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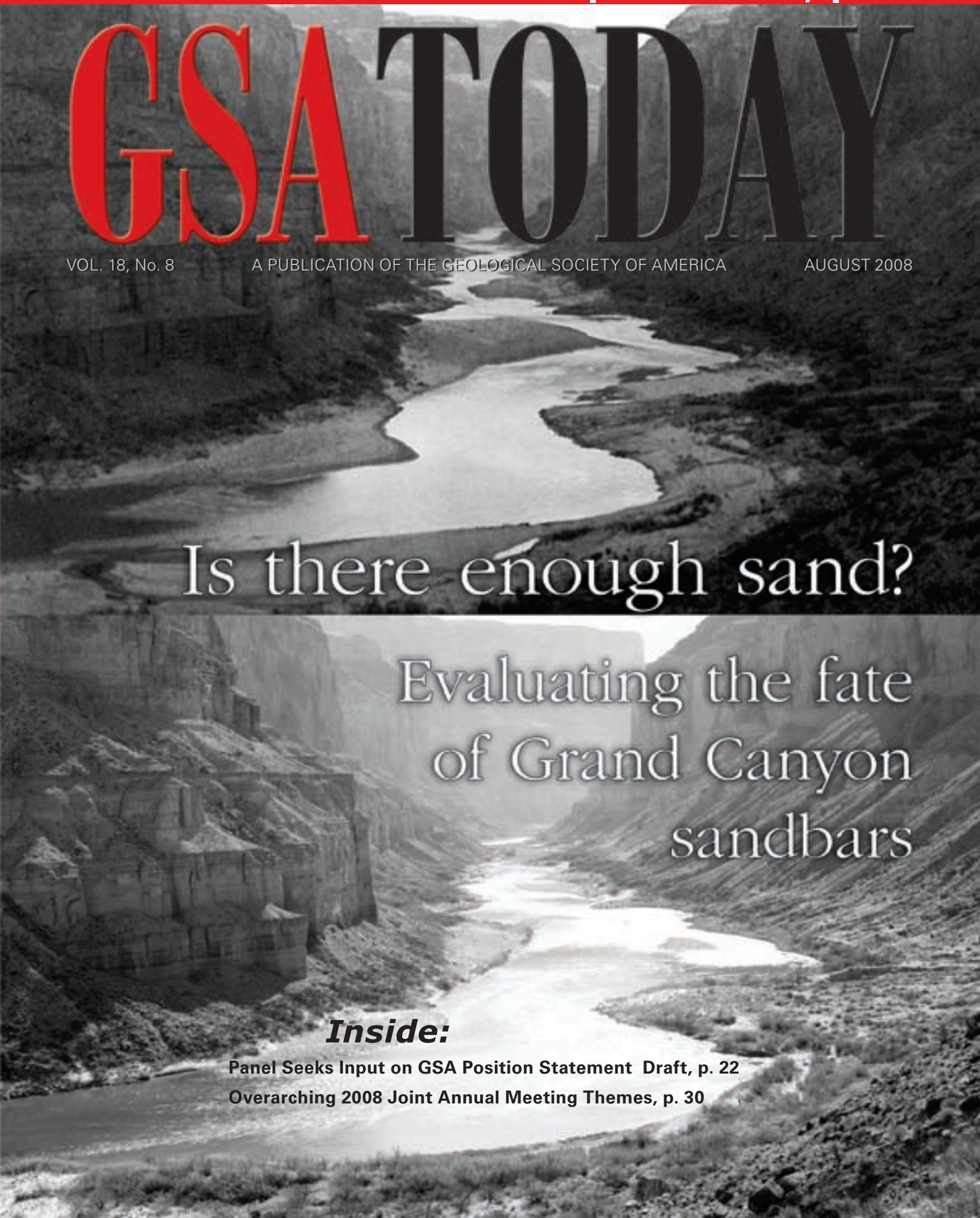

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Evaluating the fate of Grand Canyon sandbars

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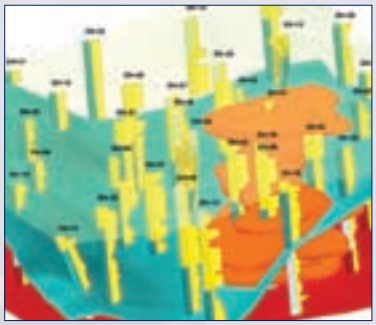

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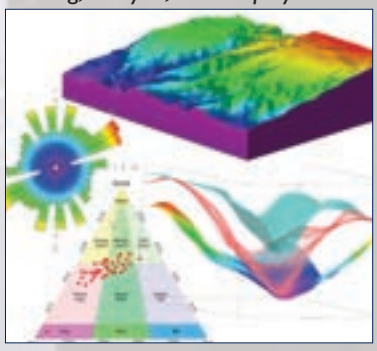

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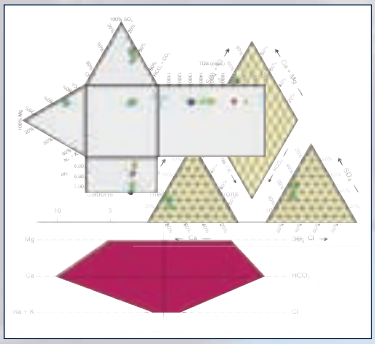

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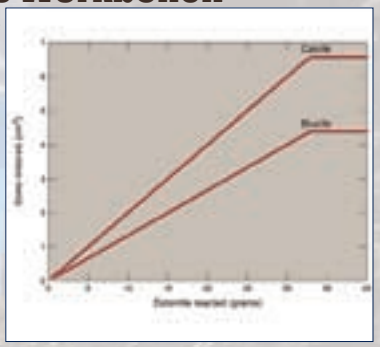

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VOLUME 18, NUMBER 8 ▲ AUGUST 2008

SCIENCE ARTICLE

Cover: Matched views of the Colorado River downstream from Nankoweap Creek in Grand Canyon National Park, ~52.8 miles from Lees Ferry, Arizona, USA. Top: 18 Jan. 1890. Robert Brewster Stanton photographed this downstream view showing the large, typically nonvegetated fluvial sandbar deposits common in Grand Canyon prior to river regulation (R.B. Stanton 361, courtesy of the National Archives). Bottom: 5 Feb. 1991. Repeat view of Stanton's location shows sandbar loss and increased riparian vegetation below Glen Canyon Dam since it was closed in 1963 (USGS, Stake 1424b). See "Is there enough sand? Evaluating the fate of Grand Canyon sandbars" by S.A. Wright et al., p. 4–10.

Erratum: Two units in the July *GSA Today* science article (v. 18, no. 7, p. 4–11) are incorrect: (1) Baoshan was used when the subject was Baoxing, and (2) Longquan was used rather than Longchuan. Please make a note of these corrections.

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Is there enough sand?
Evaluating the fate of Grand Canyon sandbars

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ABSTRACT

Large dams have the potential to dramatically alter the flow regime, geomorphology, and aquatic ecosystem of downstream river reaches. Development of flow release regimes in order to meet multiple objectives is a challenge facing dam operators, resource managers, and scientists. Herein, we review previous work and present new analyses related to the effects of Glen Canyon Dam on the downstream reach of the Colorado River in Marble and Grand Canyons. The dam traps the entire incoming sediment load in Lake Powell and modulates the hydrologic regime by, for example, eliminating spring snowmelt floods, resulting in changes in the geomorphology of the river downstream. The primary geomorphic impact has been the erosion of sandbars along the banks of the river. Recognition of this impact has led to many scientific studies and a variety of experimental operations of Glen Canyon Dam with the goal of rebuilding the eroding sandbars. These efforts have thus far been generally unsuccessful and the question remains as to whether or not the dam can be operated such that sandbars can be rebuilt and maintained over extended periods with the existing sediment supply. We attempt to answer this question by evaluating a dam operation that may be considered a "best-case scenario" for rebuilding and maintaining eroded sandbars. Our analysis suggests that this best-case scenario may indeed have viability for rebuilding sandbars, and that the initial rate at which sandbars could be rebuilt is comparable to the rate at which sandbars have been eroded since dam construction. The question remains open as to the viability of operations that deviate from the best-case scenario that we have defined.

INTRODUCTION

Large dams have the potential to profoundly transform downstream riverine hydrology, geomorphology, and ecosystem function (Nilsson et al., 2005; Collier et al., 2000; Williams and Wolman, 1984; Syvitski et al., 2005). Flood control and elimination of the upstream sediment supply perturb the downstream sediment balance (Grant et al. 2003; Schmidt and Wilcock, 2008). Immediately below a large dam, sediment deficit conditions exist because the transport capacity of the river exceeds the supply. In such a situation, fine sediment is evacuated from the channel, and the bed may become incised, potentially causing disconnection with the pre-dam floodplain and changing the distribution and availability of aquatic habitats. Sediment evacuation caused by deficit conditions has been described on many large rivers, including the Rio Grande below Elephant Butte Dam (Stevens, 1938), and the Colorado River below Glen Canyon Dam (Grams et al., 2007) and Hoover Dam (Borland and Miller, 1960). At some point farther downstream, sediment mass balance conditions may shift to surplus if there is sufficient resupply of sediment by tributaries. An extreme example of surplus is that of the Rio Grande near Presidio, Texas (Everitt, 1993). The location of the transition from deficit to surplus depends on the rate that downstream tributaries supply sediment as well as the flow regime released from the dam, which controls the transport capacity of the post-dam river. Understanding the relationship between downstream sediment supply and transport capacity is essential for resource management downstream from dams where aquatic habitat is linked to river morphology.

One notable effort to understand these relationships has been ongoing for several decades on the Colorado River in Glen and Grand Canyons downstream from Glen Canyon Dam (Fig. 1). The completion of Glen Canyon Dam in 1963 substantially reduced the downstream sediment supply by trapping in Lake Powell reservoir (Topping et al., 2000a, 2000b). In addition, flow regulation by the dam has eliminated the large annual snowmelt floods while increasing base flows (Topping et al., 2003); flow releases through the power plant also contain seasonal and daily cycles that follow electricity demand in the western U.S. (White et al., 2005). Environmental flow constraints were imposed on the dam's power plant operation after 1991 due to perceived effects on downstream physical, biological, and cultural resources (U.S. Department of the Interior, 1995, 1996). These "Record-of-Decision" (ROD) operations reduced the daily range and daily peaks of fluctuating flows, and subsequent experimental releases have included low steady flows and large simulated floods. However, more than four decades after construction of this large dam (the fourth highest in the United States) and after considerable scientific research and monitoring, scientists and river stakeholders continue to debate its impacts on downstream resources and how to reverse those environmental conditions that are deemed undesirable by society (Lovich and Melis, 2005; Melis et al., 2006).

One of the distinctive environmental attributes of the pre-dam river are sandbars that form in large eddies downstream of tributary debris fans (Schmidt, 1990; Schmidt and Rubin, 1995; Fig. 2) and floodplain-like channel-margin deposits.

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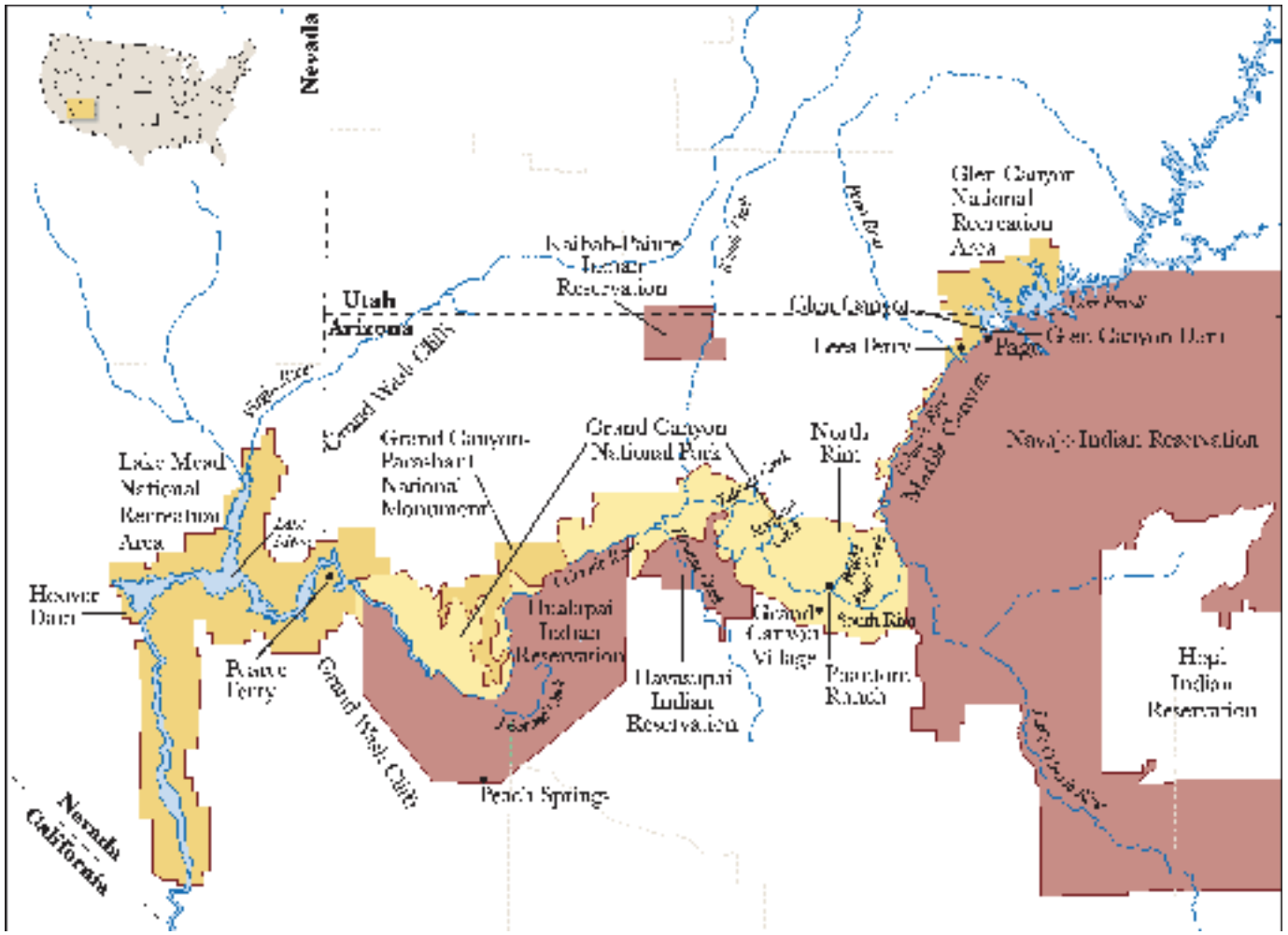

Figure 1. Location map of the Colorado River between Lakes Powell and Mead in northern Arizona, USA. Marble Canyon is the reach of river between Lees Ferry and the confluence with the Little Colorado River.

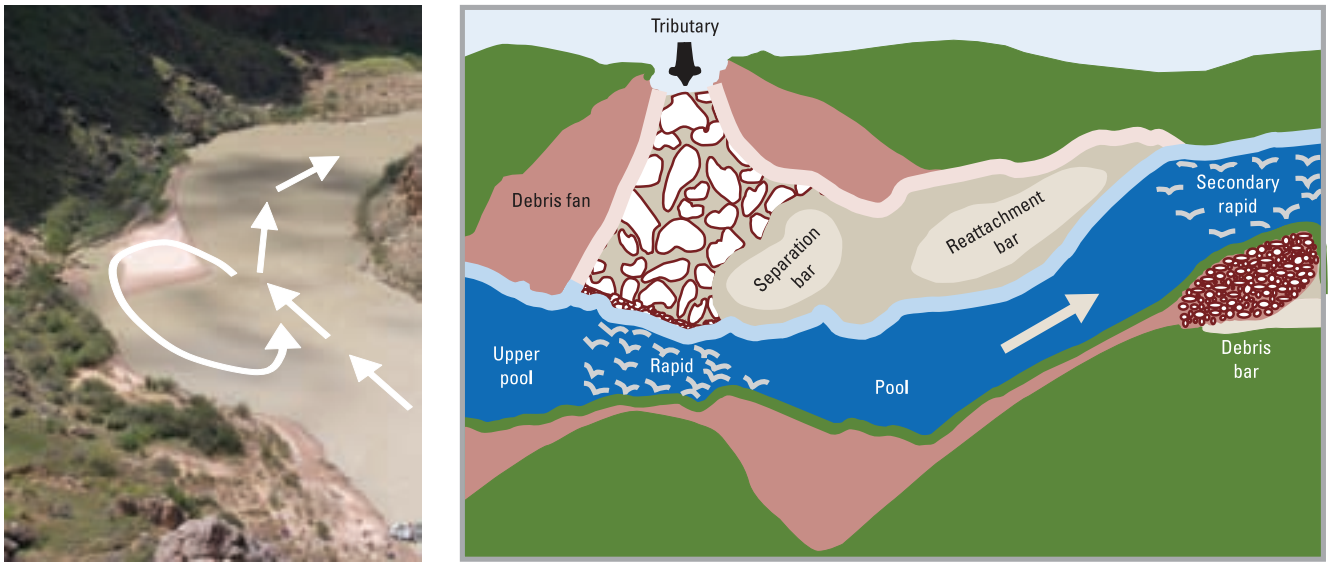

Figure 2. Example of a recirculating eddy and sandbar formed around the flow reattachment point along the Colorado River below Glen Canyon Dam. Image on right reproduced from Webb et al. (2005).

These sandbars are considered valuable resources by stakeholders of the Glen Canyon Dam Adaptive Management Program (www.usbr.gov/uc/rm/amp/index.html) for a variety of reasons: they are a fundamental element of the pre-dam riverscape within Grand Canyon National Park; they provide Park visitors, such as river runners and hikers, with recreational areas; they create zones of low-velocity aquatic habitat for juvenile native fish; they are the substrate for unique but limited riparian vegetation in an arid setting; and they are a source of sand for upslope wind-driven transport that may help protect archaeological resources.

Several attempts have been made at evaluating the post-dam sand budget; i.e., determining whether or not the amount of sand supplied by tributaries downstream of the dam exceeds the capacity of the regulated river to transport sand (see review in Wright et al., 2005). The numerous studies of the post-dam sand budget have come to conflicting results, but recent studies have concluded that the Colorado River between the dam and Phantom Ranch (Fig. 1) was evacuated of fine sediment from much of its bed and large parts of its eddies during the first three decades after dam closure and that erosion continues at a much slower rate today (Rubin et al., 2002; Schmidt et al., 2004; Wright et al., 2005; Webb et al., 2002). Because sandbars have continued to erode under ROD operations, the primary sediment-related question identified by scientists at a knowledge assessment workshop in July 2005 (Melis et al., 2006) was, "Is there a 'flow-only' operation that will rebuild and maintain sandbar habitats over decadal time scales?"

The goal of the analysis presented here is to evaluate what might be considered the "best-case flow-only scenario" for reversing the trend of sandbar erosion without sediment augmentation from sources in the upstream reservoir (Randle et al., 2007). Our analysis is conceptual but nevertheless reveals whether there is any reasonable expectation that a flow-only scenario can rebuild and maintain eroding sandbars in the post-dam era. If there is, then this analysis provides a basis for further analyses of other scenarios and sets a best-case expectation for the rate at which sandbars could be rebuilt. If not, then the analysis sets the stage for managers' value-based discussions related to costs and benefits associated with non-flow options such as sediment augmentation. The best-case flow-only scenario is relatively easy to evaluate with existing knowledge as compared to more complex scenarios, and this analysis helps to identify areas of uncertainty that require future research.

OPTIMAL DAM OPERATIONS FOR REBUILDING SANDBARS

For the analysis presented herein, flow releases from Glen Canyon Dam can be broken into two components: (1) short-duration (on a time scale of days) dam releases that are substantially higher than "normal" releases—herein referred to as "high flow events"; and (2) intervening, or "normal," operations for the remainder of the year. The intervening operations control the amount of sand that is retained, if any, in the reach during tributary flooding and the amount that is exported during periods of tributary quiescence. High flow events are required to transfer sand from the channel bed and low-elevation parts of sandbars, where sand is first deposited when a tributary brings sediment into the Colorado River, to higher-stage environments inundated only during floods, such as high-elevation parts of sandbars and other channel-margin deposits.

The "optimal" intervening dam operation is that which will result in the most tributary sand being available in the mainstem Colorado River for redistribution during high flow events. It is not difficult to specify this optimum operation because sediment transport theory dictates that a steady flow will transport less sand than an equivalent-volume fluctuating flow (e.g., ASCE, 1975). Thus, dam releases that vary seasonally and daily to meet electricity demand, such as approved by the ROD, are not optimal for retaining sand on the river bed prior to redistribution to higher elevations by high flow events. Higher sand transport rates during fluctuating flows as compared to steady flows were recognized in the 1995 Environmental Impact Statement (U.S. Department of the Interior, 1995). Thus, for a given annual volume release, the optimal dam operation for accumulating tributary sand inputs is a constant, steady flow over the entire year. The optimal annual release volume for accumulating tributary sand is the minimum volume stipulated by the various agreements that govern water delivery between the upper and lower Colorado River basins.

It is more difficult to specify the optimal frequency and hydrograph shape of short-duration high flow events, because these releases do not optimize overall sand storage. That is, high flow events have been called a "double-edged sword" by Rubin et al. (2002), because they necessarily export relatively large volumes of sand in order to transfer sand to high-elevation portions of sandbars. Thus, the optimal use of high flow events is such that they maximize storage of sand in "desirable" environments while attempting to minimize downstream export. Because we are currently unable to precisely define this optimal use, we assume an annual high flow event with a hydrograph shape that is dictated by the amount of sand that has accumulated in a given year. For example, in years with very low tributary inputs there might be no high flow event or one with a small peak of only a few hours' duration. Or, in a year with tributary inputs that are substantially above average, the high flow event may have a higher peak and longer duration. These details are not necessary for the analysis in the following section. Also, the timing of the annual high flow event is not important for our analysis so long as there is abundant sand available in the river channel below the dam from recent tributary floods.

