomorphology and Quaternary History of the Appalachian Region and Adjacent Regions.
9. Evolution of the Atlantic and Gulf Coasts from Rift Margin to Passive Margin.
10. The Integration of Marine and Non-Marine Subsurface Sediments to the Interpretation of the Stratigraphic Record of the Atlantic Coastal Plain.
11. Stratigraphy, Correlation, Depositional Environments, and Paleontology of Pliocene to Pleistocene MIS 5 Deposits of the Atlantic Coastal Plain.
12. The Impact of Climate Change on Barrier Island–Backbarrier Systems.
13. Measuring and Modeling Coastal Morphodynamics: Beaches and Shelves.
14. Coastal and Nearshore Processes Affecting Our National Parks.
15. Estuarine Sediment Dynamics.
16. Connecting Continent and Sea: Paleocologic Studies of the Eastern North American Continental Margin from Coastal Plain to Abyss.
17. Insights from Microfossils: From Geoarchaeology and Pollution Remediation to Climate and Sea-Level Change.
18. Eastern Ichnology: Advances in Paleoenvironmental Applications of Trace Fossils.
19. Geologic and Paleoenvironmental History of the Chesapeake Bay.
20. Energy Resources in the Eastern United States and Associated Environmental Effects.
21. Case Histories in Engineering Geology, Eastern United States.
22. Selenium as an Essential Micronutrient: Geologic and Geographic Sources and Efficacy.
23. Mercury in the Environment: From Maine to Florida.
24. Hydrogeology of Wetlands and Watershed Processes.
25. Cave and Karst Deposits in the Eastern United States: Archives of Paleoclimates and Paleoenvironments.
26. Interaction between Shallow and Deep Karst: Geologic, Hydrologic, Geochemical, and Biologic Indicators.
27. Ancient and Modern Carbonates of Eastern North America.
28. Faculty and Student Perspectives on Undergraduate Research: Models, Challenges, and Best Practices.
29. Innovations in Teaching Earth-System Science for the K–12 Classroom.

WORKSHOPS

1. Creating and Using Interactive Geologic Maps and Models in Google Earth.
2. Pursuing an Academic Career: An *On the Cutting Edge Workshop* for Graduate Students and Post-Docs.
3. Building Core Knowledge and Reconstructing Earth History.
4. Analyzing Earth Signals with J-DSP: Real-Time, Deep-Time, and Online.

FIELD TRIPS

Premeeting

1. Geomorphology, Soils, Landscape Evolution, and Land Use in the Virginia Piedmont and Blue Ridge.
2. Geology Trails in Delaware Water Gap National Recreation Area, New Jersey–Pennsylvania.
3. Tectonic Evolution of the Peach Bottom Area, South-Central Pennsylvania.
4. Magmatic Layering and Intrusive Plumbing in the Jurassic Morgantown Sheet, Central Atlantic Magmatic Province.
5. Coastal Processes and Engineering at Assateague Island.

Postmeeting

6. A Traverse of Proterozoic to Paleozoic Laurentia, Virginia Blue Ridge and Valley and Ridge.
7. The Early through Late Pleistocene Record in the Susquehanna River Basin.
8. Stratigraphy of Calvert, Choptank, and St. Marys—Chesapeake Bay Area.

OPPORTUNITIES FOR STUDENTS

Mentor Luncheons: Roy J. Shlemon Mentor Program in Applied Geoscience and The John Mann Mentors in Applied Hydrogeology Program. Please go to www.geosociety.org/mentors/ to learn more.

Student Travel Grants: For eligibility requirements, contact Stephen Pollock (NE Section), pollock@usm.maine.edu or Don Neal (SE Section), neald@ecu.edu, or go to www.geosociety.org/grants/travel.htm. Application deadline: 28 February 2010.



Photos from Baltimore, Maryland, USA. Opposite page: Top: Maryland Science Center. Bottom: Baltimore Harbor. Above: Fort McHenry. Photos courtesy Visit Baltimore.

JOINT MEETING

44th Annual Meeting, North-Central
Section, GSA

44th Annual Meeting, South-Central
Section, GSA

Branson, Missouri, USA

11–13 April 2010



Field trip participants examine megabreccia exposures in the Weaubleau impact structure. Photo by Kevin R. Evans.

Meeting Co-Chairs: Tom Plymate, tomplymate@missouristate.edu; Marcia Schulmeister, mschulme@emporia.edu

Technical Program Chair: Kevin Mickus, kevinmickus@missouristate.edu

Field Trips: Kevin Evans, kevinevans@missouristate.edu; Jim Aber, jaber@emporia.edu

Location: Hilton Convention Center at Branson Landing

REGISTRATION

Early registration deadline: 8 March 2010

Cancellation deadline: 15 March 2010

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

	Early		Standard	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	\$130	\$90	\$160	\$100
Professional Member 70+	\$80	\$60	\$110	\$60
Professional Nonmember	\$160	\$110	\$200	\$120
Student Member	\$45	\$30	\$60	\$40
Student Nonmember	\$60	\$40	\$75	\$50
K–12 Professional	\$40	\$30	\$60	\$40
Guest or Spouse	\$30	\$30	\$40	\$40
Field Trip or Workshop Only	\$30	\$30	\$40	\$40

Note: The South-Central Section will pay registration fees for attendees from the Mexican states of Coahuila, Nuevo León, Tabasco, Tamaulipas, and Veracruz. Please contact Mérida Gutierrez, mgutierrez@missouristate.edu, before you register.

ACCOMMODATIONS

Hotel reservation deadline: 12 March 2010

Hilton Branson Convention Center Hotel: 200 East Main Street, Branson, MO 65616, USA; +1-417-336-5400; toll-free reservation line: +1-866-442-0959 (use group code GSA); learn more at www.geosociety.org/sectdiv/Northc/2010mtg/lodging.htm.

Rates: US\$119 single/double; US\$139 triple/quad (plus tax, per night). Suites are an additional US\$50.

CALL FOR PAPERS

Abstract deadline: 19 January 2010

Abstract submission fee: US\$10

Submit online at www.geosociety.org/sectdiv/Northc/2010mtg/

TECHNICAL PROGRAM

Symposia

1. They Say That “Breaking Up Is Hard to Do”: Geological, Geophysical, and Remote Sensing Investigations of Continental Rifts.
2. Advances in the Chronology, Correlation, and Stratigraphy of Pre-Wisconsinan Glacigenic Sediments.
3. Geological Aspects of the Civil War.
4. Sedimentary Geology of the North American Craton and its Southern Margin.
5. Cultural Geology: Archaeological and Historic Building Stones, Sites, and Materials, Terrain, Terroir, and More.

Theme Sessions

1. Lithospheric Structure of the Mid-Continent Region: What We Know, What We Need to Know, and What EarthScope Can Tell Us.
2. Geological Evolution of the Sierra Madre Oriental, Mexico.
3. Precambrian Geology of the Midcontinent: Celebrating the Career of W.R. Van Schmus.
4. Geology of the Ozark Plateaus.
5. Earth, Moon, Mars, and Beyond: Midcontinental Perspectives on Planetary Geology Problems and Research.
6. Current Conodont Research: A Pander Society Session in Honor of Raymond Ethington, Tom Thompson, and Jim Miller.
7. Ichnofossils: The Marriage of Sedimentology and Ecology.
8. Paleocology: Variation in Fossil Communities through Space and Time.
9. Mid-Continent Paleontology.
10. Pennsylvanian and Permian Cyclothem of Midcontinental North America.

11. Developments in Early Paleozoic Stratigraphy in the U.S. Midcontinent.
12. Environmental Microbiology: Intersections between the Biosphere and the Geosphere.
13. Is Mother Nature out to Get You? Medical Geology Issues in the Mid-Continent.
14. The 2005 Taum Sauk Reservoir Breach: Failure Mechanisms, Flood Effects, Bedrock Exposures, and Current Remediation Efforts.
15. Carbon Sequestration: Research, Deployment, and Commercialization.
16. Water-Rock-CO₂ Interactions during Carbon Sequestering Activities.
17. The Tri-State Mining District, a Decades-Long Project: Progress, Challenges, and Revelations.
18. Devonian and Mississippian Strata of the Midcontinent North America: Sequence Stratigraphy, Paleontology, and Hydrocarbon Potential (Gas Shales, Carbonates, Cherts).
19. Ore Deposits of the Central U.S.: Origin, Mining, and Environmental Remediation.
20. Issues in Geoscience Education.
21. Arts Integration in K–16 Geoscience Education.
22. Teaching Sustainability.
23. Easy-to-Incorporate Inquiry-Based Activities for the K–16 Classroom.
24. Water Resources Sustainability in the Deep Carbonate Aquifers of the Ozark and Midwest Regions: Will We Have Enough?
25. Karst Hydrogeologic Systems of the Central United States and Northern Mexico.
26. Aquifer Management Challenges: Unsustainable, Unbounded, Undefined, or Unregulated.
27. Tracers in the Environment: Tried and True or Something New—Identifying Issues with the Hydrogeologic System.
28. Innovative Approaches to Characterization and Remediation of Contaminated, Unconsolidated Aquifers.
29. Reservoir Science: Sediment and Water-Quality Studies for Effective Management.
30. Speleogenesis, Processes, and Records in Karst Systems.
31. Human Impacts on Fluvial Systems.
32. Urbanization Influences on Stream Geomorphology, Hydrology, and Sediment Transport.
33. Undergraduate Research (Posters).

