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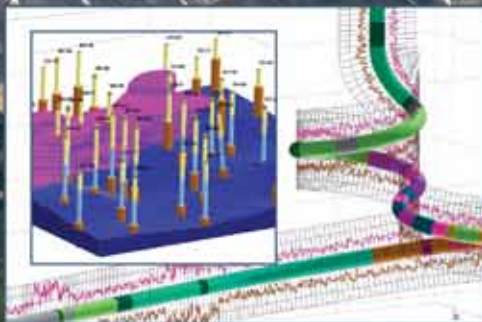
Model for the eruption of the Old Faithful geyser, Yellowstone National Park

Firehole River

Old Faithful

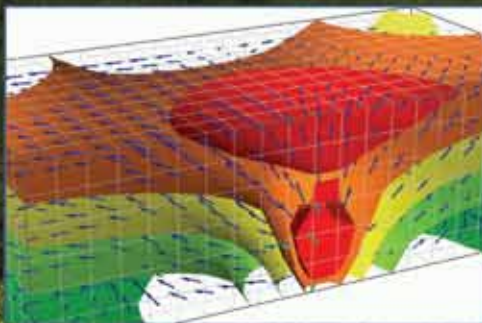
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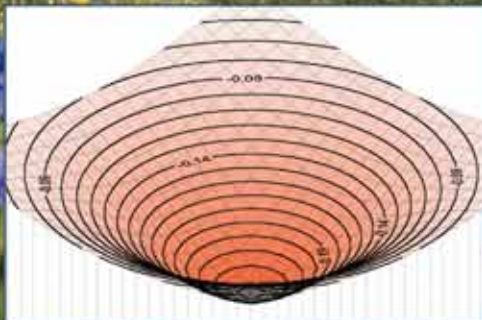
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GSA TODAY STAFF

Executive Director and Publisher: John W. Hess

Science Editors: Bernie Housen, Western Washington Univ. Geology Dept. (ES 425) and Advanced Materials Science and Engineering Center (AMSEC), 516 High Street, Bellingham, WA 98225-9080, USA, bernieh@www.edu; R. Damian Nance, Ohio University Dept. of Geological Sciences, 316 Clippinger Laboratories, Athens, OH 45701, USA, nance@ohio.edu

Managing Editor: K.E.A. "Kea" Giles, kgiles@geosociety.org, gsatoday@geosociety.org

Graphics Production: Margo McGrew

Advertising (classifieds & display): Ann Crawford, +1-800-472-1988 ext. 1053; +1-303-357-1053; Fax: +1-303-357-1070; advertising@geosociety.org; acrawford@geosociety.org

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Cover: Ikonos satellite image of the Upper Geyser Basin region in Yellowstone National Park. Light colored areas are silica-rich geothermal deposits (sinter). The drainage pattern from Old Faithful appears to be mainly to the north (top) to the Firehole River. Source: DigitalGlobe.



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Model for the eruption of the Old Faithful geyser, Yellowstone National Park

Kieran D. O'Hara, *Dept. of Earth and Environmental Sciences (emeritus) University of Kentucky, Lexington, Kentucky 40506, USA, kieran.ohara@uky.edu; and E.K. Esawi*, *Division of Physical Sciences, Elizabethtown Community & Technical College, Elizabethtown, Kentucky 42701, USA*

ABSTRACT

A physical model of the Old Faithful geyser successfully replicates the eruption interval for the years 2000–2011. It is based on convective boiling in the conduit in three stages, and the model is in good agreement with published time-temperature-depth data. The preplay phase, which triggers the main eruption, displays a Rayleigh probability density function with a mode at nine minutes, and it plays an essential role in determining the main eruption interval. It is assumed that temperature gradients are small due to convection, and individual convection cells can be assigned a single heat content. Based on previous observations and drill-hole measurements, the bottom heating and recharge temperatures are assumed to be 110 °C and 80 °C, respectively, and the total volume of the cylindrical conduit is 23 m³. A prescription for both short and long eruption intervals is

eruption interval = (time to boiling of upper stage) + (preplay time).

A composite model reproduces the bimodal eruption pattern in which long eruption durations are followed by long eruption intervals and short eruption durations are followed by short eruption intervals. The cause of short eruption durations is not addressed and remains unresolved.

INTRODUCTION

The Old Faithful geyser, an icon of the American West, has been studied for more than a century (Hayden, 1872). In 2010, 3.6 million tourists visited the Yellowstone National Park, Wyoming, for a total of 170 million visits since the park was established in 1872, indicating an enduring curiosity by the public in geyser activity. The geyser is not as regular as is commonly thought, because the eruption interval is bimodal and has varied over time (Rinehart, 1980). For example, in 1948 the mean eruption interval was 64 minutes (Birch and Kennedy (1972), in 1979 it was ~80 minutes (Kieffer, 1984), and in 2011 it was ~92 minutes (GOSA, 2011). This pattern is attributed to earthquake activity and its effect on the local hydrology. Lengthening of the eruption cycle and other changes in geyser activity have been documented following major earthquakes in 1959, 1983, and 2002 (Rinehart, 1972; Hutchinson, 1985; Husen et al., 2004). Decadal and seasonal variations in the eruption interval have also been ascribed to variations in the hydrological cycle in Yellowstone (Hurwitz et al., 2008).

Several models have been proposed for geysers (Steinberg et al., 1978; Steinberg, 1980; White et al., 1967; Murty, 1979; Rinehart, 1980; Ingebritsen and Rojstaczer, 1993, among others) and for the Old Faithful geyser in particular (Rinehart, 1965, 1969; Fournier, 1969; Kieffer, 1984, 1989; Dowden et al., 1991; Kedar et al., 1998). These studies provide substantial insight into the eruption dynamics of geysers in general. The goal of our study is to present a new physical model for the observed eruption interval of Old Faithful over a continuous period of time for which we have interval data (both logbook and electronic) as well as duration and preplay times. Our model differs from previous studies in that the heating mechanism of the water occurs by convective boiling in three stages; in addition, the length of the preplay phase plays a central role in modeling the geyser eruption interval. Our study is based on data for the twelve-year period 2000–2011. Because the data are averaged over time, changes in the eruption interval with time due to intermittent or short-term effects (e.g., earthquakes or climate effects) are not addressed. The raw data for this study were provided by the Geyser Observation and Study Association's website at <http://gosa.org/ofvclogs.aspx> (GOSA, 2011).

ERUPTION CYCLE

The eruption cycle can be divided into three phases:

1. The eruption duration (2–5 min.);
2. The eruption interval (or recharge phase, 55–120 min.); and
3. The preplay phase (small, discrete eruptions lasting 1–35 min.).

The eruption itself can be subdivided into three stages:

1. Initiation and unsteady flow;
2. Steady flow; and
3. Decline (Kieffer, 1984).

The bimodal eruption pattern for the years 2000–2011 is shown in Figure 1. The eruption interval shows a major mode at ~92 minutes and a subsidiary mode at ~60–65 minutes (Fig. 1A). The eruption duration for the same period shows a mode at 4–4.5 minutes with the shorter duration events (2–2.5 minutes) being relatively rare, accounting for ~5% of all eruptions (Fig. 1B).

The eruption interval shows a pattern whereby short eruption durations are followed by short recharge intervals, and long eruption durations are followed by long recharge intervals; this pattern has been explained by the geyser's seismicity (Rinehart, 1965). Seismic noise produced by Old Faithful is interpreted in terms of the dynamics of vapor bubble formation (and collapse) during boiling in the conduit (Kieffer, 1984, 1989; Kedar et al., 1996, 1998; Cros et al., 2011). That seismic activity resumes almost

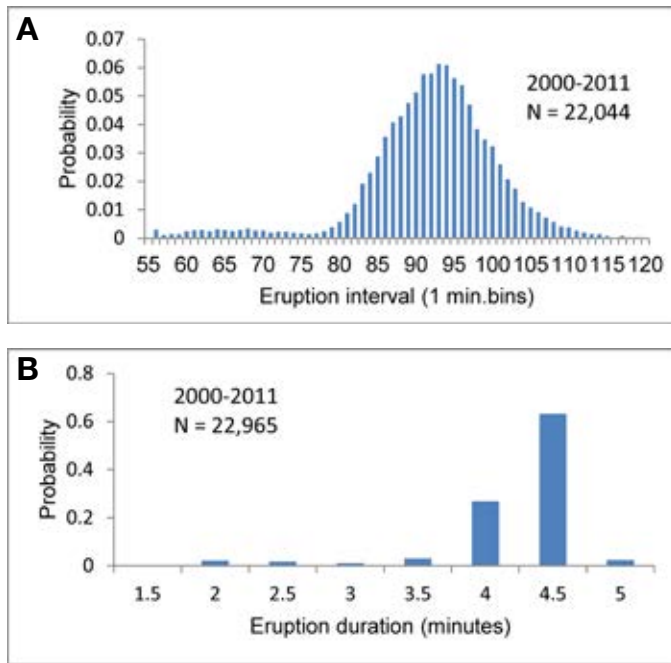


Figure 1. Probability histograms for eruption interval (A) and eruption duration (B) for the years 2000–2011 for Old Faithful. Electronic interval data (GOSA, 2011) for this time period agree with the log book data to within 1 min. when weekly averages are compared.

immediately after short-duration eruptions, but takes substantially longer to resume after long eruptions, is consistent with the idea that it takes longer for the water to recharge and come to a boil after a long eruption (resulting in a seismic quiet period), whereas after a short eruption, the water remaining in the conduit is still boiling and emits seismic noise throughout the recharge phase (e.g., Kieffer, 1984).

PREPLAY PHASE

The preplay phase consists of discrete splashes (each several meters in height lasting a few seconds) and precedes the main eruption. For example, observations of five consecutive eruptions on live video in May 2012 showed the following preplay lengths (in minutes) with the number of discrete splashes in parentheses: 17 (17); 10 (9); 12 (16); 13 (15); and 20 (18), suggesting that preplay events occur on average about once a minute. It has long been inferred that these discrete events trigger the main eruption by bringing the water in all or part of the conduit onto the boiling curve by reducing hydrostatic pressure in the water column (Bunsen, 1845, quoted in Allen and Day, 1935, p. 210), and this idea is still accepted (e.g., Kedar et al., 1998). For the most part, the discrete nature of these smaller eruptions is easily distinguished from the main eruption phase. However, in the case of very short preplay times, it becomes a judgment call whether the unsteady initiation of flow is part of the main eruption itself or represents a short preplay event—this would overestimate the number of short preplay events.

The length of the preplay phase was calculated by subtracting the time of the beginning of preplay from the beginning of the main eruption (Fig. 2). The preplay distribution shows a mode at nine minutes with a standard deviation of 5.6 minutes, and the distribution is skewed to the right. This distribution can best be

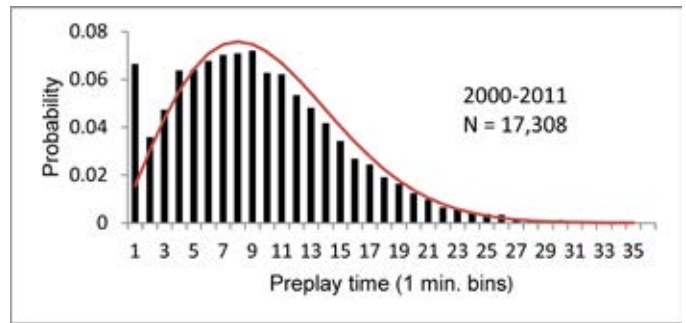


Figure 2. Probability histogram for the preplay eruption length for the years 2000–2011. The data have a mode at 9 min. (standard deviation [s.d.] = 5.6 min.). The distribution can be best modeled by a single parameter Rayleigh probability density function (Eq. 1 in text) with a mode at $\sigma = 9$ min. (s.d. = 5.2) for $x \geq 0$. The anomaly in the data at 1 min. is inferred to be an artifact of observation.

modeled using a single parameter Rayleigh probability density function ($x > 0$)

$$f(x, \sigma) = \frac{x}{\sigma^2} e^{-\frac{x^2}{2\sigma^2}} \quad (1)$$

with a mode (σ) at nine minutes and a standard deviation of 5.2 minutes (solid curve, Fig. 2). The anomalously large number of one-minute preplay events is attributed to assigning some of the unsteady initiation stage to a short preplay event. In general, Rayleigh distributions have been used to model, among other phenomena, the height of ocean waves and wind velocities (e.g., Abd-Elfattah, 2011). The Rayleigh function fit indicates that the preplay eruptions are discrete random events.

PHYSICAL MODEL

Conduit Geometry

A variety of Old Faithful conduit shapes have been proposed to account for aspects of its eruption characteristics or filling history (Geis, 1968; Rinehart, 1980; Kieffer 1984). Based on down-hole video camera observations, Hutchinson et al. (1997) indicate that the immediately accessible conduit is an irregularly shaped enlarged east-west-trending fracture ~22 m deep. A constriction exists at ~7 m, above which the water level does not rise, except during preplay and the main eruption itself—presumably because an overflow outlet exists at this depth, possibly connected to the adjacent Firehole River (Rinehart, 1980). For simplicity, we assume here that the conduit is cylindrical with a cross sectional area of 1.5 m² for a total volume of ~23 m³ (23,000 liters) (Fig. 3). The conduit recharge phase is divided, for the purposes of calculation and for comparison with the data of Birch and Kennedy (1972), into three stages (S_1 , S_2 , and S_3), each with a height of 5 m and a volume of 7.7 m³ (7,700 liters). As discussed later, our model is not particularly sensitive to the details of the conduit geometry.

Water Temperatures and Recharge Rate

The data of Birch and Kennedy (1972) are still the most important time-temperature-depth information available for Old Faithful—and their Figure 5 is recast here in Figure 4. This diagram reveals in-phase heating and cooling episodes at different depths superimposed on an overall heating trend, which we interpret to be due to three distinct convection cells in the conduit

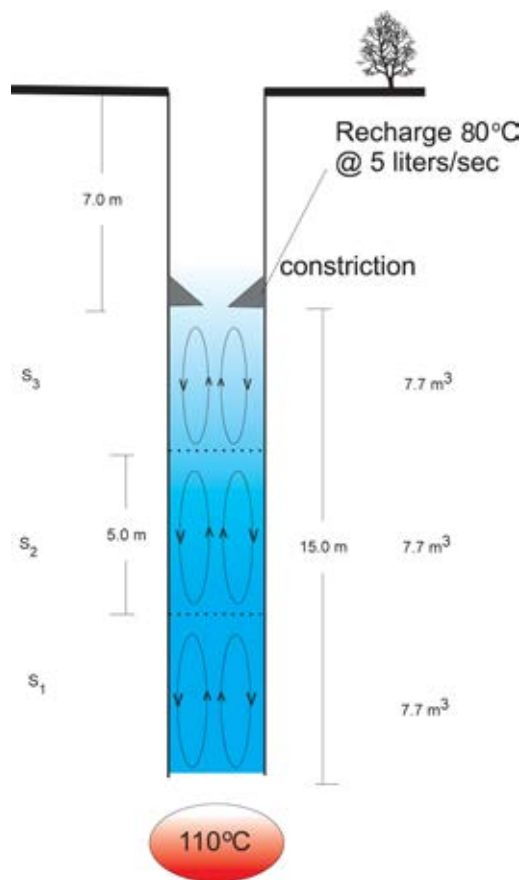


Figure 3. Idealized cylindrical model (radius 0.7 m) for the Old Faithful conduit to a depth of ~22 m with a total volume of 23 m³. The recharge water temperature is assumed to be 80 °C, and the bottom source temperature is assumed to be 110 °C. Recharge of the conduit occurs in three equal stages: S₁, S₂, and S₃. Convection cells are based on Figure 4.

(Fig. 3). The data of Birch and Kennedy (1972, their fig. 5) also show a maximum temperature of 116 °C at the deepest levels, and Rinehart (1969, his fig. 1) observed a maximum temperature of ~110 °C during two eruption cycles (but his depth estimate of 30 m may be in error). Over a period of ~30 minutes before an eruption, Hutchinson et al. (1997) also observed water temperatures of ~110 °C near the bottom of the conduit; they interpreted temperature oscillations to be due to convection. Drilling in the Upper Geyser Basin, to which Old Faithful belongs, showed bottom hole temperatures at a depth of 20 m of 90 °C (Y-7 hole); 135 °C (Y-8); 120 °C (Y-1); and 125 °C (Carnegie I) (White et al., 1975), for a mean temperature of 118 °C at a depth equivalent to the base of the Old Faithful conduit. Based on geochemical arguments and water salinity, Fournier (1979, his fig. 7) indicated the existence of a parent water source of ~200 °C for the Upper Basin at depth, but such a high temperature has not been measured in the accessible conduit of Old Faithful.