EVALUATION OF THE OPTIMAL DAM OPERATIONS

Marble Canyon Sand Budget

We focus our analysis on Marble Canyon, the 100-km reach of the Colorado River situated between the confluences of the Paria River, the first major tributary below the dam, and Little Colorado River (Fig. 1), because this is the first reach downstream of the dam with a significant post-dam sand supply. A simple annual average sand budget for this reach is

$$\Delta M = M_{in} - M_{io} - M_{bf}, \quad (1)$$

where ΔM is the change in sand mass in the reach, M_{in} is the incoming mass of sand from the Paria River and other smaller

tributaries, M_{io} is the mass of sand exported during intervening operations, and M_{hf} is the mass exported during high flows. The mass of sand coming into the reach from upstream (Glen Canyon) is assumed to be zero because releases from the dam contain almost no sediment, and the 25-km-long reach from the dam to Lees Ferry is substantially depleted of sand (Grams et al., 2007). Since the tributary inputs will almost always occur during intervening operations, M_{in} and M_{io} can be combined into a term representing the change in storage during intervening operations:

$$\Delta M = \Delta M_{io} - M_{hf}, \quad (2)$$

where $\Delta M_{io} = M_{in} - M_{io}$. From (Eq. 2) it is apparent that in order for the overall storage in the reach to be positive, the export during high flow events must be less than the amount of sand that accumulates in the reach during intervening operations. It follows that if ΔM_{io} is negative, then no sand would be available, on average, for redistribution during high flows, and it would thus be impossible to rebuild and maintain sandbars. The first step, then, in evaluating the optimal dam operation is to estimate the potential sand accumulation during intervening operations (i.e., the sign and magnitude of ΔM_{io}).

Accumulation during Intervening Operations

The average annual sand supply from tributaries (M_{in}) is relatively well constrained. The Paria River is the primary sand supply to Marble Canyon (Fig. 1) and delivers ~1,500,000 metric tons of sand per year (t/yr) (Topping et al., 2000a). Smaller tributaries are estimated to supply ~290,000 t/yr to Marble Canyon (Webb et al., 2000), resulting in total tributary sand supply of ~1,800,000 yr. Pre-dam, ~23,000,000 yr of sand was supplied from the watershed upstream from the Paria River (Topping et al., 2000a), such that the post-dam sand supply to Marble Canyon is ~7%–8% of the pre-dam supply.

In order to estimate export during intervening operations, the year-round steady flow rate must be specified. This rate depends on the minimum annual release volume from the dam. In December 2007, the U.S. Secretary of the Interior signed a ROD that implemented interim guidelines for the coordinated operation of Lakes Powell and Mead (U.S. Department of the Interior, 2007a). These interim guidelines stipulate a minimum objective release volume of 10.2×10^9 m^3/yr (8.23 million acre-feet [MAF]) as well as operational tiers under which the annual release may be reduced to as low as 8.6×10^9 m^3 (7.0 MAF). However, the final environmental impact statement concludes that during the period 2008–2026, the probability of releases being below the minimum objective is ~10% (U.S. Department of the Interior, 2007b, figures 4.3-13, p. 4-43). Because of this relatively low probability and the uncertainty surrounding future hydrologic conditions in the basin (Barnett et al., 2008; Seager et al., 2007), we chose to evaluate the minimum objective release volume of 10.2×10^9 m^3 (8.23 MAF), which, averaged over the entire year, equates to a steady flow of 322 m^3/s. We also note that this has been the annual release volume since 2001 due to drought conditions and low reservoir levels.

The next step is to estimate the sand concentration at the steady 322 m^3/s water discharge. Several previous studies have attempted to define a relationship between water discharge and sand concentration, such as Randle and Pemberton (1987), upon which the ROD operation was based. Subsequent research, however, has shown that the relationship between suspended-sand concentration and water discharge is not constant in this reach of river; rather, substantial shifts occur due to changes in the upstream supply of sand (Topping et al., 1999, 2000a, 2000b, 2005, 2007; Rubin and Topping, 2001). These shifts make the estimation of sand concentration at a steady 322 m^3/s water discharge a more complicated affair than in rivers where discharge and sediment supply are more in equilibrium. That is, some assumptions regarding the state of sand supply must be made in order to estimate the sand concentration.

Figure 3 shows suspended-sand concentration versus water discharge as measured at two gages in Marble Canyon between August 1999 and January 2008, illustrating the wide range in sand concentration that can occur for a given water discharge. The 30-mile gage is located in middle Marble Canyon, and the 61-mile gage is located at the lower end of Marble Canyon (see Topping et al., 2006a, 2006b). At the 30-mile gage, sand concentrations for flows within ±5% of 322 m^3/s ranged from 9 to 104 mg/L, with median, mean, and standard deviation of 51, 51, and 31 mg/L, respectively. At the 61-mile gage, sand concentrations ranged from 11 to 150 mg/L, with median, mean, and standard deviation of 23, 34, and 29 mg/L, respectively. Figure 4 illustrates the effects of sand supply on sand concentration by plotting the concentrations contained in the box of Figure 3 along with the daily water discharge record for the Paria River (U.S. Geological Survey gage 09382000). During periods of little tributary activity, when the sand budget tends to be negative under ROD releases, such as 2001–2003 (Wright et al., 2005), the sand concentrations are lower. During periods

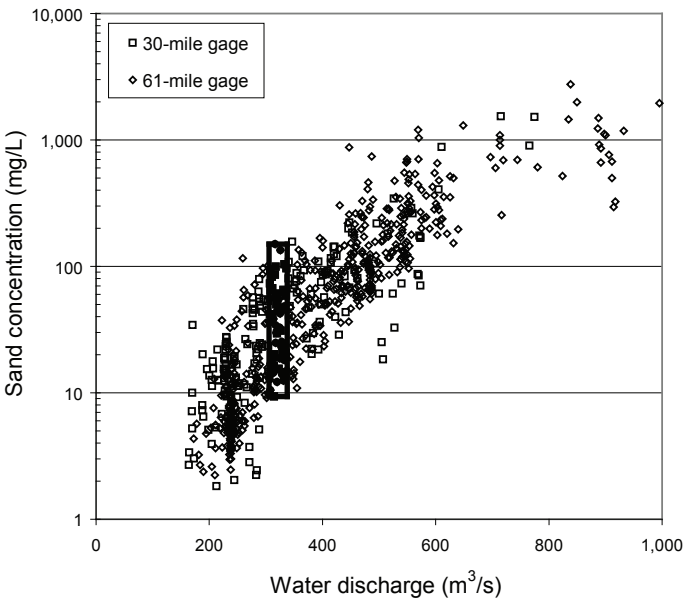

Figure 3. Suspended-sand concentration versus water discharge as measured in middle Marble Canyon (30-mile gage) and at the lower end of Marble Canyon (61-mile gage) for August 1999–January 2008. Bold rectangle encloses measurements made in the water discharge range of 322 m^3/s ±5%.

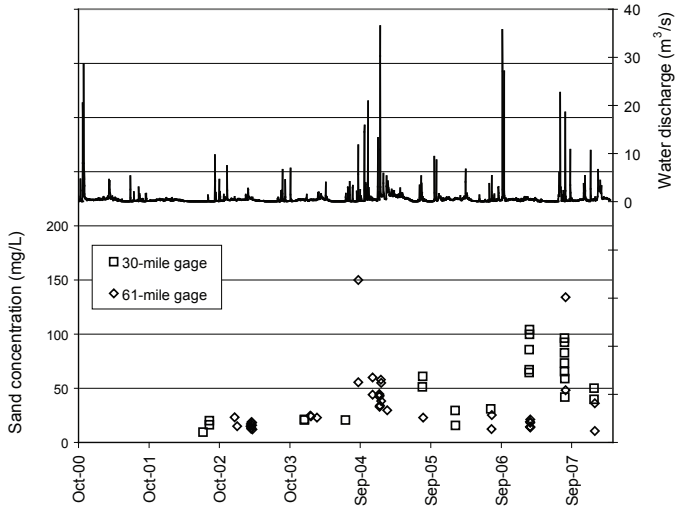

Figure 4. Paria River water discharge (top) and mainstem Colorado River sand concentrations for mainstem discharges in the 322 m^3/s ±5% range (bottom) for October 2000–April 2008. Sand concentrations increased during temporary sand accumulation in Marble Canyon following Paria floods in fall 2004, winter 2005, and fall 2006 and subsequently decreased as the tributary sand was exported from Marble Canyon.

of substantial tributary flooding and temporary accumulation of sand in Marble Canyon, such as fall 2004 (Topping et al., 2006b), winter 2005, and fall 2006 (U.S. Department of the Interior, 2008), concentrations are higher because sand supply is greater.

Because the steady 322 m^3/s operation is expected to transport substantially less sand than ROD operations, the sand supply should be greater on average such that sand concentrations under this operation would tend toward the high end of those measured during 1999–2008. Given this, our best estimate is based on the period from October 2006–January 2008, because tributary inputs were above average, dam releases were minimum annual volumes, and substantial accumulation of sand occurred in Marble Canyon (U.S. Department of the Interior, 2008). The median sand concentration measured during this period, based on both Marble Canyon gages, was 54 mg/L (Fig. 4), which when combined with steady 322 m^3/s yields an annual sand flux of ~500,000 t. This is the value we have used for M_{io} in subsequent calculations while acknowledging substantial uncertainty in the estimate due to the difficulty in projecting future sand supply conditions.

Redistribution during High Flow Events

Using these estimates for tributary inputs (1,800,000 t) and export during intervening operations (500,000 t), the potential accumulation in Marble Canyon, ΔM_{io}, is ~1,300,000 t. This is the mass of sand, on average, that would be available for redistribution during a high flow and is near the upper bound of the estimate for sand storage in upper Marble Canyon going into the November 2004 high flow (Topping et al., 2006a). In the pre-dam river, Topping et al. (2000a) estimated seasonal fine sediment accumulation in an average year of ~7,000,000 t, such that the potential accumulation during intervening dam operations described herein is ~20% of the estimated pre-dam seasonal accumulation. There would be substantial variation in the amount of sand accumulation from year to year owing to variability in tributary inputs, but we have chosen to focus on the average response instead of the variability because it provides more insight with respect to the long-term prospects for rebuilding and maintaining sandbars.

The degree to which sandbars can be rebuilt depends on how much of the sand that accumulates during intervening operations remains in sandbars following a high flow event. That is, what fraction of the accumulated sand is exported downstream, eventually to Lake Mead, versus deposited in sandbars? Topping et al. (2006b) estimated that ~10%–20% of the tributary sand that had accumulated in upper Marble Canyon was still in the reach following the 2004 high flow, presumably in sandbars. Though the 1996 high flow event resulted in an overall net loss of sediment from sandbars (Schmidt, 1999; Hazel et al., 2006), there was a gain in high-elevation volume ~20% of that was the losses from the low-elevation portions of sandbars and the channel. Hazel et al. (2006) estimated the potential active storage in sandbars in Marble Canyon to be ~13,000,000 t, or ~20% of the total pre-dam fine sediment load. Thus, it appears that a reasonable estimate for the fraction of sand transferred to sandbars during high flow events is ~10%–20% of the available supply. It follows, then, that ~200,000 t/yr of the 1,300,000 t/yr of potential sand accumulation could go toward building sandbars.

Comparison with Post-Dam Erosion Rates

Several existing data sets and previous analyses facilitate comparison of the potential annual accumulation in sandbars with the rate of sandbar erosion since dam closure. Using daily sediment records from gages near Lees Ferry and Phantom Ranch (Fig. 1), Rubin and Topping (2001) estimated that 16,000,000 t of fine sediment was eroded from this reach during high flow releases in April–June 1965. It is impossible to know precisely how much of this sediment came from sandbars versus the channel bed, but even a conservative estimate of 10% from sandbars yields 1,600,000 t of erosion during this three-month period, which is eight times our estimated potential annual accumulation. Schmidt et al. (2004) and Hazel et al. (2006) estimated the loss of fine sediment from sandbars from the pre-dam era through the 1990s to be ~6,000,000 t. Over the ~40 years since dam construction, this equates to an average annual erosion rate of ~150,000 t, which is in the same range as our estimated potential annual accumulation in sandbars (200,000 t). Thus, our analysis indicates that under the "best-case scenario" for hydrologic conditions and dam operations, sandbars could potentially be rebuilt, at least initially, at approximately the same rate as they have eroded since dam construction.

DISCUSSION

Though our analysis suggests potential annual sandbar accumulation at about the same rate as the post-dam erosion rate, we do not mean to imply that pre-dam conditions could be achieved in 40 years; this is almost certainly not the case. The cumulative rate of sandbar building depends on how much of the annual accumulation is maintained between high flow events, how the system changes as accumulation occurs over

time, and the frequency and magnitude of deviations in future annual release volumes from the minimum objective volume. Our analysis evaluates only the potential for accumulation in a given "average" year and does not address cumulative accumulation because there is too much uncertainty about how the system would evolve over multiple years, or even decades, under these operations. For example, we know that as accumulation occurs, sand export during intervening operations will increase, but we do not know by how much. Also, we have very little information on how stable the sandbars would be under steady flows. Finally, the probability that annual releases will exceed the minimum objective release in a given year is ~60% (U.S. Department of the Interior, 2007b, figure 4.3-13, p. 4–43) such that incremental gains in sandbar building made during periods of minimum objective releases would be subjected to higher flows more than half the time in the future.

The question remains open as to the viability of operations that deviate from the optimal conditions that we have defined, such as the current ROD operations that contain seasonal and daily variations in flow releases. One of the advantages of the operation we have defined is that it is simple enough that it can be evaluated relatively quickly with our existing knowledge. More complicated scenarios that include variability in upper basin hydrology, dam releases, and tributary sand supply become much more difficult to evaluate, particularly over extended periods, and require models that are as yet not available. Currently, all that we can say is that deviations from the optimal operation, such as annual volumes that exceed minimum objective releases and/or seasonal and daily flow variations, will either reduce the rate of sandbar building or lead to continued erosion instead of accumulation. That is, the sandbar rebuilding rate under the optimal operation can be considered an upper bound.

The ability to evaluate more complex operational scenarios will require future research, and one of the reasons for conducting the analysis presented here was to identify areas with the greatest uncertainty. Considerable research and monitoring has been conducted to define the magnitude of tributary inputs and the rate at which these inputs are exported from the system by ROD dam releases such that we feel these components of the analysis are relatively well constrained. The greatest uncertainty lies with our understanding of the processes of sandbar building during high flows and readjustment during subsequent flows. For example, our estimate for the transfer of sand from the channel to sandbars during high flows is made on the basis of only two experimental releases, conducted in 1996 and 2004 (data from a third experimental high flow test in March 2008 are still being collected and analyzed as of this writing). Also, significant uncertainty exists as to the rate at which recently deposited sandbars are eroded by subsequent flows, particularly under steady flows.

CONCLUSIONS

Despite extensive research and monitoring over the past several decades, the question of whether sandbars can be rebuilt and maintained in a sustainable manner along the Colorado River in Grand Canyon below Glen Canyon Dam has remained unanswered. Here, we have drawn from this extensive literature to conduct a relatively simple analysis of the potential for rebuilding sandbars under what might be considered a "best-case scenario" in terms of hydrologic conditions and dam operations. Our analysis suggests that this scenario may indeed have viability for rebuilding sandbars. We estimate a potential sandbar rebuilding rate of ~200,000 t/yr, which is comparable to the estimated average sandbar erosion rate since dam construction of ~150,000 t/yr. However, the similarity in these rates should not be used to infer that pre-dam conditions could be achieved in 40 years. Potential cumulative sandbar building would depend on how much of the annual accumulation is maintained between high flow events, how the system changes through time as accumulation occurs, and the frequency and magnitude of deviations in future annual release volumes from the minimum objective release. Deviations from our best-case scenario, such as seasonal variability in flow releases, daily flow fluctuations, or greater than minimum release volumes would either reduce the sandbar accumulation rate or result in continued erosion of sandbars.

REFERENCES CITED

ASCE, 1975, Sedimentation Engineering, Vanoni, V.A. ed.: ASCE Manuals and Reports on Engineering Practice, no. 54, 745 p.

Barnett, T.P., Pierce, D.W., Hidalgo, H.G., Bonfils, C., Santer, B.D., Das, T., Bala, G., Wood, A.W., Nozawa, T., Mirin, A.A., Cayan, D.R., and Dettinger, M.D., 2008, Human-induced changes in the hydrology of the western United States: Science, v. 319, p. 1080–1083, doi: 10.1126/science.1152538.

Borland, W.M., and Miller, C.R., 1960, Sediment problems of the lower Colorado River: Proceedings of the American Society of Civil Engineers: Journal of the Hydraulics Division, v. 86, HY4, p. 61–87.

Collier, M., Webb, R.H., and Schmidt, J.C., 2000, Dams and Rivers, a primer on the downstream effects of dams: U.S. Geological Survey Circular 1126, 94 p.

Everitt, B., 1993, Channel response to declining flow on the Rio Grande between Ft. Quitman and Presidio, Texas: Geomorphology, v. 6, p. 225–242, doi: 10.1016/0169-555X(93)90048-7.

Grams, P.E., Schmidt, J.C., and Topping, D.J., 2007, The rate and pattern of bed incision and bank adjustment on the Colorado River in Glen Canyon downstream from Glen Canyon Dam, 1956–2000: Geological Society of America Bulletin, v. 119, no. 5–6, p. 556–575, doi: 10.1130/B25969.1.

Grant, G.E., Schmidt, J.C., and Lewis, S.L., 2003, A geological framework for interpreting downstream effects of dams on rivers, *in* O'Connor, J.E., and Grant, G.E., A Peculiar River, geology, geomorphology, and hydrology of the Deschutes River, Oregon: American Geophysical Union Water Science and Application 7, p. 203–219.

Hazel, J.E., Topping, D.J., Schmidt, J.C., and Kaplinski, M., 2006, Influence of a dam on fine-sediment storage in a canyon river: Journal of Geophysical Research, v. 111, p. F01025, doi: 10.1029/2004JF000193.

Lovich, J.E., and Melis, T.E., 2005, Lessons from 10 years of adaptive management in Grand Canyon, *in* Gloss, S.P., Lovich, J.E., and Melis, T.S., The state of the Colorado River ecosystem in Grand Canyon: U.S. Geological Survey Circular 1282, p. 207–220.

Melis, T.S., Wright, S.A., Ralston, B.E., Fairley, H.C., Kennedy, T.A., Andersen, M.E., Coggins, L.G., Jr., and Korman, J., 2006, 2005 Knowledge Assessment of the Effects of Glen Canyon Dam on the Colorado River Ecosystem: An experimental planning support document: U.S. Geological Survey, 82 p.

Nilsson, C., Reidy, C.A., Dynesius, M., and Revenga, C., 2005, Fragmentation and flow regulation of the world's large river systems: Science, v. 308, p. 405–408, doi: 10.1126/science.1107887.

Randle, T.J., and Pemberton, E.L., 1987, Results and analysis of STARS modeling efforts of the Colorado River in Grand Canyon: Glen Canyon Environmental Studies Report, 41 p. plus 95 figures and 26 tables.

Randle, T.J., Lyons, J.K., Christensen, R.J., and Stephen, R.D., 2007, Colorado River ecosystem sediment augmentation appraisal engineering report: Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 71 p., http://www.gcmrc.gov/library/reports/physical/Fine_Sed/Randle2007.pdf (last accessed 12 May 2008).

Rubin, D.M., and Topping, D.J., 2001, Quantifying the relative importance of flow regulation and grain-size regulation of suspended-sediment transport (α), and tracking changes in bed-sediment grain size (β): Water Resources Research, v. 37, p. 133–146, doi: 10.1029/2000WR900250.

Rubin, D.M., Topping, D.J., Schmidt, J.C., Hazel, J., Kaplinski, M., and Melis, T.S., 2002, Recent sediment studies refute Glen Canyon Dam hypothesis: Eos (Transactions, American Geophysical Union), v. 83, no. 25, p. 273, 277–278, doi: 10.1029/2002EO000191.