WORKSHOPS

1. Core Workshop: Surface to Subsurface High-Resolution Sequence Stratigraphy and Reservoir Analysis of Mississippian Strata in the Four-State Area (Missouri, Arkansas, Kansas, Oklahoma).
2. Geology and Human Health: On the Cutting Edge.
3. From Passive to Active: Classroom Makeovers that Improve Teaching and Learning.
4. Online Teaching of Introductory Geoscience Courses.
5. Exploring the Wonders of Geoscience through Use of GSA CD-ROM Teaching Resources.
6. Geoscience Education: Introducing Students to Subsurface Characterization Using Fictional Small County.

FIELD TRIPS

Premeeting

1. High-Resolution Stratigraphy of Upper Devonian and Lower Mississippian Strata of the Ozark Region with Reference to Subsurface Kansas and Oklahoma.
2. Route 66—Geology and Legacy of Mining in the Tri-State District of Missouri, Kansas, and Oklahoma.
3. Civil War and Cultural Geology of Southwestern Missouri, Part 1: The Geology of Wilson's Creek Battlefield and the History of Stone Quarrying.
4. Innovative Storm-water Management Practices.
5. Introduction to Karst Landscape Development—Ozark Underground Laboratory.
6. Civil War and Cultural Geology of Southwestern Missouri, Part 2: Geologic Influences on the Battle of Forsyth, Guerilla Activities, and Post-War Vigilantism.

Postmeeting

7. Geomorphology and Paleontology of Riverbluff Cave, Springfield, Missouri.
8. Rift-Related Volcanism and Karst Geohydrology of the Southern Ozark Dome; Montauk to Big Spring—Geologic Framework of the Upper Current River Region.
9. Geology of Weaubleau and Decaturville Impact Structures, Missouri.
10. Geology of the Taum Sauk Reservoir Scour, Missouri.
11. Geology and Karst Landscapes of Buffalo National River, Northern Arkansas.

OPPORTUNITIES FOR STUDENTS

Mentor Luncheons: Roy J. Shlemon Mentor Program in Applied Geoscience and The John Mann Mentors in Applied Hydrogeology Program. Please go to www.geosociety.org/mentors/ to learn more.

Travel Grants: Please go to www.geosociety.org/grants/travel.htm for application details.

Volunteering: Contact Damon Bassett, +1-417-836-4897, dbassett@missouristate.edu, for information and to arrange complimentary registration in exchange for volunteering at the meeting.

Student Awards: Awards will be given for the best student presentations; students must be lead authors and presenters.



Worm burrows. Photo by Kevin R. Evans.

Second Announcement and Call for Papers

ROCKY MOUNTAIN

62nd Annual Meeting, in association
with the Western South Dakota Hydrology
Water Conference
Rapid City, South Dakota, USA

21–23 April 2010

***From Ancient Rocks to New Knowledge of
the Universe: Exploring the Geologic Diversity
of the Black Hills and Rocky Mountain Region***

www.geosociety.org/sectdiv/Rockymtn/2010mtg/

Location: Rushmore Plaza Civic Center, 444 Mount Rushmore
Road, Rapid City, SD 57701-1197, USA; +1-605-394-4115.

Accommodations: Holiday Inn Rapid City–Rushmore Plaza
Hotel, 505 N. 5th Street, Rapid City, SD 57709, USA; +1-605-348-
4000. The Holiday Inn is located adjacent to the Civic Center.

Host and Contacts: Local Host: Dept. of Geology and Geo-
logical Engineering, South Dakota School of Mines and Tech-
nology, <http://geology.sdsmt.edu>. Meeting co-chairs: Michael
P. Terry, michael.terry@sdsmt.edu; Larry D. Stetler, larry.stetler@sdsmt.edu.

REGISTRATION

Early registration deadline: 22 March 2010

Cancellation deadline: 29 March 2010

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

	Early		Standard	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	\$140	\$75	\$170	\$100
Professional Member 70+	\$75	\$45	\$100	\$65
Professional Nonmember	\$160	\$110	\$190	\$140
Student Member	\$45	\$35	\$65	\$55
Student Nonmember	\$55	\$45	\$75	\$65
K–12 Professional	\$45	\$30	\$55	\$40
Guest or Spouse	\$30	\$15	\$40	\$25

Note: Students and the general public attending only the West-
ern South Dakota Hydrology Conference Session (WSDHCS)
on Thurs., 22 Apr., are not required to pay the registration fee
but must obtain a badge. Professionals attending only the
WSDHCS are required to pay the one-day professional member
registration fee.

THEME SESSIONS

1. Geoscience and Engineering at the Deep Underground
Science and Engineering Lab (DUSEL) in Lead, South
Dakota.
2. Structural and Tectonic Evolution of the Proterozoic
Trans-Hudson–Archean Wyoming Province Boundary.
4. Geologic Hazards of the Rocky Mountains and
Great Plains.
5. Laramide Tectonics and Stratigraphy of the Northern
Rocky Mountains and Great Plains.
6. Recent Advances in Understanding the Geologic History
of the White River Badlands.

JANUARY 2010, GSA TODAY



Summit of Harney Peak, Black Hills, Pennington County, South Dakota, USA. Sitting in this 12 Aug. 1897 photo are J.A. Holmes, C.D. Walcott, and Henry Gannett. Courtesy USGS; photo ID: Walcott, C.D. 424; <http://libraryphoto.cr.usgs.gov/html/lib/btch391/btch391j/btch391z/wcd00424.jpg>.

Bottom left: Bear Butte, a tertiary intrusive. Photo by Larry D. Stetler

Right: Mount Rushmore.



7. Geological Studies in National Park Service Areas of the Rocky Mountain Region.
8. GIS and Remote Sensing Applications in the Geosciences.
9. The Future of Geosciences Field Education.
10. Hydrologic and Geologic Framework of the Central Missouri River Corridor.
11. Geology of Shale: From Source Rocks to Reservoir Rocks.
12. Hydrology of Coals: New Information from Mining and Coal-Bed Methane Development in the Rocky Mountains.
13. Western South Dakota Hydrology Conference.
14. EarthScope: New Information on the Structure and Evolution of the Rocky Mountain Region.
15. Microbiology Effects on Hydrologic Systems in the Deep Underground: Implications for Limits of Life from Deep Underground Science and Engineering Lab (DUSEL) Homestake.
16. Geologic Enigmas: Unexpected Puzzles from Geologic Research.
17. Geological Constraints on Future Exploration and Ultimate Recovery of Energy Resources in the Rocky Mountains (Oil, Gas, Coal, Oil Shale, cbm, Uranium, Hydro, Wind).
18. Undergraduate Research (Posters).
3. Karst and Fractured Aquifer Hydrogeology: Recent Advances in the Conceptualization, Characterization, and Interpretation of Fluid Movement and Transport Dynamics.
4. The Black Hills and I-90–Hwy 79 Development Corridor.
5. Laramide Tectonics and Stratigraphy of the Northern Rocky Mountains and Great Plains.
6. Recent Advances in Understanding the Geologic History of the White River Badlands.
7. Environmental Geology and Abandoned Uranium Mines, Harding County.
8. Holocene Paleoflood Events in the Black Hills: Evidence Preserved in Alcoves and Caves.
9. Trace Fossils at the Cambrian-Precambrian Nonconformity, West of Rapid City, Black Hills.
10. Mammoth Site in Hot Springs, South Dakota.
11. Paleozoic Stratigraphy of the Northern Black Hills.

OPPORTUNITIES FOR STUDENTS

Mentor Luncheons: Roy J. Shlemon Mentor Program in Applied Geoscience and The John Mann Mentors in Applied Hydrogeology Program. Please go to www.geosociety.org/mentors/ to learn more.

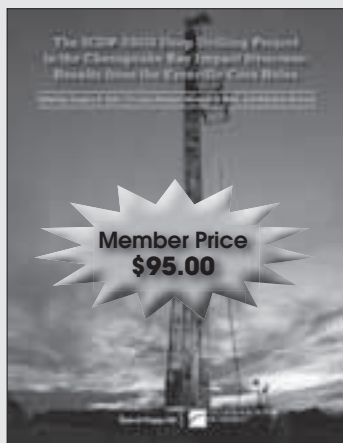
Travel Grants: Application details are at www.geosociety.org/grants/travel.htm.

FIELD TRIPS

1. Geology of the Homestake Gold Mine (Deep Underground Science and Engineering Lab [DUSEL]) in Lead, South Dakota.
2. Structural and Tectonic Evolution of the Proterozoic Trans-Hudson–Archean Wyoming Province Boundary.

The ICDP-USGS Deep Drilling Project in the Chesapeake Bay Impact Structure: Results from the Eyreville Core Holes

edited by Gregory S. Gohn, Christian Koeberl, Kenneth G. Miller, and Wolf Uwe Reimold



In 2005 and 2006, an international deep drilling project, conceived and organized under the auspices of the International Continental Scientific Drilling Program and the U.S. Geological Survey, continuously cored three boreholes to a total depth of 1.766 km near the center of the Chesapeake Bay impact structure in Northampton County, Virginia. This volume presents the initial results of geologic, petrographic, geochemical, paleontologic, geophysical, hydrologic, and microbiologic analyses of the Eyreville cores, which constitute a step forward in our understanding of the Chesapeake Bay impact structure and marine impact structures in general. The editors have organized this extensive volume into the following sections: geologic columns; borehole geophysical studies; regional geophysical studies; crystalline rocks, impactites, and impact models; sedimentary breccias; postimpact sediments; hydrologic and geothermal studies; and microbiologic studies. The multidisciplinary approach to the study of this impact structure should provide a valuable example for future scientific drilling investigations.