The lowest temperature observed by Hutchinson et al. (1997) was 86 °C and is interpreted to be due to recharge water percolating into the conduit from shallower levels. Drilling in the Upper Geyser basin also indicates bottom hole rock temperatures at a depth of 7 m in the range of 60–100 °C (White et al., 1975). The lowest temperature reported by both Birch and Kennedy (1972, their fig. 5) and Rinehart (1969, his fig. 1) was 93 °C.

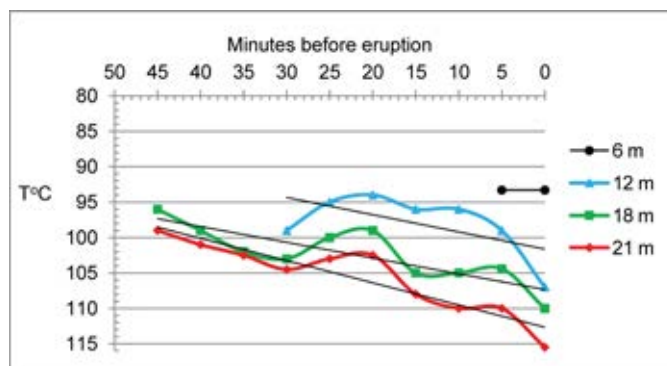


Figure 4. Time-temperature plot for a single Old Faithful eruption at four depths (6, 12, 18, and 21 m) based on Figure 5 in Birch and Kennedy (1972). The in-phase cooling and heating at three different depths is interpreted to be due to convective mixing (see Fig. 3). The data indicate that the temperature in individual convection cells is not homogenized over time. Best-fit lines indicate an overall heating trend.

Based on these data, a temperature of 110 °C is taken here as the temperature of the heat source at the base of the observable conduit, and the temperature of the recharge water is assumed to be 80 °C. A constant recharge rate of 5 liters per second is also assumed, based on the total volume of discharge and the recharge time (Kieffer, 1984); this rate would fill the conduit up to the 7-m level in ~77 minutes. A constant recharge rate is a reasonable approximation because the hydrostatic pressure in the conduit shows an approximately linear profile over most of the recharge cycle (Hutchinson et al., 1997, their fig. 5A).

Lumped Capacitance Assumption

The process of filling a conduit from above with cold water and heating it from below at the same time produces an inherently unstable situation. The difference in density of water at 110 °C compared to 80 °C is ~20 kg/m³, which produces sufficient buoyancy to overcome viscous forces (i.e., high Rayleigh numbers), leading to convective overturn (Murty, 1979). The temperature variations plotted in Figure 4, and those observed by Hutchinson et al. (1997; their fig. 6) are attributed to vigorous convective overturn and mixing of parcels of hot and cold water. In the context of convection, Newton's law of cooling relates the heating rate (dQ/dt in W/m²) to the difference in temperature between the source temperature and the ambient temperature of the water (ΔT) at a given pressure:

$$dQ/dt = hA\Delta T, \quad (2)$$

where h is the convective heat transfer coefficient (W/m²K) and A is the cross sectional area of the conduit (1.5 m²).

If convection dominates over heat conduction and the water within individual convection cells is well mixed so that thermal gradients become small, the average thermal energy (Q) of each stage can be specified—it is simply related to temperature (T) by the specific heat capacity (C): $dQ/dT = C$ (kJ/kg). This is termed the Lumped Capacitance Assumption (Incropera and DeWitt, 2005, p. 240), and because of the vigorous convective mixing observed in the conduit, this approximation appears to be justified. The change in heat energy with time is then $dQ/dt = CdT/dt$. Substituting this relationship into equation (2) gives the change in temperature with time:

$$d(\Delta T)/dt = \frac{hA}{C} \Delta T, \quad (3)$$

and the solution to equation (3) is

$$\Delta T = \Delta T_o e^{-kt}, \quad (4)$$

where ΔT_o is the temperature difference at time $t = 0$ and the constant $k = hA/mC$, where m is the mass of the water. It is assumed that at the end of each recharge stage the reservoirs are well mixed due to convection and each stage can be assigned a single heat content and a temperature. This allows the thermal evolution of each stage to be modeled individually using the Lumped Capacitance Assumption.

Nucleate Boiling

During convection, rising parcels of hot water will spontaneously boil at lower water pressures. Vapor bubbles nucleate and rise, causing liquid mixing, effectively transporting heat upward. On reaching the cooler water, the rising bubbles collapse and give up their heat to the surrounding water (collapsing bubbles also then produce the seismic noise referred to earlier). These processes are referred to as nucleate boiling, and it is a very effective heat transfer mechanism (Incropera and DeWitt, 2005, p. 599).

Because of the complexity of analytical solutions during nucleate boiling, values for the convective heat transfer coefficient h are usually derived empirically. Experimental evidence indicates that h increases as ΔT in equation (2) increases, where ΔT is now the difference between the boiling temperature and the heating source temperature. The experiments indicate that nucleate boiling occurs when ΔT is 5 °C to 30 °C and produces values of dQ/dt in the range of 10^4 – 10^6 (W/m²); when $\Delta T = 10$ °C, $dQ/dt \approx 10^5$ (Incropera and DeWitt, 2005, p. 598).

In the present case, nucleate boiling would occur if a parcel of water at 11 m depth (boiling point of 105 °C) rose to a depth of ~7.5 m in the conduit (boiling point of 95 °C). Direct evidence in support of this process comes from the existence of superheated geyser waters throughout Yellowstone National Park (Allen and Day, 1935, their table 3; Bloss and Barth, 1949) and Old Faithful itself (Hutchinson et al., 1997). A preliminary estimate for the value of h can be made by taking ΔT in equation (2) as 10 °C, based on the example above, which corresponds to a value of dQ/dt of 10^5 (W/m²) based on experimental data. This produces a value for h of 6.6×10^3 W/m²K. A value approximately twice this amount, 1.2×10^4 W/m²K, produces the best fit to the data of Birch and Kennedy (1972) in the following models, and this value is used here (Table 1). The sensitivity of our model to this value is discussed later.

MODEL RESULTS

Figure 5 shows the temperature versus time evolution for each of the three stages using equation (4). Stage one (S_1) begins filling at $t = 0$ at a rate of 5 liters per second, and this takes ~25 minutes, at which time S_2 begins to fill. This takes an additional 25 minutes, after which time S_3 begins to fill; all three stages are full after ~77 minutes. The temperature at each stage increases with time from its initial value of 80 °C. Stage 1 is heated from below at

Table 1. Model Parameters

Parameter	Symbol	Value
Third stage volume	S_3	7.7 m ³
Second stage volume	S_2	7.7 m ³
First stage volume	S_1	7.7 m ³
Recharge rate		5 liters/sec
Recharge temperature		80 °C
Source temperatures		110 °C (S_1); 105 °C (S_2); 99 °C (S_3)
Specific heat capacity	C	4.18 kJ/kg
Conduit area	A	1.5 m ²
Convective heat transfer coefficient	h	1.2×10^4 W/m ² K

110 °C. Stage 2 is heated from below at 105 °C, which is the mean temperature of S_1 during S_2 filling. Stage 3 is heated from below at 99 °C, which is the mean temperature of S_2 during S_3 filling.

Two methods of heating were used—one heated the entire volume of water at each stage (7.7 m³) as a function of time (Fig. 5, solid curves), and the second method heated the water while incrementally increasing the volume by 5 liters per second (Fig. 5, dashed color curves). The incremental heating produces an initial rapid temperature rise in the early part of the heating history, but after ~25 minutes, the two curves converge for each stage. Also shown on Figure 5 are the best fit lines from Figure 4 at different depths, based on the data of Birch and Kennedy (1972). Both heating methods produce a good fit to the data in the later part of the heating history. This allows a constant value for the mass of water (m) to be used in equation (4) (Fig. 5, solid curves). From a thermodynamic point of view, because enthalpy is a state function (Smith, 2005), the final temperature of each stage is independent of the heating path so that both heating methods produce the same final result.

The temperature of the water at each stage as a function of depth and time can be evaluated from Figure 5. Figure 6 shows the temperature of S_1 , S_2 , and S_3 at 75 minutes and at 85 minutes into the recharge phase. Also shown in Figure 6 is the reference boiling point curve (solid heavy line) and the depth-temperature curve of Birch and Kennedy (1972) 2.5 minutes before eruption (dashed heavy line). After 75 minutes into the recharge phase, all three stages are below the boiling curve, but at 85 minutes the uppermost stage (S_3) has reached boiling.

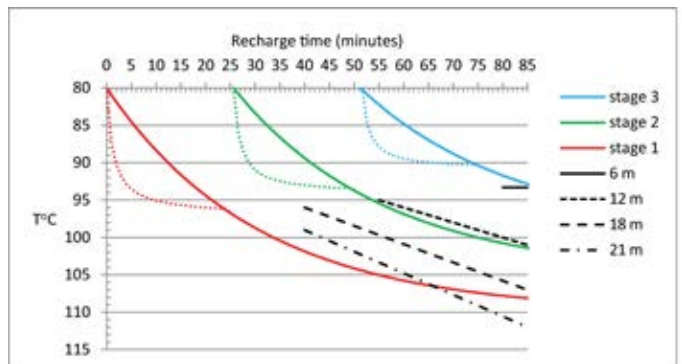


Figure 5. Temperature evolution with time (solid curves) for the three stages, based on equation (4) in the text using the parameters in Table 1. Stage 1 begins filling at $t = 0$, followed by stage 2 at ~25 min. and stage 3 at ~50 min. The colored dashed curves indicate the heating path when the conduit is incrementally filled at a rate of 5 liters/s, using equation (4). After ~25 min. into each stage, both solid and dashed curves converge and become identical. The best fit lines from Figure 4 at different depths are indicated—the heating curves are a good fit to the data.

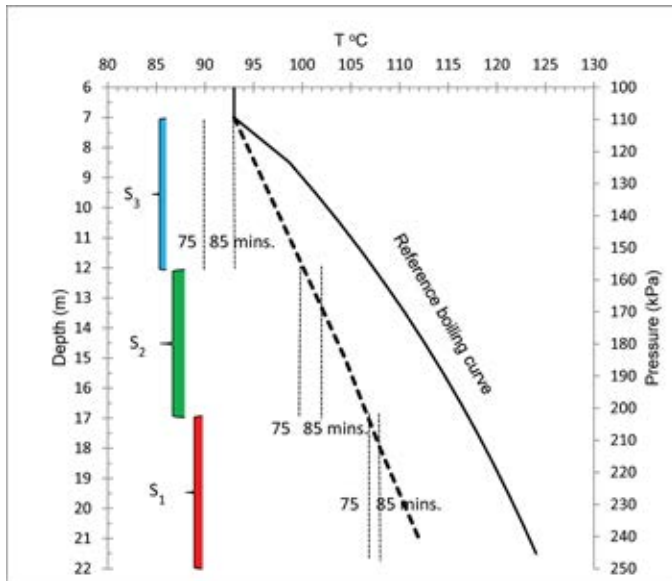


Figure 6. Temperature in the conduit after 75 and 85 min. (vertical dashed lines), based on Figure 5, relative to the boiling curve. The water boils at 93 °C at the park elevation (2246 m). The uppermost stage (S_3) intersects the boiling curve after 85 min. The heavy dashed curve represents the data of Birch and Kennedy (1972), 2.5 min. before eruption. The temperature in each stage after 85 min. is consistent with these data.

The middle and lower stages are still below the boiling curve at 85 minutes, consistent with the Birch and Kennedy (1972) data 2.5 minutes before the eruption.

Long and Short Eruption Intervals

Boiling at the top of the upper stage (S_3) will cause small amounts of water to be emitted at ground level, thereby reducing the pressure on deeper water, which in turn causes more boiling at deeper levels (Kieffer, 1989)—this is the beginning of the preplay phase. The net result of these small emissions is that the pressure reduction propagates downward until all the water column is at or above boiling—this triggers the main eruption phase, which occurs according to the following recipe:

$$\text{Eruption interval} = \text{refill and boiling time for } S_3 + \text{preplay time (Rayleigh distribution)}.$$

Refill and boiling time after a long eruption for S_3 is typically 85 minutes, based on our model (Fig. 5). The pressure data of Hutchinson et al. (1997) shows a pressure drop of 0.2 bars (20 kPa) immediately before an eruption, corresponding to the emission of 2 m of water (or about 3000 liters). This pressure drop is interpreted to be part of the preplay phase that triggered the main eruption.

Short eruption intervals follow short eruptions. This is usually rationalized on the basis that short eruptions expel smaller amounts of water and therefore the conduit takes a shorter time to recharge and heat to boiling before the next eruption. For illustration purposes (Fig. 7), it is assumed here that short eruptions involve only the second and third stages (S_2 and S_3), but any large fraction of the total volume could be expelled. If a short eruption expels these two stages, the remaining contents (namely, S_1) continue to heat toward boiling. Because the water level is well

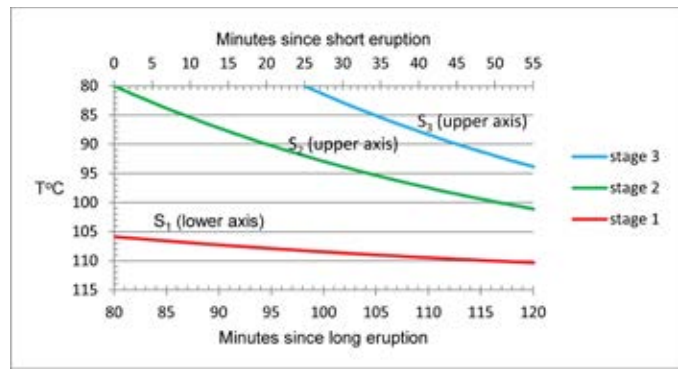


Figure 7. Temperature-time evolution of the upper stage (S_3) and middle stage (S_2) after a short eruption (upper axis) and the temperature-time evolution of the lower stage (S_1) after a long eruption (lower axis). The upper stage takes only 55 min. to reach boiling, which begins the preplay stage. Preplay activity triggers a full eruption, as described in the text.

below the surface, this continuous boiling will not produce any preplay activity. The continuous boiling accounts for the continuous seismic noise after a short eruption but absent after a long eruption (Kedar et al., 1998). After a short eruption, the second stage will begin to refill and heat as before, followed 25 minutes later by the uppermost stage.

Figure 7 shows the temperature evolution of all three stages after a short eruption using the same parameters as before (Table 1). The upper axis refers to the time after a short eruption for S_2 and S_3 , whereas the lower axis refers to the time after a long eruption for S_1 . The upper stage (S_3) reaches boiling (~93 °C at this elevation) within 55 minutes. This boiling initiates the preplay phase, causing S_2 to boil as hydrostatic pressure is released on the entire water column. The recipe for a short eruption interval is the same as before but with a shorter heating time for S_3 (compare S_3 in Figs. 5 and 7).

In the case of the long eruptions, the Rayleigh preplay distribution (mode = 9 min.) is superimposed on an 85-minute heating phase and a 55-minute heating phase for short eruptions, producing the composite distribution shown in Figure 8. The agreement with the observed data (Fig. 1A) is quite good, with a subsidiary mode at ~60 minutes for short eruption intervals and a mode at ~92 minutes for long eruption intervals. The physical cause of short-duration eruptions remains unresolved.

DISCUSSION

An alternative model with a conduit geometry based on that illustrated by Hutchinson et al. (1997) yields very similar results to those presented here, indicating that the model is not particularly sensitive to the conduit geometry. On the other hand, the model is quite sensitive to parameters such as the absolute value of the source temperature and the recharge temperature—changes as small as $\pm 20\%$ in these values produce a substantially worse fit to the data of Birch and Kennedy (1972); these temperatures, however, are reasonably well constrained.