Schmidt, J.C., 1990, Recirculating flow and sedimentation in the Colorado River in Grand Canyon, Arizona: The Journal of Geology, v. 98, p. 709–724.
Schmidt, J.C., 1999, Summary and synthesis of geomorphic studies conducted during the 1996 controlled flood in Grand Canyon, *in* Webb, R.H., Schmidt, J.C., Marzolf, G.R., and Valdez, R.A., eds., The controlled flood in Grand Canyon: Washington, D.C., American Geophysical Union, Geophysical Monograph Series, v. 110, p. 329–341
Schmidt, J.C., and Rubin, D.M., 1995, Regulated streamflow, fine-grained deposits, and effective discharge in canyons with abundant debris fans: Geophysical Monograph, v. 89, p. 177–194.
Schmidt, J.C., and Wilcock, P.R., 2008, Metrics for assessing the downstream effects of dams: Water Resources Research, v. 44, W04404, doi: 10.1029/2006WR005092
Schmidt, J.C., Topping, D.J., and Grams, P.E., 2004, System-wide changes in the distribution of fine-grained alluvium in the Colorado River corridor between Glen Canyon Dam and Bright Angel Creek, Arizona: Final Report to the Grand Canyon Monitoring Research Center, 107 p., http://www.gcmrc.gov/library/reports/physical/Fine_Sed/Schmidt2004.pdf (last accessed 12 May 2008).
Seager, R., Ting, M., Held, I., Kushnir, Y., Lu, J., Vecchi, G., Huang, H., Harnik, N., Leetmaa, A., Lau, N., Li, C., Velez, J., and Naik, N., 2007, Model projections of an imminent transition to a more arid climate in southwestern North America: Science, v. 316, p. 1181–1184, doi: 10.1126/science.1139601.
Stevens, J.C., 1938, The effect of silt-removal and flow-regulation on the regimen of Rio Grande and Colorado Rivers: Transactions, American Geophysical Union, v. 19, p. 653–659.
Syvitski, J.P.M., Vorosmarty, C.J., Kettner, A.J., and Green, P., 2005, Impact of humans on the flux of terrestrial sediment to the global coastal ocean: Science, v. 308, p. 376–380, doi: 10.1126/science.1109454.
Topping, D.J., Rubin, D.M., Nelson, J.M., Kinzel, P.J., III, and Bennett, J.P., 1999, Linkage between grain-size evolution and sediment depletion during Colorado River floods, *in* Webb, R.H., Schmidt, J.C., Marzolf, G.R., and Valdez, R.A., eds., The 1996 controlled flood in Grand Canyon: American Geophysical Union Geophysical Monograph 110, p. 71–98.
Topping, D.J., Rubin, D.M., and Vierra, L.E., Jr., 2000a, Colorado River sediment transport: Part 1: Natural sediment supply limitation and the influence of Glen Canyon Dam: Water Resources Research, v. 36, p. 515–542, doi: 10.1029/1999WR900285.
Topping, D.J., Rubin, D.M., Nelson, J.M., Kinzel, P.J., III, and Corson, I.C., 2000b, Colorado River sediment transport: Part 2: Systematic bed-elevation and grain-size effects of supply limitation: Water Resources Research, v. 36, p. 543–570, doi: 10.1029/1999WR900286.
Topping, D.J., Schmidt, J.C., and Vierra, L.E., Jr., 2003, Computation and Analysis of the Instantaneous-Discharge Record for the Colorado River at Lees Ferry, Arizona—May 8, 1921, through September 30, 2000: U.S. Geological Survey Professional Paper 1677, 118 p.
Topping, D.J., Rubin, D.M., and Schmidt, J.C., 2005, Regulation of sand transport in the Colorado River by changes in the surface grain size of eddy sandbars over multi-year timescales: Sedimentology, v. 52, p. 1133–1153, doi: 10.1111/j.1365-3091.2005.00738.x.
Topping, D.J., Wright, S.A., Melis, T.S., and Rubin, D.M., 2006a, High-resolution monitoring of suspended-sediment concentration and grain size in the Colorado River using laser-diffraction instruments and a three-frequency acoustic system: Proceedings, 8th Federal Interagency Sedimentation Conference, April 2–6, 2006, Reno, Nevada, CD-ROM only, ISBN 0-9779007-1-1.
Topping, D.J., Rubin, D.M., Schmidt, J.C., Hazel, J.E., and Melis, T.S., Wright, S.A., and Kaplinski, M., 2006b, Comparison of sediment-transport and bar-response results from the 1996 and 2004 controlled flood experiments on the Colorado River in Grand Canyon: Proceedings, 8th Federal Interagency Sedimentation Conference, April 2–6, 2006, Reno, Nevada, CD-ROM only, ISBN 0-9779007-1-1.
Topping, D.J., Rubin, D.M., and Melis, T.S., 2007, Coupled changes in sand grain size and sand transport driven by changes in the upstream supply of sand in the Colorado River: Relative importance of changes in bed-sand grain size and bed-sand area: Sedimentary Geology, v. 202, no. 3, p. 538–561, doi: 10.1016/j.sedgeo.2007.03.016.
Webb, R.H., Griffiths, P.G., Melis, T.S., and Hartley, D.R., 2000. Sediment delivery by ungaged tributaries of the Colorado River in Grand Canyon, Arizona: U.S. Geological Survey Water-Resources Investigations Report 00-4055, 67 p.
Webb, R.H., Melis, T.S., and Valdez, R.A., 2002, Observations of Environmental Change in Grand Canyon, Arizona: U.S. Geological Survey Water-Resources Investigations Report 02-4080, 33 p.
Webb, R.H., Griffiths, P.G., Magirl, C.S., and Hanks, T.C., 2005, Debris flows in Grand Canyon and the rapids of the Colorado River, *in* Gloss, S.P., Lovich, J.E., and Melis, T.S., eds., The state of the Colorado River ecosystem in Grand Canyon: U.S. Geological Survey Circular 1282, p. 139–152.
White, M.A., Schmidt, J.C., and Topping, D.T., 2005, Application of wavelet analysis for monitoring the hydrologic effects of dam operation: Glen Canyon Dam and the Colorado River at Lees Ferry, Arizona: River Research and Applications, v. 21, p. 551–565, doi: 10.1002/rra.827.
Williams, G.P., and Wolman, M.G., 1984, Downstream effects of dams on alluvial rivers: U.S. Geological Survey Professional Paper 1286, 83 p.
Wright, S.A., Melis, T.S., Topping, D.J., and Rubin, D.M., 2005, Influence of Glen Canyon Dam operations on Downstream Sand Resources of the Colorado River in Grand Canyon, *in* Gloss, S.P., Lovich, J.E., and Melis, T.S., eds., The state of the Colorado River ecosystem in Grand Canyon: U.S. Geological Survey Circular 1282, p. 17–31.
U.S. Department of the Interior, 1995, Operation of Glen Canyon Dam final environmental impact statement: Salt Lake City, March 1995, Bureau of Reclamation, Upper Colorado Region, 337 p. plus appendices.
U.S. Department of the Interior, 1996, Record of decision, operation of Glen Canyon Dam: Washington, D.C., October 1996, Office of the Secretary of Interior, 15 p., http://www.usbr.gov/uc/rm/amp/pdfs/sp_appndxG_ROD.pdf.
U.S. Department of the Interior, 2007a, Record of decision, Colorado River interim guidelines for lower basin shortages and the coordinated operations for Lake Powell and Lake Mead: Washington, D.C., December 2007, 59 p., http://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf.
U.S. Department of the Interior, 2007b, Final environmental impact statement, Colorado River interim guidelines for lower basin shortages and coordinated operations for Lake Powell and Lake Mead: Bureau of Reclamation Upper and Lower Colorado Regions, October 2007, http://www.usbr.gov/lc/region/programs/strategies/FEIS/index.html.
U.S. Department of the Interior, 2008, Final environmental assessment experimental releases from Glen Canyon Dam, Arizona, 2008 through 2012: Bureau of Reclamation Upper Colorado Region, February 2008, 60 p., http://www.usbr.gov/uc/envdocs/ea/gc/2008hfe/GCD-finalEA2-29-08.pdf.

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legacy of human health disruption. The need is becoming obvious, and geology has a significant role to play in helping to understand, prevent, and solve these kinds of problems."

Meeting Highlights

Plumlee says, "The biggest highlight for me was having the opportunity to interact with a number of people from the health sciences that I had not come into contact with previously."

"The format turned out to be very stimulating!" comments Finkelman. "Case studies were followed by two or three hours of free-form discussion, which created a lot of good give and take. It turned out to be a much better formula for stimulating discussion than having a more traditional series of half-hour presentations with two or three minutes of questions."

"I really enjoyed the case studies," Plumlee says. "One of the most interesting addressed arsenic in Bangladesh. It followed researchers from Columbia University: a group of earth scientists working with epidemiologists to understand the distribution of wells that were providing high arsenic groundwater, and how that was linked to disease rates. It was a beautiful example of extensive collaboration. Hydrologists and geochemists provided input on what might be controlling arsenic in the groundwater and different hydrogeologic environments in which higher arsenic groundwater was occurring. Public health scientists collected all the biomonitoring data, and the two groups working together greatly enhanced overall understanding of the problem."

Another insight that came out of the meeting was that health scientists must not only design studies from a scientific perspective but must also meet legal and policy requirements. Public health sciences have been far more constrained by privacy requirements, for example, than earth scientists. Earth scientists working in this realm are going to become increasingly familiar with institutional review boards, which monitor, approve, and review biomedical and behavioral research involving humans to protect the rights and welfare of these research subjects. The meeting exemplified how scientists working together were able to come to an understanding of the kinds of data and study processes that other disciplines need in order to be successful.

Funding Issues

"Coordinated funding of collaborations is an issue that has been with us since day one," explains Finkelman. "I returned from China with a colleague in 1996 and looked into funding for research on a horrendous problem of arsenic and fluorine poisoning. Basically, it was possible to get funding for the health issues from the health community, and for the geoscience aspects of the problem from the geologic community, but there was no way to coordinate those efforts. Unfortunately that situation still exists. I think this is a critical issue: not simply the funding per se, but the coordination of funding for geoscientists and public health–biomedical researchers to … coordinate their efforts on these issues."

"The ideal situation," notes Plumlee, "is to get a common source of funding early on in a project that will provide the venue for both the health sciences and the earth sciences work. If you have both sides working from a common funding source, it increases the ability to collaborate. In the arsenic case … one-hundred-thousand U.S. dollars in seed money was put into place by Columbia University, and that was a case where a common source of funding actually allowed a team to get going on the project."

Foundation for Future Cooperation

According to Plumlee, "The conference did create opportunities for people to start talking about future collaborations. There was recognition on both sides that a lot of opportunities exist, and there was clearly interest from all the attendees in trying to figure out where to start, and how to continue to enhance collaboration between disciplines. There was also recognition, however, that within the broad descriptors of health sciences and earth sciences there are actually a lot of different subdisciplines. Toxicologists, epidemiologists, and clinicians deal with different things. The same is true of hydrologists, geochemists, and petrologists. It is easy to speak in broad terms, but you can't lump them all together. Each discipline has its own particular way of going about research and the system is rather complex. I think people came away with a better understanding of that on both sides."

"There were some very good ideas about what [scientists] can do going forward," says Finkelman in summing up the meeting results:

- Participate in joint meetings between earth- and health-science societies;
- Pursue an American Association for the Advancement of Science (AAAS) Gordon Research Conference focusing on these issues;
- Submit more cross-disciplinary manuscripts to existing journals; and
- Investigate the need for a new geology and health journal.

The GSA Geology and Health Division has grown to more than 200 members since its inception in 2006. Plumlee is looking forward to further growth and credits GeoHealth I with being an important step in that direction. He foresees the Division serving as a catalyst for increasing involvement in interdisciplinary studies and future alliances between GSA and professional health science societies.

GeoHealth I: Building Bridges Across the Geological and Health Sciences

International Year of Planet Earth 2008

Mount McKinley, Denali National Park, Alaska

The International Year of Planet Earth (IYPE) is a global initiative of the International Union of Geological Sciences (IUGS) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO), which aims to ensure wider use of the knowledge accumulated by the world's 400,000 earth scientists. The goal of the IYPE is to recognize and draw attention to the benefits of the earth sciences for society. The 2006 United Nations General Assembly meeting in New York proclaimed the year 2008 as the official International Year of Planet Earth, with science and outreach activities spanning 2007–2009. The IYPE initiative is the largest international effort of its kind to promote the earth sciences.

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- Determine the non-human factors in climatic change;
- Enhance the understanding of occurrences of natural resources in order to contribute to efforts to reduce political tension;
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2009

GSA Section Meeting Calendar

Southeastern Section
Tampa, Florida, USA
12–13 March
Abstract deadline:
9 December 2008

South-Central Section
Dallas, Texas, USA
16–17 March
Abstract deadline:
TBA

Northeastern Section
Portland, Maine, USA
22–24 March
Abstract deadline:
16 December 2008

North-Central Section
Rockford, Illinois, USA
2–3 April
Abstract deadline:
30 December 2008

Cordilleran Section
Kelowna, British Columbia, Canada
7–9 May
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Rocky Mountain Section
Orem, Utah, USA
11–13 May
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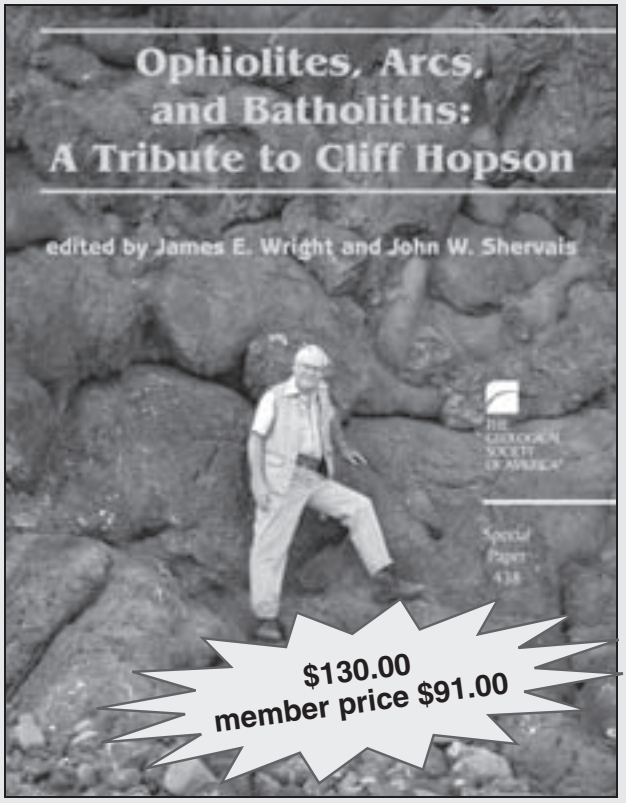
Ophiolites, Arcs, and Batholiths: A Tribute to Cliff Hopson



edited by James E. Wright and John W. Shervais

The western U.S. cordillera developed as an accretionary orogen from the early Paleozoic until the present. Much of our knowledge concerning ophiolite genesis, arc volcanism, and batholith emplacement finds its roots in the study of this orogenic belt. Cliff Hopson has made significant contributions to our understanding of the origin of ophiolites, arcs, and batholiths—including seminal studies of the Coast Range ophiolite of California, the Semail ophiolite of Oman, batholith emplacement in the Cascades, and basalts from the Mid-Atlantic Ridge. This volume honors Hopson's contributions with papers by his many colleagues and former students. The papers focus on ophiolites, arcs, and batholiths in western cordillera, with additional contributions on adjacent regions and the ophiolite conundrum.

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GEOLOGIC PAST

***Highlighting articles from past issues of* GSA Bulletin**

Water through the Hands of Time

GSA Bulletin, September 1908

W.J. McGee (1853–1912)

The Hydrogeology Division of the Geological Society of America was established in 1959 and is GSA's second largest Division. Seven of GSA's Associated Societies focus on the science of water. Here's a look at the science in its infancy.

Photo by John Karachewski used with permission.

In "Outlines of Hydrology," published in *GSA Bulletin* in September 1908 (v. 19, p. 193–220), geologist and ethnologist W.J. McGee called for the establishment of the "Science of Water, already known somewhat vaguely as hydrology." McGee justified this call by noting the "transcendent importance of the water of the earth to human welfare" (p. 194) and believed that the study would unite the "formal sciences," such as mathematics, astronomy, and physics, with the "natural sciences" of meteorology, geology, zoology, and anthropology.

Hydrology, in McGee's mind, "would be particularly close with geology and meteorology, since water is at once a terrestrial mineral and agency and a highly effective constituent of the atmosphere" (p. 194–195). In its three states—solid, liquid, and vapor—writes McGee, "the mineral H_2O … takes a leading role in the play of terrestrial progress … it is the most effective known agent in determining external terrestrial conditions" (p. 195).

In the bulk of his discussion, McGee defines and characterizes the hydrosphere and the special functions of moving water. Perhaps reflecting his interests as an ethnologist, however, McGee turns his attention to another element of hydrology, what he calls the "ontosphere." McGee defines the ontosphere as "a relatively minute fraction of the terrestrial H_2O [that] is withdrawn from the distinctive divisions of the hydrosphere and incorporated into living organisms" (p. 212).

While the volume of the ontosphere is relatively small compared to the hydrosphere, McGee notes, "its efficiency in modifying the earth face is disproportionately large: The rate of geologic process on each part of every continent is largely controlled by the flora and the soil which the floras of the ages have accumulated" (p. 213).

Citing a substantial, but "perhaps too indefinite," correspondence between the work of H_2O within Earth's flora and the fauna and the "virtually autonomous work of running water," McGee continues his discussion of the ontosphere's influence on Earth in an almost lyrical fashion: "During each eon the flora itself has been modified and started toward reconstruction by the fauna, as when the cryptograms of the Paleozoic were set on the way to decadence by flower-seeking and pollen-bearing insects, when fruit-bearing trees were placed in the lead by the help of seed-scattering birds, and when man appeared to cultivate the innocuous and exterminate the noxious among the fruits and grains and tubers."

McGee concludes his paper by breaking down the application of hydrology into six functions: "Functions of the Psychosphere"—that is, "the function of organized intelligence to control natural powers"; the "Use of the Corpus"—the geosociopolitical forces behind the use of water; "Navigation," "Power," "Diversion," and even "Production." Regarding production, McGee proposes that humankind will someday engage in "hydrogeny—the actual production of water through organic decomposition of compound substances: The production of water at will promises to mark one of the two greatest steps in the human aspect of planetary development; the earlier step was the conquest of fire" (p. 219).

By June 2009, this and all other *GSA Bulletin* articles will be available in digital form. Currently, *GSA Bulletin* is digitized back to 1945, and those articles are available for purchase via GSA's Bloc of Docs program.

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John M. (Jack) Sharp, Jr.

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GSA HOSTS FIRST LEADERSHIP WEEKEND

2–3 May 2008

Boulder, Colorado, USA

John M. (Jack) Sharp, Jr., *The University of Texas at Austin*
2007–2008 President, Geological Society of America

For two days immediately preceding the GSA Council meeting, GSA conducted a successful experiment: hosting its first-ever leadership weekend. More than 90 participants met to discuss GSA policies, directions, and the strategic plan. If you've ever been to a meeting where "everyone comes together to revise or develop a strategic plan," you might imagine a myriad of trepidations about holding such a large gathering. In my own experience, meetings like this can be a real waste of time, where nothing changes or unreasonable or unreachable goals are declared. This was not my experience at the GSA leadership weekend. Language was clarified, goals were outlined, communications methods were analyzed, and GSA meetings were further defined. Participants generally concluded that leadership weekends should be held again periodically. Perhaps this is in part because GSA is essentially a volunteer organization driven from the grass-roots level: We are what you, the members, desire.

The idea for this leadership weekend grew out of deliberations of the Executive Committee and GSA Council last October. For a number of years, the GSA Section secretaries have met in conjunction with Council and were invited to sit in on Council meetings to ensure adequate communications. Representatives from GSA's Divisions and Associated Societies (formerly AAS) were invited to a separate meeting earlier in the calendar year. In addition, over the past three years, we have assembled four *ad hoc* committee reports: the *ad hoc* Committee on Sections (2005), the *ad hoc* Committee on Divisions (2007), the *ad hoc* Committee on AAS (2007), and the *ad hoc* Committee on Divisions/Sections Integration (2008). Questions were raised: "Wouldn't it be wonderful to assemble all these groups together to discuss how we can meet the needs of the geosciences, GSA, our Associated Societies, and the public?" and "What is GSA's proper role in the context of globalization?" We also decided to invite the chairs of GSA's standing committees along with the GSA Councilors, many of the GSA staff, and the GSA Foundation Trustees. Each element of GSA has something important to offer. Sections, with their regional meetings, can bring our science to all areas of North

America; the Divisions and the Associated Societies drive the science programs at the annual meeting; and the committees help drive GSA policy.

GENERAL CHARGE OF THE MEETING

The two-day meeting was broken down into several sessions, with a general charge to create language for the updated strategic plan that reflects:

- How the interactions of GSA's Sections, Divisions, committees, Associated Societies, and GSA Headquarters can be enhanced;
- How each group separately and all groups working together can carry out the strategic plan; and
- How the strategic plan can be most effectively fulfilled.

Six Broad Goals of the Strategic Plan

1. Increase the quality and vitality of meetings and conferences;
2. Increase the quality and vitality of publications;
3. Promote geoscience in the service of society;
4. Attract and sustain a dynamic, dedicated, diverse, and viable membership and be responsive to this membership;
5. Maintain GSA and the GSA Foundation as financially viable entities; and
6. Optimize GSA's governance and organizational structure in fulfillment of GSA's mission.

OVERVIEW

On the first morning, each group (Sections, Divisions, Associated Societies, and committee chairs) addressed the strategic plan with individual Councilors and/or GSA staff. In the afternoon, all four groups met and discussed common issues for enhanced communication and organization, as well as the strategic planning process. This was followed by a very pleasant reception.

On the second day, the four groups held business meetings, followed by breakout group sessions on the six strategic plan goals in the afternoon. Each of the breakout groups had a mix of participants from the four initial groups. This was followed by synopses and group reports, and the always exciting GSA Corporate Meeting ended the leadership weekend.

DISCUSSION POINTS

Global Arrangements

Consensus was that GSA and the geosciences would benefit by a greater international emphasis:

- We need to consider reciprocal arrangements with science groups and sister societies internationally.
- GSA's International Division and some of our Associated Societies are functioning globally.
- We need more international input on GSA committees.

Communication

Communication was a major topic of discussion and a common thread in all the *ad hoc* reports:

- We need better communication "across silos" (i.e., among committees, Associated Societies, Sections, and Divisions. The Divisions have largely taken over setting the scientific program for the Annual Meeting. Some Divisions and

Associated Societies run great science programs. GSA staff was charged to find a better way of communication "across silos."
- GSA's Web site should be updated with contact information.
- Form an e-GSA *ad hoc* committee to examine how people are networking and interacting via new modes of communication, including podcasts, facebook, blogs, etc. It is important for students and new members to feel a sense of community and be provided with scientific social networking opportunities.

Penrose Conferences and Field Forums

In the case of Penrose Conferences and Field Forums, further direction is needed to push cutting-edge science:
- The next Programmatic Overview Committee will invite the chair of the Penrose and Field Conference Committee to discuss how we can take on a more proactive role.
- GSA should host a two-hour Penrose panel and Web-cast hot topics at the Annual Meeting.

Section Meetings

Section Meetings were recognized as an underutilized resource. It was suggested that each Section:
- Sponsor or organize field trips targeted to local officials.
- Have targeted meetings with local officials at their offices to address national issues at state and local levels.
- Expand the mentor programs through short field trips to view local geology and discuss applied issues.
- Contact Division representatives to work together on developing programs.
- Prepare best-practices memos.

Annual Meeting

In conjunction with the globalization issues, it was noted that GSA has an *annual* meeting and NOT a *national* meeting. It is the **Annual Meeting and Exposition.**
- Recommendations for set times for students to talk to Council and GSA staff were made, with a note that this could be done at Section Meetings as well.
- The Committee on Innovative Science (a subcommittee of the Annual Program Committee) is charged to bring forward programs and events not normally held at the annual meeting in the past.
- Best practices memos for Division and Associated Societies programs were recommended.

Committees

Committee Chairs were charged with the task of recommending students, recent graduates, or new hires to serve on committees.

Overarching Themes

GSA needs to define and advertise important science issues or themes that transcend the GSA Divisions (and even the geosciences), to include
- Themes for annual meetings;
- Highlighting these themes on the GSA Web site;
- An e-GSA communications *ad hoc* committee to identify appropriate overarching themes and communicate those to GSA's Divisions and Associated Societies so they can determine where they fit within those themes; and
- Expanding Associated Societies to non-geoscience and recruit organizations that have overlapping interests.

COUNCIL MEETING

The leadership weekend was followed by the spring Council meeting. Several actions were taken following these discussions.

Globalization

The GSA Sections have been extended into Mexico by expanding the Cordilleran, Rocky Mountain, South-Central, and Southeastern Sections based upon geological similarities and geographic proximity. We thank outgoing Councilor Elena Centeno-Garcia for her insights on these matters. The American states and Canadian provinces have long been grouped into common sections.

Council also voted to establish an International Section concomitant with the sunsetting of the International Division. Every GSA Member in the United States and Canada is automatically assigned to the Section in which they reside, although members can designate assignment to a different Section. Two dollars of our annual dues automatically go to GSA's Sections; thus, GSA Members from Mexico and all other countries have paid for but until now had no sectional home. Now, the two dollars from members not from the United States, Canada, or Mexico will go to the International Section. In addition, this Council action will allow GSA Members to be voting members of more than one Section (for an additional two dollars each). The projected plan is for the GSA International Section to hold a meeting at the same time of year as other Section Meetings and in conjunction with a geological society from the hosting country (e.g., the Geological Society of Australia and the GSA International Section might host a joint meeting). We stress that these meetings must be reciprocal, and they can include Field Forums and Penrose Conferences. Council appreciates the input of Paul Robinson of the International Division on these issues. It's also important to note that at the October meeting of Council, we added the International Secretary to the Executive Committee and as an *ex-officio* member of Council.