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THE
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Call for Applications and Nominations

GSA SCIENCE EDITORS

GSA's internationally recognized journals and books rely on the expertise of dedicated science editors who ensure stringent peer review, maintain excellent content, and provide leadership in determining the future course of GSA publications. Desirable characteristics for successful candidates include:

- a broad interest and experience in geosciences;
- international recognition;
- a progressive attitude, willingness to take risks and encourage innovation;
- familiarity with many earth scientists and their work;
- a sense of perspective and humor;
- organized and productive;
- willingness to work closely with GSA headquarters staff;
- ability to make decisions;
- familiarity with new trends in geosciences; and
- willingness to consider nontraditional research in geosciences.

GSA is currently soliciting

co-editor applications and nominations

for these upcoming openings.

- *Lithosphere*, four-year term beginning January 2011
- *GSA Bulletin*, four-year term beginning January 2011
- *GSA Books*, four-year term beginning January 2011
- *GSA Today*, four-year term beginning January 2011

Each editor will work out of his or her current location at work or at home. GSA provides some funding for each position; for specifics, please contact Jeanette Hammann, +1-303-357-1048, jhammann@geosociety.org. If you wish to be considered, please submit a curriculum vitae and a brief letter describing why you are suited for the position. If you wish to nominate another, submit a letter of nomination and the individual's written permission and CV. Send nominations and applications to Jeanette Hammann, GSA Publications, P.O. Box 9140, Boulder, CO 80301, USA; jhammann@geosociety.org. Nominations or applications received by 19 February 2010 will be given first consideration.

2009 Exceptional Reviewers

GSA thanks the people who make its peer-reviewed journals possible—the reviewers! Completing timely, thorough, and even-handed reviews is a time-consuming and sometimes thorny task. Among those who conscientiously hit the “accept” link on e-mailed invitations are reviewers who are consistently prompt, insightful, meticulous, and tactful. GSA’s journal science editors have selected the following people from this group for special recognition in 2009. (Photos of these colleagues are posted at www.geosociety.org/pubs/reviewers.htm.)

Geology

Sonja Aulbach, University of Alberta
Phyllis Camilleri, Austin Peay State University
Julia Hammer, University of Hawaii
Andrew P. Roberts, University of Southampton
Daniela Rubatto, The Australian National University
Zoe Shipton, University of Glasgow
Pieter Vermeesch, University of London



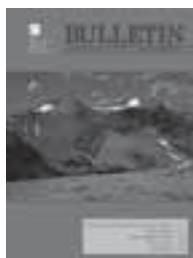
Geosphere

Michael Audley-Charles, University College London
Alan Cooper, University of Otago
Roy Dokka, Louisiana State University
Katharine Huntington, University of Washington
Toshio Nozaka, Okayama University
Brendan McNulty, California State University–Dominguez Hills
Harold Stowell, University of Alabama
Wayne Thatcher, U.S. Geological Survey



GSA Bulletin

Calvin G. Barnes, Texas Tech University
Simon Brocklehurst, The University of Manchester
Don I. Cummings, Geological Survey of Canada
Katharine Huntington, University of Washington
Mustapha Meghraoui, Institut de Physique du Globe de Strasbourg
Randall Parrish, NERC Isotope Geosciences Laboratory
Gerhard Wörner, Geowissenschaftliches Zentrum Göttingen



GSA Today

Joel Johnson, Massachusetts Institute of Technology
Zachary Adam, University of Washington
Glen Stockmal, Geological Survey of Canada
Peter Fermor, Devon Energy Canada



Lithosphere

Rick Bennett, University of Arizona
Mihai N. Ducea, University of Arizona
Valiya Mannathal Hamza, Observatório Nacional
Brian K. Horton, The University of Texas at Austin
Sharon Mosher, The University of Texas at Austin



Call for Papers

GSATODAY

SCIENCE

GSA Today's science co-editors (Stephen T. Johnston and David E. Fastovsky) seek timely, high-quality, focused science articles covering current topics and discoveries in the earth sciences that appeal to a broad geoscience audience. The circulation for *GSA Today* reaches over 22,000, with high international visibility and regular media coverage, and articles are always open access online. Science articles are limited to six print pages and will receive a rigorous peer review. *GSA Today* features rapid turnaround from both receipt to acceptance and acceptance to publication.

“GROUNDWORK”

Also submitted directly to *GSA Today's* science co-editors for peer review, these short, hot-topic or issue-driven articles are intended to lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. Groundwork articles are limited to two print pages.

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GSA Foundation Update

Donna L. Russell, Director of Operations

Research Grant Opportunities for Students

Each year the requests for funding for student research grants increases.

In 2009, the requests totaled 638, and only about one-third of those could be granted. With the continued support of the GSA membership, we expect that funding for student research grants will increase. Providing opportunities for students is a priority for the GSA Foundation, which manages the following funds for student research:

Alaska & Caribbean	Alexander Sisson Research Award
Alaska Research	Bruce "Biff" Reed Scholarship Award; John T. Dillon Alaska Research Award
Applied Geology	John F. Mann Institute for Applied Geology Fund
Archaeology	Claude C. Albritton Award
Biostratigraphy	Charles A. and June R.P. Ross Research Award
Cascadia Research	Parke D. Snavelly, Jr., Cascadia Research Award
Coal	Antoinette Lierman Medlin Scholarship; Alexander and Geraldine Wanek Fund for Graduate Studies
Desert Research	Farouk El-Baz Student Award
Engineering	John T. and Carol G. McGill Award; Roy J. Shlemon Scholarship for Engineering Geology Award
General Research	GEOSTAR (Supporting The Advancement of Research)
Geophysics	Allan V. Cox Student Scholarship Award
International	Charles Lum Drake International Grant; The Maurice "Ric" Terman Award
Limnogeology	Kerry Kelts Research Award

Planetary	Dwornik Planetary Geoscience Award
Quaternary Geology and Geomorphology	Arthur D. Howard Award; J. Hoover Mackin Award
Sections	Cordilleran Section Endowment Award; North-Central Section Endowment Award; Northeastern Section Endowment Award; Rocky Mountain Section Endowment Award; South-Central Section Endowment Award; Southeastern Section Endowment Award
Volcanology	Lipman Research Award

For complete descriptions of these GSA Foundation funds, please contact Donna Russell, Director of Operations, GSA Foundation, drussell@geosociety.org, +1-303-357-1054.



Most memorable early geologic experience:

In Caro, Venezuela, on a team with Farouk El-Baz, finding watering troughs made of tree trunks—one meter in diameter in a zone that now is desert due to over-grazing—once a rain forest.

—Anna C. Roosevelt

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2009 Subaru Minority Student Scholarship Recipients



Subaru of America, Inc., in partnership with the GSA Foundation, has generously funded a scholarship program to benefit undergraduate minorities considering a degree in the geosciences. The Subaru Minority Student Scholarship Program provides US\$1,000 to one student (nominated by a GSA Campus Representative) at an accredited university or college in each of GSA's six U.S. regional Sections. The student also receives free registration to attend the GSA Annual Meeting. The purpose of the award is to encourage minority students to continue studies in the geosciences as a possible degree choice.

NORTHEASTERN SECTION

Schae Martin, *Norwich University, Vermont*

SOUTHEASTERN SECTION

Keith DePew, *Virginia Tech, Virginia*

NORTH-CENTRAL SECTION

Alexander Nereson, *Macalester College, Minnesota*

SOUTH-CENTRAL SECTION

Philip O'Brien, *Texas Tech University, Texas*

ROCKY MOUNTAIN SECTION

Dale Hernandez, *Colorado State University, Colorado*

CORDILLERAN SECTION

Gale Vasquez, *Central Washington University, Washington*

Nomination forms for the 2010 program will be sent to GSA Campus Reps in April. Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org, +1-303-357-1036.

NEW Division Award

Israel C. Russell Award for Limnogeology

Call for Nominations Deadline: 1 March 2010

New from the Limnogeology Division: The Israel C. Russell Award recognizes major achievements in limnogeology through contributions in research, teaching, and service. Nominations should include a curriculum vita and a letter describing the nominee's accomplishments in the field of limnogeology (broadly defined to include limnogeology, limnology, and paleolimnology), service to students, teaching, and contributions to GSA. The nominee need not be a member of the Division or of GSA, but must have made valuable contributions to the Society. Send nominations electronically to the Limnogeology Division treasurer, David Finkelstein, dfinkels@utk.edu.

Nominations are valid for three years; the dossiers of nominees who do not receive the award this inaugural year will be retained and considered for the next two years. Updated information for carry-over candidates may be sent to the Division treasurer during the next call for nominations.

This award will be presented at the Division Business Meeting and Awards Ceremony at the Annual Meeting of the Geological Society of America. The citationist will normally be the nominator, or another individual selected by the recipient in consultation with the Division chair.

The Limnogeology Division promotes collaborative interdisciplinary research and education on modern and ancient lakes around the world. This is an exciting new award for the Division and we hope that you will participate in providing a strong list of potential candidates for this prestigious award. Israel C. Russell Award Committee members are encouraged to initiate nominations for the award.

About People

GSA Fellow **Marcia McNutt** was confirmed by the U.S. Senate on 22 Oct. 2009 as Director of the U.S. Geological Survey and Science Advisor to the Secretary of the Interior.