Changes in the value of the convective heat transfer coefficient (h) of $\pm 20\%$ also produce substantially worse fits to the data. The value we chose (based on $\Delta T = 10$ °C) is slightly above the middle of the experimental range for the nucleate boiling regime (Incropera and DeWitt, 2005, p. 598). Lastly, Hutchinson et al. (1997) suggested that CO_2 may be present in the conduit water

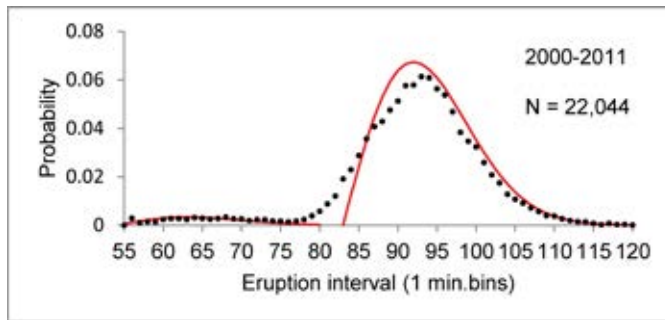


Figure 8. By adding 55 min. (short eruption heating time) and ~85 min. (long eruption heating time) to the preplay Rayleigh distribution (Eq. [1], with a mode of 9 min.; solid curves), the distribution of short and long eruption intervals are reproduced quite well for the period 2000–2011. The circular symbols are the same data as in Figure 1A. Because short eruptions occur about 5% of the time, the Rayleigh probability was scaled by a factor of 0.05 relative to long eruption intervals.

with a pressure of up to 0.2 bars (20 kPa), which would act to lower the reference boiling curve. On Figure 6, this corresponds to ~2 m of hydrostatic pressure and would bring the reference curve closer to the P - T conditions in the conduit by this amount (equivalent to 3000 liters of water). The overall effect would be equivalent to shortening the preplay phase (and the eruption interval) by a few minutes.

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1963 GSA Annual Meeting Science Highlights, Part 2

The theme of GSA's 125th anniversary meeting is "Celebrating Advances in Geoscience: Our science, our societal impact, and our unique thought processes," with a focus on how far GSA and geoscience in general have come as a result of scientific and technological advances in the last 50 years, as well as a look to the future.

Going back 50 years takes us to GSA's 75th Annual Meeting in New York on 17–20 November 1963. More than 90 papers were presented at that meeting, including "Urban geology: A world view" by Robert F. Legget of Ottawa, Canada, the abstract of which is reproduced here:

The increasing attention that is being devoted to the exploration of subsurface conditions at urban building sites, coupled with the great volume of current construction in almost all the major cities of the world, is providing geologists with unusually valuable opportunities for obtaining useful information about the surficial geology of urban areas, previously unmapped. Collection, correlation, and storage of such information are handled in a variety of ways. The system developed for the city of Paris, France, which includes the accurate recording of the many miles of underground quarries beneath the city (of which the famous "catacombs" are a part), is probably the most detailed of any of those in use in major cities of the world. London, New York, Tokyo, Prague, Montreal, Toronto, and Ottawa each provide at least one unique feature in the way in which their "urban geology" is being recorded. If geologists will cooperate with the engineering organizations responsible for urban subsurface exploration, the science of geology can often benefit by the assembly of information that might otherwise be lost. (p. 100–101)

In 1963, Legget's "urban geology" referred to the greater opportunity afforded geologists to access geological structures uncovered during urban construction. As the population of urban centers has grown during the past ~50 years¹, the term "urban geology" has expanded to cover many facets of the structure and nature of urban environments. For example, abstracts concerning

urban geology presented at the 2012 GSA Annual Meeting & Exposition included the following:

- "Lead in urban soils: A case study from a Terre Haute community garden," by D.T. Van Halen and colleagues;
- "Effects of surficial geology, lakes, and land use on urban stream temperatures: Metropolitan Seattle," by D.B. Booth and colleagues (presentation by K.A. Kraseski);
- "The environmental and medical geochemistry of urban disasters," by G.S. Plumlee and S.A. Morman; and
- "An urban karst geophysical study in Springfield, Missouri," by L.M. Gerson and colleagues.

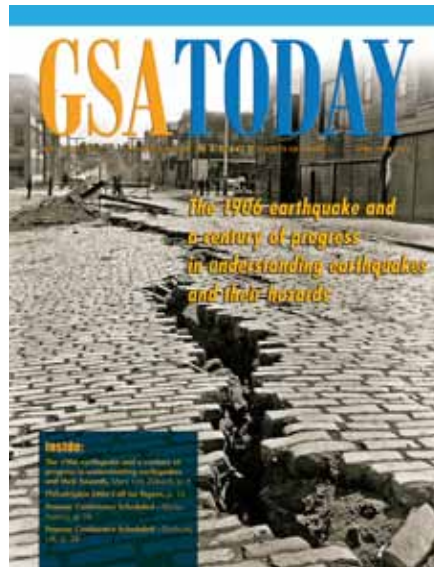
The 2006 GSA book, *1906 San Francisco Earthquake Centennial*

Field Guides, recounts the events of the 1906 Great San Francisco Earthquake and places great emphasis on understanding the effects of major earthquakes on urban environments. Several chapters discuss remediation efforts in construction of new buildings as well as repair of older ones. Field trips detailed in the book include "A walk along the Old Bay Margin in downtown San Francisco: Retracing the events of the 1906 earthquake and fire," by Raymond Sullivan; "Remnant damage from the 1906 San Francisco earthquake," by John Boatwright; "Twenty-first century high-rises," by Neville Mathias and colleagues; "The 1906 earthquake rupture trace of the San Andreas fault north of San Francisco, with stops at points of geotechnical interest," by Tina Niemi and colleagues; and "The effects of the 1906 earthquake on the Stanford University

campus" by Clayton T. Hamilton and colleagues.

Another facet of urban geology, in this case, understanding the geological provenance of building stones, has been trending at the last few GSA Annual Meetings. The 2012 meeting in Charlotte, North Carolina, USA, included a self-guided "Building stone walking tour" (www.geosociety.org/meetings/2012/documents/SelfGuidedFTguide.pdf). This trend is also exemplified by the highly successful book, *Stories in Stone: Travels through Urban Geology*, by David B. Williams (2009; discussed and reviewed in two posts on Michael Welland's "Through the Sandglass" blog [2009a, 2009b]).

As urban areas expand and populations grow, geoscientists are likely to see "urban geology" as an ever-broadening,



¹In 1960, 69.9% of the U.S. population lived in urban centers, with 30.1% rural (U.S. Census Bureau, 1995). By 2000, the ratio was 79% urban to 21% rural (U.S. Census Bureau, 2000), and in 2010, 80.7% of the U.S. population lived in urban settings (U.S. Census Bureau, 2010).


multidisciplinary field of study. Included would be the effect of humans as geologic agents. The December 2012 *GSA Today* science article, “Land transformation by humans: A review,” by Roger LeB. Hooke² and José F. Martín-Duque, addresses this issue, examining the “changes that human activities have wrought in Earth’s life support system” (p. 4). The article includes a striking figure (their Fig. 1, www.geosociety.org/gsatoday/archive/22/12/figure/i1052-5173-22-12-4-f01.htm) comparing a computer-generated image of Manhattan Island “before New York” (Miller, 2009) and a photo of Manhattan today. Another example of the expansion of urban geology is the growing acceptance of the term “Anthropocene,” denoting “the global environmental effects of increased human population and economic development” (Zalasiewicz et al., 2008, p. 4).

Urban geology is certainly one area in which GSA can “celebrate advances in geoscience: our science, our societal impact, and our unique thought processes.”

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² Roger LeB. Hooke also authored the Sept. 1994 *GSA Today* science article, “On the efficacy of humans as geomorphic agents.”



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Mount Sneffels near Ridgway and Telluride; photo by Matt Inden/Miles. Used with permission from Colorado Tourism Office.

<http://community.geosociety.org/2013AnnualMeeting/>

Message from the **ANNUAL MEETING GENERAL CHAIR**

Come to Colorado, where great ideas will drop out of thin air during the 125th Anniversary Meeting of the Geological Society of America! Denver is ready for you with a great convention center, conveniently located hotels, the fourth largest museum in the nation, and lots of friendly geologists to help you feel at home. And GSA staff and officers and the local committee are going all-out to make this a memorable experience for you.

And, of course there is Colorado—offering a diversity of scenery and geology that is unparalleled in the nation, including

- The 5,000-square-mile Pleistocene dune field on the eastern plains;
- The 1.7 billion-year-old granitic complex in Rocky Mountain National Park;
- The huge monoclines of Dinosaur National Park;
- The vast calderas of the “Switzerland of America”;
- The rich energy resources of the Roan Plateau;
- The spectacular Paleozoic strata of Glenwood Canyon;
- The world’s largest molybdenum deposit;
- The nation’s most voluminous rare earth deposit;
- The vast array of glacial and periglacial features throughout the state; and
- The superb insect fossils at Florissant.



Vince Matthews

Colorado has something for everyone. So, come early, and stay late!

In addition to being the nation’s highest state (6,800 feet above mean sea level) and having 58 named peaks over 14,000 feet in elevation, Colorado has a geologist as governor, and it is the nation’s center for craft beer, with more than 160 craft brewers.

Oh yeah, and the 125th Annual Meeting itself!

- 27 field trips planned, including one on the Yellowstone hotspot;
- 33 short courses submitted;
- A record number of technical sessions (259!) and 13 Pardee sessions;
- An exciting Hall of Maps;
- A black-tie/Victorian gala that includes a new symphony (*Formations*) composed to celebrate GSA’s 125 years.

You do NOT want to miss this one!

Vince Matthews, Leadville Geology LLC
Annual Meeting General Chair



Denver Skyline. Photo by Ron Ruhoff. Denver Metro Convention & Visitors Bureau.

NEW

Get Your **SCIENCE** Here!

NEW SESSION HOURS: All sessions will run 8 a.m.– noon or 1–5 p.m., with a poster hall beer reception 5–6:30 p.m. Mon.–Wed.

1

DISCIPLINE SESSIONS group abstracts submitted to a particular discipline category (see the April/May 2013 *GSA Today*, p. 38–39) so that workers in these areas can combine their expertise to create broad, comprehensive sessions. To begin your abstract submission process, go to the meeting website and click on Sessions>Discipline.



4

PARDEE KEYNOTE SYMPOSIA represent cutting-edge, interdisciplinary science and address broad, fundamental geoscience issues and/or areas of public policy. Speakers in these sessions are leaders in their fields. Learn more on the website by clicking on Sessions>Keynote. These symposia are named in honor of GSA Fellow and benefactor Joseph Thomas Pardee (1871–1960; <http://gsahist.org/gsat2/pardee.htm>) via a bequest from Mary Pardee Kelly. Pardee is best known for his work on Glacial Lake Missoula.



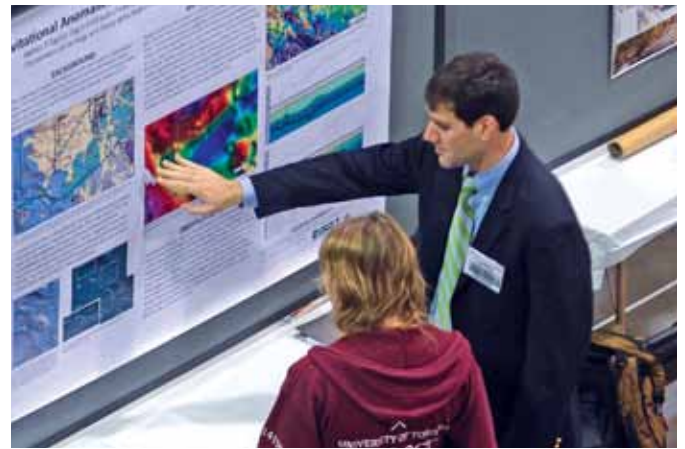
Denver Museum of Nature & Science. Photo by Sheri O'Hara, Denver Metro Convention & Visitors Bureau.

2

TOPICAL SESSIONS, as the name implies, are focused on specific topics to encourage an exchange of multidisciplinary science. To submit an abstract to a particular topical session, review the list at www.geosociety.org/meetings/2013/sessions/topical.asp.

3

SPECIAL SESSIONS are typically four hours long. The session chairs have few boundaries on what they are able to schedule in these sessions. If this piques your curiosity, plan on attending a session during the meeting. Learn more on page 28.



5

DIGITAL POSTERS: Four topical sessions are accepting digital poster presentations this year: T26, T100, T109, and T119. You can view the descriptions on the website by clicking on Sessions>Topical. Due to the costs of Internet and monitors, the fee to submit an abstract to these sessions is US\$80.

1888

- American Geological Society founded for the purpose of “the promotion of the science of geology by the issuance of scholarly publications, the holding of meetings, the provision of assistance to research, and other appropriate means.”
- First Annual Meeting held in Ithaca, New York
- James Hall, Jr., elected first president

NETWORK and Have FUN!



GSA's meetings are known for more than great science—they are also about community, opportunity, and just plain fun! You'll walk away feeling reenergized with an abundance of new ideas and connections.

Don't miss out on several events and activities that people will be talking about. Start the meeting off on Saturday night from 5 to 7 p.m. with the Denver Icebreaker—Plan to meet up with friends and colleagues, enjoy a beverage, and find the new hot spots for dining in Denver. Peruse the Exhibit Hall beginning with the Exhibits Opening Reception on Sunday evening, 5–7 p.m. And enjoy a beer on Monday, Tuesday, and Wednesday from 5 to 6:30 p.m. in the Poster Hall, giving you a dedicated time to view the posters, including the cutting-edge digital displays.

Fifth Annual Photo Contest Sponsored by GigaPan

1

Submission deadline: 15 Aug.

Five Categories This Year:

1. **Regional Geology:** Landscapes, features, or geologic activity within the Rocky Mountain region;
2. **Abstract Images:** The patterns of geology at any scale, from photomicrographs to satellite images;
3. **Geologic Processes Past and Present:** Processes or features resulting from a specific process (for example: an erupting volcano or volcanic rocks that represent ancient eruptions).
4. **Iconic Landscapes:** Iconic geologic landscapes and features (for example: Grand Canyon, Death Valley);
5. **NEW: Gigapixel Photos:** High-resolution, interactive gigapixel panoramic images.

Timeline

- Submit your .jpg files (max. two entries per category) by 15 Aug. to geosocphotos@gmail.com.
- For the gigapixel contest, submit online at gigapan.com (max. two entries) by 15 Aug.
- Winners will be notified by 15 Sept.

Plus: A student photo contest is in the works. Check the meeting website for updates.



NETWORK and Have FUN!

2 **Guest Program** The Society warmly welcomes all members of the GSA community. We've provided a comfortable hospitality suite for registered guests to enjoy while their companion geologists are busy attending sessions. The suite will offer complimentary refreshments, entertaining and educational seminars, and local experts with plenty of information, ready to answer your questions about the area. Various local tours and activities will also be offered for an additional fee. We hope that you take advantage of the tours to get out and learn more about Denver and Colorado's Front Range.



Arrowhead Golf Course . Photo by Richard Grant.
Denver Metro Convention & Visitors Bureau.



3 **Scientific Field Trips** Geology is a field-based science. Come celebrate GSA's 125th anniversary in true geologic fashion by exploring some of the extraordinary field relationships on display in the Rocky Mountain region. You may have gone on trips at past Denver meetings, but Colorado offers an abundance of exciting geology to delight you and get you thinking. Twenty-seven scheduled trips (see p. 32) will explore near and far, from the extensive museum collections and research facilities located in the Denver area to the nearby, eye-catching ramparts of the Rockies to the intriguing geologic relations farther west and in adjacent states. Some trips focus explicitly on the evolution of geologic thought regarding key field sites that shaped our science, while others concentrate on new thinking. All will enlighten you and present the up-to-the-minute thinking regarding the topic at hand.

Get Connected with GSA

 twitter.com/geosociety

 www.facebook.com/GSA.1888

Learn more about connecting with GSA on p. 24.



1888
thru
1890

GSA Headquarters at the University of the City of New York

Boost Your **CAREER!**

NEW

Geoscience Career Program

1

The new Geoscience Career Program will connect industry and students in a day of progressive sessions, including a student workshop to prepare for job searches; a morning session for students to discuss their research with sponsoring companies; and the popular *Geology in Industry* lunch panel. In the afternoon, students will have a chance to learn about the companies, their unique cultures and work environments, and the types of geoscience careers available. The program concludes with an evening reception for student research presenters, sponsoring corporations, and recently graduated GSA members.