Associated Societies

The distinction between *allied* versus *associated* societies has always been somewhat blurry. The terminology was intended to differentiate those with whom we had formal memorandums of understanding (MOU) from those with whom we didn't. Council voted to have only one category—all are now Associated Societies. MOUs will continue to be initiated as necessary; for example, when we co-host events such as this year's Joint Annual Meeting & Exposition in Houston.

Communications

An e-GSA communications *ad hoc* committee will form soon; please contact GSA if you have ideas about electronic communications or otherwise wish to participate.

FINAL NOTE

The leadership weekend and following Council meeting were both productive and enjoyable. As your outgoing president, I want to state that I found it a pleasure to work with my dedicated scientific colleagues and the professional staff at GSA headquarters.

GSA Awards 2008 Intel International Science and Engineering Fair Prize

Congratulations to these students!

From left to right: GSA Representative Barbara Tewksbury and 2008 Intel International Science and Engineering Fair GSA Special Award winners Oxana Balzhinimaeva, Hank Zwally, and Katherine Cagen.

At the 2008 Intel International Science and Engineering Fair in Atlanta, Georgia, USA, The Geological Society of America awarded prizes for science and engineering projects investigating Earth and related sciences. The winners and their schools will receive a free subscription to *GSA Today* as well as a cash prize. Projects were judged on their demonstration of a high level of understanding of earth science concept(s), how Earth is a system, and use of innovative methods to explain concepts. GSA would like to sincerely thank our volunteer judges: Daniel Snyder and Tina Mahaffee of Middle Georgia College.

Katherine Thompson Cagen, 17, Horace Mann School, Riverdale, New York, USA. **First Award: US$2,000**—EA011: Evidence for a tsunami generated by an impact event in the New York metropolitan area approximately 2300 years ago.

Hank Jay Zwally, 15, Centennial High School, Ellicott City, Maryland, USA. **Second Award: US$1,500**—EA021: Does water around melting Arctic sea ice stratify into horizontal thermal gradients that help to insulate the ice from the warm ocean water?

Oxana Ayushievna Balzhinimaeva, 16, Duldurga Secondary School, Duldurga, Chita Region, Russia. **Third Award: US$500**—EA024: The description of the Mesozoic flora of Urey.

2008 John C. Frye Memorial Award in Environmental Geology

The 2008 John C. Frye Memorial Award recipient is *The Generalized Geologic Map for Land-Use Planning* Map Series by **Daniel I. Carey**, Kentucky Geological Survey, 2007. Carey will be recognized for this exceptional series at the GSA Presidential Address and Awards Ceremony during the 2008 Joint Annual Meeting in Houston this October.

NOTICE of GSA Council Meeting

The Geological Society of America Council will meet next at 8 a.m., Saturday, 4 October, and again at 8 a.m., Wednesday, 8 October, at the 2008 Joint Annual Meeting in Houston, Texas, USA.

All GSA Council meetings are open to GSA Fellows, Members, and Associates, who may attend as observers, except during executive sessions. Only Councilors and officers may speak to agenda items, except by invitation of the chair.

THE GEOLOGICAL SOCIETY OF AMERICA®

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DRAFT

Panel Seeks Input on GSA Position Statement

Public Investment in Earth Science Research

PREFACE

Overall investment in research funding is a major topic of discussion these days, both within the United States and internationally. For some sectors of the GSA community, funding is increasing, but for most, funding has remained flat or decreased. The multiple and varied reasons for these decreases require that each case where funding is sought be evaluated individually. Generally, however, the problem lies in the need for federal and state funding sources to recognize that earth science research is an important investment in their future well-being and economic vitality.

This draft statement comes at a time of growing congressional awareness of the need to increase investment in scientific research and to support the continued efforts of groups like the Coalition for National Science Funding and the USGS Coalition, which encourage such funding increases. The National Academies' recent report, "Rising Above the Gathering Storm," and passage of the America COMPETES Act with strong bipartisan support clearly underscore the importance of research investments, yet little has been done to implement proposed solutions to insufficient research funding.

Please submit your comments and suggestions regarding the content of the following *position statement draft* by **11 August 2008** to Richard Berg at berg@isgs.uiuc.edu. Go to www.geosociety.org/positions/ to learn more.

INTRODUCTION

Funding for earth science research is fundamental to the socioeconomic well-being and security of the United States. Earth science research provides knowledge and data essential for establishing national, state, and local policies; enacting legislation; regulating and implementing land-, mineral-, and water-use policies; and making necessary investments to accomplish societal objectives. In October 2007, the National Science Foundation and the Department of Commerce's Bureau of Economic Analysis released a study showing that research and development accounted for 5% of growth in the U.S. gross domestic product (GDP) between 1959 and 2004 and 7% between 1995 and 2004. In spite of this significant impact on the U.S. economy, the GDP would have been 3% higher each year between 1959 and 2004—$284 billion higher in 2004 alone—if research and development spending had been treated as an investment in U.S. national income and product accounts. This underscores the common economic wisdom that investment in research is critical to national economic growth and development. Because of the increased pace towards globalization, perhaps this is even more critical today.

Earth science research also forms the basis for the training and education of the next generation of geoscience professionals who will carry this research forward and be the professionals needed by industry and government agencies. The Geological Society of America recognizes the need to actively support measures and appropriations that strengthen earth science research and research capabilities, foster research partnerships among universities, government agencies, and industry, and provide support for the education of our next generation.

The purpose of this position statement is to summarize consensus views of The Geological Society of America regarding public investment in earth science research; recognize that investment in earth science research is important for the future health and economic vitality of society; improve public and political awareness and understanding of the value of investing in earth science research and thereby encourage the need for increased funding; and provide recommendations for implementation of a strategy that strengthens the commitment to public investment in earth science research by GSA and its members.

SCIENTIFIC AND PUBLIC POLICY ASPECTS OF EARTH SCIENCE RESEARCH

Earth science research focuses on earth processes, including the natural events that impact daily lives and that provide the energy, mineral, and water resources that sustain society. Prominent natural hazards, such as earthquakes, volcanic eruptions, hurricanes, and floods, significantly impact lives and property and will continue to do so; therefore geoscientists need to continue to develop our understanding of them so that we can better prepare for and lessen their impact as well as improve our ability to predict their occurrence and magnitudes. Energy and mineral resources are finite, often difficult and costly to find, and are extracted in ways that can negatively impact environmental resources, local economies, and quality of life, yet their continued availability is critical to the basic functioning of our society and to national security. In order to manage and utilize these resources in economically and environmentally sensitive ways, we must continue to increase our knowledge of their location and basic characteristics. The availability and quality of surface and groundwater will strongly influence the future of our society, yet our understanding of these resources is far from sufficient, particularly if we are to balance water use with "green" growth and development. Our ability to predict the outcomes of human interactions with earth's natural system is limited by our incomplete understanding of geologic and environmental processes. Human-influenced environmental impacts are occurring and climate change is happening; therefore, our knowledge of these processes must improve in order to increase confidence in our ability to predict future states and mitigate or reverse adverse impacts.

Public investment in research is essential to addressing these and other concerns. This investment must come from national, state, and local government sources and support not only academic research but also mission-driven federal and state agencies. Research partnerships with private industry and foundations are also critical. Policy-makers are increasingly aware of the importance of research to the future of our

nation, states, municipalities, industries, and society. This increased concern for research comes at a time of reduced spending on geoscience research by private industry and state governments, further increasing the burden on the federal and state funding portfolios. Despite the need for increased investment in research, the level of available funds has not kept pace with new demands. It is critically important to significantly increase the funding of earth science research to be able to meet challenges posed by the human interactions with Earth's natural system and to help sustain our national economy. With the proper tools and scientific advances, society will be able to face these challenges in the near term and over the coming decades.

IMPLEMENTATION AND RECOMMENDATIONS

- The Geological Society of America (GSA), through the National Leadership Initiative (NLI), and Director for Geoscience Policy (DGP), should support federal legislation and appropriations that strengthen earth science research and research facilities. These activities should include, but not be limited to, support letters for legislation, personal contacts with congressional members and staff, interactions with appropriations and other committee staff, and interaction with the White House Office of Management and Budget.
- The DGP, the GSA Geology and Public Policy Committee (GPPC), and the GSA Geology and Society Division should encourage and instruct GSA Members and community groups about interacting with their congressional and state legislative delegations to educate them on the value of scientific investment. This can be achieved by demonstrating the relevance of earth science to the nation, states, and/or districts through linking the science to specific legislation or committee activities, and in so doing encourage increased investment in earth science research.
- GSA, at its national and regional meetings, should hold forums and town hall meetings for open community discussion on the range of issues associated with increasing society's level of investment in earth science research. This will better demonstrate the return on investment that society receives, thereby empowering its members as constituents and stakeholders to be advocates for increased earth science research funding.
- GSA should encourage geoscientists to communicate their concerns to decision makers regarding ways in which investment in geoscientific research provides value to society.
- The NLI and DGP, working in conjunction with the GPPC, will provide summaries of factual data on various legislative issues, coalitions, community research initiatives and organizations, congressional committees, etc., that GSA and other community members can use to document their concerns when talking to decision makers.
- GSA should work with industry to dramatically increase the role that industry (environmental, engineering, extraction, exploration, and others) plays in the support of educational programs.

2007–2008 Congressional Science Fellow Report

A Risky Proposition

Maria Honeycutt

"Risk" is a word I've heard with increasing frequency on Capitol Hill, most often in the context of the subprime-mortgage crisis. As a geoscientist, I'm far more accustomed to considering risk in terms of natural hazards. Like many of my peers, I have researched past hazard events and current-day processes and used the results to identify the risk of similar events occurring in the future. Having a scientist's perspective on risk has proven to be extremely helpful while working on the Hill, where the day's top issue can shift quickly from discussion of risky mortgage-lending practices to the earthquake potential in southern Illinois.

As a Congressional Science Fellow, I have had to leave the familiar, comfortable realm of hazards science and dive head-first into other dimensions of hazards policy. I arrived last fall with academic training and work experience focused on the geology and geomorphology of our coasts and how both can influence erosion and flooding during storms. My work on the Gulf Coast following the 2004 and 2005 hurricanes opened my eyes to some of the ways in which hazard information is factored alongside local economic and political concerns when recovery decisions are made.

On the national stage, the hazards-policy landscape is naturally a bit more complex, but much of what I observed at the local and regional levels seems to hold true. Management of natural-hazards risk has traditionally been approached in three ways: (1) eliminating some fraction of the risk through mitigation, including land use; (2) using insurance as financial protection against some portion of potential damages; and (3) accepting the residual risk, including the financial and societal consequences. In working with nonscientist colleagues on the Hill, I've seen the challenges that lawmakers face in developing policies that respect not only the science but economic and social concerns and political realities as well.

Financial markets and natural hazards intersect directly in many ways, with insurance currently at the forefront. As in the aftermath of Hurricane Andrew in 1992, private insurers reexamined their risk models after the 2004 and 2005 hurricanes and many were uncomfortable with their financial exposure. Some have elected to pull out of certain coastal markets, causing those states to become insurers of last resort. Repercussions have spread up the eastern seaboard and, to a limited extent, nationwide.

Some states have tried to use their regulatory authority to increase the availability and affordability of private property insurance coverage, which the insurance industry has opposed. Other experts, including hazard-mitigation specialists, have similarly opposed state actions that would artificially reduce rates. Unless the underlying vulnerabilities are also addressed, such actions may ultimately result in the public assuming greater financial burden, whether as direct reinsurers of the private market or through disaster relief to the inadequately insured.

As with the mortgage crisis, recent debate over hazards policy on the Hill has centered on the appropriate role for the federal government. Congress is examining numerous proposals to increase stability in the private reinsurance market. There is discussion during each legislative session on fostering development of a private, multi-peril market to cover all natural hazards (i.e., fire, wind, hail, earthquakes, and possibly floods).

Some in Congress have proposed expanding federal hazard insurance. Because many coastal areas lack affordable wind coverage, several representatives and senators have proposed expanding the National Flood Insurance Program (NFIP) to include a combined wind-and-flood policy. Proponents have offered this as a solution for coastal residents who have faced rapidly rising wind insurance premiums. These proponents assume that the federal rates, which the legislation requires be "actuarial," would be less expensive than private insurance or state-backed coverage. Opponents are concerned about the government taking on significant additional exposure when the NFIP is operating at more than $17 billion in debt. Despite a Government Accountability Office report released in May that found the federal program would likely be *more* expensive to policyholders, the concept remains popular with the public, and the legislative debate continues.

Compared to insurance, legislative proposals concerning mitigation and public risk awareness have received far less attention from Congress. From its inception in 1968, the NFIP has included hazard mapping and mitigation components to reduce flood losses through time; however, current reauthorization bills would do more to expand insurance coverage than strengthen loss-reduction goals. Although the federal government supports interagency programs that conduct research and translate results into forecasts, emergency operations, and other products (e.g., National Earthquake Hazards Reduction Program; National Tsunami Hazard Mitigation Program; National Windstorm Impact Reduction Program), Congress struggles every year to appropriate adequate funding.

Given the current state of U.S. hazard management, how can geoscientists best contribute to sound policy? An obvious role is to continue researching the factors that control hazard intensity, frequency, and geographic distribution, as well as the potential impacts of climate change. Scientists and engineers also analyze materials and test hazard-resistant design and construction techniques. All of these efforts contribute to better land-use planning, building codes, and other mitigation techniques that go beyond building codes to further reduce loss of life and property damage.

Scientists also have the potential to be key risk communicators, bringing an objective, fact-based perspective to policy

discussions. The challenge, of course, is in fulfilling that potential. Some within the scientific community have questioned whether we failed to communicate risk effectively when decisions were made to reoccupy hazard-prone areas along the Gulf Coast. Such criticism is not unique to the Katrina recovery—similar criticism is raised after significant earthquakes, landslides, wildfires, and riverine floods.

Where I believe we, as scientists, can do better is in explaining what residual risks remain if a proposed policy is implemented, and in quantifying the likely consequences. It's not enough to testify at public meetings about the hazards identified and what could happen in the future. Decision makers, particularly at the local level where land-use decisions are made, must weigh economic development and the tax base (their life blood) against events that scientists say "may" happen. To maximize the use of science in decision making, we should be prepared to describe the residual risk associated with each policy option and its financial and societal costs. Apples-to-apples comparisons, incorporating both natural and social science, are needed to challenge the acceptance of residual risk by decision makers and citizens.

Forming collaborative relationships with social scientists, economists, and lawyers is not a normal part of our scientific training, and even well-intentioned scientists struggle in moving their work into the policy arena. More often than I'd like to admit, I've ended presentations and papers with a discussion of potential real-world applications, leaving the difficult task of actually turning that potential into reality to someone else while I moved on to my next project. My time here on Capitol Hill has shown me the perils of this practice.

While we will always have a great need for scientists devoted to research, I want to encourage action, preferably before the next Katrina, Northridge earthquake, or other natural catastrophe. I encourage you to leave your scientific comfort zone, partner with specialists in other disciplines, and devote the time needed to engage local decision makers and the public in an ongoing dialogue about what residual risks truly are acceptable.

This manuscript is submitted for publication by Maria Honeycutt, 2007–2008 GSA–U.S. Geological Survey Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 07HQGR0140. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government. Honeycutt can be reached at maria_honeycutt@billnelson.senate.gov.

THE GEOLOGICAL SOCIETY OF AMERICA®

Mentors and Students Unite for a Win-Win Opportunity

GSA offers two great mentor programs at each GSA Section Meeting: the Roy J. Shlemon Mentor Program in Applied Geology and the John Mann Mentors in Applied Hydrogeology Program. These popular events, supported by the GSA Foundation through generous gifts from Roy J. Shlemon and John Mann, are designed to extend the mentoring reach of individual professionals from applied geology.

Each mentor program provides a forum for undergraduate and graduate students interested in applied geology or hydrogeology as a career to participate in informal conversations with professionals currently practicing in these fields. They are relaxed, small-scale, focused events that include a free meal for all participants.

The 2008 season has been exceptional. Mentor volunteers—from private and public businesses and government agencies—represented a broad range of backgrounds, education, experience, and expertise. This year, the Shlemon Program funds have provided mentor experiences to 432 students and 68 mentors, and the Mann Program has reached 85 students with 19 mentors.

Both mentors and students leave these events expressing feelings of personal and professional growth. New friendships are made, and professional contacts are established.

COMMENTS FROM MENTORS:

- "Thanks for the invitation to participate in this luncheon. I really enjoyed meeting the students … it was a win-win situation in my book!"
- "The students were very enthusiastic. I had many stimulating discussions. There were good prospects for our intern positions."
- "The students' questions were thought-provoking and they made me realize what a satisfying job I've got. I'd like to do this again!"

COMMENTS FROM STUDENTS:

- "I think this was one of the best experiences of the conference."
- "The mentors had some fantastic things to say—Thanks!"
- "It is really nice to be able to speak to professionals outside of academia. I was able to have questions answered that I've been wanting to ask for a while!"
- "It was very helpful, and it opened up my eyes to what the real world has to offer."

GSA gratefully acknowledges the following mentors for their individual gifts of time and for sharing their insight with GSA's Student Members. For more information about these programs, or to be a mentor for a future program, please contact Jennifer Nocerino, jnocerino@geosociety.org.





The John Mann Mentors in Applied Hydrogeology Program

2008 CORDILLERAN–ROCKY MOUNTAIN JOINT SECTION MEETING

Sue Ann Finstick
Bulloch Brothers Engineering Inc.

Michael M. Reddy
U.S. Geological Survey

Marvin (Nick) Saines
Saines Environmental Hydrogeology

2008 NORTHEASTERN SECTION MEETING

Jerold C. Bastedo
Penn Dixie Paleontological and Outdoor Education Center

Bill Goodman
RESPEC

Bill Prehoda
Leggette, Brashears & Graham Inc.

Michael Schaffner
NOAA's National Weather Service

Stephen J. Urbanik
New Jersey Dept. of Environmental Protection

2008 SOUTH-CENTRAL SECTION MEETING

Jay S. Johnston
AR Natural Resources Commission

Christopher A. King
USDA–Natural Resources Conservation Service

Daniel S. Yeatts
U.S. Geological Survey

2008 SOUTHEASTERN SECTION MEETING

Charles G. Pippin
Golder Associates NC Inc.

Al Quarles
S&ME Inc.

Gary D. Rogers
Schnabel Engineering South P.C.

Craig L. Sprinkle
CH2M HILL

2008 NORTH-CENTRAL SECTION MEETING

Rodney A. Sheets Jr.
U.S. Geological Survey

Jerry Unterreiner
Indiana Dept. of Natural Resources

Clifford S. Yantz
O'Brien & Gere Engineers Inc.

Lynn Yantz
Logs by Lynn

Photos from left to right: Valley of Fire State Park. Las Vegas News Bureau, www.lvcva.com/press/media-resources/vegas-images.jsp. Waterfront Buffalo, courtesy Buffalo Niagara Convention & Visitors Bureau and Angel Art Ltd. Hot Springs Convention Center, courtesy of Hot Springs Convention & Visitors Bureau. Downtown Charlotte, North Carolina, USA, courtesy of Visit Charlotte. Casino Aztar at night, courtesy of Evansville Convention and Visitors Bureau.

The Roy J. Shlemon Mentor Program in Applied Geology

2008 CORDILLERAN–ROCKY MOUNTAIN JOINT SECTION MEETING

David Applegate
U.S. Geological Survey

Roger W. Bond
Barrick Goldstrike Mines Inc.

Laurie J. Brandt
Buckhorn Geotech Inc.

John Curtis
Samson Resources Co.

Robert P. Dickerson
S.M. Stoller Corp.

Sue Ann Finstick
Bulloch Brothers Engineering Inc.

Derrick D. Hirsch
U.S. Geological Survey

David C. Jacobs
Chevron Mining Inc.–Questa Mine

Tyler R. Knudsen
Utah Geological Survey

William R. Lund
Utah Geological Survey

Joe Meglen
Samson Resources Co.

Donald L. Rasmussen
Plateau Exploration Inc.

Michael M. Reddy
U.S. Geological Survey

Marvin Saines
Saines Environmental Hydrogeology

Steven Semken
Arizona State University

Jon E. Spencer
Arizona Geological Survey

Kathleen Springer
San Bernardino County Museum

De Anne S.P. Stevens
Alaska Division of Geological & Geophysical Surveys

2008 NORTHEASTERN SECTION MEETING

Jerold C. Bastedo
Penn Dixie Paleontological and Outdoor Education Center

Bill Goodman
RESPEC

Susan D. Halsey
Admiral Coastal Consulting

William M. Kelly
New York State Geological Survey

Jack L. Krajewski
American Consulting Professionals of New York PLLC

Bill Prehoda
Leggette, Brashears & Graham Inc.

Douglas W. Rankin
U.S. Geological Survey

Michael Schaffner
NOAA's National Weather Service

Woodrow Thompson
Maine Geological Survey

Gregory J. Walsh
U.S. Geological Survey

2008 SOUTH-CENTRAL SECTION MEETING

Dave Freiwald
U.S. Geological Survey

James L. Gooding
Geoclime LLC

Doug Hanson
Arkansas Geological Survey

Duane Heckelsberg
Range Resources Corporation

Christopher A. King
USDA–Natural Resources Conservation Service

Tony Kolodziej
Integrated Oil & Gas Tech

Kenneth Luza
Oklahoma Geological Survey

Steve Rudd
Hot Springs National Park

Chris Sumner
Vulcan Materials Company

Neil Suneson
Oklahoma Geological Survey

Paul D. Thompson
Garland County Dept. of Environmental Services

William Willis
Weyerhaeuser Company

Daniel S. Yeatts
U.S. Geological Survey

2008 SOUTHEASTERN SECTION MEETING

Jennifer Bryson Bauer
North Carolina Dept. of Environment and Natural Resources

Stephanie M. Briggs
William Lettis & Associates Inc.

Matt Crawford
Kentucky Geological Survey

Ken A. Gillon
North Carolina Geological Survey

Rebecca Latham
North Carolina Geological Survey

Tim McConnell
Portland Cement Association

Charles G. Pippin
Golder Associates NC Inc.

Gary D. Rogers
Schnabel Engineering South P.C.

Craig L. Sprinkle
CH2M HILL

Steve Stadelman
Novozymes North America Inc.