GSA Member **Rob Thomas** of the University of Montana–Western, Dillon, Montana, USA, has been named Outstanding Baccalaureate Colleges Professor of the Year by the Council for Advancement and Support of Education

and The Carnegie Foundation for the Advancement of Teaching. Learn more at http://www.usprofessorsoftheyear.org/poy_press09.cfm.

Citations and Responses for the **GSA Medals & Awards** and the **2009 GSA Division named awards** are online at www.geosociety.org/awards/. You'll find many outstanding GSA members and new GSA Fellows listed there.

STUDENT Grants, Awards & Scholarships

Graduate Student Research Grants

Applications due 1 Feb. 2010

The primary role of GSA's research grants program is to provide partial support of master's and doctoral thesis research in the geological sciences for graduate students enrolled in universities in the United States, Canada, Mexico, and Central America. Up to US\$4,000 per student will be awarded. For information and to apply, go to www.geosociety.org/grants/gradgrants.htm. Questions? Please e-mail awards@geosociety.org or call +1-303-357-1028.

Farouk El-Baz Student Award

Applications due 1 Feb. 2010

The Farouk El-Baz Student Award encourages and promotes desert research. The award, established by the GSA Foundation, is named after GSA Fellow Farouk El-Baz, who says, "Deserts have received far less attention than other types of landforms in geological studies. This award will encourage more students to pursue investigations of arid lands, which constitute over one-third of the land surface of our planet."

Up to two students will be awarded this honorarium at the 2010 GSA Annual Meeting in Denver, Colorado, USA, based on proposals for arid land research and advisor recommendations. Recipients will be selected by a committee appointed by GSA's new International Section.

Find guidelines and the application form at <http://rock.geosociety.org/forms/el-bazGrant.asp>. Questions? Please e-mail awards@geosociety.org or call +1-303-357-1028.

Antoinette Lierman Medlin Scholarship in Coal Geology

Applications due 15 Feb. 2010

The Coal Geology Division's Antoinette Lierman Medlin Scholarship provides monetary support and recognition to students in coal science (the origin, occurrence, geologic characteristics, or economic implications of coal and associated rocks). Two awards are given each year: one for the completion of laboratory/analytical research, and one for the completion of field work.

Scholarships for the 2010–2011 academic year provide full-time students involved in coal geology research with one year of financial support for their project. These funds can be used to cover field or laboratory expenses, sample analyses, instrumentation, supplies, or other expenses essential to the successful completion of the research project. Scholarship recipients may also be provided with a stipend to present research results at the 2010 or 2011 GSA Annual Meeting.

Students may apply for both scholarships but can receive only one award. To apply, submit five copies each of the following to Sharon M. Swanson, U.S. Geological Survey, 956 National Center, Reston, VA 20192-0001, USA, fax +1-703-648-6419, smswanson@usgs.gov: (1) a cover letter indicating the award(s) sought; (2) a concise statement (no more than five double-spaced pages including references) of objectives and methods and how the scholarship funds will be used to enhance the project; and (3) a letter of recommendation from the student's immediate advisor that includes a statement of financial need and the amount and nature of other available funding for the research project. A panel of coal geoscientists will evaluate the proposals, and successful applicants will be notified by 2 April 2010.

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

Stephen E. Dwornik Student Paper Award

The GSA Planetary Geology Division's Stephen E. Dwornik Student Paper Award was established in 1991 to provide encouragement, motivation, and recognition to outstanding future planetary scientists. To apply, go to www.lpi.usra.edu/meetings/lpsc2010/ for instructions, an application form, and further information. The 2010 award applies to papers presented at the 40th Lunar and Planetary Science Conference on **1–5 March 2010** in The Woodlands, Texas, USA.

To be eligible, a student must be (1) the senior author of the abstract; (2) a U.S. citizen; and (3) enrolled in a college or university in the field of planetary geoscience. Papers will be judged on the quality of the scientific contributions, including methods and results, clarity of material presented, and the method of delivery (oral or display). Two awards are given each year—one for the best oral presentation and one for the best poster presentation. This award is administered through GSA's Planetary Geology Division; award funds are managed by the GSA Foundation.

History of Geology Student Award

Applications due 3 May 2010

GSA's History of Geology Division established this award (managed by the GSA Foundation) to recognize proposals for student papers to be presented at upcoming GSA Annual Meetings. The topic of the proposed paper may be, but is not limited to, (1) the history of geology, (2) a literature review of ideas for a technical work or thesis/dissertation, or (3) some imaginative aspect of the history of geology we have not thought of before.

Go to <http://gsahist.org/HoGaward/awards.htm> for proposal guidelines and the application form. Questions? Please contact Jane P. Davidson, jdhexen@unr.edu.

This award, established in 2004, is made possible by a bequest from the estate of Mary C. Rabbitt. Consideration will be given to students who are in good standing at the time of application; presentation at the GSA Annual Meeting may take place after graduation. Faculty advisor(s) may be listed as second author(s) but not as lead author, and while both oral and poster presentations are acceptable, oral presentations are preferred. Nominees need not be members of the History of Geology Division or of the Geological Society of America.



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Broomfield, Colorado June 7–11, 2010 Omni Hotel

3rd USGS Modeling Conference focuses on the development and application of analytical and theoretical models and data availability that support managing the Nation's resources and help protect lives and property. Scientists and managers from all Department of the Interior (DOI) Bureaus, national and international Federal, State, and local agencies, academic institutions, and non-governmental organizations are encouraged to participate.

Important Dates to Remember

February 1, 2010..... Conference registration opens
February 12, 2010..... Abstracts Submissions Deadline
June 7–11, 2010..... 3rd USGS Modeling Conference

<http://geology.usgs.gov/modeling2010/>





View of Bear and South Boulder Peaks from Marshall Mesa, Colorado, USA. Photo by keasmus.

January

- 12 **2010 GSA Annual Meeting Technical Session proposals** due at <http://gsa.confex.com/gsa/2010AM/sessionproposals.epl>.
- 19 **Abstracts deadline:** North-Central–South Central Sections Joint Meeting (see p. 20).
- 26 **Abstracts deadline:** Rocky Mountain Section Meeting (see p. 22).

February

- 01 Applications for **2010 GeoCorps™ America positions** due. Learn more at www.geosociety.org/geocorps/.
- 01 Nominations due for the **2010 GSA Medals and Awards, GSA Fellowship, and the AGI Medal in Memory of Ian Campbell**. Learn more at www.geosociety.org/awards/.

- 01 **2010 Student Research Grant** applications are due by 11:59 MST at www.geosociety.org/grants/gradgrants.htm.
- 01 Applications for the **2010 Post-Doctoral Research Awards** (Gladys W. Cole Memorial Research Award and W. Storrs Cole Memorial Research Award) are due via www.geosociety.org/grants/postdoc.htm.
- 01 Nominations due for the Geoscience Education Division's **Biggs Award for Excellence in Earth Science Teaching**. Access the nomination form at http://gsaged.org/biggsaward/09_biggs_form.pdf; submit nominations to Paul E. Baldauf, Nova SE Univ., Farquhar College Arts & Sciences, Math, Science & Technology Division, 3301 College Ave., Fort Lauderdale, FL 33314-7721, USA; pb501@nova.edu.
- 01 Nominations due for the History of Geology Division's **Mary C. Rabbitt History of Geology Award**; send them to Jane P. Davidson, Univ. of Nevada, Reno, NV 89557-0001 USA; jdhexen@unr.edu.
- 15 Nominations due for the Geophysics Division's **George P. Woollard Award** at http://geoscience.unlv.edu/pub/GSA_Geop/woollard.html. Nominations should include a description of the nominee's specific contributions and their scientific impact.
- 20 Nominations due for the Sedimentary Geology Division's **Laurence L. Sloss Award for Sedimentary Geology**. Submit via e-mail to Paul Link, Sedimentary Geology Division secretary, linkpaul@isu.edu, (1) a cover letter describing the nominee's accomplishments in sedimentary geology and contributions to GSA and (2) a curriculum vita.
- 25 **GSA Officer and Councilor Elections** begin (see p. 15).
- 28 Nominations due for the Coal Division's **Gilbert H. Cady Award**. Send three copies of the following to Ronald H. Affolter, USGS, Denver Federal Center, MS 939, P.O. Box 25046, Denver, CO 80225-0046, USA; affolter@usgs.gov: (1) name, office or title, and affiliation of the nominee; (2) date and place of birth; (3) education, degree(s), and honors and awards; (4) major events in his or her professional career; and (5) a brief bibliography noting outstanding achievements and accomplishments.

March

- 01 Nominations due for the **Limnogeology Division's NEW Israel C. Russell Award**. See p. 27 of this issue.
- 09 **Abstracts deadline:** Cordilleran Section Meeting.
- 13–16 **Joint Meeting of GSA's Northeastern and Southeastern Sections**, Baltimore, Maryland, USA.

- 26 **GSA's Officer and Councilor election ballots due.**
- 31 Nominations due for the **John C. Frye Environmental Geology Award**. Learn more at www.stategeologists.org/awards_honors.php.