2

Continuing Education Credits The meeting offers an excellent opportunity for you to earn CEUs toward your general continuing education requirements. Credits are available for technical sessions, short courses, and field trips. Ten contact hours are required for one CEU. For example, one day (8 hours) of technical sessions equals 0.8 CEUs. After the meeting, contact Beth Engle at bengle@geosociety.org to receive a meeting evaluation form. Once you've completed the form, please return it, and we'll send you a CEU certificate.



3

Employment Service Center GSA runs a year-round online employment service database. Prior to the annual meeting, numerous employers post jobs in this database and search résumés so that they can set up interviews during the meeting. Don't miss this opportunity! GSA members can post their résumés for FREE. If you are close to graduating or are looking for a new position, this service is for you! Learn more at www.geosociety.org/Employment_Service/.

4

GSA Mentor Programs GSA runs four mentoring programs at the Annual Meeting, all designed to

- Develop skills and knowledge to enhance the professional and personal growth of students and K-12 teachers;
- Concentrate on employment within various sectors (*Geology in Government* and *Geology in Industry*), specialties (*John Mann Mentors in Applied Hydrogeology*) and specific issues (*Women in Geology*);
- Facilitate future career choices by sharing resources, skills, and knowledge;
- Enhance professional development;
- Provide networking opportunities with professionals and other students; and
- Provide attendees with critical feedback (the government and industry programs are driven entirely by student questions).



Boost Your CAREER!

5 K-12 Educator Events

K-12 educators register for only US\$55!

- This year we are offering **four short courses for K-12 educators** with a special “Attend one, attend a second FREE!” discount.
- **Plus:** Two field trips;
- *And our annual Educators’ Reception.*



6 Short Courses GSA’s Short Courses run from four hours to two days in length and are ideal for geologists at all levels of their careers, as well as students and K-12 teachers. These courses are cost-effective and provide you with professional development to meet your personal interest and career advancement needs. In addition, these courses provide an excellent opportunity to interact and exchange information with your peers, network, and receive technical assistance. For details and course descriptions, see p. 34 or check the meeting website.

7 Campus Connection (Formerly the Graduate School Information Forum) *Looking to further your education?* Stop by the Campus Connection area in the Exhibit Hall to meet face-to-face with representatives at top geoscience schools. Plan ahead and schedule interviews with participating school representatives. Last year, close to 70 schools participated.

Looking to showcase your geoscience program? Don’t miss out on an opportunity to highlight your school to 2,500 students in a relaxed, informal setting. Find more information on the website under “Expo.”

GEOLOGICAL SOCIETY OF AMERICA FOUNDATION

LAVA CAP Wines GSA is celebrating 125 years of geoscience innovation with Lava Cap wines, which are nourished by the prime volcanic soil of the Sierra Nevada Foothills. As geologists, the Jones winemaking family appreciates GSA’s interest in Earth’s history, processes, and resources. Here’s to 125 years of ground-breaking geoscience and our passion for the never-ending mysteries of Earth!

Celebrating GSA’s 125th Anniversary



Learn more at www.lavacap.com/aboutus.html; order your special anniversary wine via the secure link at www.geosociety.org/125/.

OPPORTUNITIES to Help & Be Helped

Child Care

Sat.–Wed., 7 a.m.–6 p.m. daily

- Attend sessions while your children have some fun of their own! Kiddie Corp is a nationally recognized provider of onsite child care programs and we are pleased to be working with them again this year. Registration is open and detailed information is available on the meeting website.



Black Canyon: Painted wall of the Black Canyon of the Gunnison National Park, Colorado. This cliff, more than 2,200 feet high, exposes Precambrian gneiss cut by numerous pegmatite dikes. Photo by Marli Bryant Miller, University of Oregon.

Student Members: Volunteer!

Earn FREE meeting registration when you volunteer for ten hours, PLUS one US\$25 stipend for every five hours worked, PLUS get an insider's view of the meeting! Sign up early online for the best selection of jobs, then register for the meeting as a student volunteer.

Grant Assistance

Need assistance getting to the meeting? GSA Sections, Divisions, and Associated Societies are ready to help! Various groups are offering grants to help defray your costs for registration, field trips, short courses, and travel. Check out the website for application and deadline information. Note: Eligibility criteria and deadline dates may vary by grant.

Want to help? You can support participation in GSA's Annual Meetings by donating to the Student Travel Fund when you register.

GSA Student Travel Grants

Application deadline: 23 Sept. Check the annual meeting website for details.

Geoscience Education Division Student Travel Grants

Application deadline: 15 Sept., www.geosociety.org/divisions/ged/gedTravelGrants.htm

Planetary Geology Division Student Travel Grants

Application deadline: 20 Sept., http://rock.geosociety.org/pgd/awards.html#_travel

Quaternary Geology & Geomorphology Division Field Trip Grants

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

Structural Geology and Tectonics Division Student Short Course/Field Trip Grants

Application deadline: 18 Sept., <http://rock.geosociety.org/sgt/StudentTravelAward.htm>

International Section Travel Grants

Application deadline: 5 July, www.geosociety.org/sections/International/travelGrants.htm

Give 125

Are you wondering what to give GSA on such a momentous birthday? Give 125! Dollars, time, possessions—whatever works for you: www.geosociety.org/125/.

Thank You to This Year's ORGANIZING COMMITTEE



General Chair: Vincent Matthews, Leadville Geology LLC

Technical Program Chair: Richard C. Berg, Illinois Geological Survey

Technical Program Co-Chair: Kevin Mickus, Missouri State University

Field Trip Co-Chairs: Lon Abbott, University of Colorado; Greg Hancock, College of William & Mary

Education Chair: Samantha Richards, Denver Museum of Nature & Science

Student Committee: Melissa Bernardino, Kara Brugman, Sarah Crump, Elisa Dahlberg, Katrina Jewell, Matt Weingarten

ACTION Items

Dates & Deadlines

- 1 • Campus Connection: Reserve Now!
- Space request deadline (standard fee): 5 June
- International Section grant application deadline: 5 July
- Abstract submission deadline: Tuesday, 6 Aug. (midnight PDT)
- Photo contest submission deadline: Thursday, 15 Aug.
- Early registration deadline: Monday, 23 Sept.
- Registration cancellation deadline: Monday, 30 Sept.
- Housing deadline: Monday, 30 Sept.

International Visas—Do You Need One?

- 2 Please check the U.S. State Department website at http://travel.state.gov/visa/visa_1750.html. The International Visitors' Office of the Board on International Scientific Organizations (from the National Academy of Science website) has a great site for scientists coming to the U.S.: <http://sites.nationalacademies.org/PGA/biso/visas/index.htm>.

Space Requests There is still time to reserve a meeting room for business meetings, luncheons, award ceremonies, parties, alumni receptions, and more. Please complete and submit the space request form at <http://community.geosociety.org/2013AnnualMeeting/Conference/Events/EventPlanning> as soon as possible, and include your payment at that time. The space request information will assist GSA staff in determining the size of room and setup needed for your event.

Submit Your Abstract(s)

- 4 **Abstract submission deadline:** Tuesday, 6 Aug. (midnight PDT)
 - To begin submission, go to <http://gsa.confex.com/gsa/2013AM/index.epl>.
 - **Submission fees:** US\$45/professional; US\$25/students; US\$80/digital posters.
 - **You may present two volunteered abstracts as long as one is a poster (incl. digital poster).**

1889

- Mary Emilee Holmes became first woman GSA Fellow
- (27 Dec.) GSA's second Annual Meeting—formal adoption of a revised constitution and bylaws
- *American Geological Society* changed name to the *Geological Society of America*

1890

First issue of the *Bulletin of the Geological Society of America* published



Sand Dunes: Wind Ripples on sand dunes, Great Sand Dunes National Park, Colorado. Sangre de Cristo Range in the background. Photo by Marli Bryant Miller, University of Oregon.

NEW Presenters

- 5 **NEW hours for Poster (Including Digital) Presentations**
 Sun., 9 a.m.–5 p.m., with authors present 3–5 p.m.
 Mon.–Wed., 9 a.m.–6:30 p.m., with authors present during the afternoon beer reception, 5–6:30 p.m.
Presenters are also encouraged to be present for one hour in the morning and one hour in the afternoon.

SPEAKERS

- The normal length of an oral presentation is 12 minutes plus three minutes for questions and answers.
- You *must* visit the Speaker Ready Room at least 24 hours before your scheduled presentation.
- Each technical session room is equipped with a PC using Office 2013.

QUESTIONS?

2013 Technical Program Chair: Dick Berg, rberg@illinois.edu

2013 Technical Program Co-chair: Kevin Mickus, kevinmickus@missouristate.edu

GSA Technical Program Manager: Nancy Wright, nwright@geosociety.org

ACTION Items

GSA is celebrating its 125th Anniversary all year long, and we're expecting record-breaking attendance at this special anniversary meeting, with opportunities for scientists of all sectors and stages of their careers. You won't want to miss out on this commemorative event!

Registration

- 5** Early registration deadline: 23 September
Cancellation deadline: 30 September

REGISTRATION FEES (in U.S. dollars)	Early (June–23 Sept.)		Standard & On-Site (after 23 Sept.)	
	Full Mtg	One Day	Full Mtg	One Day
Member professional	\$345	\$225	\$425	\$255
Member professional (70+ years old)	\$260	\$160	\$345	\$185
Nonmember professional	\$460	\$300	\$530	\$320
Member student	\$115	\$75	\$150	\$85
Nonmember student	\$155	\$99	\$190	\$110
K–12 professional		\$55		\$65
High school student		\$40		\$40
Guest or Spouse		\$85		\$90
Field Trip or Short Course only		\$40		\$40
Low Income Country*		50%		50%

*Participants from countries classified as “Low or Lower Middle Income Economies” by the World Bank need only pay 50% of the category fee for full meeting or one day registration. Online registration is not available for “Low or Lower Middle Income Economy” registrants. Please fill out a printable version of the registration form and mail it to GSA, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA; or FAX it to +1-303-357-1070.

When you register, don't forget to...

- 6**
- Register for tours, special events, field trips, and workshops;
 - Purchase tickets for special events (including the Black-Tie/Victorian Gala) or other meetings/luncheons that require advance registration;
 - Apply for the Student Travel Grant program (or donate to it!) by 23 September;
 - Make your hotel reservation;
 - Book your travel; and
 - Invite a colleague to attend!

Events Requiring Tickets/Advance Registration

7 Several GSA Divisions and Associated Societies will hold breakfast, lunch, receptions, and awards presentations that require a ticket and/or advance registration. The 125th Anniversary Black-Tie/Victorian Gala will also require a ticket. A complete list of ticketed events is available on the meeting website.

8 **Housing** “Visit Denver” is the official housing bureau for the GSA Annual Meeting. **Stay in the block and SAVE**—book now but pay later, no change fees, no FULL prepayment, **plus** get complimentary Internet in your guest room and the best networking opportunities due to the high concentration of attendees staying within the hotel block! Go to the meeting website for specific hotel information and to make a reservation. See page 38 for a list of hotels and a map of the area.



GSA Foundation's 2013 **SILENT AUCTION**

This year's Silent Auction is joining GSA's 125th Anniversary GIVE 125 challenge, and we need your help to reach our goals! We're seeking items that broadly pertain to the geosciences. *Proceeds will support "On To the Future," a GSA initiative to bring 125 students from underrepresented groups to the annual meeting.*

- Help us build our "well-equipped geoscientist" area, from head to toe, classroom to field—with tools, field supplies, gear, software;
- Add to the collection of geologic specimens;
- Contribute to our selection of wine & wine accessories;
- People always appreciate gift certificates (e.g., Amazon, special events, trips, restaurants);
- GSA meeting attendees love books; and
- Geo-gifts, jewelry, and apparel donations are great for our pre-holiday meeting.



To make a donation, or if you have any questions, please contact Ann Crawford, acrawford@geosociety.org; +1-800-472-1988, ext. 1053, or +1-303-357-1053.



SPONSORSHIP OPPORTUNITIES



Our science, our societal impact, and our unique thought processes

GSA Annual Meeting & Exposition
Denver, Colorado, USA | 27–30 October 2013



Connect with the best and brightest geoscience students and professionals...

Sponsorship offers

- Contact with thousands of students soon to be entering the workforce;
- Visibility throughout the meeting, onsite and beyond; and
- Awareness of your company as a partner supporting GSA's programs and doing business in our members' communities.

NEW opportunities include the 125th Anniversary Gala, continuing our year-long celebration, and the Geoscience Career Program, connecting industry and students.

For a full menu of sponsorship opportunities visit www.geosociety.org/meetings/2013/ or contact Debbie Marcinkowski at +1-303-357-1047 or dmarcinkowski@geosociety.org for help in selecting the best way to showcase your company.



www.geosociety.org/meetings/2013/documents/13GSA_sponsorship.pdf



Photo by Bret Webster.

GSA Connected Community Now Accepting Members!

GSA values your membership and appreciates your commitment and investment of resources. We want you to know that we are investing in you, too. GSA is proud to announce the launch of our **Connected Community**—an innovative member benefit that is going to change the way we communicate and build relationships.

When you visit the **125th Anniversary Annual Meeting website**, you'll notice that a few things are different. You can still find all the public information you need about the meeting—that hasn't changed—but you'll also see that you can now log-in to the site. Under the "Community" tab, you'll find new options for connecting with members and sharing information.

GSA Members: You *already* have a profile in the Connected Community—all you have to do is activate it! Not a GSA member? You can join the Connected Community as well. Learn how to log in at <http://community.geosociety.org/Help/HowtoLogIn>.

Benefits of Using the Connected Community for the Annual Meeting

- Post questions and comments to the Open Forum discussion;
- Get recommendations on must-attend sessions;
- Use the Meeting Bulletin Board to share a ride or find a roommate;
- Complete your profile in the member directory, and invite your colleagues to do the same. Search member profiles and find out who is attending; and
- Read up on blogs and resources posted by geoscience thought leaders.

In the coming weeks and months you'll be hearing a lot more about the Connected Community. As participation grows, it will become increasingly valuable as a networking resource and a tool for collaboration. We're committed to making sure you have the training and support you need to get familiar with and comfortable in this new environment. **To start, here are a few highlights you'll want to know about:**

Member Directory 2.0

Create a comprehensive and interactive profile that will represent you both professionally and individually within the

GSA community. Your profile is similar to an online résumé but with member connections. Users will not only be able to browse information and facts about you, they will also be able to interact with you. For example, users can see your committee participation and volunteer activities, which are dynamically updated through the GSA member database.

Think of your profile as your personal platform amongst the GSA community. You have the option to search for other members, browse profiles, and identify potential contacts and groups of like-minded people. Connect with colleagues and friends in a matter of minutes, essentially building a professional network you can access from anywhere in the world. A variety of security settings exist so that you can set access to various parts of your profile and decide how your profile should be used.

♦ **HOT TIP:** Upload a professional picture. Pictures are worth a thousand words, so make sure the image best represents you and what you want to accomplish. Consider using the same picture across all social media channels; this enhances recognition.

Discussions or e-Groups

Discussions are a hybrid of listserv and threaded discussion forum technology. Are you looking for recommendations or have a question you'd like to ask your network? Using GSA e-Groups/ Discussions, users can post, respond, or browse discussion threads. You'll receive an easy-to-read e-mail that includes a picture of the author and a link to the author's profile, a link to the online archive where all postings are automatically stored, and a mistake-free link to respond to either the author or the entire group. Start new conversation topics or conduct research. You'll be amazed at the collection of information and data GSA's e-Groups will generate every day.

♦ **HOT TIP:** Customize your experience. Adjust your preference settings to include the receipt of real-time or daily digest postings, or subscribe to RSS feeds to stay well-informed.

Section, Committee & Division Communities

Several community types are set up within our social network for you to join. Begin streamlining your volunteer experience and

improving your membership interactions by participating. Start with a simple search. For example, if you're on a committee, check out your committee site. Within the committee site, you will be able to conduct committee business, share resources, and engage with other committee members. But GSA's Community sites are not just for committees—you'll also have a Section community and maybe a Division affiliation to explore. Sites and discussion groups can be set up for all kinds of GSA happenings—from education and networking events to special projects and interest groups.