Gerry L. Stirewalt
U.S. Nuclear Regulatory Commission

Shuying Wang
North Carolina Dept. of Environment and Natural Resources

Bill Witherspoon
Fernbank Science Center

Anne Carter Witt
North Carolina Dept. of Environment and Natural Resources

2008 NORTH-CENTRAL SECTION MEETING

Heather Gastineau-Lyons
ARCADIS U.S. Inc.

Dustin Graves
ATC Associates Inc.

Sallie E. Greenberg
Illinois State Geological Survey

Bryant J. Griggs
ARCADIS U.S. Inc.

John D. Kiefer
Kentucky Geological Survey

Sherman Lundy
BMC Aggregates

Shannon Mahan
U.S. Geological Survey

David Paul Nance
Indiana Dept. of Natural Resources

David B. Saja
Cleveland Museum of Natural History

Rodney A. Sheets Jr.
U.S. Geological Survey

Douglas L. Shrake
Ohio Dept. of Natural Resources

John C. Steinmetz
Indiana Geological Survey

Gregory Waltz
Office of Land Quality

Donna L. Russell, *Director of Operations*

JOHN F. MANN CENTER FOR THE GEOSCIENCES & SOCIETY

In December 1994, John F. Mann Jr. and his wife Carolyn V. Mann created the John F. Mann Jr. Charitable Remainder Unitrust and named the GSA Foundation as the charitable remainderman. This gift was an important addition to the Second Century Fund capital campaign for Earth–Education–Environment and the third largest gift in GSA and GSA Foundation history.

Upon John F. Mann Jr.'s death in 1999 and Carolyn Mann's death in 2007, the unitrust passed to the GSA Foundation. The proceeds of almost US$1.2 million now reside in the John F. Mann Fund, and the formal establishment of the John F. Mann Center for the GeoSciences & Society is now complete, augmenting the Manns' vision for the geosciences.

John F. Mann Jr. was a central figure in the long and continuing saga of groundwater management in southern California. His work with the United Water Conservation district, United States Borax and Chemical, and the Los Angeles Dept. of Water and Power, among many other clients, was crucial to the adjudication of groundwater rights in the region, to the evaluation and protection of groundwater resources, and to the theoretical development of groundwater hydrology.

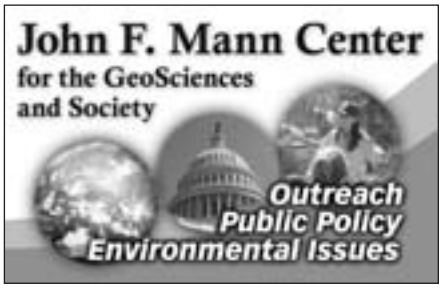
Mann's work embodied three overarching tenets: environmental processes must be studied and understood as a system; good science drives good natural-resource decisions; and scientists have a responsibility to apply their insights for the benefit of society. In turn, these three tenets underlie and unify all of the activities of the John F. Mann Center for the GeoSciences & Society.

The Center's Mission

The Center will strive to enhance the contribution of geoscience to the resolution of society's growing environmental and natural-resource challenges. With the global population continuing to climb, geoscientific knowledge and expertise provide an increasingly important foundation for effective action in such areas as water quality and supply, natural resources development, and ecosystem protection and restoration.

The Center's Activities and Goals

The Center will promote its mission through a broad range of programs focused on three principal goals:



Mentor Programs: The Center will support current mentor programs and those that may be developed, offering geoscientists a forum to share their professional and personal experiences with undergraduate and graduate students and faculty.

Intern Programs: In order to help build the capacity of the geoscience community to participate in research and decision making in the environmental and natural-resource arena, the Center will support programs for GSA undergraduate student members to work as summer interns in national parks, monuments, forests, etc. It will also support placement of a geoscientist in a congressional staff position on Capitol Hill.

Environmental Programs: The third principal goal of the Center is to apply geoscience knowledge and expertise to selected, high-priority environmental and natural-resource challenges. Programs and environmental forums focusing on current environmental issues will be sponsored by the Center in order to provide a source of scientific information for the public. The Center may also use new technologies to create a decision process for solutions to environmental, natural resources, and land-use disputes.

Mann's career as a leading groundwater consultant and his vision for the future of the geosciences will live on in the programs supported by this gift to the GSA Foundation and the Society. **To donate to the Center, go to gsafweb.org.**

CHECK OUT THE GSA EDUCATION AND OUTREACH PROGRAM!

GSA offers a number of educational products and services to K–12 teachers and other educators; a few are highlighted here. To learn more about GSA's Education and Outreach program, go to **www.geosociety.org/educate/**.

Explore GEOSCIENCE Educational CD-ROMs for Geoscience Teachers

Each CD-ROM contains information, activities, images, and models for topics like weathering and erosion, volcanoes, tsunamis, earthquakes, caves, fossils, and more. Go to **www.geosociety.org/educate/cds.htm** to learn about all of our exciting earth-science CD-ROMs, and order yours today!

Written *for* geoscience teachers *by* geoscience teachers.

Teacher Advocate Program (TAP)

GSA is dedicated to increasing the appreciation of Earth's history, processes, and resources through earth science education. Recognizing that the future of geology rests in the hands of our nations' school teachers is the fundamental building block of the TAP program. Learn more and obtain resources at **www.geosociety.org/educate/tap.htm.**

The Nature of Science and the Scientific Method

This free publication from GSA, written by teacher-in-residence Christine V. McLelland, illustrates a methodical approach to studying the natural world. Science asks basic questions: How does the world work? How did it come to be? Science also helps discover what the world was like in the past, what it is like now, and what it will be like in the future. *The Nature of Science and the Scientific Method* promotes the understanding of science and how the scientific method is used to advance it, focusing in particular on earth sciences. It also includes talking points for those who would like help explaining the nature of science to others.

Download your copy at www.geosociety.org/educate/NatureOfScience.htm.

Webcasts of GSA Public Forums

Go to **www.geosociety.org/educate/products.htm** to listen to Webcasts from past GSA Annual Meeting & Exposition Public Forums.

Forensic Geology—Learn how scientists use geology to aid in criminal and civil investigations.

Understanding Climate Change—with speakers Richard Alley of Penn State and Robert Jackson of Duke University.

The Latest (Red) Dirt from the Mission Makers—from the 2004 Public Forum in Denver, Colorado, USA.

2008 Joint Annual Meeting

OVERARCHING THEMES

This year 10 meeting themes cross disciplines to be of interest to all meeting attendees, regardless of society affiliation. These overarching themes drive the plenary sessions, which feature invited speakers, and the joint technical sessions. Some of the following will be "blackout" sessions, which means there will be no other sessions or events scheduled at the same time. *Cosponsored by GSA, SSSA-ASA-CSSA, and GCAGS.*

October 2008

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
5	**6**	**7**	**8**	**9**

SUNDAY 5

10 a.m.–noon
Climate Change through Time: Evidence in the Geologic Record

James Zachos, University of California; **Connie Woodhouse,** University of Arizona; **Lonnie Thompson,** Byrd Polar Research Center, Ohio State University; **André Droxler,** Rice University

5–7 p.m.
The Impending Global Water Crisis: Geology, Soils, Agronomy, and International Security
E.T. & Vam York Distinguished ASA Lectureship

Peter Gleick, Cofounder and President of the Pacific Institute for Studies in Development, Environment, and Security; **Sandra Postel,** Founder and Director of the Global Water Policy Project

MONDAY 6

8 a.m.–10 a.m.
Energy and the Global Market

Douglas Durante, Clean Fuels Development Coalition; **Peter McCabe,** AGI President, CSIRO; **Bruce McCarl,** Texas A&M

1:30–3:30 p.m.
Globalization of Biogeochemical Cycles

Luc Maene, Director General, International Fertilizer Industry Association; **Scott Fendorf,** Stanford University

TUESDAY 7

8 a.m.–noon
River Restoration: Environmental Success or Strategic Failure?

Victor R. Baker, University of Arizona; **John G. Elliott,** U.S. Geological Survey; **Benjamin Hayes,** Bucknell University; **Jerry R. Miller,** Western Carolina University; **John C. Schmidt,** Utah State University; **David Sear,** University of Southampton

1:30–5:30 p.m.
Reducing Vulnerability of Gulf Coast Communities to Hurricane Impacts and Sea-Level Rise: Are Large-Scale Restoration and Engineering the Answer?

Denise Reed, University of New Orleans; **Garrett Graves,** Louisiana Office of the Governor; **Asbury Sallenger,** U.S. Geological Survey; **Ty Wamsley,** U.S. Army Engineer Research and Development Ctr.; **Harold R. Wanless,** University of Miami–Coral Gables; **Robert Young,** Western Carolina University

WEDNESDAY 8

8–10 a.m.
Geobiology and Biomineralization: From the Origins of Life to the Origins of Cities

Patricia Dove, Virginia Tech University; **Eugene Kelly,** Colorado State University; **Joseph Kirschvink**, California Institute of Technology; **Ke Li**, Arizona State University

1:30–3:30 p.m.
Emerging Trace Contaminants in Surface and Groundwater Generated from Waste Water and Solid Waste Application

Bryan Brooks, Center for Reservoir and Aquatic Systems Research; **Kang Xia,** Mississippi State University; **Mark Benotti,** Southern Nevada Water Authority; **Vicki Colvin,** Rice University

3–5:30 p.m.
Carbon Sequestration: Methods, Markets and Policy

Richard Birdsey, Climate, Fire, and Carbon Cycle Sciences, Northern Global Change Research Program; **Haroon Kheshgi,** ExxonMobil Research & Engineering Co.; **Brian McPherson,** University of Utah, **Ronald Amundsen,** University of California; **Allison Wood,** Hunton & Williams

THURSDAY 9

8–10 a.m.
Human Influences on the Stratigraphic Record

Roger LeB. Hooke, Climate Change Institute, University of Maine; **Jeffrey Lee,** Texas Tech University; **Jon Sandor,** Iowa State University; **David Montgomery,** University of Washington

2008 Joint Annual Meeting

GSA Mentor Programs

Find full program descriptions at
www.geosociety.org/science/.
For additional information, contact Jennifer Nocerino
jnocerino@geosociety.org.

WOMEN IN GEOLOGY

Sun., 5 Oct., noon–1:30 p.m.

SUBARU

This new mentoring program, sponsored by Subaru, will address the issues faced by women in geology. This social hour begins with a few key women speakers, followed by a relaxing forum for socializing, sharing ideas, and meeting other women in geology. Appetizers will be provided. Registration is not required.

GEOLOGY IN GOVERNMENT

Mon., 6 Oct., 11:30 a.m.–1 p.m.

FREE lunch for undergraduate and graduate students. This popular annual event features a select panel of mentors representing various government agencies who will invite questions from students, offer advice about preparing for a career, and comment on the prospects for current and future job opportunities within their agencies. Registration is not required.

GEOLOGY IN INDUSTRY

Tues., 7 Oct., 11:30 a.m.–1 p.m.

FREE lunch for undergraduate and graduate students. This event features a select panel of mentors representing various industries who invite questions from the students, offer advice about preparing for a career in industry, and comment on the prospects for current and future job opportunities within their companies. Registration is not required.

JOHN MANN MENTORS IN APPLIED HYDROGEOLOGY PROGRAM

This program underwrites the cost for up to 25 students to attend the distinguished Hydrogeology Division Luncheon and Awards Presentation. **Eligible students are those who have (1)** checked the box on their membership application indicating their professional interest in hydrology/hydrogeology, AND **(2)** registered for the 2008 Joint Annual Meeting **by 2 Sept. 2008.** Ticket recipients will have the chance to meet with some of the nation's most distinguished hydrogeologists. Tickets will be awarded to the first 25 students who respond to an **e-mail invitation**, based on the eligibility criteria above. Date TBA. **Registration required.**

THE GEOLOGICAL SOCIETY OF AMERICA®

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Letter

This year's Joint Annual Meeting is half a day longer than usual, running through noon Thursday, 9 October. The Jewish holy day, Yom Kippur, falls on 9 October this year as well. GSA tries to avoid booking meetings over any religious holiday. We want to explain why this has happened this year.

GSA had originally planned to hold this year's joint annual meeting in Chicago, but problems caused us to pull out of that city. Our options for meeting locations were limited because, as a joint meeting, we required more convention center and hotel space. Houston was the only city that could house this meeting and accommodate our short lead time, but 5–9 October were the only dates available. We hope our members who observe Yom Kippur will still be able to attend most of the meeting.

If you have any questions or comments, feel free to contact me.

Melissa Cummiskey, *GSA Director of Meetings & Events*
mcummiskey@geosociety.org

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Student Travel Grants

HOUSTON 2008 JOINT ANNUAL MEETING

Application deadline: 2 September 2008

Students: Make your trip to the annual meeting easier on your wallet—check out the following grants!

❶ GSA Student Travel Grant for Minorities, Women, and Persons with Disabilities

The GSA Minorities and Women in the Geosciences Committee and the GSA Foundation announce the availability of student travel grant funds for one or more eligible students to attend the Joint Annual Meeting. The primary goal of this grant is to encourage the participation of women, minorities, and persons with disabilities in the geosciences at national meetings. Each student will receive GSA membership for 2009 and an average cash award of US$500 to be used for roundtrip airfare, hotel accommodations, meeting registration, and/or meals.

Apply online at **www.geosociety.org/meetings/2008/travelgrants.htm.** Contact Chris McLelland at +1-303-357-1082 or +1-800-472-1988, ext. 1082, if you have any questions.

Eligibility Requirements:

- Full-time student enrolled in an accredited university or college for the fall semester 2008 and majoring in geology, earth science, or a related field.
- U.S. citizenship, or permanent residency, with a valid social security number.
- Preference will be given to students presenting papers/posters either as primary or secondary authors.
- Undergraduate and graduate students may apply.
- Must be a GSA Student Member at the time of application.
- Awardees are expected to attend the entire meeting and to participate in GeoScience Day (a geological field trip for middle and/or high school students).

❷ GSA Section Travel Grant

The GSA Foundation has made US$4,500 in grants available to each of the six GSA Sections. The money, when combined with equal funds from the Sections, is used to help GSA Student Members travel to GSA meetings. **For eligibility requirements,** please visit the following Section Web sites or contact the Section secretary directly.

North-Central: www.geosociety.org/grants/ncgrant.htm
South-Central: www.geosociety.org/sectdiv/southc/index.htm#travel
Northeastern: www.geosociety.org/grants/negrant.htm
Southeastern: core.ecu.edu/geology/neal/segsa/travel.html

The Rocky Mountain and Cordilleran Sections offer student travel grants for their regional Section Meetings but not for the Joint Annual Meeting.

❸ Joint Meeting Student Travel Fund

This grant is for any student member of any of the organizations participating in the 2008 Joint Annual Meeting. Information and eligibility requirements are available in the STUDENTS section on the main meeting Web site at **www.acsmeetings.org/students/travel-grants/.**

Note: Applying for a travel grant DOES NOT register you for the meeting. You must register for the meeting (at www.acsmeetings.org/registrations/) ***before*** you can apply for a travel grant. You may apply for multiple grants but can only receive one. Notification of grant status will be made by e-mail, and you must pick up your check in person (with photo ID) in Houston.

NEW!

GSA's Planetary Geology Division is offering two travel grants of US$500 each for students presenting first-authored papers at the 2008 GSA Annual Meeting.

See www.unb.ca/passc/GSA/ for more information.

HOUSTON 2008 JOINT ANNUAL MEETING

Guest Program

TOURS

All Joint Annual Meeting guests and attendees are welcome to register for the following tours, which include professional tour guide fees, roundtrip transportation, admission fees, meals (when noted), and gratuities. **Tours may be canceled if minimum attendance is not met, so please register early!**

Sunday, 5 October

101. **Motorcoach Orientation Tour: Downtown Houston and Gateway to the Museum District.** 10 a.m.–noon. Cost: US$28. Min.: 20.

Monday, 6 October

102. **Up, Down, and All Around—Downtown Walking Tour.** 10 a.m.–12:30 p.m. Cost: US$16. Min.: 20.

103. **Chinatown Dim Sum Lunch & Chinese Supermarket Tour.** 11 a.m.–3 p.m. Cost: US$54; includes lunch. Min.: 20.

Tuesday, 7 October

104. **Religious Diversity in Multicultural Houston—Hindu & Buddhist Temples, Islamic Mosque.** 8 a.m.–4 p.m. Cost: US$68; lunch not included. Min.: 20.

105. **Bayou Bend Collection and Gardens—Plus the Grand Homes of River Oaks.** 1–4:30 p.m. Cost: US$53. Min.: 20.

Wednesday, 8 October

106. **Art Tour Extraordinaire—Rice University Gallery and the Menil Complex.** 1–5 p.m. Cost: US$40. Min.: 20.

107. **Galveston Tour—Ocean Star, The Strand, and Haak Vineyards.** 9 a.m.–5 p.m. Cost: US$70; lunch not included. Min.: 20.

If you'll be attending the meeting as a guest of a professional or student registrant, then guest registration is for you! The fee for the entire meeting is only $US90 before 2 September and US$95 after that. When you register as a guest, you'll receive a special gift, and you'll be able to attend your companion's technical session(s). You will also be our guest to visit the exhibit hall and Guest Hospitality Suite as much as you'd like. Finally, you can even sign up for tours and field trips—simply pay the tour or trip fee!

Please note that individuals whose professional interests are related to geoscience, soil, agronomic, crop, or environmental sciences do not qualify for guest registration.

Guest Hospitality Suite Hours

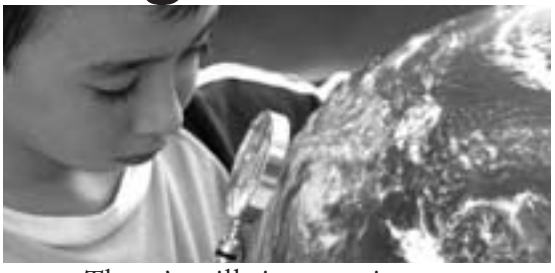
Sun.–Wed., 5–8 Oct., 8 a.m.–5:30 p.m. & Thurs., 9 Oct., 8 a.m.–noon

The Guest Hospitality Suite, which is staffed by a hostess to answer your questions regarding restaurants, activities, and attractions, as well as offer general information about Houston, includes complimentary seminars, light food and beverages throughout the day, and the Presidents' guest breakfast.

Read More about It

To learn more about guest tours and seminars, as well as our many field trips, check the Joint Annual Meeting Web site, **www.acsmeetings.org/2008/.** If you're interested in learning more about Houston on a one-on-one level, check out the Houston Greeters at **www.houstongreeters.org/.** For Houston venues & upcoming events, check **www.artshound.com** and **www.visithoustontexas.com.**

Bring Your Kids!



There's still time to sign up.
Deadline: **5 September 2008.**

HOUSTON 2008 JOINT ANNUAL MEETING

Go to **www.kiddiecorp.com/gsakids.htm** for more information and to register.

KiddieCorp will provide on-site child care Saturday–Thursday, 4–9 October, at the **Hilton Americas–Houston.** KiddieCorp offers professional child care services for children ages 6 months to 12 years. Children will enjoy games, story time, arts and crafts, and other fun-filled activities for each age group. Fees are US$6 per hour, per child, with a two-hour minimum.

Child care services are a contractual agreement between each individual and the childcare company. GSA/SSSA/ASA/CSSA/GCAGS/HGS assume no responsibility for the services rendered.

2008 Joint Annual Meeting

PUBLIC FORUM: Understanding Evolution

Tuesday, 7 Oct., 7–9 p.m.

Everyone is invited to hear the latest evidence about the theory of evolution and the importance of keeping it in our classrooms. Learn the science and the facts that support the theory, as well as why intelligent design should not be considered science. Audience Q&A will follow the presentation. This forum is nontechnical and suitable for anyone who is interested in the science behind evolution.

SUBARU

Sponsored by Subaru of America Inc.

2008 Joint Annual Meeting

Geoscience Educators Reception

Saturday, 4 Oct., 5–7 p.m.

Appetizers and cash bar provided.

Join other educators in a relaxing forum for socializing, sharing ideas, and meeting other geoscience community members interested in education. Meet the GSA Education and Outreach staff as well!

Short Course Program

HOUSTON 2008 JOINT ANNUAL MEETING

MORE CAREER DEVELOPMENT OPPORTUNITIES THAN EVER BEFORE!

The following short courses are open to all. **Early registration is recommended;** registration after 2 Sept. is an additional US$30.

If you would like to attend only a short course, you can do so by paying the nonregistrant fee (US$45 by 2 Sept.; US$50 late/onsite registration) in addition to the course fee. This nonregistrant fee may be applied toward meeting registration. GSA K–12 Teacher Members, however, need only pay the short course fee (no nonregistrant fee required).

Continuing Education Units **(CEUs):** Most professional development courses and workshops offer CEUs. One CEU comprises 10 contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction (one contact hour = 60-minutes of classroom instruction or its equivalent).

Go to **www.acsmeetings.org/programs/short-courses/** or contact Jennifer Nocerino, jnocerino@geosociety.org, for additional information. **Cancellation deadline:** 19 September 2008.

PROFESSIONAL COURSES

501. **Estimating Rates of Groundwater Recharge.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$191; includes lunch. Limit: 35. CEU: 0.8. Rick Healy, U.S. Geological Survey; Bridget Scanlon, Univ. of Texas.

Estimates of groundwater recharge are required to accurately assess water resources and evaluate aquifer vulnerability to contamination. This course will review theory, assumptions, uncertainties, advantages, and limitations of different approaches for estimating recharge rates. We will discuss physical, tracer, and numerical modeling techniques based on surface water, unsaturated zone, and saturated zone data. Course content is aimed at practicing hydrologists and advanced hydrology students.

502. **Geopressure and Pore Pressure Prediction Fundamentals.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$160; includes lunch. Limit: 30. CEU: 0.8. Selim S. Shaker, Geopressure Analysis Services Inc. *Cosponsored by GCAGS.*

This one-day course is essential for every technical professional involved in exploration, production, and drilling for oil and gas. Basic geological building blocks are used as the foundation for pore pressure predictions. This course covers the essentials of geopressure compartmentalization in relation to pore pressure development with depth and emphasizes the differences between the geopressured and hydrodynamic systems. It is an introduction to definitions, models, measurements, predictions, calibrations, and appraisals of subsurface geopressure and also briefly discusses different geopressure case histories and their implications for exploration and exploitation.