April

- 02 Nominations due for the Quaternary Geology and Geomorphology Division's **Farouk El-Baz Award for Desert Research**. Submit (1) a statement of the significance of the nominee's research, (2) a curriculum vitae, (3) letters of support, and (4) documentation of published research results that have significantly advanced the knowledge of the Quaternary geology and geomorphology of desert environments to P. Kyle House, Nevada Bureau Mines & Geology, Univ. of Nevada, MS 178, Reno, NV 89557-0178, USA; khouse@unr.edu.
- 11–13 **Joint Meeting of GSA's North-Central and South-Central Sections**, Branson, Missouri, USA.
- 21–23 **Meeting of GSA's Rocky Mountain Section**, in association with the Western South Dakota Hydrology Water Conference, Rapid City, South Dakota, USA.

May

- 16–22 **Field Forum: Significance of along-strike variations for the 3-D architecture of orogens: The Hellenides and Anatolides in the eastern Mediterranean, Samos, Greece.**
- 27–29 **Joint Meeting of GSA's Cordilleran Section and the Pacific Section of the American Association of Petroleum Geologists**, Anaheim, California, USA.

CALL FOR APPLICATIONS

2010–2011 GSA-USGS Congressional Science Fellowship

Bring your science and technology expertise to Capitol Hill to work directly with national leaders at the interface between geoscience and public policy.

Deadline for application: 1 February 2010

The GSA-USGS Congressional Science Fellowship provides a rare opportunity for a unique individual. Prospective candidates are GSA Members with a broad geoscience background and excellent written and oral communication skills. Minimum requirements are a master's degree with at least five years professional experience or a Ph.D. at time of appointment. This fellowship is open only to U.S. citizens or permanent U.S. residents.

Find application information at www.geosociety.org/csf/ or contact Ginger Williams, +1-303-357-1040, gwilliams@geosociety.org.

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Kristin Frederick, Hydrologist at Great Sand Dunes National Park and Preserve, 2009.

Classified Rates—2010

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact advertising@geosociety.org, +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses. To estimate cost, count 54 characters per line, including punctuation and spaces. Actual cost may differ if you use capitals, boldface type, or special characters. Rates are in U.S. dollars.

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Additional lines	\$4.50	\$4.50
Fellowship Opportunities	\$8.85	\$8.60

Positions Open

GEOLOGIST/CLASTIC SEDIMENTOLOGIST WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY (WGNHS)

Wisconsin Geological and Natural History Survey (WGNHS) is recruiting for a full-time, tenure-track faculty position available 1 July 2010. Duties include conducting fundamental and applied research in the areas of Clastic Sedimentology through field-based investigations, including geologic mapping, focusing on the stratigraphic and hydrostratigraphic framework of Quaternary and/or Paleozoic sediment and rocks of Wisconsin. Work will be performed in cooperation with other Survey staff, university personnel, and collaborating local, state,

and federal agencies whose interests may include geology, geophysics, hydrogeology, and mineral/energy resources. This position also has a role in the leadership of related outreach and educational functions within the WGNHS.

Salary minimum: \$52,000, excellent benefits package. Office is located in Madison, Wisconsin. Applications will be reviewed beginning 1/08/2010. For a complete position description and how to apply, please visit www.uwex.edu/ces/hr. AA/EEO Employer.

ASSISTANT OR ASSOCIATE PROFESSOR DEPARTMENT OF GEOLOGY UNIVERSITY OF WISCONSIN-OSHKOSH

The University of Wisconsin-Oshkosh Department of Geology seeks a full-time, tenure-track assistant or associate professor starting 1 September 2010. Specialty areas should complement existing faculty expertise and might include (but not limited to) mineralogy, volcanology, metamorphic petrology, and economic geology. Ph.D. required; prior college teaching experience preferred. Successful candidate will be a hard rock geologist who investigates field relationships as a fundamental component of his/her research and who is committed to undergraduate education, including advising students and developing a research program involving students. Teaching responsibilities include introductory courses, field trips, and mineralogy or petrology. Ability to teach economic geology and geochemistry desirable. Submit letter of application, concise statement of teaching and research interests and experience, curriculum vitae, and undergraduate and graduate transcripts (original or photocopy) by 15 February 2010 to Dr. William Mode, Chair, Department of Geology, University of Wisconsin Oshkosh, Oshkosh, WI 54901. Have three current letters of reference sent directly to Department by that date. For additional information, see www.uwosh.edu/departments/geology/. Employment requires criminal background check. AA/EEOE.

VISITING ASSISTANT PROFESSOR GEOSCIENCES, DENISON UNIVERSITY

The Department of Geosciences at Denison University invites applications for a 1-year appointment for the 2010–2011 academic year. The area of specialization is open. Primary teaching responsibilities will be introductory sections of physical geology and an intermediate-level environmental geology course. In addition, the possibility exists to teach an upper-level course in the candidate's area of expertise. A completed Ph.D. at time of appointment is desirable but ABD will be considered. Our department stresses a balance of classroom, field and laboratory experiences for our majors, and we seek a colleague who will contribute to all of these components of our undergraduate curriculum. Denison is a selective liberal arts college strongly committed to and supportive of excellence in teaching and active faculty research that involves undergraduate students.

Submit application materials electronically at <https://employment.denison.edu>. Please include a cover letter; separate teaching and research statements; a vita; academic transcripts or list of geosciences coursework; and contact information for three references. Please contact Dr. Tod Frolking, Dept. Geosciences, Denison University, Granville, OH 43023; +1-740-587-6217; frolking@denison.edu or visit www.denison.edu/academics/departments/geosciences/ for more information about the position and department. Post application materials by 30 January 2010 for full consideration. Denison is an affirmative action/equal opportunity employer. To achieve our mission as a liberal arts college, we continually strive to foster a diverse campus community, which recognizes the value of all persons regardless of religion, race, ethnicity, gender, sexual orientation, disability, or socio-economic background.

LOW TEMPERATURE GEOCHEMIST SAM HOUSTON STATE UNIVERSITY

The Geology program of the Department of Geography and Geology at Sam Houston State University wishes to appoint at the Assistant Professor level a **Low Temperature Geochemist** with research interests in the broad field of either *Aqueous Geochemistry* (surface or groundwater), *Environmental Geochemistry*, or *Petroleum Geochemistry*. The candidate will already hold the Ph.D. and will be in process of developing a strong research program with the likelihood of external funding. Primary teaching responsibilities will include an upper level course in Geochemistry to be taught each year; an upper level course related to the candidate's research field to be taught alternate years; plus coverage of sections of an introductory level Geological/Environmental Hazards course designed to attract majors. It would be particularly advantageous if the candidate could offer a general survey course in *Hydrology* (surface and groundwater) that includes modeling.

At the present time, geology and geography form a combined department with separate degree programs. The geology curriculum is deliberately generalist but rigorous and we have success in placing our graduates in entry level positions in both environmental and petroleum-related fields, as well as in good graduate programs. It is probable that in the relatively near future geology will become an independent department and will begin the process of building a focused graduate program of its own. We seek a geologist who would enjoy full participation from the start of this building process.

The start date for this position will be August 2010. However, given the availability of a candidate of exceptional merit we would consider a start date as early as January 2010. A letter of interest, vita, e-mail addresses of referees and a statement of research interests should be e-mailed or snail mailed to Dr. Chris Baldwin (baldwin@shsu.edu), Acting Chair, Department of Geography and Geology, Sam Houston State University, Box 2148, Huntsville TX 77341-2148.

SHSU is an EEO/AAP employer and a member of The Texas State University System.

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

Position Description: The Department of Geological Sciences at the University of Texas at El Paso (UTEP) announces a tenure-track faculty position in the area of **hydrological sciences**. As hydrologic and water resources problems are becoming increasingly important in the desert southwest, the successful candidate



Colorado School of Mines Geology and Geological Engineering Assistant Professor – Structural Geology & Tectonics

Colorado School of Mines invites applications for an anticipated tenure-track Assistant Professor in the field of structural geology and tectonics to begin in August 2010. Information about the school and the department can be found at <http://geology.mines.edu/>.

The successful candidate will be expected to develop a strong and vibrant externally funded research program and establish an international reputation through publication, in addition to teaching at the undergraduate and graduate levels, directing graduate research and supervising thesis projects.

Candidates must possess a doctoral degree in structural geology/tectonics or related discipline. Research interests should complement and support existing campus programs, and candidates linking their research in structure geology and tectonics to the evolution, exploration and development of mineral deposits are desired. Preference will be given to applicants who can teach undergraduate and graduate courses in structural geology, tectonics, and structural aspects of mineral deposits.

For a complete job announcement and the instructions for applying, see the complete announcement at http://www.mines.edu/Academic_Faculty.

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will be able to leverage UTEP's regional location in the southwest to perform cutting-edge water-related research. We are particularly interested in candidates who use isotopic tools to investigate water-related problems. We expect to hire at the assistant professor level, however, candidates with exceptional qualifications including industry experience may be considered for a higher rank.

Required Qualifications: A Ph.D. in the geosciences or closely related discipline is required. The successful candidate will be expected to establish a funded research program, to mentor undergraduate and graduate students in research, and to teach introductory earth science as well as higher-level courses in the candidate's specialty.

About the Department of Geological Sciences: The Department of Geological Sciences at UTEP has a faculty of 14 and enrollment of more than 100 graduate and undergraduate students. The department is housed in an attractive, 90,000 sq. ft. building that contains faculty and student offices, laboratory and classroom space with research infrastructure that includes wet chemical laboratories, a clean room, and a variety of analytical facilities, including a multi-collector (MC)-ICP-MS for measuring isotopic ratios. Other research centers at UTEP that focus on water research include the Center for Inland Desalination Systems (CIDS) and the Center for Environmental Resource Management (CERM). More information about the activities and facilities in the department can be found at our Web site, www.geo.utep.edu. The department also participates in interdisciplinary PhD programs in Materials Science Engineering, Environmental Science and Engineering and Computational Science.