♦ **HOT TIP:** The GSA OPEN FORUM is a place for *everyone* to post questions, photos, videos, or share thoughts.

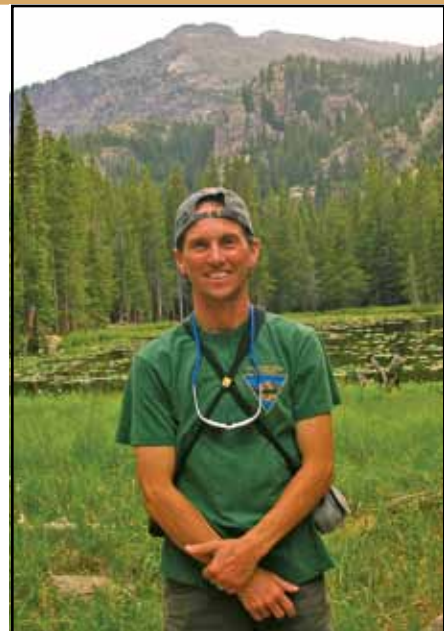
Resource Library—Jackpot!

The resource library is a treasure trove of user-generated content posted by members for members. You can securely share documents pertaining to your collaborations with other members while archiving content into GSA's knowledge base. The resource library can hold multiple kinds of documents, including streaming video, PowerPoint presentations, PDFs, images, and Microsoft Office and Apple iWork docs.

This resource is what you make of it. Comment, rate, and tag documents to offer additional context to the posting to make it easy to search the resource pool.

♦ **HOT TIP CHALLENGE:** Register for the GSA 125th Anniversary Meeting and activate your profile with a photo in the Connected Community to make the most of your meeting experience.

♦ **HOT TIP EXTRA CREDIT:** Tell a colleague, coworker, or friend that you've registered for the meeting and the community site, and explain why you think it would be of value to them.



Why would I join the Connected Community?

Cory W. Black Eagle recognized that GSA did not have a Division devoted to karst geology. So he created the GSA Karst Interest Group, and now he and all of the community's members have a built-in network, a discussion platform, a library of shared resources, and a platform for taking action to establish a new GSA Division.

Contribute to the power of GSA's Connected Community!

♦ **HOT TIP:** Is there a group you'd like to see started? Take action. Send us an e-mail at community@geosociety.org and let's have a conversation.



Connected Community



PRESIDENT'S STUDENT BREAKFAST RECEPTION

When: Sunday, 27 Oct., 7–8:30 a.m.

Location: Colorado Convention Center



GSA President **Suzanne Mahlburg Kay** invites all students registered for the meeting to attend a free breakfast buffet sponsored by ExxonMobil Corporation. Sue and members of GSA leadership will be on hand to answer questions and address student issues. ExxonMobil will also be presenting the ExxonMobil Field Camp Scholar Awards and GSA/Bighorn Basin Field Awards.

Each student registered for the meeting will receive a complimentary ticket for the breakfast buffet. This is one of the most popular events at the meeting—Join in and take this opportunity to network with fellow students and meet the officers of GSA in a casual, friendly setting.

1891
thru
1906

GSA Headquarters at Rochester University in Rochester, New York

PARDEE KEYNOTE Symposia



Pardee Keynote Symposia are named in honor of GSA Fellow and benefactor Joseph Thomas Pardee (1871–1960) via a bequest from Mary Pardee Kelly. Pardee is perhaps best known for his work on Glacial Lake Missoula. These symposia consist of invited papers covering a broad range of topics.

P1. 125 Anniversary Pardee Symposium: 125 Years of Exploration and Geoscience with GSA and the National Geographic Society: Celebrating the Rich History of Geoscientist Explorers Who Have Broadened Our Horizons and Knowledge of Our World

Advocates: Cory W. Black Eagle, University of Kentucky; George Veni, National Cave & Karst Research Institute; Barbara EchoHawk, Metropolitan State University of Denver

This session will showcase the intimate linkage between geology and exploration, both historically and currently. Speakers are scientist-explorers who have made contributions to the discipline over the last 50 years, as well as today’s geoscientists who are pushing the frontiers of science and providing us with new views of planet Earth. Individual speakers will represent different arenas of exploration and study: caves, mountains, oceans, polar regions, deserts, plains and grasslands, jungles, and planetary geology.

P2. 125 Anniversary Pardee Symposium: Advances in Understanding Earth Structure and Process from EarthScope

Advocate: Eugene D. Humphreys, University of Oregon

The three components of EarthScope—the seismic USArray, the geodetic Plate Boundary Observatory, and deep drilling of the San Andreas fault—provide observations that give earth scientists truly

unprecedented access to the inner workings of continents and the deeper Earth. This symposium will highlight work using EarthScope data that has advanced our understanding of Earth structure and process, often with fundamentally surprising insight.

P3. 125 Anniversary Pardee Symposium: In the Footsteps of Geology Giants

Advocates: Marjorie A. Chan, University of Utah; R.M. Clary, Mississippi State University; K.R. Aalto, Humboldt State University

Many “geology giants” dramatically impacted geoscience with pivotal discoveries, explorations, and contributions. As our science looks forward, we learn from the past and follow in the footsteps of those who went before us. This session invites speakers to highlight the life of notable North American geoscientists (no longer living) who promoted ground-breaking ideas that historically changed the discipline and directed its future progression.

P4. 125 Anniversary Pardee Symposium: Quaternary Geology and Geomorphology: Past, Present, and Future

Advocates: Jim E. O’Connor, U.S. Geological Survey; Alan R. Nelson, U.S. Geological Survey

This session looks at the past, present, and future of Quaternary geology and geomorphology: Where have we been? What have we learned? Where are we headed? This all-day program begins with a morning highlighting our discipline’s accomplishments over the past decades through the perspectives of top-notch QG&G scientists. In the early afternoon, emerging early-career scientists will identify the most recent advances and possible future directions in QG&G research. These oral sessions are to be followed by a late-afternoon session of contributed posters amplifying these topics. This will be a day for all to celebrate GSA’s role in Quaternary geology and geomorphology.

P5. Evolution of the North American Cordilleran Lithosphere

Advocates: Anne F. Sheehan, University of Colorado; Christine Siddoway, Colorado College; Basil Tikoff, University of Wisconsin

This session focuses on the geodynamic evolution of the North American Cordillera with an emphasis on the U.S. West. Its goal is to integrate the entire tectonic history of the region on the crustal to lithospheric scale, emphasizing the relationship of ongoing geological phenomena to the lithospheric architecture inherited from past geological events.

P6. Energy and Health: The Emergence of Medical Geology in Response to the Shale Gas Boom

Advocates: Thomas Darrah, Duke University; Saugata Datta, Kansas State University; Robyn Hannigan, University of Massachusetts; Richard K. Miller, University of Rochester

This session aims to increase the relevance of “Geology and Health” by integrating a multidisciplinary set of researchers actively engaged in critical aspects of shale gas development. Topics will include recent advances in research approaches surrounding this highly public and contentious issue.

P7. Back to the Future: Eocene–Early Oligocene Climatic Response to Geological Processes and Implications for the Future Earth

Advocates: Yildirim Dilek, Miami University; Philippe Claeys, Vrije Universiteit Brussel; Christian Koeberl, University of Vienna

The major climatic shifts in Earth's history 55–33 million years ago indicate the significance of our need to understand climate changes and their causal mechanisms to better predict the future climate trends. The rates/amplitudes of these changes and the forcing mechanisms are still debated. We need to better document the mode/nature of those geological/impact processes during the Eocene that produced significant CO₂ output and withdrawal in and out of the atmosphere. This symposium will serve as a forum to address many of the questions on the Eocene climate, geology, and paleogeography, and to develop strategies and new directions in addressing these topics.

P8. Fossil Fuel Production, Economic Growth, and Climate Change

Advocates: James W. Murray, University of Washington; Charles A.S. Hall, State University of New York

Evidence indicates that global crude oil production has reached a supply limit and that coal production may be smaller than many believe. The impacts on current and future economic growth and the extent of future climate change need to be evaluated. Public awareness of this global situation is limited; there needs to be open discussion of these issues. The objectives of this session are (1) assessment of the most recent data for fossil fuel resources and production; (2) recognition of constraints on the global economy and on climate change; and (3) consideration of policy implications.

P9. From the Sahara to Mars and Beyond: The History and Future of Aeolian Research

Advocates: Nicholas Lancaster, Desert Research Institute; Alan F. Halfen, University of Kansas

Ralph A. Bagnold explored the deserts of Libya more than 75 years ago and effectively created the field of modern aeolian science, which today extends beyond the dunes of the Sahara millions of miles to Mars. This session will explore the history of aeolian research and highlight current advances and future research avenues within the field through a mixture of presentations by internationally renowned career scientists, early-career scientists, and students.

P10. Paleotopography

Advocates: Mark T. Brandon, Yale University; Frank J. Pazzaglia, Lehigh University

Paleotopography has long fascinated geoscientists who assemble the stratigraphic, tectonic, and geomorphic evidence of past landscapes. Well-established and emerging techniques in geochronology, thermochronology, stable-isotopes, geomorphology, biology, biogeochemistry, basin analysis, and seismology are offering new and more detailed insights into past landscapes, specifically the deep Earth processes that uplift rocks and the erosional processes that tear them down. This topic has engendered interest across the geoscience spectrum and has invited spirited debate focused on high-interest landscapes, such as the western U.S. (including Grand Canyon), the Alps, and the Andes.

P11. Rare Earth Elements: Minerals, Mines, Magnets (and More)

Advocates: Anton Chakhmouradian, University of Manitoba; Frances Wall, Exeter University

Rare earth elements (REE) are all around us, not only in nature, but in our everyday lives: in every car, smartphone, and energy-efficient lamp, as well as in ceramics, lasers, and more. The realization that rare earths are essential to the progress of technology and science but that their supply is currently limited has brought these elements into the headlines and created a critical-metals agenda. This symposium will provide a forum for discussion of the key aspects of REE behavior in Earth systems and of those challenges that face geoscientists, technologists, and industry involved in the rare earth business.

P12. Resourcing Future Generations: What Needs to Be Done in the Near Term to Meet Demand for The Mineral Resources Needed in the Long Term?

Advocate: Ian B. Lambert, Canberra, Australia

There are major challenges in meeting the needs of future generations, given rapid increases in demand resulting from the burgeoning global population and the aspirations of developing countries. Constraints that will need to be overcome will be discussed and an initiative being planned by IUGS to address these will be outlined. Details of this initiative will be developed at the "Future Resources Summit" in 2014 in China, which will bring together international experts from government agencies, research groups, and industry. This will involve detailed discussions with a view to reaching agreement on priority activities, funding arrangements, and parties involved.

P13. "Water, Water, Everywhere..." in the Solar System

Advocates: Devon M. Burr, University of Tennessee; Robert C. Anderson, Jet Propulsion Laboratory

This session will provide an overview of ongoing discovery of water throughout the Solar System and its potential for in-situ resource utilization and supporting life.

1891

(Aug.) GSA adopts an official seal (revised 1935, 1945, 1961, 1972, 1998)



1901

GSA's first Section (Cordilleran Section) formed

SPECIAL Sessions

The following special sessions extend and enhance opportunities for diverse learning and presentation modes within the technical program. Each session is structured by the individual organizer(s) to best fit their purpose, in order to provide an interesting and unique session for the meeting attendees.

A Life in Earth History from Tectonics to Climate: The Scientific Legacy of Paul F. Hoffman

Advocates: Robert S. Hildebrand, University of California at Davis; Francis A. Macdonald, Harvard University; Samuel A. Bowring, Massachusetts Institute of Technology; Galen P. Halverson, McGill University

This session will focus on recent advances in crustal, climate, and biogeochemical evolution, from tectonics to Snowball Earth, and their interactions.

CRvolution 2: Cenozoic Landscape Evolution of the Colorado Plateau–Rocky Mountain Region and the Carving of Grand Canyon

Advocate: Karl E. Karlstrom, University of New Mexico
The western U.S. field laboratory, because of its spectacular exposure, has been at the forefront of the scientific breakthroughs in geomorphology, stratigraphy, paleontology, and tectonics for more than a century (Dutton, 1882). The century-long debate about the evolution of the continental-scale Colorado River system and the carving of Grand Canyon are poised for resolution! This session is a step toward that breakthrough and complements an ongoing GSA *Geosphere* theme volume on CRvolution.

Process Geomorphology and the Legacy of Dale F. Ritter: Linkages within the Natural and Human Landscape

Advocates: R. Craig Kochel, Bucknell University; Jerry R. Miller, Western Carolina University; Dru Germanoski, Lafayette College

This special session will assemble leading scientists and educators whose work highlights the theme of *Process Geomorphology*, building upon the legacy of process and dynamics in geomorphic systems championed by Dale F. (Dusty) Ritter. Based on his pioneering research on glaciofluvial processes and landforms, Dusty mentored hundreds of students and provided a focus for the field with his first edition of *Process Geomorphology* in the 1970s. This session will focus on research on a broad range of geomorphic topics, including glaciofluvial systems, applied environmental geomorphology, and process linkages that exist within watersheds and, where possible, will highlight student-professor collaborations.

GSA 125th Anniversary Books: I, *The Web of Geological Sciences: Advances, Impacts, and Interactions*; II, *The Impact of Geological Sciences on Society: Authors Present Summaries of Their Articles*

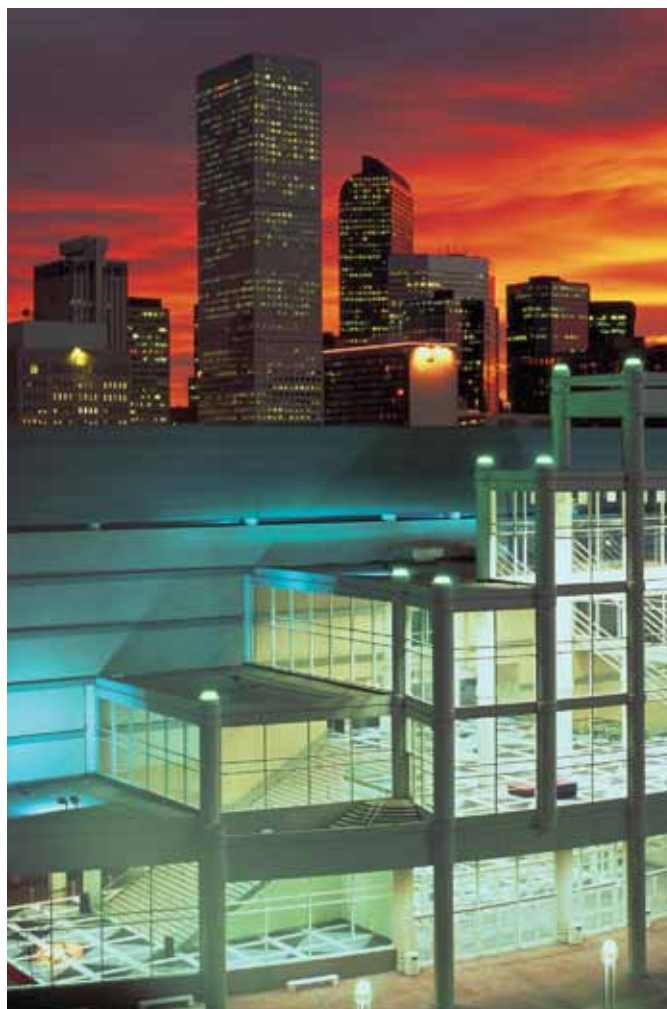
Advocate: M.E. Bickford, Syracuse University

In this session, authors of invited articles for two GSA Special Papers commissioned for GSA's 125th Anniversary celebration will present summaries of their articles.

Cutting Edge Applied Geoscience in Exploration: The Best of AAPG

Advocates: Robbie Gries, Priority Oil and Gas, LLC; Paul Weimer, University of Colorado

Three-dimensional seismic visuals, innovative structural geological applications, amazing application of the newest stratigraphic thinking—these concepts and more have captured presentation awards from a cadre of peers at the annual meetings of the American Association of Petroleum Geologists (AAPG). This session is designed to expose GSA attendees to the latest in applied geoscience for the advancement of resource development.



Colorado Convention Center at night. Photo by Bob Ashe. Denver Metro Convention & Visitors Bureau.