503. **How to QC and Interpret What Your Petrophysicist Gives You.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$160; includes lunch. Limit: 25. CEU: 0.8. Elizabeth Fisher, Hess Corp.; Jeff Baldwin, Fugro-Jason; Tad Smith. *Cosponsored by GCAGS; Fugro-Jason.*

The objective of the class is to teach geophysicists and geologists how to QC petrophysical data. To do this properly, they need to understand what the petrophysicist does (typical workflows used), problems that might be encountered, assumptions made, and how problems can be identified in a variety of QC plots. This will include calibration of logs, hole effects, tool failure, and rock physics. Participants should have a basic understanding of well logs and their purpose. **If you have questions about class content, please e-mail efisher@hess.com.**

504. **Seismic Amplitude Interpretation.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$220; includes lunch. Limit: 30. CEU: 0.8. Fred Hilterman, Geokinetics Inc. *Cosponsored by GCAGS.*

A reservoir's composition is derived from seismic amplitude interpretation. This course introduces the rock-physics basics for reservoir characterization and catalogs rock properties to expected seismic signatures. Techniques for recognizing and quantifying hydrocarbons in different rock-property settings (class 1–4) are presented and illustrated with numerous field examples. Various seismic amplitude attributes for distinguishing lithology and pore fluid are introduced, and rock-property and AVO modeling programs are supplied to each participant to assist in the seismic discrimination of lithology and pore-fluid.

505. **Introduction to Geographic Information Systems (GIS) Using ArcGIS for Geological and Environmental Science Applications.** Sat.–Sun., 4–5 Oct., 8 a.m.–5 p.m. Fee: US$45; includes lunch and 6-month software. Limit: 20. CEU: 1.6. Ann Johnson, ESRI; Mike Price, ESRI; Willy Lynch, ESRI. *Cosponsored by ESRI.*

Participants will be introduced to the use of GIS in geosciences and environmentally related applications through brief lectures, demonstrations, and hands-on computer exercises. Participants do not need experience with ArcGIS, but familiarity with Windows OS is helpful. A brief introduction to spatial concepts and GIS using ArcGIS ArcMap and Spatial and 3D Analyst extensions will follow with the creation of a project covering many analysis techniques (geoprocessing using Toolbox tools and ModelBuilder). Use of Geodatabase Model schema and resources for accessing data will be explored.

506. **Seal Analysis Workshop.** Sat., 8 a.m.–5 p.m. & Sun., 8 a.m.–4 p.m., 4–5 Oct. Fee: US$320; includes lunch. Limit: 40. CEU: 1.5. William C. Dawson, Chevron; William R. Almon, Chevron. *Cosponsored by GCAGS.*

Seals are absolutely fundamental to hydrocarbon accumulations on many levels; they control migration, charge volumes, the lateral and vertical distribution of hydrocarbons in a basin, percent fill of a reservoir, and the flow of hydrocarbons during production. The economic success or failure of a project is strongly dependent on proper seal risking; despite that, they are the least-studied element of the petroleum system. Participants will learn analytical approaches for seal analyses, controls on seal character, seal development and burial history, seal risk analysis, sequence stratigraphic framework of seals, and predictive models for estimating top and fault seal capacity.

507. **Ethics for Geoscientists.** Sat., 4 Oct., noon–1 p.m. Fee: US$40 with lunch; US$30 without lunch. Limit: 150. CEU: 0.1. Chris Mathewson, Texas A&M. *Cosponsored by GCAGS*; *Houston Geological Society*.

Many licensure boards require registered geologists to meet continuing education requirements. One of those requirements is a minimum of one professional development hour per renewal period in the area of professional ethics, roles, and responsibilities. This one-hour program begins with a lecture that covers situations in which geoscientists will be challenged to select the most ethical course of action. Some situations are easy, but as illustrated in this course, some are not. A question-and-answer session will follow, and course participants will debate various alternatives to situations they have encountered. This course is enlightening and thought-provoking.

508. **The WRB (World Reference Base for Soil Resources)—An International Soil Classification System.** Sun., 5 Oct., 8:30 a.m.–12:30 p.m. Fee: US$170. Limit: 50. CEU: 0.4. Peter Schad, Technische Univ. München; Erika Micheli, Szent Istvan Univ. *Cosponsored by SSSA Division S-5 (Pedology)*.

WRB is an international soil classification system officially used by the International Union of Soil Sciences for communication between soil scientists all over the world. This workshop will discuss the principles, architecture, and rules for classification. The 32 Reference Soil Groups comprising the first hierarchical level will be introduced, and the second level (qualifier level) will be explained. Benchmark soils from the United States and other countries will be used as training examples and to show correlation possibilities between WRB and soil taxonomy. The target audience includes university teachers who want to include WRB in their curriculum, other professionals, and graduate students.

509. **Parameter Estimation and Uncertainty Analysis Course.** Thurs., 5 p.m.–9 p.m. & Fri., 8 a.m.–5 p.m., 9–10 Oct. Fee: US$425; includes lunch, software, and numerous publications. Limit: 20. CEU: 1.2. Matthew Tonkin, SS Papadopulos & Associates; John Doherty, Watermark Numerical Computing. *Cosponsored by California Groundwater Resources Association.*

This course is led by John Doherty, author of the open-source inverse code, PEST, and Matt Tonkin. The course includes lectures presenting theory and practical applications together with labs enabling participants to apply PEST. Course CDs contain lecture, lab, and reference materials, plus PEST and associated software. Topics include parameter estimation theory, the use of pilot points, mathematical regularization, the calibration solution and null spaces, and linear and nonlinear predictive error analysis, including calibration-constrained Monte Carlo. Attendees who will benefit from this course range from experienced modelers to non-modelers who make decisions on the basis of models**.**

FACULTY AND GRADUATE STUDENT COURSES

510. **Brittle Deformation of Crustal Rocks: Insights from Experimentation and Microstructural Studies.** Thurs., 5–9 p.m., Fri., 8 a.m.–5 p.m. & Sat., 9 a.m.–5 p.m., 2–4 Oct. Fee: US$150; includes banquet dinner and lunch. Course to be held at Texas A&M in College Station, Texas; *fee does not include transportation* (two-hour drive or 30-minute flight from Houston; shuttle service available). Limit: 30. CEU: 1.9. Frederick Chester, Texas A&M; Dave Wiltschko, Texas A&M; Judith Chester, Texas A&M; Steve Laubach, Univ. of Texas.

This course covers the brittle processes of deformation and recovery in granular and clastic rocks over the range of conditions from near-surface to deep crust and will include lectures from multiple speakers with ample time for group discussion, hands-on microstructural observations and laboratory activities, tour of a rock deformation laboratory, demonstration of rock deformation experiments, sharing of education and research products, and socializing. Geared towards researchers, graduate students, and faculty.

511. **3-D Visualization in Teaching and Research.** Fri., 10 Oct., 8 a.m.–5 p.m. Fee: US$93; includes lunch. Limit: 24. CEU: 0.8. Bill Keach, Brigham Young Univ. & Univ. of Utah–Energy and Geoscience Institute; John McBride, Brigham Young Univ. *Cosponsored by Landmark/Halliburton*.

Come learn how to use 3-D visualization in the classroom to broaden your students' understanding of complex depositional systems and structural environments. The first half of the course will teach the basic operation of 3-D visualization techniques. In the second half, you will have the opportunity to apply these techniques to 3-D datasets from a variety of depositional and structural settings around the world. Examples will include 3-D seismic-reflection and ground-penetrating radar data.

512. **Sequence Stratigraphy for Graduate Students.** Fri.–Sat., 3–4 Oct., 8 a.m.–5 p.m. No fee, but preregistration is required. Limit: 55. CEU: 1.6. Art Donovan, BP Upstream Technology Directorate; K.M. Campion, ExxonMobil Upstream Research. *Cosponsored by ExxonMobil; BP*.

This free short course is designed to teach graduate students the principles, concepts, and methods of sequence stratigraphy. Sequence stratigraphy is a methodology that uses stratal surfaces to subdivide the stratigraphic record. This methodology allows the identification of coeval facies, documents the time-transgressive nature of classic lithostratigraphic units, and provides geoscientists with an additional way to analyze and subdivide the stratigraphic record. With exercises that utilize outcrop, core, well-log, and seismic data, the course provides a hands-on experience for learning sequence stratigraphy. Exercises include classic case studies from which many sequence stratigraphic concepts were originally developed. **For more information or to register, please e-mail art.donovan@bp.com.**

513. **Education Research I: Conducting Qualitative Geoscience Education Research.** Sat., 4 Oct., 8 a.m.–noon. Fee: US$103. Limit: 50. CEU: 0.4. Julie Sexton, National Science Foundation Center for Learning and Teaching in the West, Colorado State Univ.

In this workshop, participants will learn qualitative education data collection and analysis methods used in geoscience education research. Case studies, demonstrations, and hands-on activities will be used to introduce participants to developing qualitative research questions, collecting qualitative data (e.g., interviews), and analyzing qualitative data (e.g., coding). This workshop is geared for students, college and K–12 educators, and researchers who are engaged in or who plan to be engaged in geoscience education research. This course can be taken alone or in conjunction with the short course "Education Research II: Conducting Quantitative Geoscience Education Research" (no. 525).

514. **Hands-on Tools for Earth Science Inquiry: The Learning with Data Workshop.** Sat., 4 Oct., 8 a.m.–noon. Fee: US$65. Limit: 30. CEU: 0.4. William Prothero, Jr., Univ. of California at Santa Barbara (emeritus); Sabina Thomas, Baldwin Wallace College.

Increase student learning in general education earth science courses by implementing data exploration and writing activities with the "Learning with Data Workshop" (LWD). LWD is a comprehensive resource intended to support learning about Earth using real data. It allows learners to access earth data, create and annotate data display images, and incorporate them into writing activities, which are also included in the package. Workshop participants will gain familiarity with the software content, learn how to use it to support effective inquiry and writing activities, and learn how to customize the assignments that are included with LWD. **For more information, go to http://earthednet.org/lwd/.**

515. **Teaching Darwin.** Sat., 4 Oct., 9 a.m.–noon. Fee: US$70. Limit: 50. CEU: 0.4. Leo F. Laporte, Univ. of California at Santa Cruz. *Cosponsored by GSA History of Geology Division*.

The purpose of this workshop is to enable participants to develop a course of their own on Darwin. Workshop leader Leo Laporte taught a course on

Darwin for many years at the University of California at Santa Cruz; he has taught this workshop previously and has developed a Web site of Darwin course resources. 2009 will be the 150th anniversary of the publication of *On the Origin of Species* and also the 200th anniversary of Darwin's birth. The GSA History of Geology Division is pleased to sponsor this timely workshop. **Contact Leo Laporte, laporte@ucsc.edu, with questions.**

516. **Using Authentic NASA Earth and Planetary Science Data for Inquiry in Courses for Future Science Teachers.** Sat., 4 Oct., 8 a.m.–noon. Fee: US$14. Limit: 40. CEU: 0.4. Tim Slater, Univ. of Wyoming; Rick Pomeroy, Univ. of California at Davis; Stephanie Shipp, Lunar Planetary Institute; Stephanie Slater, Univ. of Wyoming; Lin Chambers, NASA. *Cosponsored by NASA.*

This participatory workshop for college and university faculty provides strategies, classroom-ready tools, and instructional materials designed for use with future science teachers in undergraduate geoscience courses and courses on science teaching methods. It will cover how to effectively conduct scientific inquiry investigations using NASA earth and planetary science data. Participants are encouraged, but not required, to bring their own laptops equipped with MS Office and a CD-ROM drive.

517. **Multi- and Hyperspectral Remote Sensing for Geologic Applications.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$208. Limit: 30. CEU: 0.8. William Farrand, Space Science Institute; John Mars, U.S. Geological Survey.

This short course will provide an introduction to the theory, processing, and geologic applications associated with multi- and hyperspectral remote sensing. Multispectral data from a sensor such as ASTER can be used to map iron-bearing minerals, carbonates, phyllosilicate, and other silicate minerals. Hyperspectral data has higher spectral resolution and can be used to identify many minerals based on characteristic absorption features associated with these minerals. These data can be used for a number of geologic applications, including mineral and lithologic mapping, sedimentary facies mapping, mineral exploration, abandoned mine land assessment, and soils mapping.

518. **Starting out in Undergraduate Research and Education: A Professional Development Workshop for Young Faculty.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$65; includes lunch. Limit: 30. CEU: 0.8. Jeffrey Ryan, Univ. of South Florida; Lydia Fox, Council on Undergraduate Research; Jill Singer, Council on Undergraduate Research. *Cosponsored by Council on Undergraduate Research; National Association of Geoscience Teachers.*

This workshop is targeted at early-career faculty and postdoctoral scientists or graduate students seeking an academic career. Topics include resources for generating exemplary geoscience courses, methods for integrating research practices into the classroom, and effective approaches to mentoring undergraduate researchers toward their best benefit and that of their faculty mentors. Based on the demographics of our participants, we may also include a section on how to get a job at an academic institution (primarily undergraduate institution or regional university). Facilitators are all officers of the Council on Undergraduate Research or the National Association of Geoscience Teachers.

519. **Teaching Petrology and Structural Geology in the 21st Century.** Sat., 4 Oct., 8 a.m.–5 p.m. Fee: US$45; includes lunch. Limit: 50. CEU: 0.8. Barbara Tewksbury, Hamilton College; Yvette D. Kuiper, Boston College; Jeffrey Ryan, Univ. of South Florida. *Cosponsored by On the Cutting Edge; GSA Structural Geology and Tectonics Division; GSA Geoscience Education Division.*

This workshop is a follow-on to the highly successful 2003 and 2004 "On the Cutting Edge" workshops on "Teaching Petrology and Teaching Structural Geology in the 21st Century." We seek participants who can share innovative and effective classroom, lab, field, or GIS activities or who have ways to integrate concepts from these two disciplines into courses taught in other areas of the undergraduate curriculum. This workshop will also provide an opportunity to discuss issues related to teaching the two disciplines. Participants will contribute their activities to the Cutting Edge online resource collections for teaching petrology and structural geology, http://serc.carleton.edu/NAGTWorkshops/.

520. **Beyond the Content: Teaching Scientific and Citizenship Literacies in the Geosciences.** Sat., 4 Oct., 9 a.m.–5 p.m. Fee: US$47. Limit: 30. CEU: 0.7. Erin Campbell-Stone, Univ. of Wyoming; James Myers, Univ. of Wyoming.

A primary goal of many geoscience courses is to provide students with the scientific knowledge necessary to make informed decisions about societal issues, but often students are not equipped with the scientific literacies necessary to convert facts into understanding, nor are they able to make connections between content and society. Course leaders will share techniques for assessing students and courses (introductory to junior-level undergraduate courses) with regard to scientific and citizenship literacies and provide tools for adding a literacy component to participants' existing courses.

521. **Making the Case for Tenure: A Workshop for Early Career Faculty.** Sat., 4 Oct., 9 a.m.–5 p.m. Fee: US$50. Limit: 35. CEU: 0.7. Kristen St. John, James Madison Univ.; Heather Macdonald, College of William and Mary. *Cosponsored by On the Cutting Edge; GSA Geoscience Education Division; National Association of Geoscience Teachers.*

This workshop addresses topics regarding building a case for tenure, preparing a tenure package, and other matters related to the tenure process. Participants will examine excerpts from tenure packages from a range of academic institutions and will discuss successful tenure packages and strategies used to make persuasive arguments. They will also review teaching materials (including their own) and discuss how they could be used as evidence of teaching excellence. Participants should be in a tenure-track (or equivalent) position in a two- or four-year college or university at the time of the workshop.

522. **The Use of GPS, LiDAR, and InSAR Data to Learn about Plate Tectonics, Crustal Deformation, Isostasy, and Ice Flow: A Short Course for Faculty at Two- and Four-Year Institutions.** Sat., 4 Oct., 9 a.m.–5 p.m. Fee: US$31; includes continental breakfast and refreshments. Limit: 20. CEU: 0.7. Helmut Mayer, UNAVCO; Susan C. Eriksson, UNAVCO; Shelley Olds, UNAVCO. *Cosponsored by UNAVCO.*

This course is geared toward faculty at two- and four-year colleges who teach earth science or a science course in which plate tectonics is a topic. Participants will be introduced to place-based, data-rich educational materials about GPS and plate tectonics to use in their classrooms, receive an introduction to high-precision GPS, and have the opportunity to discuss pedagogical strategies for classroom implementation. Anticipated topics include slow earthquakes in Cascadia, volcano deformation, isostatic rebound, and ice flow. Applications of new technologies, such as LiDAR and InSAR, will be introduced. Knowledge of GPS is not required.

523. **Writing and Evaluating Geoscience Concept Inventory Questions.** Sat., 4 Oct., 9 a.m.–5 p.m. Fee: US$10; includes continental breakfast. Limit: 50. CEU: 0.7. Julie Libarkin, Michigan State Univ.; Steven W. Anderson, Univ. of Northern Colorado. *Cosponsored by National Science Foundation.*

The Geoscience Concept Inventory, or GCI, is a valid and reliable assessment tool designed for entry-level college earth science courses. Although used widely, the GCI currently consists of only 69 validated questions and covers only a narrow range of topics relevant to the earth sciences. The geoscience community can help build assessment tools relevant to their own courses through participation in a new GCI initiative to generate a community-developed bank of GCI questions. Participants in this workshop will learn techniques for writing multiple-choice questions and will receive training in qualitative data analysis for concept inventory development.

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• Geological Society Special Publication 297

The Boundaries of the West African Craton

Edited by N. Ennih and J.-P. Liégeois

The boundaries of rigid cratons can be affected by subsequent orogenic events, leading to 'metacratonic' characteristics not often properly recognized and still poorly understood. Major lithospheric thickening is absent and early events such as ophiolites are preserved; however, metacratonic boundaries are affected by major shear zones, abundant magmatism and mineralizations, and local high-pressure metamorphism.

West Africa, marked by the large Eburnian (c. 2 Ga) West African craton, the absence of Mesoproterozoic events, the major Pan-African (0.9-0.55 Ga) mobile belts that generated the Peri-Gondawanan terranes, and the weaker but enlightening Variscan and Alpine orogenies, is an excellent place for tackling this promising concept of metacratonization.

The papers in this book consider most of the West African craton boundaries, from the reworking of the Palaeoproterozoic terranes, through the Pan-African encircling terranes, the late Neoproterozoic-early Palaeozoic extension period and the Peri-Gondwanan terranes, the Variscan imprint to the current situation.

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• Geological Society Special Publication 296

Landscape Evolution: Denudation, Climate and Tectonics over Different Time and Space Scales

Edited by K. Gallagher, S. J. Jones and J. Wainwright

The morphology of Earth's surface reflects the interaction of climate, tectonics and denudational processes operating over a wide range of spatial and temporal scales. These processes can be considered catastrophic or continuous; depending on the timescale of observation or interest. Recent research had required integration of historically distinct subjects such as geomorphology, sedimentology, climatology and tectonics. Together, these have provided new insights into absolute and relative rates of denudation, and the factors that control the many dynamic processes involved. Specific subject areas covered are sediment transport processes and the timescales of competing processes, the role of the geological record and landscapes in constraining different processes, the nature of landscape evolution at different spatial scales and in contrasting geological environments.

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• Geological Society Special Publication 295

Fishes and the Break-up of Pangaea

Edited by L. Cavin, A. Longbottom and M. Richter

This volume, in honour of Peter L. Forey, is about fishes as palaeobiogeographic indicators in the Mesozoic and Cenozoic. The last 250 million years in the history of Earth have witnessed the break-up of Pangaea, affecting the biogeography of organisms. Fishes occupy almost all freshwater and marine environments, making them a good tool to assess palaeogeographic models. The volume begins with studies of Triassic chondrichthyans and lungfishes, with reflections on Triassic palaeogeography. Phylogeny and distribution of Late Jurassic neoselachians and basal teleosts are broached, and are followed by five papers about the Cretaceous, dealing with SE Asian sharks, South American ray-finned fishes and coelacanths, European characiforms, and global fish palaeogeography. Then six papers cover Tertiary subjects, such as bony tongues, eels, cypriniforms and coelacanths. There is generally a good fit between fish phylogenies and the evolution of the palaeogeographical pattern, although a few discrepancies question details of current palaeogeographic models and/or some aspects of fish phylogeny.

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• Geological Society Special Publication 294

West Gondwana: Pre-Cenozoic Correlations Across the South Atlantic Region

Edited by R. J. Pankhurst, R. A. J. Trouw, B. B. de Brito Neves and M. J. de Wit

Some 75 years after the visionary work of Wegener and du Toit, Neoproterozoic to Mesozoic geological correlations between South America and Africa are re-examined in the light of plate tectonics and modern geological investigation (structural and metamorphic studies, stratigraphic logging, geochemistry, geochronology and palaeomagnetism). The book presents both reviews and new research relating to the shared Gondwana origins of countries facing each other across the South Atlantic Ocean, especially Brazil, Argentina, Cameroon, Nigeria, Angola, Namibia and South Africa. This is the first comprehensive treatment to be readily available in book form. It covers the common elements of cratonic areas pre-dating Gondwana, and how they came together in late Precambrian and Cambrian times with the formation of the Pan-African/Brasiliano orogenic belts (Dom Feliciano, Brasília, Ribeira, Damara, Gariep, Kaoko, etc.). The subsequent shared Palaeozoic and Mesozoic sedimentary record (Karoo system) prior to Gondwana break-up is also reviewed.

All prices and postage valid until 31 December 2008. **Postage: UK:** +5% (£4.00 minimum) **Europe:** +15% (£8.00 minimum) **Rest of world:** +15% (£12.50 minimum) *Please allow up to 28 days for delivery of in stock items in the UK. Parcels to Europe and Rest of World are sent by surface mail and can take 6 to 12 weeks to arrive. (Air or courier rates available on request).*

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524. **An Introduction to Improving Your Teaching by Conducting Science Education Research in Your Classroom.** Sat., 4 Oct., 1–5 p.m. Fee: US$14. Limit: 40. CEU: 0.4. Tim Slater, Univ. of Wyoming; Julie Libarkin, Michigan State Univ.; Stephanie Slater, Univ. of Wyoming. *Cosponsored by NASA.*

This participatory workshop for college and university geoscience faculty provides an overview and introduction to the motivations, strategies, methodology, and publication routes for improving geoscience education through conducting science education research in their own classrooms. Participants will evaluate the value of various education research questions, identify strengths and weaknesses of several research design methodologies, learn how to obtain Institutional Review Board approval to conduct education research on human subjects, and become more aware of how education research articles are created for publication in journals such as the *Journal of Geoscience Education.*

525. **Education Research II: Conducting Quantitative Geoscience Education Research.** Sat., 4 Oct., 1–5 p.m. Fee: US$103. Limit: 50. CEU: 0.4. Julie Sexton, National Science Foundation Center for Learning and Teaching in the West, Colorado State Univ.; James J. Dugan, Research and Development Center for the Advancement of Student Learning, Colorado State Univ. and Poudre School District.