Application/Nomination Procedure: Review of applications will begin on 19 Jan. 2010 and will continue until the position is filled. Anticipated appointment date is Fall 2010. **Only electronic submissions will be considered** and must include "Faculty Position Application: YOUR NAME" in the "subject" block of the e-mail. Complete applications/nominations will consist of a letter of application/interest, detailed curriculum vitae, names of at least three references, and a statement of teaching and research to: Dr. David Borrok, Chair of the Search Committee, Geological Sciences (Hydrological Geosciences), dborrok@utep.edu.

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**ASSISTANT PROFESSOR, GEOLOGY
FULL TIME, TENURE-TRACK, FALL 2010
WESTFIELD STATE COLLEGE**

Teach 12 hours per semester. Courses include physical geology, historical geology, and geologic hazards. Develop introductory courses (examples: oceanography, planetary geology, or earth systems). Teach occasional upper-level courses that integrate other physical sciences with a geological topic. Also expected are contributions to the college community, student advising, and some continuing scholarship. Salary is competitive.

Qualifications: A Ph.D. in any area of geology is required, excellent communication and interpersonal skills and a strong commitment to teaching at the introductory undergraduate level.

Online Application Required at <http://jobs.wsc.ma.edu/applicants/Central?quickFind=51464>. View the detailed job description and qualifications; submit the online application; and obtain the mailing address for additional application materials. For assistance, call +1-413-572-8809.

Westfield State College is an Affirmative Action/Equal Opportunity Employer.

**TENURE-TRACK FACULTY POSITION
EARTH AND ENVIRONMENTAL SCIENCE
UNIVERSITY OF WISCONSIN-EAU CLAIRE**

Earth and Environmental Science position available 23 August 2010. A completed doctorate in geology, environmental science or a closely related discipline is required at the time of appointment. Essential qualifications include demonstrated ability or potential to teach an inquiry-based, laboratory and field intensive, introductory Earth and Environmental Science course for the General Education program and education majors (grades 1-9). Area of specialization is open, but should be focused on earth and environmental sciences,

ASSISTANT PROFESSOR

Geological Sciences – Molecular Geochemistry

The Department of Geological Sciences at the University of Alabama has an opening for a faculty member in the area of molecular geochemistry. We are seeking an outstanding scientist whose research will explore and elucidate the complex interactions among physical, chemical, and biological processes at the molecular scale. Specific areas of research may include, but are not limited to, geomicrobial processes, interfacial chemistry, bioremediation, and biomarker applications to paleoenvironments/paleo-climatology or petroleum maturation/genesis. This is a tenure-track appointment and will be filled at the assistant professor level in August 2010. The successful candidate will be expected to (i) establish a vigorous, externally-funded, research program; (ii) teach geology courses at the introductory level, as well as develop and teach courses at the undergraduate and graduate levels in their field of expertise, and (iii) supervise student research projects at the undergraduate, masters, and doctoral levels. The Department has an excellent analytical infrastructure which includes electron beam, wet and dry chemistry, and stable isotope mass spectrometry instrumentation.

Applications for this position must be submitted electronically. A list of required documents and application instructions can be found at <https://facultyjobs.ua.edu>; other Document to include contact information for 3 references. For additional information, contact the search committee chair, Dr. Rona J. Donahoe, at rdonahoe@geo.ua.edu or 205-348-1879, or visit www.geo.ua.edu. Applications will be reviewed beginning January 15, 2010, but will be accepted until the position is filled.

Prior to hiring, the final candidate(s) may be required to successfully pass a pre-employment background investigation.

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including but not limited to: the interface of geology and biology, environmental remediation, microbes in the environment or earth resources.

Interested individuals should provide a letter describing their background, qualifications for the position, and a statement of teaching and research interests, a curriculum vitae and unofficial copies of university transcripts. This packet should be sent electronically via e-mail (PDFs strongly preferred) to GeologyHire@uwec.edu. Three individual referees must submit letters of recommendation electronically or by mail addressed to Dr. Robert Hooper, Chair, Department of Geology, University of Wisconsin-Eau Claire, Eau Claire, WI 54702-4004.

Review of completed applications will commence January 15, 2010 and continue until the position is filled. For a complete position description, call +1-715-836-3732 or visit www.UWEC.edu/Geology. A criminal background check will be required prior to employment. UW-Eau Claire is an AA/EEO employer and encourages applications from women and minorities.

**ASSISTANT PROFESSOR
STABLE ISOTOPE GEOCHEMISTRY
UNIVERSITY OF NORTH CAROLINA-WILMINGTON**

The Department of Geography and Geology at the University of North Carolina-Wilmington invites applications for a tenure-track assistant professor position in stable isotope geochemistry to begin August 2010. The candidate's area of specialty should complement established research and teaching programs in the department such as coastal and marine processes, sedimentology/stratigraphy, hydrology/climatology, and paleobiology. The successful candidate will teach introductory and advanced courses in their area of expertise, direct graduate student research, establish an externally funded research program, and provide leadership for the Isotope Ratio Mass Spectrometry laboratory at

the Center for Marine Science (CMS). The successful candidate will have the opportunity to collaborate with a wide range of related programs within the College of Arts and Sciences and the CMS. A Ph.D. in geological sciences, marine sciences, or a related field is required. The department currently offers B.A., B.S., and M.S. degrees in geology, B.A. in geography, along with a GIS certificate and minors in geology, geography, and oceanography.

For additional information on faculty and programs see www.uncw.edu/earsci. To apply, complete the online application process at <http://consensus.uncw.edu>. A letter of application including brief statements of teaching and research interests, a curriculum vitae and contact information, including e-mail addresses, for three professional references should be attached to the online application, not e-mailed, mailed, or faxed (MS Word or PDF attachments are required). For questions about the position, contact Dr. Richard Laws, Search Committee Chair, laws@uncw.edu, +1-910-962-4125. For questions about the online application process, contact Ms. Cathy Morris, morris@uncw.edu or +1-910-962-3536. Review of application will begin 1 February 2010, but applications will be accepted until the position is filled.

UNC-Wilmington actively fosters a diverse and inclusive working and learning environment and is an equal opportunity employer. Qualified men and women from all racial, ethnic, or other minority groups are strongly encouraged to apply.

**TENURE TRACK FACULTY POSITION
(SEISMOLOGY), TEXAS A&M UNIVERSITY**

The Department of Geology & Geophysics at Texas A&M University invites applications for a tenure-track faculty position in reflection seismology beginning September 2010. The position is offered at the Assistant Professor level.

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continued from page 33

The successful applicant will establish an active, innovative research program while complementing current departmental strengths in petroleum geology and geophysics, sedimentology, stratigraphy, and structural geology and will participate actively in the newly established Berg-Hughes Center for Petroleum and Sedimentary Systems. Furthermore, opportunities exist to participate in and build on collaborative programs with colleagues in petroleum engineering, oceanography, and elsewhere at Texas A&M University. Applicants must have a Ph.D. in Geophysics, Geology or a related field at the time of appointment. Post-doctoral research and teaching experience are desirable.

The successful applicant will be expected to teach effectively at the undergraduate and graduate levels in geology and geophysics, including classes in the petroleum geology curriculum; supervise undergraduate, M.Sc. and Ph.D. students; and initiate and maintain a vigorous externally funded research program.

Interested candidates should submit electronic versions of a curriculum vita, statement of research interests and teaching philosophy, the names and email addresses of at least three references, and up to four reprints by email attachments, to the Chair of the Sedimentary Geology Search Committee, seismosearch@geo.tamu.edu. Screening of applications will begin 15 January 2010 and will continue until the position is filled.

The Department of Geology and Geophysics (geoweb.tamu.edu) is part of the College of

Geosciences, which also includes the Departments of Geography, Oceanography, and Atmospheric Sciences, Sea Grant, the Geochemical and Environmental Research Group (GERG), and the Integrated Ocean Drilling Program (IODP). Texas A&M University, a land-, sea-, and space-grant university, is located in a metropolitan area with a dynamic and international community of 152,000 people. Texas A&M University is an affirmative action/equal opportunity employer committed to excellence through the recruitment and retention of a diverse faculty and student body and compliance with the Americans with Disabilities Act. We encourage applications from minorities, women, veterans, and persons with disabilities. Texas A&M University also has a policy of being responsive to the needs of dual-career partners (hr.tamu.edu/employment/dual-career.html).

POSTDOCTORAL OPPORTUNITY ENVIRONMENTAL GEOCHEMISTRY WOFFORD COLLEGE

Wofford College, a private Phi Beta Kappa liberal arts college founded in 1854, has launched a new program in Environmental Studies. We seek a postdoctoral scholar with strong interest in undergraduate education for an 18-month position with both program and research responsibilities, preferably starting January 2010. Candidates should ideally have expertise in two or more of the following areas: uranium geochemistry, geochemical and/or transport modeling, X-ray absorption spectroscopy, pore-scale imaging, environmental

mineralogy. See www.wofford.edu/environmentalstudies for further information.

It is the policy of Wofford College to provide equal opportunities and reasonable accommodation to all persons regardless of race, color, creed, religion, sex, age, national origin, disability, veteran status, or other legally protected status in accordance with applicable federal and state laws.