You are invited
to an evening of celebration in honor of
THE GEOLOGICAL SOCIETY OF AMERICA'S
125th ANNIVERSARY GALA

HISTORY COLORADO CENTER • 1200 BROADWAY, DENVER

TUESDAY, 29 OCTOBER

BLACK TIE OR VICTORIAN DRESS. COST: US\$125 PER PERSON.
6:30 p.m. COCKTAIL RECEPTION AND VIEWING OF EXHIBITS

7:30 p.m. BOULDER PHILHARMONIC PERFORMANCE
OF SYMPHONY NO. 1, *FORMATIONS*

8:00 p.m. DINNER AND PROGRAM

SPACE IS LIMITED, SO PLEASE RESERVE YOUR PLACE WHEN YOU REGISTER FOR THE MEETING.

TABLE SPONSORSHIPS ARE AVAILABLE—FOR MORE INFORMATION,
PLEASE CONTACT DEBBIE MARCINKOWSKI AT
DMARCINKOWSKI@GEOSOCIETY.ORG OR +1-303-357-1047.

IF YOU HAVE QUESTIONS, PLEASE CONTACT
MEETINGS@GEOSOCIETY.ORG.

Symphony No. 1
FORMATIONS



In honor of our 125th Anniversary, The Geological Society of America and the Boulder Philharmonic Orchestra have co-commissioned a new work composed by Jeffrey Nytech, director of the Entrepreneurship Center for Music at the University of Colorado Boulder's College of Music. With a geology degree from Franklin & Marshall College prior to his career as a composer, Nytech has a unique interest and perspective from which to create *Formations*. This work of four movements is inspired by the geology of the Rocky Mountain region.

The world premiere of Symphony No. 1 (*Formations*) kicks off the Boulder Phil's season on 7 Sept. 2013 at Macky Auditorium. IT WILL ALSO BE PERFORMED AT GSA'S 125TH ANNIVERSARY GALA ON 29 OCTOBER DURING THE ANNUAL MEETING. Be on the lookout for more news, materials, and even CDs of this unique partnership!



EXHIBITORS by Category *(as of press time)*

COMPUTER SOFTWARE

International Centre for
Diffraction Data

ENVIRONMENTAL

British Geological Survey
Environmental Isotope Lab
WKU Hoffman Environmental
Research Institute

GEMS/MINERALS DEALERS, JEWELRY/GIFTS

Cornerstone Minerals
Crystals Unlimited
Finesilver Designs/Jewelry
Gems & Crystals Unlimited
Geographics
IKON
Komodo Dragon
Natural Earth Craft LLC
Nature's Own
Xeno Designs

GENERAL EDUCATIONAL PRODUCTS

Little River Research & Design
McGraw-Hill Higher Education

GEOGRAPHIC SUPPLIES AND RELATED EQUIPMENT

Estwing Mfg. Co.
Forestry Suppliers Inc.
Rite in the Rain

GEOLOGICAL SOCIETY OF AMERICA

GSA Environmental and
Engineering Geology Division
GSA Geoinformatics Division
GSA Geology and Public Policy
GSA Geology and Society
Division
GSA Geoscience Education
Division
GSA Headquarters Services
GSA History and Philosophy of
Geology Division
GSA Hydrogeology Division
GSA Limnogeology Division

GSA Mineralogy, Geochemistry,
Petrology, and Volcanology
Division
GSA Planetary Geology Division

GEOLOGICAL AND GEOPHYSICAL INSTRUMENTATION

ASC Scientific
Bruker Corporation
Decagon Devices Inc.
elementar Americas Inc.
EmCal Scientific Inc.
Gatan Inc.
Geophysical Survey Systems Inc.
HORIBA Scientific
IDS North America Ltd.
IsotopX Inc.
IXRF Systems Inc.
Leica Microsystems Inc.
Mala Geoscience USA Inc.
Martin Microscope
Optech Inc.
RIEGL USA
Rigaku Americas Corporation
Sensors & Software Inc.
Thermo Scientific
TSI Inc.
UNAVCO

GOVERNMENT AGENCIES (FEDERAL, STATE, LOCAL, INTERNATIONAL)

EARTHTIME
NASA
National Park Service
National Science Foundation
U.S. Forest Service
U.S. Geological Survey

OTHER

35th International Geological
Congress (IGC) Foundation
Consortium of Universities for
the Advancement of
Hydrologic Sciences Inc.
(CUAHSI)
Coordinating Office for Research
on the Sedimentary Crust,

Deep-Time & the Earth-Life
System

Critical Zone Observatories
(CZO)

Esri
Geocognition Research Lab
Iris Consortium
Subaru of America Inc.

PROFESSIONAL SOCIETIES AND ASSOCIATIONS

AAPG
AASP - The Palynological Society
American Geophysical Union
American Geosciences Institute
American Institute of Professional
Geologists
American Meteorological Society
American Quaternary
Association
Association for Women
Geoscientists
Association of Earth Science
Editors
Association of Environmental &
Engineering Geologists
Clay Minerals Society
Colorado Scientific Society
Council on Undergraduate
Research
Cushman Foundation
European Geosciences Union
Geochemical Society
Geological Association of Canada
Geoscience Information Society
GeoScienceWorld
International Advisory for
Geoscience Diverse-Ability
International Association of
Geochemistry
International Union of Geological
Sciences
Mineralogical Association of
Canada
Mineralogical Society of America
Minerals Education Coalition/
Society for Mining, Metallurgy
& Exploration

National Association of
Geoscience Teachers
National Cave & Karst Research
Institute
National Ground Water
Association
National Speleological Society
Paleontological Research
Institution
Paleontological Society
SEPM (Society for Sedimentary
Geology)
Sigma Gamma Epsilon
Society for the Preservation of
Natural History Collections
Society of Economic Geologists
Society of Exploration
Geophysicists & Geoscientists
without Borders[®]

PUBLICATIONS, MAPS, FILMS

Cambridge University Press
Columbia University Press
Copernicus Meetings & Open
Access Publications
Elsevier
Friendship Publications
Geologic Data Systems
Geological Society of London
Kendall Hunt Publishing Co.
Micropaleontology Project
Nature Publishing Group
Oxford University Press
Pearson
Springer
Taylor & Francis—CRC Press
*Treatise on Invertebrate
Paleontology*
University of California Press
University of Chicago Press
W.H. Freeman
W.W. Norton
Waveland Press
Wiley
Yale University Press



**SERVICES
(EXPLORATION,
LABORATORIES,
CONSULTING, AND
OTHERS)**

Beta Analytic
DOSECC Exploration Services
GNS Science/Rafter
Radiocarbon
Ruen Drilling Inc.

STATE SURVEYS

Association of American State Geologists

UNIVERSITIES/SCHOOLS

Schools in **boldface** will be located in the Campus Connection area of the Exhibit Hall (formerly the Graduate School Information Forum).

- Ball State University**
- Baylor University Geology Dept.
- Central Washington University**
- Colorado School of Mines
- Colorado School of Mines Dept. of Geology & Geological Engineering**
- Cornell University**
- EarthScope
- East Carolina University**
- Gemological Institute of America
- Indiana University–Purdue University Indianapolis**
- Indiana University–Bloomington**
- John D. Cooper Archaeological & Paleontological Center

- Kansas State University
- Mississippi State University Dept. of Geosciences
- Missouri State University GGP Dept.**
- Missouri University of Science and Technology**
- National Centre for Groundwater Research & Training
- NSF Antarctic Data Consortium
- Pennsylvania State University**
- Rice University Earth Science Dept.**
- San Diego State University**
- Syracuse University Dept. of Earth Sciences**
- Texas A&M University
- Texas Tech University Dept. of Geosciences**
- The Ohio State University School of Earth Sciences**
- The University of Texas at Austin Jackson School of Geosciences

- The University of Texas at Dallas Geosciences Dept.**
- University of Arkansas–Fayetteville**
- University of Idaho**
- University of Michigan**
- University of Nevada–Las Vegas
- University of Nevada–Reno
- University of North Carolina at Charlotte**
- University of Oklahoma ConocoPhillips School of Geology and Geophysics**
- University of South Carolina School of Earth, Ocean and Environment**
- University of Southern California Dept. of Earth Sciences**
- University of Toledo**
- University of Wisconsin–Madison**
- Western Michigan University Dept. of Geosciences**



CAMPUS CONNECTION Bringing Students and Schools Together

Meet face-to-face with more than 2,500 prospective students in a relaxed, informal setting.

GSA's Campus Connection (formerly Graduate School Information Forum) provides an excellent opportunity for students to meet face to face with representatives from top U.S. geoscience schools. Last year, 68 schools participated in the four-day event, saving students time and travel expenses and giving the schools a chance to meet with some of the best student geoscientists in the world in a relaxed, informal setting.

The new Campus Connection will be located in the Exhibit Hall. The Poster Sessions will be on one side and just prior to entering the educational area, there will be another new feature: The Quad—a lounge especially designed for GSA's student participants. As on most campuses, The Quad will be a gathering point for networking opportunities.

If your school would like to participate in the Campus Connection, sign up soon! Go to <http://community.geosociety.org/2013AnnualMeeting/Expo/CampusCxn> to learn more.

1907
thru
1922

GSA Headquarters at American Museum of Natural History, New York

1909

First Honorary Fellow chosen

Scientific **FIELD TRIPS**

Field-Trip Co-Chairs: Lon Abbott, lon.abbott@colorado.edu; Greg Hancock, gshanc@wm.edu.

GSA Contact: Beth Engle, bengle@geosociety.org.

Please contact trip leaders directly if you have questions about trip details; leader contact information and expanded trip descriptions are listed on the meeting website. All trips begin and end at the Colorado Convention Center in Denver unless otherwise indicated.

401. **The Yellowstone Hotspot Track: Volcanic, Tectonic, Hydrothermal, and Glacial Processes above Caldera-Related Magma Chambers.** Tues.–Sat., 22–26 Oct. US\$475. **Leaders:** Lisa A. Morgan, USGS; Kenneth L. Pierce, Jake Lowenstern, W.C. Pat Shanks. **CANCELED**
402. **Early Mesozoic Sandstones in Utah's Canyon Country: Signatures of Subsurface Microbes, Reducing Fluids, and Jurassic Earthquakes.** Wed.–Sat., 23–26 Oct. US\$445. Trip starts in Grand Junction, Colorado, and makes a counter-clockwise circuit that ends in Denver via Green River, Kanab, Monument Valley, Moab, and Grand Junction. **Leaders:** David B. Loope, University of Nebraska–Lincoln; Richard M. Kettler, Peter S. Mozley, Derek T. Burgess.
403. **Making the Case for the Picuris Orogeny: Evidence for a 1.5 to 1.4 Ga Orogenic Event in the Southwestern United States.** Wed.–Sat., 23–26 Oct. US\$436. **Leaders:** Christopher G. Daniel, Bucknell University; James V. Jones, Christopher L. Andronicos.
404. **The Laramie Anorthosite Complex and Its Contact Relationships.** Wed.–Sat., 23–26 Oct. US\$373. **Leaders:** Robert L. Bauer, University of Missouri; James S. Scoates, B. Ronald Frost.
405. **Colorado Geology Then and Now, 1901 to 2013: Following the Route of the Societies' 1901 Trip through Central Colorado—Evolution of Geological Thought and Discovery.** Thurs.–Sat., 24–26 Oct. US\$340. **Leader:** Elizabeth Simmons, Colorado Scientific Society and Metropolitan State College of Denver.
406. **Origin and Evolution of the Upper Colorado River System: Evaluating the Competing Roles of Neogene Tectonism and Drainage Integration.** Thurs.–Sat., 24–26 Oct. US\$343. **Leaders:** Andres Aslan, Colorado Mesa University; Karl E. Karlstrom, Eric Kirby.
407. **Sevier Fold-Thrust Belt to Laramide Foreland Transect: Exploring the Evolution of a Complex Orogenic System.** Thurs.–Sat., 24–26 Oct. US\$368. This trip begins in Salt Lake City, Utah, and ends in Denver, Colorado. **Leaders:** Adolph Yonkee, Weber State University; Arlo Brandon Weil, Gautam Mitra.
408. **There's More to This Than Meets the Eye: Human-Induced Changes in Hydrology, Geomorphology, and Biogeochemistry in High-Elevation Watersheds of the Southern Rockies.** Fri., 25 Oct. US\$105. **Leaders:** Ellen Wohl, Colorado State University; Jill S. Baron, Nicholas A. Sutfin.
409. **Laramide Basin CSI: Comprehensive Stratigraphic Investigations of Paleogene Sediments in the Colorado Headwaters Basin, North-Central Colorado.** Fri.–Sat., 25–26 Oct. US\$212. **Leaders:** James C. Cole, USGS; Marieke Dechesne, James H. Trexler, Patricia H. Cashman.
410. **Coal Geology and Mining History of the Raton Mesa Coal Region.** Fri.–Sat., 25–26 Oct. US\$220. **Leaders:** Chris Carroll, Wyoming State Geological Survey; Gretchen Hoffman.
411. **Geological Photography: Capturing and Processing Geologic Images with Digital Camera and Gigapan.** Fri.–Sat., 25–26 Oct. US\$162. **Leaders:** Ellen M. Bishop, Whitman College; Marli Bryant Miller, Stephen G. Weaver, Mike Franz.
412. **Gully Erosion along the West Bijou Escarpment, Colorado High Plains.** Sat., 26 Oct. US\$87. **Leaders:** Greg Tucker, University of Colorado; Francis K. Rengers.
413. **Geology along the Rocky Mountain Front Range, Morrison to Golden, Including Structure, Stratigraphy, Paleontology, Volcanology, and Economic Geology (Pre-Meeting).** Sat., 26 Oct. US\$107. **Leaders:** Timothy B. Connors, National Park Service; Norb Cygan.
414. **Rocky Mountain Unsaturated Zones—Exploring Fire-Earth-Sky Connections.** Sat., 26 Oct. US\$68. **Leaders:** David A. Stonestrom, USGS; Brian Ebel, Bruce D. Honeyman, Dean E. Anderson, Suzanne Prestrud Anderson, Geoffrey N. Delin.
415. **Discovering Treasures for Educators: Behind the Scenes in Earth Sciences at the Denver Museum of Nature & Science.** Sat., 26 Oct. US\$64. **Leaders:** Samantha Richards, Denver Museum of Nature and Science; Carol Lucking, Ian Miller.
416. **Lessons Learned from the 1982 Lawn Lake Dam Failure Flood and the 1976 Big Thompson Canyon Flood, Colorado.** Sat., 26 Oct. US\$95. **Leaders:** Robert D. Jarrett, WRD, National Research Program; Wayne Graham.
417. **The Role of Bioturbation in Producing the Mima-Type, Mima-Like, and Various Related Mounds and Heaps in the Greater Denver-Boulder Area, Colorado.** Sat., 26 Oct. US\$91. **Leaders:** Donald L. Johnson, University of Illinois; Randall J. Schaetzl.
418. **Ancient Denvers: A Journey through the Front Range's Geologic History.** Sun., 27 Oct. US\$88. **Leader:** Lon D. Abbott, University of Colorado.



419. **A Survey of the Depositional Environments, Paleoflora, and Paleofauna of the Western Interior Seaway Greenhorn Cyclothem in the Comanche National Grassland, Southeastern Colorado.** Mon., 28 Oct. US\$108. **Leader:** Steven Miller, Western Interior Paleontological Society.

420. **Tour of the U.S. Bureau of Reclamation Laboratories, Denver Federal Center.** Mon., 28 Oct. US\$57. **Leader:** Audrey Hughes Rager, U.S. Bureau of Reclamation.

421. **Kirk Bryan Field Trip: Critical Zone Evolution: Climate and Exhumation.** Wed., 30 Oct. US\$85. **Leaders:** Suzanne P. Anderson, University of Colorado–Boulder; David P. Dethier, Gregory E. Tucker, Robert S. Anderson.

422. **Seismogenic Fault-Zone Processes and Heterogeneity Recorded by Pseudotachylite: New Insights from the Homestake Shear Zone, Colorado.** Thurs., 31 Oct. US\$96. **Leaders:** Joseph L. Allen, Concord University; Colin A. Shaw.

423. **Geology along the Rocky Mountain Front Range, Morrison to Golden Including Structure, Stratigraphy, Paleontology, Volcanic and Economic Geology** (Post-Meeting). Thurs., 31 Oct. US\$107. **Leaders:** Timothy B. Connors, National Park Service; Norb Cygan.