This interactive, activity-based course serves as an introduction to quantitative education research methods. It is designed for geoscience faculty or students who are or will be conducting quantitative education studies. Topics include developing quantitative education research questions, designing a quantitative study (e.g., selecting appropriate statistical tests), collecting quantitative data (e.g., surveys), and analyzing education data using statistical tests (e.g., ANOVA). This course can be taken alone or in conjunction with the short course "Education Research I: Conducting Qualitative Geoscience Education Research" (no. 513).

526. **Visualization in Geoscience Education: The Power of Immersive Environments.** Sat., 4 Oct., 1–5 p.m. Fee: US$60. Limit: 25. CEU: 0.4. Alison Stokes, EL CETL; Helen King, Independent Consultant. *Cosponsored by Experiential Learning in Environmental and Natural Sciences Centre for Excellence in Teaching and Learning (EL CETL); GSA Geoscience Education Division; Higher Education Academy Subject Centre for Geography, Earth & Environmental Sciences.*

This course will introduce participants to immersive "dome" technology and demonstrate its potential for geoscience education and outreach. Whilst many virtual environments act as tools in the preparation for fieldwork, immersive environments are finding wider and more innovative applications, such as visualizing complex data sets and processes that act on time and space in scales that cannot be observed directly. The pedagogic potential of dome environments will be explored through a combination of formal presentation, participant discussion and activities, and demonstrations of immersive technology within a portable dome environment.

527. **Your First Steps in the Profession and the Future.** Sat., 4 Oct., 1–5 p.m. Fee: US$25. Limit: 50. CEU: 0.4. Robert A. Stewart, LFR Inc.; Raymond Talkington, Geosphere Environmental Management Inc. *Cosponsored by AIPG; Northeast Section, AIPG.*

This workshop is designed for upper-level undergraduates and graduate students who are examining their options upon graduation. We will discuss job-search techniques in the private sector, including consulting, industry, and government. Also to be presented are opportunities for geologists in oil and gas, exploration and extraction of metallic and nonmetallic minerals, environmental management and water supply, state and federal agencies, and academic teaching and research.

528. **Introduction to the Petroleum Geology of Deepwater Settings.** Sat.–Sun., 4–5 Oct., 8 a.m.–5 p.m. US$400; includes lunch and book, *AAPG Studies in Geology* no. 57. Limit: 40. Fee: CEU: 1.6. Paul Weimer, Univ. of Colorado. *Cosponsored by GCAGS.*

The purpose of this course is to provide a broad overview of the petroleum systems of deepwater settings for the working geoscientist. The salient points to be covered can be integrated into a geoscientist's daily work flow, and include a global overview of deepwater exploration and production; sequence stratigraphic setting of deepwater systems; sedimentary-gravity flows and their processes; deepwater-reservoir elements (channels, levee-overbank, sheet sandstones; mass-transport deposits, hybrid-type); interpretation pitfalls; biostratigraphy; reservoir quality; traps; and petroleum systems. This overview will cover ~70%–75% of the information, and several exercises will be included in the course.

529. **Teaching Field Methods in Geology Using Rugged Tablet Computers, GPS, and Digital Data.** Sun., 5 Oct., 8 a.m.–5 p.m. Fee: US$80. Limit: 20. CEU: 0.8. Mark Manone, Northern Arizona Univ.; Peter Knoop, Univ. of Michigan. *This course is made possible in part by a generous donation from HP.*

Field geology is benefiting greatly from digital technologies of all kinds. In particular, the use of ruggedized tablet computers with integrated GPS, GIS, data management, and note-taking software presents a fundamentally new way to map and collect data in the field. This combination of integrated technologies offers exciting avenues for teaching field geology and geologic mapping. This workshop will expose field instructors to all aspects of working with these integrated technologies, including hardware, software, data, logistics, and future trends. Workshop participants will be involved with hands-on applications throughout the entire session.

530. **Teaching Introductory Geoscience Using Lecture Tutorials.** Sun., 5 Oct., 1–5 p.m. Fee: US$93. Limit: 50. CEU: 0.4. Karen Kortz, Community College of Rhode Island & Univ. of Rhode Island; Jessica Smay, San José City College. *Cosponsored by GSA Geoscience Education Division.*

Participants will learn about lecture tutorials and other classroom techniques designed to make lectures more interactive. Lecture tutorials are short, interactive worksheets students complete in class after a brief lecture, designed to increase learning and decrease misconceptions. Each teaching technique will be demonstrated, providing participants practice with classroom-ready examples and guidance as they create their own examples. Participants will receive a book of lecture tutorials and examples of other interactive techniques with references for more. This workshop is geared toward faculty at two- or four-year institutions or graduate students who will teach introductory geoscience courses.

531. **Fundamentals of Seismic Structural Analysis and Hydrocarbon Entrapment Analysis for Graduate Students.** Thurs.–Fri., 9–10 Oct., 9 a.m.–5 p.m. No fee, but preregistration is required. Limit: 30. CEU: 1.4. Peter Vrolijk, ExxonMobil Upstream Research Corp.; Peter Hennings, ConocoPhillips; Franco Corona, ExxonMobil; Steve Davis, ExxonMobil. *Cosponsored by ExxonMobil; ConocoPhillips; GSA Structural Geology and Tectonics Division.*

The purpose of this course is to introduce geoscience graduate students to general concepts of seismic structural interpretation and the role of structural interpretation in evaluating subsurface petroleum traps. The course will be taught in ConocoPhillips and ExxonMobil facilities using a combination of lecture materials and hands-on exercises. Day one will introduce students to the fundamentals of seismic interpretation of structural systems in exploration and production; day two will focus on the application of structural interpretations to the problems of petroleum trapping and the interaction of multiphase fluids with geologic structures and rocks in the subsurface. **For information or to register, please e-mail peter.vrolijk@exxonmobil.com.**

532. **Structural and Stratigraphic Concepts Applied to Basin Exploration.** Thurs.–Fri., 9–10 Oct., 9 a.m.–5 p.m. No fee, but preregistration is required. Limit: 30. CEU: 1.4. Lori L. Summa, ExxonMobil Exploration; Bob Stewart, ExxonMobil Exploration. *Cosponsored by ExxonMobil Exploration Corp.*

This course will explore concepts, methods, and tools of petroleum geoscience used on a day-to-day basis in the energy industry, with a focus on how we make decisions with limited information, evaluate risk versus uncertainty, and maximize value from integrated teams. Day one reviews fundamental stratigraphic and structural concepts; day two is an applied problem in basin exploration. Students will make "play" maps, bid on prospective acreage, and analyze individual prospects within that acreage. Throughout the course, we stress integration across disciplines and scales, focusing on the interaction and expression of basin formation, fill, and evolution processes from regional to prospect scales. **For information or to register, please e-mail lori.l.summa@exxonmobil.com.**

K–12 TEACHER COURSES

533. **More! Rocks in Your Head: Earth Science Professional Development for Teachers Grades 3–8 (K–12 Welcome).** Fri., 3 Oct., 8 a.m.–4:30 p.m. No fee; lunch provided, along with a manual, labeled rock and mineral samples, the U.S. Geological Survey *Time and Terrain Tapestry* map of the United States, Texas Assessment of Knowledge and Skills correlation charts, and a "Hunt for Fossil Fuels" oil exploration game. Limit: 60. CEU: 0.8. Janie Schuelke, Consultant. *Cosponsored by the Ellison Miles Geotechnology Institute; AAPG; Houston Geological Society; Region 4 Texas Education Service Center.*

This course covers the full scope of earth sciences for third- through eighth-grade teachers, and the comprehensive manual provided will enable full or partial incorporation into their curriculum. Build confidence with (1) background information, (2) vocabulary, (3) project information, (4) hands-on projects, (5) "gifted/talented," and (6) cross-curricular ideas. Includes Earth's structure, rock cycle, igneous, sedimentary, and metamorphic rocks, soil and sand analysis, erosion and deposition, caves, fossils, plate tectonics, geologic history, relative and absolute age dating, minerals, mining, fossil fuels, and landform forces.

534. **Discovering Plate Boundaries for Middle and High School Teachers.** Fri., 3 Oct., noon–5 p.m. No fee; lunch provided. Limit: 40. CEU: 0.4. Dale Sawyer, Rice University. *Cosponsored by Houston Geological Society; Region 4 Texas Education Service Center.*

Discovering plate boundaries is a data-rich classroom exercise that helps middle- and high-school students discover plate-boundary processes. The exercise is built around four global data maps: (1) earthquake location and depth, (2) location of recent volcanic activity, (3) seafloor age, and (4) topography and bathymetry. The exercise is based on the "jigsaw" concept, mixing students into different groups during the exercise, and takes about three hours. Participants will experience the exercise from both the student's and teacher's perspectives and will take away a reusable kit for teaching.

ALLIED & ASSOCIATED SOCIETY SHORT COURSES

535. **An Introduction to Petroleum Geology for Students.** Fri., 3 Oct., 8 a.m.–5 p.m. Fee: US$350; includes lunch and refreshments. Limit: 50. CEU: 0.7. Stephen L. Bend, Univ. of Regina. *Cosponsored by AAPG.*

This course is for undergraduate and graduate students who are curious about oil and gas exploration and possible careers in the industry. The emphasis is on the applied side, to demonstrate the practicality of their geological knowledge and to show the multidimensional aspect of the industry in order to convey a sense of the diverse career opportunities for geoscientists. Topics include the geology of oil and gas, formation and entrapment of oil and gas, the economics and geology of exploration, how geoscientists explore for oil and gas, and how oil and gas is produced. No course notes will be provided, but attendees will be given a copy of the American Association of Petroleum Geologist's e-text on petroleum geology. **For information or to register, please e-mail dboonstra@aapg.org.**

536. **Epigenic and Hypogenic Karst: Recognizing Each and Their Implications in Research and Management.** Sat., 4 Oct., 8 a.m.–noon. Fee: US$112. Limit: 50. CEU: 0.4. George Veni, National Cave and Karst Research Institute; Kevin Stafford, Stephen F. Austin University. *Cosponsored by NCKRI.*

Karst research and management has been predominantly based on the premise that karst aquifers are developed epigenically (by descending groundwater). While many are, recent studies show that many and major karst aquifers have hypogenic (ascending groundwater) origins. Major differences occur between these modes that affect groundwater flow patterns, modeling, chemistry, aquifer evolution, cave morphology, land management practices, and the occurrence of economic mineral deposits. Course participants will learn how epigenic and hypogenic systems work, how to identify them, and how to adjust research and management strategies to be suitable for each.

537. **Paleontological Society Centennial Short Course—From Evolution to Geobiology: Research Questions Driving Paleontology at the Start of a New Century.** Sat., 4 Oct., 8 a.m.–5 p.m. No fee; no limit. Richard K. Bambach, Smithsonian National Museum of Natural History; Patricia H. Kelley, Univ. of North Carolina–Wilmington. *Cosponsored by Paleontological Society.*

At the centennial of the Paleontological Society, this program surveys the broad range of research topics that hold promise for the future of our profession. Rather than asking "the usual suspects" to pontificate on what we already know interests them, we have invited a group of early- to mid-career leaders to address the spectrum of research questions motivating their research. New approaches to issues ranging across all of paleontology, each with new results, are on the program, representing geobiology, evolution, vertebrate paleontology, systematics, isotope studies, paleobiogeography, paleoecology, paleobotany, and more. This will be a day to connect with the "new" multidisciplinary paleontology. Join us and expand your horizons. **For more information, please e-mail Patricia H. Kelley, kelleyp@uncw.edu, or Richard K. Bambach, bambachr@si.edu.**

538. **Introduction to Petroleum Geology for Faculty.** Sat.–Sun., 4–5 Oct., 8 a.m.–5 p.m. Fee: US$580; includes lunch and refreshments each day. Limit: 50. CEU: 1.5. Stephen L. Bend, Univ. of Regina. *Cosponsored by AAPG.*

This introduction is for university and college professors and instructors and will provide course material to those with limited resources and experience in petroleum geology and teaching stratagems to help increase professional competency in the subject matter. Topics include overviews of the formation and accumulation of oil and gas, the business of exploration, the exploration process/making a play, drilling and production, and the use and application of petrophysical logs. No course notes are provided, but attendees will receive a copy of the American Association of Petroleum Geologist's e-text on petroleum geology, as well as copies of exercises used in class. **For information or to register, please e-mail dboonstra@aapg.org.**

Field Trips

HOUSTON 2008 JOINT ANNUAL MEETING

Many field trips are still open! The Houston area offers unique opportunities to explore classic field locations and learn about groundbreaking research, so budget some extra time for a field trip this October and encourage your friends and colleagues to do the same.

If you'd like to take part in a field trip without registering for the meeting, you can do so by paying the nonregistrant fee (US$45 by 2 Sept.; US$50 late/onsite registration) in addition to the field trip fee. This nonregistrant fee may be applied toward meeting registration. Trip fees include transportation during the trip, and other services, such as meals and lodging, are noted by the following: B—breakfast, L—lunch, R—refreshments, D—dinner, ON—overnight lodging.

All trips begin and end at the George R. Brown Convention Center in Houston unless otherwise indicated. Precise trip itineraries will be provided upon registration; you may also contact the field trip leaders directly. Questions? Please contact Eric Nocerino, +1-303-357-1060, enocerino@geosociety.org. Complete registration details and trip descriptions are posted at **www.acsmeetings.org/programs/field-trips-and-tours/field/.**

The Houston bay area. Image courtesy Greater Houston Convention and Visitors Bureau.

PREMEETING

401. **The Southern Extension of the Western Interior Seaway: Geology of Big Bend National Park and Trans-Pecos, Texas.** Mon.–Sat., 29 Sept.–4 Oct.; US$595 (B, L, R, 6ON). Dee Ann Cooper, University of Texas, Austin, Tex., +1-409-651-7619; Roger W. Cooper, Lamar University, Beaumont, Tex., +1-409-755-7244. *Cosponsored by Big Bend National Park.*

402. **Platform-Basin Transition and Sequence Stratigraphy of the Permian Rocks, Guadalupe Mountains, West Texas and Southeastern New Mexico.** Begins and ends in El Paso, Texas. Wed.–Sat., 1–4 Oct.; US$395 (L, R, 3ON). Michael C. Pope, Washington State University, Pullman, Wash., +1-509-335-5989; James R. Markello, ExxonMobil Upstream Research Co., Houston, Tex. *Cosponsored by GSA Sedimentary Geology Division; Society of Sedimentary Geology (SEPM).*

403. **Sequence Stratigraphy and Reservoir Characteristics of the Booch Sandstones, McAlester Formation (Desmoinesian), Arkoma Basin, Oklahoma.** Begins and ends in McAlester, Oklahoma. Thurs.–Fri., 2–3 Oct.; US$230 for professionals; US$95 for students (L, D, R, 1ON). Neil H. Suneson, Oklahoma Geological Survey, Norman, Okla., +1-405-325-7315; Dan T. Boyd, Oklahoma Geological Survey, Norman, Okla.; Rick Andrews, Mewbourne College of Earth and Energy, University of Oklahoma, Norman, Okla. *Cosponsored by Oklahoma Geological Survey.*

404. **Fluvial Systems of East-Central Texas: Responses to Climate and Sea-Level Change over the Past Two Glacial-Interglacial Cycles.** Thurs.–Sat., 2–4 Oct.; $US385 (L, R, 2ON). Mike Blum, Louisiana State University, Baton Rouge, La., +1-225-578-5735. *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; Gulf Coast Association of Geological Sciences.*

405. **The Texas Grenville Orogen, Llano Uplift, Texas.** Begins and ends in Austin, Texas. Thurs.–Sat., 2–4 Oct.; US$270 (B, L, D, R, 2ON). Sharon Mosher, Jackson School of Geosciences, University of Texas, Austin, Tex., +1-512-471-4135; Jamie Levine, University of Texas, Austin, Tex.; Mark Helper, University of Texas, Austin, Tex. *Cosponsored by GSA Structural Geology and Tectonics Division.*

406. **Sedimentology and Structure of Terrestrial to Shallow Marine Outcrops of the Pennsylvanian Mingus Formation, Mineral Wells, Texas.** Thurs.–Sat., 2–4 Oct.; US$325 (L, R, 2ON). Janok P. Bhattacharya, University of Houston, Houston, Tex., +1-713-743-4720; Russell K. Davies, Rock Deformation Research USA, Inc., McKinney, Tex.; Karen D. McGowen, ConocoPhillips, Houston, Tex. *Cosponsored by Houston Geological Society.*

407. **Characterization and Interpretation of Soils and Geologic Formations with Carbonates, Gypsum, and Other Soluble Salts.** Begins and ends in Midland, Texas. Thurs.–Sun., 2–5 Oct.; US$395 (L, R, 3ON). Wayne Hudnall, Texas Tech University, Lubbock, Tex., +1-806-742-4490. *Cosponsored by SSSA Division S-5 (Pedology); SSSA Division S-9 (Soil Mineralogy); SSSA S-880 (Soils-Geomorphology Committee).*

408. **Examination of a Vertisol Climosequence across the Texas Coast Prairie and its Implications for Interpreting Vertic Paleosols in the Geologic Record.** Begins in Corpus Christi, Texas, and ends in Houston. Fri.–Sat., 3–4 Oct.; US$386 (L, 2ON). Lee C. Nordt, Baylor University, Waco, Tex., +1-254-710-2195; Steven G. Driese, Baylor University, Waco, Tex.; Jonathan Wedenfield, USDA–Natural Resources Conservation Service, Rosenberg, Tex. *Cosponsored by GSA Sedimentary Geology Division; SSSA Division S-5 (Pedology); Society of Sedimentary Geology (SEPM).*

Houston Arboretum Nature Center; courtesy Greater Houston Convention and Visitors Bureau.

409. **Fault Zone Deformation in Cretaceous Carbonates of Central Texas.** Fri.–Sat., 3–4 Oct.; US$221 (L, R, 1ON). David A. Ferrill, Southwest Research Institute, San Antonio, Tex., +1-210-522-6082; Alan P. Morris, Southwest Research Institute, San Antonio, Tex.; Chris Zahm, University of Texas, Austin, Tex. *Cosponsored by GSA Structural Geology and Tectonics Division.*

410. **Birding the Upper Texas Coast.** Sat., 4 Oct.; US$105 (L, R). Cyn-Ty Lee, Rice University, Houston, Tex., +1-713-348-5084.

411. **Geomorphic and Hydrochemical History of the Edwards Aquifer at Inner Space Cavern.** Begins and ends in Austin, Texas. Sat., 4 Oct.; US$150 (L, R). Jay Banner, University of Texas, Austin, Tex., +1-512-471-5016; George Veni, National Cave and Karst Research Institute, Carlsbad, N.Mex. *Cosponsored by GSA Quaternary Geology and Geomorphology Division.*

412. **History of Oil and Gas Exploration in Southeast Texas.** Sat., 4 Oct.; US$85 (L, R). Neal Immega, Houston Gem and Mineral Society. *Cosponsored by GSA History of Geology Division.*

413. **Hands-on at IODP's Gulf Coast Repository—Authentic Scientific Ocean Drilling Samples and Data for Earth Systems Science Inquiry.** Sat., 4 Oct.; US$25 (B, L, D, R). Leslie Peart, Joint Oceanographic Institutions, Washington, D.C., +1-202-232-3900; Kristen St. John, James Madison University, Harrisonburg, Va.; Debbie Thomas, Texas A&M University, College Station, Tex.; John Firth, Texas A&M University, College Station, Tex. *Cosponsored by Deep Earth Academy; Consortium for Ocean Leadership; Integrated Ocean Drilling Program; National Science Foundation.*

414. **The Formation and Future of the Galveston-Follets-Bolivar Barrier System.** Sat., 4 Oct.; US$78 (L, R). John Anderson, Rice University, Houston, Tex., +1-713-348-4884; Antonio Rodriguez, University of North Carolina, Horehead City, N.C.

415. **The Origin of the Sandy Mantle and Mima Mounds of the East Texas Gulf Coastal Plain: Geomorphological, Pedological, and Geoarchaeological Perspectives.** Sat., 4 Oct.; $96 (L, R). Rolfe D. Mandel, University of Kansas, Lawrence, Kans., +1-785-864-2171; Donald L. Johnson, University of Illinois, Urbana, Ill.; Charles D. Frederick, University of Texas, Austin, Tex. *Cosponsored by GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; SSSA Division S-5 (Pedology); Council on the History, Philosophy, and Sociology of Soil Science.*

416. **Geology of and Hurricane Rita effects on the Chenier Plain, Southwestern Louisiana.** Sat.–Sun, 4–5 Oct.; US$238 (L, D, R, 1ON). Donald E. Owen, Lamar University, Beaumont, Tex., +1-409-835-5848; Richard A. Ashmore. *Cosponsored by Lamar University; Houston Geological Society.*

DURING THE MEETING

417. **A Field Exercise on Groundwater Flow Using Seepage Meters and Mini-Piezometers.** Sun., 5 Oct.; S$110 (L, R). David R. Lee, University of Waterloo, Waterloo, Ontario; Donald O. Rosenberry, U.S. Geological Survey, Lakewood, Colo.