Applicants should email a cover letter, curriculum vitae, statement describing career goals, teaching and research interests, and contact information for three references to Kaye Savage, Director of Environmental Studies, savageks@wofford.edu.

Opportunities for Students

Undergraduate Research Program, Sevilleta Long Term Ecological Research Site (LTER). The Sevilleta LTER is seeking undergraduate applicants for the summer 2010 Research Education Opportunities for Undergraduates (REU) program. We are looking for students interested in doing independent research working with mentors in Earth & Planetary Science, Ecology & Biology. The REU program lasts 11 weeks (16 May–31 July), housing and a \$4500 stipend and up to \$500 in travel reimbursement is provided. Applications due by 20 February 2010. Online applications and further details can be found at <http://sev.lternet.edu/REU> or by emailing the program coordinator at reu2010@sevilleta.unm.edu.

Ph.D. and M.S. student opportunities in climate change research at the University at Buffalo Geology Department. Research includes monitoring Greenland and Antarctic ice sheet mass balance changes using laser altimetry and other remote sensing methods as well as reconstruction of ice sheet dynamics from historical photographs. Funding also exists for Holocene climate and glacier reconstructions using lake sediments, including fieldwork to Greenland and Baffin Island. Contact Bea Csatho or Jason Briner ([bcsatho/jbriner@buffalo.edu](mailto:bcsatho@jbriner@buffalo.edu)); www.geology.buffalo.edu/.

Research Assistantship, crustal research in Antarctica, University of Minnesota-Duluth. NSF funding is available for PhD student(s) to study petrologic and isotopic evolution of the Archean-Proterozoic East Antarctic shield, including U-Pb, Hf, and O isotope study of Paleozoic granites and Pleistocene glacial tills as samplers of ice covered crust. The project involves remote fieldwork in Antarctica and isotopic study abroad in collaboration with Mark Fanning (Australian National University) and Jeff Vervoort (Washington State University). Interested students should contact John Goodge (jgoodge@d.umn.edu, +1-218-726-7491). Students must apply to the Ph.D. program at the University of Minnesota but will be resident on the Duluth campus (www.d.umn.edu/geology/). Applications are due at the University of Minnesota by 8 Jan. 2010.

The ASDSO (Association of State Dam Safety Officials) Scholarship Program was established in 1992 to award excellence in the study of civil engineering and related fields, and to make students more aware of dam safety as a career opportunity. Each year ASDSO awards undergraduate scholarships of up to \$10,000 to seniors planning to pursue a career in dams or dam safety. Applications available online at www.damsafety.org/media/Documents/StudentOutreach/ASDSO_Scholarship%20App.pdf. Applications due by 31 March 2010.

Finlay/Keevil President's Fellowships in Geology at the University of Toronto. Each fellowship covers the full cost of study through the M.Sc. (two years) or Ph.D (four years) with possible continued financial support contingent on an annual progress review. The fellowships are designated for students who intend to take their expertise to developing nations upon completion of their degree. Preference will be given to students whose birth place is in a developing nation (e.g., "Emerging and developing economies" as defined by the IMF at www.imf.org/external/pubs/ft/weo/2009/01/weodata/groups.htm#ae). Candidates must also meet the admission criteria for graduate studies in Geology and within the School of Graduate Studies at the Univ. of Toronto. To apply, candidates should submit a research proposal and arrange for transcripts and two letters of reference to be sent directly to the address below. Students must also submit a separate statement of intent outlining their

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Twitter

Follow GSA on Twitter as "@geosociety"; and we're at <http://twitter.com/geosociety>. GSA currently has over 350 followers, most of them "geotweeps" (your fellow scientists and colleagues).

LinkedIn

The Geological Society of America is linked in at <http://www.linkedin.com/>. We invite GSA members and interested geoscience professionals to use this space for discussion and networking opportunities.



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plans for work/study in a developing nation upon graduation. The deadline for applications is 15 January 2010. Original transcripts should be mailed to Lynn Slotkin (Dept. of Geology, University of Toronto, 22 Russell St., Toronto ON M5S 3B1) and other material sent by mail or electronically (slotkin@geology.utoronto).

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

Applications for graduate study at Case are accepted on a rolling basis, though students requesting financial assistance in Fall 2010 are encouraged to apply by 1 February 2010. CWRU is committed to diversity and equality. Students from all backgrounds are encouraged to apply.

Fellowship Opportunities

WATERSHED SCIENCE AND POLICY IGERT PH.D. FELLOWSHIPS

Southern Illinois University (SIU) is offering Ph.D. fellowships under NSF's Integrative Graduate Education Research and Training (IGERT) program. Fellowships are available to U.S. citizens and permanent residents in any water-, river- or watershed-related field of study, including Geology, Hydrology, Geography, Engineering, Plant Biology, Zoology, Ecology, and other areas. Applicants should have a M.S.-level degree at the time of enrollment (direct Ph.D. possible in cases of exceptional merit) and should have grades, test scores, and research records commensurate with one of NSF's most coveted fellowship awards. Fellowship benefits include \$30,000/year stipends, \$10,500/year education allowances, student laptops, annual international river basin tours, and support for research, conference travel, etc. Application deadline is 15 Jan. 2010. For more information, please see www.igert.siu.edu or contact igert@siu.edu.

DAVID B. HARRIS POSTDOCTORAL FELLOWSHIP TEXAS A&M UNIVERSITY

The Department of Geology and Geophysics at Texas A&M University-College Station is pleased to announce the availability of a postdoctoral fellowship funded through a gift from David B. Harris. The postdoctoral fellowship appointment is two years. Outstanding young scientists who have finished their Ph.D. degree, or who will finish prior to 1 September 2010, are eligible to apply. Research may be in any area of the geological and geophysical sciences. However, we are particularly interested in receiving applications from scientists whose work will contribute to existing research programs in the Department of Geology and Geophysics. Information about the Department can be found at <http://geoweb.tamu.edu>.

Review of applications will begin 1 January 2010. Applications should include a curriculum vita, statement of proposed research, and names and addresses of three referees. Applicants are urged to contact a member of the Department of Geology and Geophysics with whom they would collaborate. Electronic submissions are encouraged (lamb@geo.tamu.edu, pdf or Word format) or they can be mailed to Dr. Will Lamb, Chair of Selection Committee, David B. Harris Postdoctoral Fellowship, Department of Geology and Geophysics, Texas A&M University, Mail Stop 3115, College Station, TX 77843-3115, USA. Texas A&M University is an affirmative action/equal opportunity employer committed to diversity.

ASSISTANT PROFESSOR

Geological Sciences – Seismologist

The Department of Geological Sciences at The University of Alabama invites applications for a tenure-track faculty position in Seismology beginning in August 2010. The position will be filled at the Assistant Professor level. Candidates must have a strong record of research and a Ph.D. in Geology, Geophysics or a related field. We are seeking an outstanding scientist, whose research will a) emphasize the use of seismic data to solve geological problems; and/or b) explore crustal structures, including sedimentary basin structures with using seismic data. The specific areas of research may include, but are not limited to, solid-earth seismology, reflection, refraction and exploration seismology. This is a tenure-track appointment and will be filled at the assistant professor level in August 2010. The successful candidate will be expected to (i) establish a vigorous, externally-funded, research program; (ii) teach geology courses at the introductory level, as well as develop and teach courses at the undergraduate and graduate levels in their field of expertise, and (iii) supervise student research projects at the undergraduate, masters, and doctoral levels. This position expands the Department's Geophysics program and complements other Department programs in Environmental Change and Natural Hazards, Petroleum Geology, Sedimentary Basin Analysis, Structural Geology and Tectonics. The Department of Geological Sciences hosts excellent computational and laboratory facilities in Geophysics.

Applications for this position must be submitted electronically. A list of required documents and application instructions can be found at <https://facultyjobs.ua.edu>. Names and contact information for at least 3 references should be attached as "Other Document." For additional information, contact Dr. Ibrahim Çemen, at icemen@as.ua.edu or 205-348-8019, or visit www.geo.ua.edu. Applications will be reviewed beginning January 15, 2010, and will continue until the position is filled.

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NOTICE

of Spring 2010 GSA Council Meeting



Meetings of the Council of The Geological Society of America are open to GSA Fellows, members, and associates of the Society, who may attend as observers, except during executive sessions. Only Councilors and Officers may speak to agenda items, except by invitation of the chair.

GSA Headquarters,
Boulder, Colorado, USA

Saturday, 17 April 2010
8 a.m.–5 p.m.

Sunday, 18 April 2010
8 a.m.–noon



The Geological Society of America, 3300 Penrose Place, P.O. Box 9140,
Boulder, CO 80301-9140, USA | +1-303-357-1000, option 3, or +1-888-443-4472

2009 OEST AWARD RECIPIENTS

The National Association of Geoscience Teachers (NAGT) has announced its 2009 Outstanding Earth Science Teacher (OEST) Award recipients. These awards are given to outstanding pre-college teachers who have made exceptional contributions to the stimulation of interest in the earth sciences.

The OEST award is administered by The Geological Society of America. For more information, go to <http://nagt.org/nagt/programs/09awards.html>.

GSA Congratulates These Outstanding Earth Science Teachers!