424. **Proterozoic Metamorphism and Deformation in the Northern Colorado Front Range.** Thurs., 31 Oct. US\$102. **Leaders:** Kevin H. Mahan, University of Colorado at Boulder; Graham Baird, Nigel Kelly, Julien Allaz.

425. **History of Paleontology at the Florissant Fossil Beds National Monument.** Thurs., 31 Oct. US\$105. **Leaders:** Herbert W. Meyer, National Park Service; Bret L. Buskirk.

426. **Strata, Structures, and Enduring Enigmas—A 125th Anniversary Overview of Colorado Springs Geology.** Thurs.–Fri., 31 Oct.–1 Nov. US\$187. **Leaders:** Christine S. Siddoway, Colorado College; Paul Myrow, Elisa Fitz-Díaz.

427. **New Views on Late Paleozoic Climate and Tectonics in the Ancestral Rocky Mountains.** Thurs.–Sat., 31 Oct.–2 Nov. US\$351. **Leaders:** G.S. (Lynn) Soreghan, Univ. of Oklahoma; D.E. (Dustin) Sweet.

Associated Society **FIELD TRIP**



Society of Economic Geologists (SEG)

Colorado Porphyry-Molybdenum Deposits and Leadville District. Thurs.–Sat., 24–26 Oct. **Leaders:** Ralph Stegen, Freeport-McMoRan; Tommy Thompson, University of Nevada. **Registration** opens 1 August via the SEG website, www.segweb.org/events.

FEES (in U.S. dollars)

	Early Reg. (1 Aug.–15 Sept.)	Late Reg (After 15 Sept.)
Members	\$795	\$895
Non-Members	\$895	\$995
Member Students	\$395	\$445
Non-Member Students	\$445	\$495

Note: GSA will not be handling registration for this field trip, but you can read the trip description and leader bios on the GSA meeting website.

1922
thru
1932

GSA Headquarters at Columbia University, New York

Short COURSES

Can I take a short course if I am not registered for the meeting? **YES!**

You're welcome to—just add the meeting nonregistrant fee (US\$40 by 23 Sept.) to your course enrollment cost. Should you then decide to attend the meeting, your payment will be applied toward meeting registration.

GSA K–12 teacher members: You are welcome to take short courses without registering for the meeting or paying the nonregistrant fee.

Continuing Education Units (CEUs):

Most professional development courses and workshops offer CEUs. One CEU comprises 10 hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction. Check the meeting website or contact Jennifer Nocerino, jnocerino@geosociety.org, for course abstracts and additional information.

Early registration deadline: 23 Sept.

Registration after 23 Sept. costs an additional US\$30

Cancellation deadline: 30 Sept.

The following short courses are open to everyone. Early registration is highly recommended to ensure that courses will run.

501. Introduction to Terrestrial Laser Scanning (Ground-Based LiDAR) for Earth Science Research. Fri., 25 Oct., 8 a.m.–5 p.m. US\$54; includes lunch. Limit: 20. CEU: 0.8. *Limited financial support is available for students; learn more online.*
Instructors: Christopher Crosby, UNAVCO; Marianne Okal, UNAVCO; David Phillips, UNAVCO; Carlos Aiken, The University of Texas at Dallas.

502. Sequence Stratigraphy for Graduate Students. Fri.–Sat., 25–26 Oct., 8 a.m.–5 p.m. US\$25. Limit: 55. CEU: 1.6. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.*
Instructors: Art Donovan, BP; Morgan Sullivan, Chevron; Bret Dixon, Anadarko; Bob Stewart; ExxonMobil.

503. Field Safety Leadership. Fri.–Sat., 25–26 Oct., 8 a.m.–5 p.m. US\$25; includes continental breakfast and lunch. Limit: 24. CEU: 1.6. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.*
Instructor: David Story, ExxonMobil Upstream Research Company.

504. Introduction to Petroleum Structural Geology. Fri.–Sat., 25–26 Oct., 8 a.m.–5 p.m. US\$25; includes continental breakfast and lunch. Limit: 30. CEU: 1.6. *Upon completion of the course, participants will receive a US\$25 coupon redeemable*

Two-Year College Faculty: Thanks to Subaru of America Inc., 45 two-year college professors (at least half-time) who attend any one short course will be reimbursed US\$100! For more information, please contact Davida Buehler at dbuehler@geosociety.org.



at the onsite GSA bookstore. **Instructors:** Peter Hennings, ConocoPhillips; J. Steve Davis, ExxonMobil Upstream Research Company.

505. Structural and Stratigraphic Concepts Applied to Basin Exploration. Fri.–Sat., 25–26 Oct., 8 a.m.–5 p.m. US\$25; includes continental breakfast and lunch. Limit: 30. CEU: 1.6. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.*
Instructors: Lori Summa, ExxonMobil Upstream Research Company; Bob Stewart, ExxonMobil Exploration Company.

506. Volcanic Crisis Awareness. Fri., 25 Oct., 8 a.m.–5 p.m., and Sat., 26 Oct., 8 a.m.–noon. US\$25. Limit: 30. CEU: 1.2. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.*
Instructors: Bruce Houghton, University of Hawaii; Kristine Kosinski, University of Hawaii.

507. Effective Strategies for Teaching Diverse College Students. Fri.–Sat., 25–26 Oct., 9 a.m.–5 p.m. US\$25. Limit: 40. CEU: 1.4. **Instructors:** Tim Slater, University of Wyoming; Stephanie Slater, CAPER Center for Astrophysics and Physics Education Research.

508. Helping Students Succeed in Geoscience Courses at Two-Year Colleges. Sat., 26 Oct., 8 a.m.–4 p.m. US\$25; includes lunch. Limit: 48. CEU: 0.8. **Instructors:** Eric Baer, Highline Community College; Robert Blodgett, Austin Community College District.

509. Near-Surface Geophysics for Non-Geophysicists. Sat., 26 Oct., 8 a.m.–5 p.m. US\$110; includes course materials. Limit: 40. CEU: 0.8. **Instructor:** Gregory Baker, University of Tennessee.

510. Three-Dimensional Geologic Mapping. Sat., 26 Oct., 8 a.m.–5 p.m. US\$75; includes lunch. Limit: 65. CEU: 0.8. **Instructors:** Richard Berg, Illinois State Geological Survey; Harvey Thorleifson, Minnesota Geological Survey; Hazen Russell, Geological Survey of Canada.

511. Introduction to the Theory and Methods of (U-Th)/He Thermochronology. Sat., 26 Oct., 8 a.m.–5 p.m. US\$75; includes lunch. Limit: 30. CEU: 0.8. **Instructors:** Rebecca

Flowers, University of Colorado—Boulder; James Metcalf, University of Colorado—Boulder.

512. **Using Laser Ablation Split Stream (LASS) Geochronology and Petrochronology to Address Tectonic and Petrologic Questions.** Sat., 26 Oct., 8 a.m.–5 p.m. US\$25; includes lunch. Limit: 25. CEU: 0.8. **Instructors:** John Cottle, University of California at Santa Barbara; Andrew Kylander-Clark, University of California at Santa Barbara; Bradley Hacker, University of California at Santa Barbara.
513. **Laser Ablation ICP-MS: An Overview of the Technique and a Look at New Advances in Quantitative Microanalyses for Geological, Biological, and Environmental Applications.** Sat., 26 Oct., 8 a.m.–5 p.m. US\$140, includes continental breakfast and lunch. Limit: 40. CEU: 0.8. **Instructors:** Alan Koenig, U.S. Geological Survey; Ian Ridley, U.S. Geological Survey.
514. **Modern Digital Geologic Mapping Techniques.** Sat., 26 Oct., 8 a.m.–5 p.m. US\$102; includes lunch. Limit: 25. CEU: 0.8. **Instructors:** Terry Pavlis, The University of Texas at El Paso; Steven Whitmeyer, James Madison University; Jose Hurtado, The University of Texas at El Paso; Richard Langford, The University of Texas at El Paso.
515. **Fundamentals of Mudrock Chemostratigraphy: Handheld XRF Analysis, Calibration, and Interpretation.** Sat., 26 Oct., 8 a.m.–5 p.m. US\$20. Limit: 84. CEU: 0.8. **Instructors:** Harry Rowe, Bureau of Economic Geology at The University of Texas at Austin; Alexander Seyfarth, Bruker Elemental; Bruce Kaiser, Bruker Elemental.
516. **Introducing ImageRover: Free Software for the 3-D Visualization and Analysis of Mars Field Data Using MER Images.** Sat., 26 Oct., 8 a.m.–noon. US\$25. Limit: 50. CEU: 0.4. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.* **Instructors:** Martha-Cary Eppes, University of North Carolina—Charlotte; Andrew Willis, University of North Carolina—Charlotte.
517. **Optical Properties of Minerals in Thin Section: Quantitative Methods in Birefringence.** Sat., 26 Oct., 8 a.m.–noon. US\$40. Limit: 30. CEU: 0.4. **Instructor:** James Nicholls, University of Calgary.
518. **Modernizing the Seismology in Your 100- and 200-Level Geoscience Courses.** Sat., 26 Oct., 8 a.m.–noon. US\$25. Limit: 25. CEU: 0.4. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.* **Instructors:** Maggie Benoit, The College of New Jersey; Michael Hubenthal, IRIS Consortium; John Taber, IRIS Consortium.
- 519A. **Teaching Geoscientific Thinking: What Does It Mean and How Do I Do It?** Sat., 26 Oct., 8 a.m.–noon. US\$55 for one course—or get two-for-one!—US\$55 for combined courses (add 519C or 519D). Limit: 40. CEU: 0.4. **Instructor:** Anne Egger, Central Washington University.
- 519B. **Teaching and Learning about Climate in Geoscience Classrooms.** Sat., 26 Oct., 8 a.m.–noon. US\$55 for one course—or get two-for-one!—US\$55 for combined courses (add 519C or 519D). Limit: 40. CEU: 0.4. **Instructors:** Tamara Ledley, TERC; Anne Gold, University of Colorado; Deb Morrison, University of Colorado.
- 519C. **Integrating Sustainability into Geoscience Courses.** Sat., 26 Oct., 1–5 p.m. US\$55 for one course—or get two-for-one!—US\$55 for combined courses (add 519A or 519B). Limit: 40. CEU: 0.4. **Instructor:** David Gosselin, University of Nebraska—Lincoln.
- 519D. **Teaching Energy: Important, But Unfamiliar, Concepts, Emerging Themes & Grand Challenges.** Sat., 26 Oct., 1–5 p.m. US\$55 for one course—or get two-for-one!—US\$55 for combined courses (add 519A or 519B). Limit: 40. CEU: 0.4. **Instructors:** James Meyers, University of Wyoming; Mark Lyford, University of Wyoming.
- 520A. **Teaching Controversial Issues 1: Climate and Energy.** Sat., 26 Oct., 8 a.m.–noon. US\$20 for one course—or get two-for-one!—US\$20 for combined courses (add 520C or 520D). Limit: 35. CEU: 0.4. **Instructors:** Don Duggan-Haas, Paleontological Research Institution and its Museum of the Earth; Richard Kissel, Yale Peabody Museum of Natural History; Laura Guertin, Pennsylvania State—Brandywine; Tanya Furman, Pennsylvania State.
- 520B. **Yellowstone National Park as a Hotbed for Inquiry—For Teachers.** Sat., 26 Oct., 8 a.m.–noon. US\$20 for one course—or get two-for-one!—US\$20 for combined courses (add 520C or 520D) Limit: 30. CEU: 0.4. **Instructors:** Nancy West, Quarter Dome Consulting; Shelley Olds, UNAVCO.
- 520C. **Teaching Controversial Issues 2: Evolution of Life and Earth.** Sat., 26 Oct., 1–5 p.m. US\$20 for one course—or get two-for-one!—US\$20 for combined courses (add 520A or 520B). Limit: 35. CEU: 0.4. **Instructors:** Don Duggan-Haas, Paleontological Research Institution and its Museum of the Earth; Richard Kissel, Yale Peabody Museum of Natural History; Laura Guertin, Pennsylvania State—Brandywine; Tanya Furman, Pennsylvania State University.

1925

Membership: 508

Short COURSES *(continued)*

- 520D. **Introduction to Critical Zone Science and Observatories.** Sat., 26 Oct., 1–5 p.m. US\$20 for one course—or get two-for-one!—US\$20 for combined courses (add 520A or 520B). Limit: 20. CEU: 0.8. *Participants must bring their own laptop computers.* **Instructor:** Timothy White, Pennsylvania State University.
521. **U-Pb Geochronology and Hf Isotope Geochemistry Applied to Detrital Minerals.** Sat., 26 Oct., 9 a.m.–5 p.m. US\$45, includes lunch. Limit: 40. CEU: 0.7. **Instructor:** George Gehrels, University of Arizona.
522. **New Tools for Teaching Earth History: Global Geology .com, Ancient Earth App, and The PALEOMAP PaleoAtlas for ArcGIS.** Sat., 26 Oct., 9 a.m.–5 p.m. US\$75, includes lunch. Limit: 30. CEU: 0.7. *Participants are required to bring their own laptops or tablet computers. Complimentary Wi-Fi will be provided.* **Instructors:** Christopher Scotese, PALEOMAP Project; Thomas Moore, PaleoTerra.
523. **Mars for Earthlings: Introductory Earth-Mars Teaching Resources for Higher Education.** Sat., 26 Oct., 1–5 p.m. US\$25. Limit: 30. CEU: 0.4. *Upon completion of the course, participants will receive a US\$25 coupon redeemable at the onsite GSA bookstore.* **Instructors:** Marjorie Chan, University of Utah; Julia Kahmann Robinson, University of Utah.
524. **Getting Started in Undergraduate Research for New, Future, and Current Faculty.** Sat., 26 Oct., 1–5 p.m. US\$35. Limit: 20. CEU: 0.4. **Instructor:** Lydia Fox, University of the Pacific.
525. **Communicating Science: Tools for Scientists.** Sat., 26 Oct., 1–5 p.m. US\$25. Limit: 30. CEU: 0.4. *Upon completion of the course, students will receive a US\$10 coupon redeemable at the onsite GSA bookstore.* **Instructors:** Tiffany Lohwater, American Association for the Advancement of Science; Christa Stratton, Geological Society of America; Kasey White, Geological Society of America.
526. **Integrating GPS, LiDAR, InSAR, and Other Geodesy Data into Undergraduate Courses.** Sat., 26 Oct., 1–5 p.m. US\$20. Limit: 30. CEU: 0.4. **Instructors:** Beth Pratt-Sitaula, UNAVCO; Vince Cronin, Baylor University; Gareth Funning, University of California at Riverside.
527. **High Relief Clinoforms in the Colville Foreland Basin, Arctic Alaska.** Thurs., 31 Oct., 8:30 a.m.–4:30 p.m. US\$80. Limit: 30. CEU: 0.7. **Instructor:** David Houseknecht, U.S. Geological Survey.

Associated Society **SHORT COURSES**

Society of Economic Geologists (SEG)

Modeling Structural Evolution to Improve Geological Models for Exploration and Mine Development. Thurs.–Fri., 24–25 Oct., 8 a.m.–5 p.m. Limit: 40. **Instructors:** Jennifer Ellis, Midland Valley; Gareth Johnson, Midland Valley. Register at www.segweb.org/events.

FEES (in U.S. dollars)

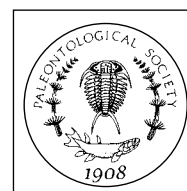
	Early Reg. (Through 30 Sept.)	Late Reg (After 30 Sept.)
Members	\$895	\$995
Non-Members	\$995	\$1,095
SEG Member Students	\$495	\$545
Non-Member Students	\$545	\$595



Note: GSA will not be handling registration for these courses. Please use the contact information provided online to learn more and to register.

Paleontological Society

Ecosystem Paleobiology and Geobiology. Sat., 26 Oct., 9 a.m.–5 p.m. FREE, with no registration needed and no course attendance limit. **Instructors:** Andrew Bush, University of Connecticut; Sara Pruss, Smith College; Jonathan Payne, Stanford University. Learn more at www.paleosoc.org.



Getting to **DENVER**



Denver skyline at dusk. Photo by Bob Ashe. Denver Metro Convention & Visitors Bureau.