418. **Texas Coastal Systems: K–12 Teachers Trip to Galveston Island and the Brazos River.** Sun., 5 Oct.; FREE (L, R). Alison Henning, Rice University, Houston, Tex., +1-713-446-6417. *Cosponsored by Houston Geological Society; Region 4 Texas Education Service.*

419. **Turfgrass Tour of Houston.** Sun., 5 Oct.; US$100 (L, R). Kurt Steinke, Texas A&M University, College Station, Tex., +1-979-862-1412. *Cosponsored by Turfgrass Science C-5.*

420. **Kirk Bryan Trip—Coastal Geomorphology and Change along the Upper Texas Coast.** Tues., 7 Oct.; US$97 (L, R). Chris Houser, Texas A&M University, College Station, Tex., +1-979-862-8421; Jim Gibeaut, Texas A&M University, College Station, Tex.; Rick Giadrino, Texas A&M University, College Station, Tex.; Doug Sherman, Texas A&M University, College Station, Tex. *Cosponsored by GSA Quaternary and Geomorphology Division.*

421. **Geological and Geophysical R&D in the Oil and Gas Industry: A Tour of ExxonMobil and Shell Research Labs.** Tues., 7 Oct; FREE (R). Steve Naruk, Shell International E&P, Houston, Tex., +1-713-245-7249; Peter Vrolijk, ExxonMobil Upstream Research Company, Houston, Tex.; Lori Summa, ExxonMobil Exploration Company, Houston, Tex. *Cosponsored by Shell International E&P; ExxonMobil Upstream Research.*

FULL

422. **Come Look at the Rocks: The University of Texas Bureau of Economic Geology's Houston Research Center.** Tues., 7 Oct.; US$50 (R). Beverly Blakeney DeJarnett, Bureau of Economic Geology–Houston Research Center, Houston, Tex., +1-713-983-9420. *Cosponsored by Houston Geological Society.*

423. **Dealing with Active Gulf Coast Growth Faults.** Wed., 8 Oct.; US$112 (L, R). Carl E. Norman, +1-713-461-7420. *Cosponsored by Houston Geological Society.*

424. **From Oilfields to Cornfields and a Lot More.** Wed., 8 Oct.; US$50 (L, R). Michael Stewart, International Plant Nutrition Institute, San Antonio, Tex., +1-210-764-1588; Ron Olson, Mosaic Co., Houston, Tex.; Harold Reetz, International Plant Nutrition Institute, Monticello, Ill. *Cosponsored by ASA Division A-7; ASA Division A-9.*

425. **RiceTec *and* Oilfields to Cornfields and a Lot More.** Wed., 8 Oct.; US$62 (L, R). Steve Norberg, Oregon State University, Ontario, Ore., +1-541-881-1417; Travis Miller, Texas A&M University, College Station, Tex.; William Heer. *Cosponsored by ASA Division A-7; ASA Division A-9.*

POSTMEETING

426. **Environments of Deposition of Texas Lignites: The Good, the Bad, the Ugly.** Thurs., 9 Oct.; US$96 (L, R). Christopher Mathewson, Texas A&M, College Station, Tex., +1-979-845-2488. *Cosponsored by Houston Geological Society.*

427. **Sedimentology and Stratigraphy of Modern Coastal Plain Depositional System (Students Only).** Fri.–Sat., 10–11 Oct.; US$50 (L, D, R, 1ON). John Anderson, Rice University, Houston, Tex., +1-713-348-4884; J. Michael Boyles, Shell International Exploration and Production Inc., Houston, Tex.; Mark Thomas, Shell International Exploration

and Production Inc., Houston, Tex. *Cosponsored by Shell International Exploration and Production Inc.*

428. **Revisiting Central Texas Late Cambrian Wilberns Stromatolites and Thrombolites.** Thurs.–Sat., 9–11 Oct.; US$398 (L, R, 2ON). André Willy Droxler, Rice University, Houston, Tex., +1-713-348-4885; Jason M. Francis, Chevron Energy Technology Company, Houston, Tex.; Wayne Ahr, Texas A&M University, College Station, Tex.

429. **Soils and Geomorphology of the Texas Gulf Coastal Plain and Texas Shoreline with Special Emphasis on Hydrology and Coastal Erosion.** Thurs.–Sat., 9–11 Oct.; $372 (L, R, 2ON). C.T. Hallmark, Texas A&M, College Station, Tex., +1-979-845-4678; Susan Casby-Horton, USDA–Natural Resources Conservation Service, Temple, Tex. *Cosponsored by SSSA Division S-5 (Pedology); SSSA S-880 (Soils-Geomorphology Committee); GSA Quaternary Geology and Geomorphology Division.*

430. **The Edwards Aquifer of South-Central Texas.** Thurs.–Sat., 9–11 Oct.; US$332 (L, R, 2ON). Geary M. Schindel, Edwards Aquifer Authority, San Antonio, Tex.; John Hoyt, Edwards Aquifer Authority, San Antonio, Tex.; Steven B. Johnson, Edwards Aquifer Authority, San Antonio, Tex.; Charles Kreitler, LBG-Guyton, Austin, Tex.; E. Calvin Alexander, University of Minnesota, Minneapolis, Minn.; George Veni, National Cave and Karst Research Institute, Carlsbad, N.Mex.; Ronald Green, Southwest Research Institute, San Antonio, Tex. *Cosponsored by Edwards Aquifer Authority; Southwest Research Institute; National Cave and Karst Research Institute; LBG-Guyton Associates; University of Minnesota.*

431. **The Sierra Madera Astrobleme, Pecos County, Texas.** Begins and ends in Midland, Texas. Thurs.–Sat., 9–11 Oct.; US$405 (L, R, 2ON). David A. Kring, Lunar and Planetary Institute, Houston, Tex., +1-281-486-2119. *Cosponsored by Houston Geological Society.*

432. **Upper Cambrian through Lower Ordovician Rocks of the Llano Region.** Thurs.–Sun., 9–12 Oct.; US$526 (L, D, R, 3ON). Emilio Mutis-Duplat, University of Texas of the Permian Basin, Odessa, Tex., +1-432-552-2243; Emily Stoudt, University of Texas of the Permian Basin, Odessa, Tex.; Robert C. Trentham, University of Texas of the Permian Basin, Odessa, Tex. *Cosponsored by West Texas Geological Society.*

433. **Searching for the Mojave-Sonora Megashear in Northeastern Mexico.** Begins and ends in Monterrey, Mexico. Fri.–Sun., 10–12 Oct.; US$353 (L, D, R, 2ON). Gary G. Gray, ExxonMobil Upstream Research Company, Houston, Tex., +1-713-431-4149; Timothy F. Lawton, New Mexico State University, Las Cruces, N.Mex.; Justin Murphy, ExxonMobil Exploration Company, Houston, Tex. *Cosponsored by GSA Structural Geology and Tectonics Division.*

Houston 2008 Joint Annual Meeting

HOUSING DEADLINE

2 September 2008

Joint Annual Meeting rates are guaranteed to those completing reservations by the 2 Sept. 2008 deadline. Make your reservation online, by fax, or by mail today!

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Fax—+1-713-227-6331 (domestic and international). Find the form in the June *GSA Today* meeting insert or go to the meeting Web site (see above) and print the form.

Mail—Houston Housing Bureau, 901 Bagby Street, Suite 100, Houston, TX 77002, USA.

HOUSTON
2008 JOINT ANNUAL MEETING
Teacher Forum:
Evolution in the Classroom

Saturday, 4 Oct., 1–4:30 p.m.

George R. Brown Convention Center, Houston, Texas, USA

Join fellow educators for a free evolution forum presenting current scientific research in a manner that will help teachers translate it to the classroom. A panel of the experts will provide answers to teachers on some of their most pressing questions about teaching evolution, and all educators will receive free evolution resources to use in the classroom.

Topics

- Evolution and the Nature of Science
- Earth's History in the Geological Record
- "Missing" Links
- Misconceptions and Myths about Evolution
- Evidence for Evolution—The Latest Word!
- Classroom Activities on Evolution

Classified Rates—2008

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Positions Open

TENURE TRACK ASSISTANT PROFESSOR EARLHAM COLLEGE

The Department of Geosciences at Earlham College invites applications for a tenure track position beginning in Fall 2009. Candidate area of specialization is open; however, successful applicants will likely:

— be broadly trained in earth science
— compliment our existing strengthsin process sedimentology and tectonics
— provide undergraduate students with research opportunities in their subfield
— demonstrate interest in teaching a wide variety of undergraduate geology classes

Course responsibilities include participation in introductory geoscience and environmental science courses, as well as upper-level courses in his or her specialty. We expect that the candidate will participate in the Environmental Science program, supervise undergraduate student research projects, and participate in the senior capstone seminar. A Ph.D. is required and previous teaching experience at the undergraduate level is preferred. Women, underrepresented minorities, and Quakers are especially encouraged to apply. Interested candidates should send curriculum vitae, materials demonstrating teaching effectiveness, and a statement detailing how your research interests will enhance the education of undergraduate students, along with the full contact information of at least three references to: Dr. Andrew Moore, Department of Geosciences, Earlham College, 801 National Rd. West, Richmond, IN 47374, USA, +1-765-983-1672, moorean@earlham.edu. Applications may be submitted electronically to moorean@earlham.edu. To ensure full consideration, please submit applications by 1 November. For expanded information, please visit Earlham's jobs page at www.earlham.edu/jobs.

MINERALOGY/PETROLOGY DENISON UNIVERSITY

The Department of Geosciences at Denison University invites applications from candidates with a background in mineralogy, petrology and high-temperature geochemistry for a tenure-track position (assistant professor) to begin in Fall 2009. We seek a broadly trained scientist to teach Physical Geology, Earth Materials, Igneous/Metamorphic Petrology and other courses that complement our program. The ideal candidate should be committed to teaching excellence in a liberal arts setting, have a strong field background, have broad interests beyond their specialty, and be able to provide a balance of classroom, field and laboratory experiences for our students. A Ph.D. at the time of appointment is required. Denison is a highly selective liberal arts college strongly committed to, and supportive of, excellence in teaching and active faculty research that involves undergraduate students.

All application materials will be handled electronically at https://employment.denison.edu.

Please include a letter of application; statements of your approaches to teaching and research in a liberal arts setting; a vita; academic transcripts; and contact information for three references. Please contact Dr. Tod Frolking, Department of Geosciences, Denison University, Granville, OH 43023, USA; +1-740-587-6217; frolking@denison.edu for more information about the position. Application materials should be posted by 15 October 2008 for full consideration. We encourage early applications. We would like to meet with candidates attending GSA, 6-8 October, and invite finalists to campus in early November. Denison University is an Affirmative Action, Equal Opportunity Employer. In a continuing effort to diversify our Campus Community, we strongly encourage women and people of color to apply.

TENURE-TRACK POSITION EXPLORATION GEOPHYSICS BOONE PICKENS SCHOOL OF GEOLOGY OKLAHOMA STATE UNIVERSITY

The Boone Pickens School of Geology at Oklahoma State University (OSU) invites applications and nominations for a geophysicist with strong research background to fill a tenured or tenure-track position in exploration geophysics at any rank (assistant, associate, or full professor). In addition, distinguished applicants with demonstrated international reputations, meeting the requirements for full professor will be considered for the Boone Pickens Chair of Exploration Geophysicist. Applicants are required to have a Ph.D. degree in geophysics or related field at the time of appointment.

The applicants should have a broad background in the geophysical sciences. Specific research areas may include, but are not restricted to seismology, seismic data processing and quantitative seismic analysis for reservoir characterization, reflection seismology, electromagnetic techniques, and ground penetrating radar. Applicants must have a strong research and publication record and a demonstrated ability to attract external funding. Salary and benefits will be competitive and commensurate with experience and future potential.

The successful candidate will be expected to pursue a vigorous research program and help strengthen our petroleum geosciences program. The candidate will supervise M.S. and Ph.D. students and develop courses in his or her specialty and participate in preparing students for employment in the energy and environmental industries.

The successful candidate will join a faculty of twelve geoscientists, including two other geophysicists, and will be part of a sedimentary geology and tectonics research group that include six other faculty and has close ties to the petroleum industry. The School of Geology has a well equipped geophysical laboratory with a Geometrics 48 channel seismograph, an Iris Syscalpro 10 channel resistivity system, an AGI Supersting resistivity system, a Scintrex C-G5 gravimeter, a Geometrix control source audio magnetelluric system (Stratagem), a Pulse Ekko GPR system, a Geonics EM-34 system, a Geometrics 858 Cs vapor magnetometer, and state of the art software for processing both potential field and seismic data. In addition the School has recently constructed the Devon Teaching and Research Laboratory, which contains state-of-the-art 3-D image processing facilities.

Applicants are encouraged to submit a complete vita/resume, statement of research and teaching interests, and a list of five references, including names, phone numbers, e-mail addresses, and complete mailing addresses to: Geophysics Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, OK 74078-3031, USA. Phone: +1-405-744-6358. Fax: +1-405-744-7841. Screening of candidates will begin in November 2008 and will continue until the position is filled. The starting date for this position will be Fall Semester 2009 or as negotiated.

Inquires about this position may be directed to Dr. Estella Atekwana (estella.atekwana@okstate.edu) or Dr. Jay Gregg (jay.gregg@okstate.edu) at the above address. More information on OSU and the Boone Pickens School of Geology can be found on the Web at http://osu.okstate.edu/ and http://geology.okstate.edu/, respectively.

Committed to health and safety Oklahoma State University maintains a tobacco free work environment.

Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

TENURE-TRACK OR TENURED POSITION GEOCHRONOLOGY, PETROLOGY, AND GEODYNAMICS STANFORD UNIVERSITY

The Department of Geological and Environmental Sciences seeks an outstanding scientist to lead a vibrant research program in the broad areas of geochronology, petrology and geodynamics in order to address large-scale petrologic and tectonic processes in the Earth's crust and mantle. Our preference is to make an appointment at the junior or mid-career level, but applications from scientists at all career levels will be considered. The successful applicant will build on newly established and long-standing strengths in geochronology, tectonics, and isotope geochemistry within the Department, interface with solid-earth processes, crustal evolution, seismology and other areas in the School of Earth Sciences, and teach at the undergraduate and graduate level. We especially welcome applications from scientists who integrate geochemical/petrological and/or physical/computational approaches to problem solving.

The Stanford School of Earth Sciences now houses a full range of isotope geochemistry/geochronology/thermochronology facilities. These feature the Stanford-USGS SHRIMP-RG ion microprobe and associated TIMS laboratory; a new multi-collector ICP-MS and high-resolution ICP-MS facility supported by newly commissioned clean labs; new $^{40}Ar/^{39}Ar$ and (U-Th)/He, and fission-track thermochronology laboratories containing multi-collector and single-collector mass spectrometers and state-of-the-art extraction lines; and cosmogenic radionuclide laboratories. In addition, an electron microprobe, a scanning electron microscope with EDAX and cathodoluminescence imaging, and sample preparation and mineral separation laboratories are available. Related facilities include stable isotope laboratories, ICP-AES and GC-MS capabilities, high-pressure experimental capabilities including a diamond-anvil cell laboratory, and the recently established Center for Computational Earth and Environmental Science.

Stanford University is an equal opportunity employer and is committed to increasing the diversity of its faculty. It welcomes nominations of and applications from women and members of minority groups, as well as from others who would bring additional dimensions to the University's research and teaching missions.

Please apply online in electronic format (.pdf only) with the following application material: cover letter, curriculum vitae, a statement outlining research and teaching experience and interests, and the names and addresses (including e-mail addresses) of three potential referees, at http://pangea.stanford.edu/jobs/. Select the Geochronology, Petrology and Geodynamics faculty position.

Questions can be directed to Elizabeth Miller (elmiller@stanford.edu).

We will begin reviewing applications 30 September 2008. Deadline for receipt of applications is 30 November 2008.

LECTURER, SKIDMORE COLLEGE

The Department of Geosciences at Skidmore College invites applications for a one-semester appointment as Lecturer beginning 1 January 2009 for the Spring 2009 semester. The successful candidate will teach GE 112: Oceanography, Introduction to the Marine Environment and three laboratory sections associated with the course. The Department seeks a candidate with strong teaching skills, a background in oceanography, ocean-atmosphere interaction, and basic processes in oceanic dynamics.

Preference will be given to those candidates with teaching experience who have a M.S. or Ph.D. in the geosciences or a related field. The review process for this position will begin 1 October 2008.

To learn more about this position and submit your application materials, please visit our Website at: jobs.skidmore.edu.

Skidmore College is committed to being an inclusive campus community and, as an Equal Opportunity Employer, does not discriminate in its hiring or employment practices on the basis of gender, race or ethnicity, color, national origin, religion, age, disability, family or marital status, or sexual orientation.

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We will be adding top talent to our geological team!

We welcome Bachelors Degrees in Geology and Geological Sciences along with related experience and training. We offer a competitive health and wellness benefits package and a good name in the industry that you can trust to be there today and in the future.

If you would like to be a part of our growing organization, visit us at **www.dartenergy.com** or email your updated resume to our recruiter, Carrie Cervantes, ccervantes@dartenergy.com.

Let's grow together!

Opportunities for Students

Ph.D. Research Assistantship in Hydrology at the University of Missouri-Columbia. Applications are invited for a PhD student research opportunity to evaluate the origin and hydrocarbon transport capabilities of solitary waves in fault conduits in the Gulf of Mexico basin. Research assistantship funding is in place to begin work on the project as early as January 2009. The project will consist primarily of numerical computer modeling, and will require a strong quantitative background and experience in programming. For further information, please contact Dr. Martin Appold (+1-573-882-0701; appoldm@missouri.edu) and visit our department Web site at http://geology.missouri.edu/.

Call for Papers:

GROUNDWORK: Furthering the Influence of Earth Science

GROUNDWORK
Furthering the Influence of Earth Science

GSA Today is seeking submissions for its "Groundwork" series—articles that lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. Articles can include in-depth geoscience commentary, short observations and analysis of hot topics, and discussion of policy news and issues.

GSA Today "Groundwork" articles must be no longer than two print pages: ~1400 words with two small figures or ~1600 words with one figure. The philosophy behind this is twofold: (1) keeping an article short can increase the clarity and quality of the writing; and (2) a short article encourages readers to engage and seek more information.

Figures to accompany a "Groundwork" article can be color at no charge to the author.

"Groundwork" articles go to *GSA Today's* science editors and are run through a rigorous peer-review before acceptance and publication. Submit your article today at **http://gsa-today.allentrack.net/cgi-bin/main.plex.**

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BGI UNIVERSITÄT BAYREUTH

The Bavarian Geoinstitute at the University of Bayreuth

invites applications for a

Full Professorship (W3) in Structure and Dynamics of Geomaterials

The position is available from September 1, 2009. We are looking for an internationally renowned scientist who studies minerals, rocks, melts or related substances with the aim of understanding large-scale geological processes. Fields of research may include, but are not limited to, studies of geophysically relevant phase equilibria, rock deformation, equations of state and physical properties of minerals, melts and fluids, the kinetics of phase transformations and diffusion. A strong interest in the development and application of high-pressure experimental techniques, particularly involving multi-anvil technology is expected.

The successful applicant will be expected to participate in teaching, particularly in the education of graduate students, in the Master Course "Experimental Geoscience" and in basic courses for geoecology students. Teaching will be mainly in English.

In addition to a Ph. D., applicants should have appropriate experience in research and teaching. Candidates must be less than 52 years old upon appointment. Women and handicapped people are especially encouraged to apply.

Applications, accompanied by a curriculum vitae, publication list, copies of university certificates, a statement on teaching experience and an outline of proposed research should be sent before October 10, 2008 to the Dekan der Fakultät für Biologie, Chemie und Geowissenschaften der Universität Bayreuth, 95440 Bayreuth, Germany.

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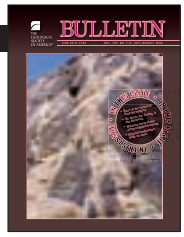

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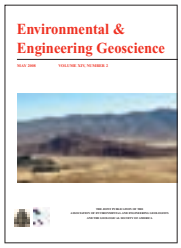

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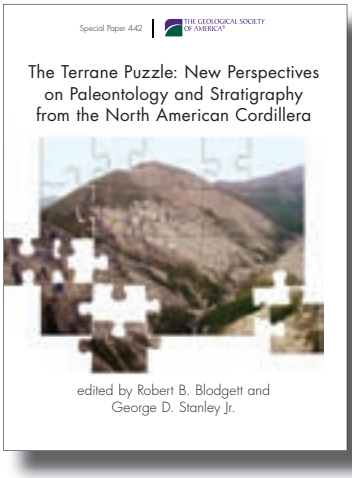
The Terrane Puzzle: New Perspectives on Paleontology and Stratigraphy from the North American Cordillera



edited by Robert B. Blodgett and George D. Stanley Jr.

Displaced or tectonostratigraphic terranes comprise a huge portion of real estate in the North American Cordillera. Terranes are discrete, fault-bound blocks of regional extent, with rocks and fossils that differ to a great extent from those of adjacent blocks. The allochthonous nature of most terranes, relative to adjacent craton, is well established. When mapped, they resemble a collage of mixed rock types, tectonic styles, metamorphism, and volcanic origins—each part resembling the pieces of a puzzle. Terrane studies remain integral to understanding the geological evolution of western North America. Since the initiation of the concept summarized in 1979 by the late David L. Jones, the significance of fossils and stratigraphy has been key to solving the puzzle. Chapters of this book, written by experts in their field, provide a sense of the diversity of approaches in paleontology and stratigraphy. Contributions span geologic time from the Precambrian (Vendian) to Cretaceous and address over 20 Cordilleran terranes.

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Image courtesy Travel Portland.

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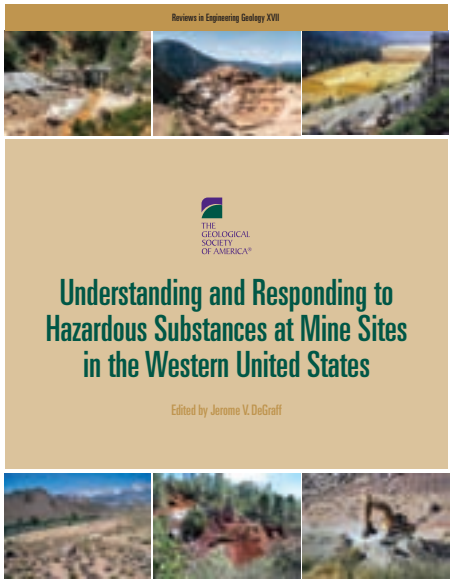

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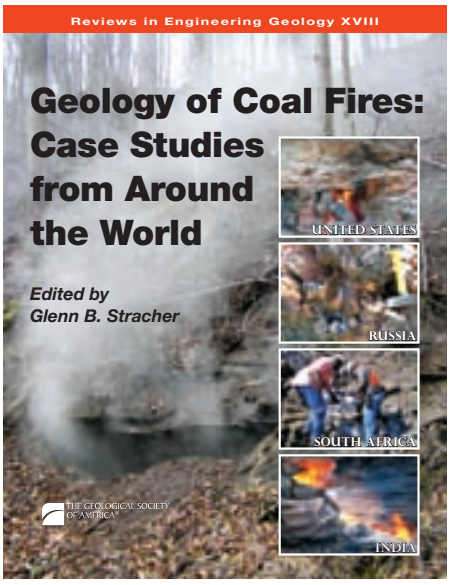

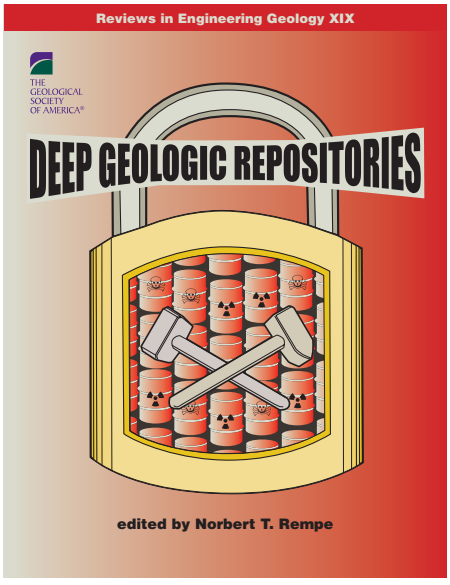

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