OEST SECTION WINNERS

CENTRAL SECTION

Dennis Dougherty

Sault Area Public Schools
(retired)
Sault Ste. Marie, Mich., USA

EASTERN SECTION

Shelly Anne Witham

High Tech High School
North Bergen, N.J., USA

PACIFIC NORTHWEST SECTION

Roger Groom

Mt. Tabor Middle School
Portland, Ore., USA

FARWEST SECTION

Laura Hollister

Pitman High School
Turlock, Calif., USA

SOUTHEAST SECTION

Cliff Hudson

Martin County Public Schools
Williamston, N.C., USA

MIDCONTINENT SECTION

Richard Snyder

Kickapoo High School
Springfield, Mo., USA

SOUTHWEST SECTION

Deborah Morgan

North Sevier Middle School
Salina, Utah, USA

NEW ENGLAND SECTION

Elisa D'Amore

Stoneham High School
Stoneham, Mass., USA

OEST STATE WINNERS

OEST ALASKA

Victor Trautman

Petersburg High School
Petersburg, Alaska, USA

OEST NEW YORK

Renee Aubry

Port Chester High School
Port Chester, N.Y., USA

OEST ARIZONA

Wendy Barnett

Sonoran Science Academy
Tucson, Ariz., USA

OEST NORTH CAROLINA

Cliff Hudson

Martin County Public Schools
Williamston, N.C., USA

OEST ILLINOIS

Charles Simer

Woodlawn Grade School
Woodlawn, Ill., USA

OEST OREGON

Roger Groom

Mt. Tabor Middle School
Portland, Ore., USA

OEST MARYLAND

Nina VanKleeck

Aberdeen High School
Aberdeen, Md., USA

OEST PENNSYLVANIA

Verle Emanuelson

Tulpehocken Junior-Senior
High School
Bernville, Pa., USA

OEST MICHIGAN

Dennis Dougherty

Sault Area Public Schools
(retired)
Sault Ste. Marie, Mich., USA

OEST SOUTH CAROLINA

Derenda Marshall

McDonald Elementary
School
Georgetown, S.C., USA

OEST NEW JERSEY

Shelly Anne Witham

High Tech High School
North Bergen, N.J., USA

OEST TENNESSEE

Frances Hamilton

Highland Rim School
Fayetteville, Tenn., USA

OEST UTAH

Deborah Morgan

North Sevier Middle School
Salina, Utah, USA

OEST VIRGINIA

James L. Ruffa II

Clements Junior High School
Prince George, Va., USA

OEST WASHINGTON

Herb Bergamini

Northwest School
Seattle, Wash., USA

OEST WEST VIRGINIA

Pamela Casto

Christ Academy
Point Pleasant, W.Va., USA

OEST WISCONSIN

Mike Steiner

Chetek Middle School
Chetek, Wis., USA



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NEW RELEASES

Carbon Cycling in Northern Peatlands

Andrew J. Baird, Lisa R. Belyea, Xavier Comas, A. S. Reeve, and Lee D. Slater, Editors

Carbon Cycling in Northern Peatlands examines the role that northern peatlands play in regulating the atmospheric carbon budget. It summarizes current research in four interconnected areas: large-scale peatland dynamics and carbon cycling; plant and microbial dynamics and their effect on carbon fluxes to the atmosphere; methane accumulation in, and loss from, peatlands; and water and dissolved carbon fluxes through peatlands.

2009, 299 pp., hardbound, ISBN 978-0-87590-449-8 • List Price \$136.00 | ~~Member Price \$95.00~~

Carbon Sequestration and Its Role in the Global Carbon Cycle

Brian J. McPherson and Eric T. Sundquist, Editors

For carbon sequestration, the issues of monitoring, assessment, and verification of carbon content and storage efficacy are perhaps the most uncertain yet most critical issues facing the broader context of climate change in relation to carbon sequestration.

2009, 350 pp., hardbound, ISBN 978-0-87590-448-1 • List Price \$124.00 | ~~Member Price \$87.00~~

State of the Cryosphere: Glaciers and Ice Sheets

Hamish Pritchard, Editor

The cryosphere is a uniquely sensitive and strikingly symbolic indicator of change, but it remains one of the most poorly sampled components of the climate system. Ice sheets and glaciers are at the heart of the cryosphere. They act as a vast and enduring reserve of ice that contrasts with the widespread but transient seasonal snow and sea ice cover.

2009, E-book, ISBN 978-0-87590-731-4 List Price \$39.00 | ~~Member Price \$27.00~~

Amazonia and Global Change

Michael Keller, Mercedes Bustamante, John Gash, and Pedro Silva Dias, Editors

Amazonia and Global Change synthesizes results of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) for scientists and students of Earth system science and global environmental change.

2009, 576 pp., hardbound, ISBN 978-0-87590-476-4 • List Price \$120.00 | ~~Member Price \$84.00~~

Surface Ocean–Lower Atmosphere Processes

Eric Saltzman, Corinne Le Quéré, Editors

The focus of *Surface Ocean–Lower Atmosphere Processes* is biogeochemical interactions between the surface ocean and the lower atmosphere. This volume is an outgrowth of the Surface Ocean–Lower Atmosphere Study (SOLAS) Summer School.

2009, 350 pp., hardbound, ISBN 978-0-87590-477-1 • List Price \$124.00 | ~~Member Price \$87.00~~

Indian Ocean Biogeochemical Processes and Ecological Variability

Raleigh Hood, S. Wajih A. Naqvi, Jerry Wiggert, Kenneth Brink, and Sharon Smith, Editors

Indian Ocean Biogeochemical Processes and Ecological Variability provides a unique synthesis of current knowledge on Indian Ocean biogeochemistry and ecology, and an introduction of new concepts and topical paradigm challenges. It also reports on the development of more extensive/frequent observational capacity being deployed in the Indian Ocean.

2009, 350 pp., hardbound, ISBN 978-0-87590-475-7 • List Price \$124.00 | ~~Member Price \$87.00~~

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radiocarbon@gns.cri.nz

Location

National Isotope Centre

30 Gracefield Road

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PO Box 31312

Lower Hutt 5040

New Zealand

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F +64-4-570 4657



Call for Papers

2010

GSA Section Meetings

Northeastern-Southeastern Joint Meeting

13–16 March, Baltimore, Maryland, USA

Early registration deadline: 8 Feb. 2010

North-Central-South-Central Joint Meeting

11–13 April, Branson, Missouri, USA

Early registration deadline: 8 March 2010

Rocky Mountain Section Meeting

21–23 April, Rapid City, South Dakota, USA

Early registration deadline: 22 March 2010

Cordilleran Section Joint Meeting with Pacific Section, AAPG

27–29 May, Anaheim, California, USA

Early registration deadline: 26 April 2010

Coming to *GSA Today* in February 2010

- * **Science article:** Rock to regolith conversion: producing hospitable substrates for terrestrial ecosystems, by R.C. Graham et al.
- * Summary of the Inaugural Young Earth-Scientists Congress, 25–28 October 2009, Beijing, China
- * Penrose Conference Announcement: Origin and Uplift of the Sierra Nevada, California, USA
- * In Memoriam

GSA Today articles from 1995 on are open access via link at www.geosociety.org/pubs/.

Journal Highlights



2009 Portland Meeting Follow-Up

Discover interesting research at the GSA Annual Meeting?

GSA received a record number of abstracts this year, and much of that research will be expanded on in our journals and books. Dig deeper at <http://www.gsapubs.org/search/>.

Have a presentation you are looking to publish?

With six journals and four book series, GSA has a range of publication outlets to meet your needs for speed of publication, article size, targeted collections, and distribution. Author information can be found at <http://www.geosociety.org/pubs/contrib.htm>.

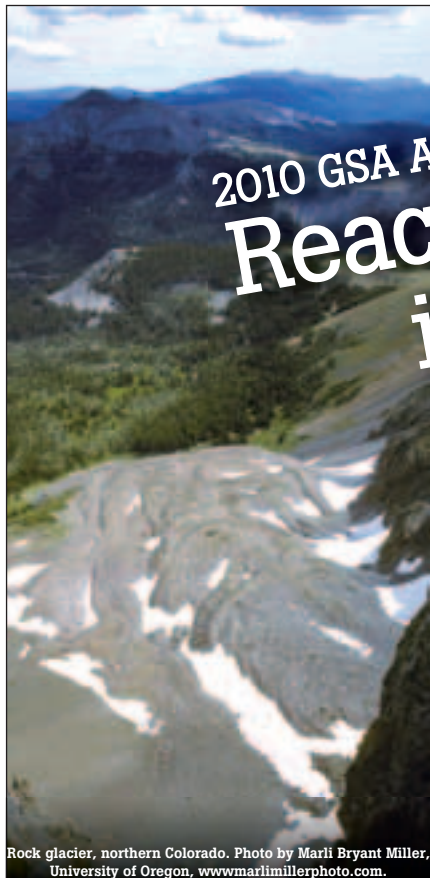
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GSA Journals online:

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Rock glacier, northern Colorado. Photo by Marli Bryant Miller, University of Oregon, www.marlimillerphoto.com.

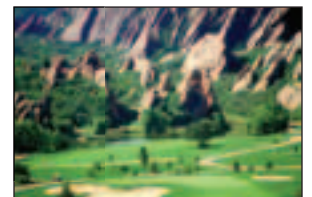
2010 GSA Annual Meeting & Exposition Reaching New Peaks in Geoscience

31 Oct. – 3 Nov. 2010
Colorado Convention Center
Denver, Colorado, USA

Abstract Deadline: 10 August 2010



Right, top to bottom: Garden of the Gods, Flatirons Golf Course, Civic Park and downtown Denver, and Colorado Sand Dunes. Photos used with permission from Visit Denver, the Convention and Visitors Bureau.



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