BY PLANE Denver International Airport (DIA) is the 5th busiest airport in the United States, serviced by 14 airlines, with nonstop flights to/from more than 160 U.S. cities and 19 international cities. DIA is located 23 miles northeast of downtown Denver. Ground transportation options between the airport and downtown include RTD SkyRide Public Bus, Commercial Shuttle/SuperShuttle, and taxi service. Costs range from \$11 to \$55 one-way. Additional information is available at www.flydenver.com.

BY CAR Colorado is bordered by seven other states and is roughly 340 miles from the center of the contiguous United States. With 25 Scenic and Historic Byways, it's hard not to find an enjoyable road to travel in Colorado (for example, "The Million-Dollar Highway": www.roadtripamerica.com/places/million.htm). Wander off the major north-south (I-25) and east-west (I-70) thoroughfares to see the real Colorado and geologic points of interest along the way.

BY BUS Greyhound provides service to and from Denver. The downtown Greyhound station is located at Arapahoe and 19th Street, about eight blocks from the Colorado Convention Center and three blocks from the free 16th Street Shuttle. For more information, go to www.greyhound.com.

BY TRAIN Experience one of the most beautiful train trips in all of North America—the California Zephyr! The Zephyr runs daily between Chicago and San Francisco with a stop in Denver. The train station is located in downtown Denver at the intersection of 21st and Wewatta Streets. Learn more at www.amtrak.com and www.denverunionstation.org. The California Zephyr also has an onboard *Trails & Rails* program operating between Denver and Grand Junction, Colorado.

The 15th step on the west side of the Colorado State Capitol is exactly 5,280 feet above sea level – one mile high. The carving in the steps is actually the wrong spot. The correct mile high spot is two steps higher and indicated by a brass marker. Photo by David Falconer. Denver Metro Convention & Visitors Bureau.

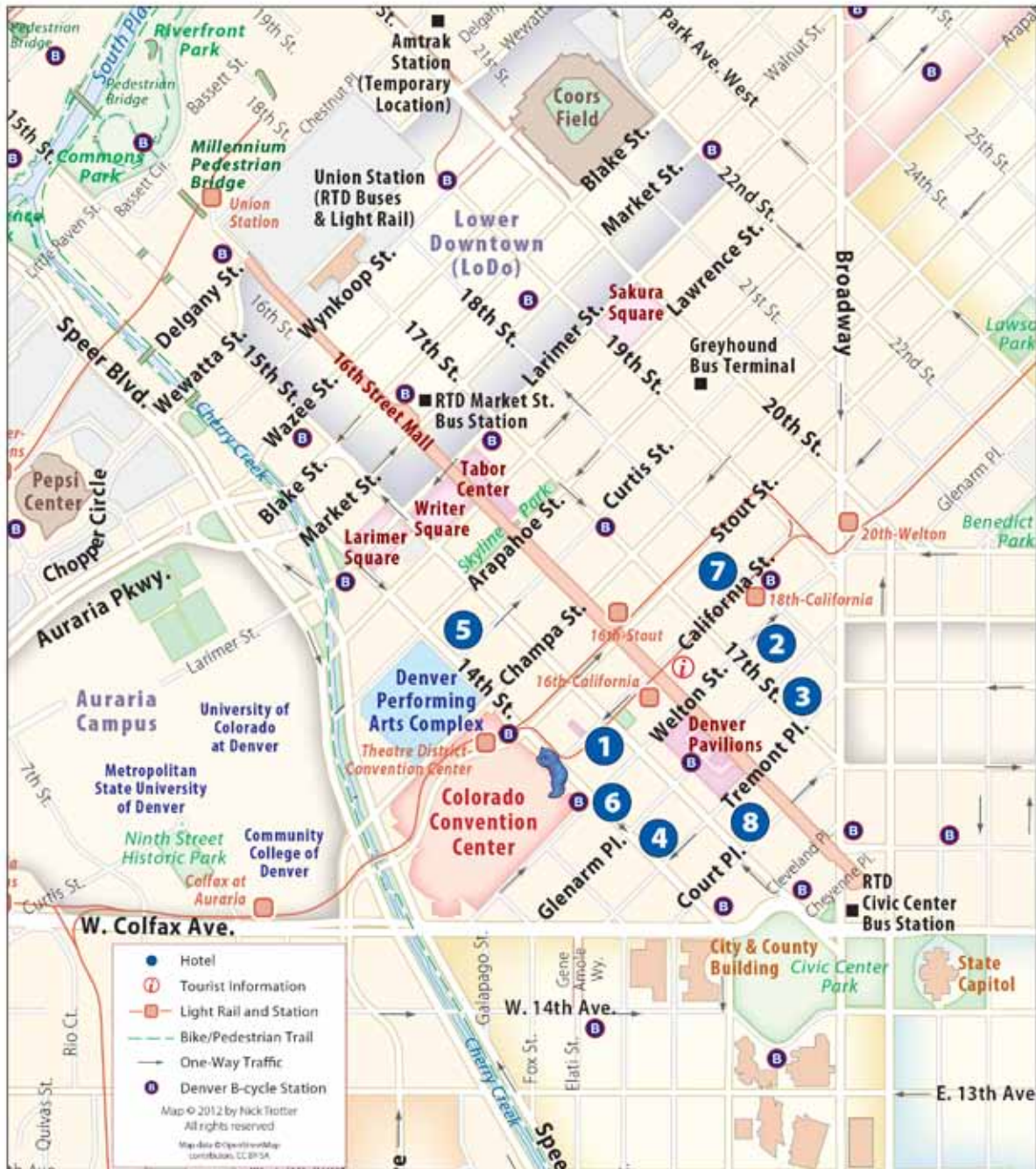


1925

Penrose Medal established by Richard Alexander Fullerton (R.A.F.) Penrose, Jr.
First Penrose Medal given to Thomas Chrowder Chamberlin

MAP of Downtown DENVER

- | | |
|--|---------------|
| 1 Hyatt Regency at CCC (HQ) | \$206 sgl/dbl |
| 2 Grand Hyatt Denver (Co-HQ) | \$179 sgl/dbl |
| 3 Comfort Inn Downtown | \$139 sgl/dbl |
| 4 Crowne Plaza Denver | \$149 sgl/dbl |
| 5 The Curtis, a Doubletree Hotel by Hilton | \$157 sgl/dbl |
| 6 Hilton Garden Inn Downtown Denver | \$169 sgl/dbl |
| 7 Denver Marriott City Center | \$179 sgl/dbl |
| 8 Sheraton Denver Downtown Hotel | \$179 sgl/dbl |



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Penrose Conference Announcement



THE
GEOLOGICAL
SOCIETY
OF AMERICA

Predicting and Detecting Natural and Induced Flow Paths for Geothermal Fluids in Deep Sedimentary Basins

19–23 October 2013 • Park City, Utah, USA

COSPONSORS:

National Research Council



CONVENERS:

John Holbrook, *Texas Christian University, Fort Worth, Texas 76129, USA, john.holbrook@tcu.edu*

Rick Allis, *Utah Geological Survey, Salt Lake City, Utah 84114-6100, USA, rickallis@utah.gov*

Derek Elsworth, *Penn State University, University Park, Pennsylvania 16802-5000, USA, elsworth@psu.edu*

Sidney Green, *Schlumberger-TerraTek, Salt Lake City, Utah 85416, USA, sgreen5@slb.com*

Joseph N. Moore, *Energy & Geoscience Institute, University of Utah, Utah 84108, USA, jmoore@egi.utah.edu*

OBJECTIVE

Deep, high heat-flow sedimentary basins potentially have geologic formations with sufficient natural permeability to provide reservoirs suitable for geothermal power generation. New technologies of permeability enhancement that have transformed the oil and gas exploration industry in recent years also have the potential to transform the geothermal power industry. The goal of this proposed Penrose Conference is to gather together experts in both the Earth and engineering sciences, and from academia, government, and industry, to focus on particular basic science challenges for developing deep, hot stratigraphic reservoirs for geothermal power. Namely, what controls long fluid pathways in sedimentary basins and how can these be predicted and/or enhanced?

PRELIMINARY AGENDA

Saturday, 19 Oct.

- 8 a.m.–2 p.m.: Optional: “Basics of Geothermal Energy” short-course;
- 3–5 p.m.: Hot stratigraphic reservoirs: geological and engineering constraints and challenges; and
- 7–9 p.m.: Ice-breaker.

Sunday, 20 Oct.

- Role of basin architecture and tectonic evolution on influencing fluid flow characteristics in deep stratigraphic reservoirs;
- Role of in-situ permeability and hydraulically induced fractures in controlling fluid flow into wells—evidence from core scale to hydraulically induced fractures;
- Oil industry experience with water flooding and enhanced oil recovery—how is a water flood different or similar to the effective heat sweep sought in a geothermal reservoir and what are the new challenges?;
- Diagenesis and its controls on natural reservoir permeability.

Monday, 21 Oct.

- The role of fluid/rock interactions in modifying natural reservoir permeability between injection and production wells on a decadal timescale;
- How uniform are stratigraphic reservoirs? Applications of modern seismic reflection technologies to mapping high permeability pathways and over pressured regions in deep basins;
- Half-day field trip looking at reservoirs exposed in outcrop and core (UGS core lab) and the Schlumberger-TerraTek rock mechanics facility.

Tuesday, 22 Oct.

- Simulating fluid flow and heat sweep efficiency between injection and production wells in a hydraulic fracture-stimulated, stratigraphic reservoir;

- Does induced seismicity limit development to remote locations?;
- Is groundwater quality perceived to be threatened? A discussion about public perception issues of geothermal development of deep stratigraphic reservoirs;
- Can petroleum systems modeling help with identifying geothermal reservoirs in hot basins?;
- Consensus, challenges, and next steps.

Wednesday, 23 Oct.

- Optional: All-day field trip to geothermal power plants, recent volcanism, and hot basins in central Utah—returning to the Newpark Hotel at 6 p.m.

ESTIMATED COSTS

The registration fee is estimated at US\$300–\$500, and covers meals from 19 Oct. (afternoon) through 23 Oct. (morning). Lunch is included for participants of the geothermal short course and the full-day field trip, and costs of the short course and field trips are also included. **Not covered** is travel to and from Park City and accommodation costs at the Newpark Hotel. Hotel rooms have been reserved at US\$105 for a deluxe room and US\$139 for a suite. Information on making a hotel reservation and room sharing will be sent out with the acceptance notices. Please **DO NOT** reserve a room until your participation is confirmed by the

conveners. There is a shuttle service available from Salt Lake City airport to the hotel (cost **not included** in registration; check www.slairport.com/limos.asp and related links for more information; reservations recommended).

ATTENDEES

The conference will be limited to 80 participants, and participants must commit to attending all technical sessions (3 p.m. Sat. to 4:30 p.m. Tues.). Participants are also encouraged to attend the geothermal short course earlier on Saturday and the all-day field trip on Wednesday. Interested graduate students are encouraged to apply, and some financial assistance is available.

APPLICATIONS AND REGISTRATION

Application deadline: 19 July

Registration deadline: 23 August

To Apply: Please contact the conveners through john.holbrook@tcu.edu with a letter that includes a brief statement of interests, the relevance of the applicant's recent work to the themes of the conference, the subject of a proposed presentation, and contact information. Also include whether you will be attending the geothermal short course and/or the full-day field trip. Once you have been selected to participate, you will be sent registration information. Please check the conference website for any updates: www.sedheat.org.



Northern Black Rock Desert, Utah, USA, a basin where temperatures of less than 200 °C were found in Paleozoic carbonates at 3 km depth during oil exploration drilling in 1981.

MANAGING U.S. COASTAL HAZARDS

GSA members are invited to submit comments and suggestions regarding the following Position Statement DRAFT by 15 July 2013. Go to www.geosociety.org/positions/ to learn more and submit comments.

POSITION STATEMENT

Storms, tsunamis, and rising sea levels threaten U.S. coastal communities and their economies. Much of the nation's existing coastal infrastructure must be adapted to expected future conditions or relocated, and new coastal development and post-storm reconstruction should be planned, sited, and maintained with coastal geologic hazards clearly in mind.

Purpose

This position statement summarizes the main geologic hazards along the nation's coasts—Atlantic, Gulf, Pacific, and Arctic—and urges scientists and policy makers to collaborate toward integrating geoscience information into policy and management actions in order to reduce the nation's vulnerability to these hazards in the future.

Rationale

The United States is vulnerable to coastal hazards. In 2010, more than half of the U.S. population resided in coastal watershed counties (Crossett et al., 2004; NOAA, 2013a). The U.S. coastal zone supports 66 million jobs and contributes \$8.3 trillion to the U.S. economy, or 58 percent of the nation's economic output (NOAA, 2013a). The high population density of coastal regions and continued pressure for residential, commercial, and industrial growth persist despite a range of natural hazards and an increasing number of disasters. Hurricanes such as Katrina (2005), Ike (2008), and Sandy (2012) underscore the nation's vulnerability to shoreline hazards and the risks and costs of rebuilding in disaster-prone areas.

The type and severity of coastal geologic hazards—and the potential harm they can inflict on existing or future development—vary because of differences in geology, tectonic setting, topography, climate, and oceanographic conditions. The scientific community has made considerable progress in improving our understanding of these hazards and the risks they pose. Resource managers and decision makers in all sectors (government, business, and non-profit) must be willing and able to access and apply geoscience information in order to avoid catastrophic losses from the following hazards:

Coastal Storms

Some of the costliest natural disasters in U.S. history have resulted from tropical and extratropical storms that brought storm surges, large waves, heavy precipitation, and shoreline erosion. The nature of these storms varies, but development along all U.S. coastlines is

exposed to significant risks. Low-lying areas along the Gulf and Atlantic coasts are routinely battered by hurricanes and other tropical systems. Barrier islands are particularly vulnerable. The combination of storm surge and large waves can wash over islands, undermining structures built on the shoreline or dunes and destroying roads and bridges connecting the islands to the mainland.

- Nor'easters produce high winds, storm surges, and very large waves, which have flooded low-lying areas and overwashed and eroded the beaches and dunes of the Atlantic barrier islands (Hyndman and Hyndman, 2010).
- El Niño events on the Pacific Coast have elevated sea levels as much as 30 cm for weeks at a time. High tides and storm waves during these periods have flooded low-lying communities and extensively damaged coastal development and infrastructure on cliffs, bluffs, dunes, and beaches (National Research Council, 2012; Russell and Griggs, 2012).

The number of hurricane-related deaths has decreased over the past century due in large part to our improved ability to both predict landfall location and evacuate at-risk populations. Unfortunately, the cost of damages has dramatically increased, reflecting rapidly growing coastal populations, more construction in hazardous locations, and more expensive buildings. Nine of the twelve most costly hurricanes in U.S. history occurred between 2004 and 2012 (Wikipedia, 2013), including Katrina at >\$90 billion. Estimates for economic losses from Hurricane Sandy in 2012 are \$30 to \$50 billion (EQECAT Inc., 2012).

Tsunamis

The 2004 Indian Ocean disaster spurred worldwide progress toward reducing loss of life from future tsunamis. Major advances include official early warnings for tsunamis generated by earthquakes in distant locations (Bernard et al., 2006). Such warning systems, formerly limited to the Pacific Ocean, now have the potential to help reduce loss of life on Atlantic and Caribbean shores as well. There remains, however, the greater hazard posed by tsunamis from nearby earthquakes. Near-field waves may arrive before official warnings can (Yulianto et al., 2010). Nearly all the loss of life from the 2011 Japanese tsunami occurred in the near-field. The tsunami first reached the shoreline within 25 minutes after the earthquake began (Yulianto et al., 2010). In some areas, maps that underestimated the tsunami hazard guided the evacuations, leading to greater losses (Wikipedia, 2013).

The coasts of the United States are subject to far-field and near-field tsunami hazards (Barth and Titus, 1984). The greatest near-field hazards are associated with subduction zones in Alaska, Cascadia, and the Caribbean. The subsidence that would accompany a repeat of the giant 1700 Cascadia earthquake would cause a relative sea-level rise of as much as 1.5 m along parts of coastal Washington, Oregon, and northern California. The National Tsunami Hazard Mitigation Program has taken steps to address these hazards with measures that include inundation modeling, evacuation signage, and public education, although the program continues to face challenges.

Climate Change and Sea-Level Changes

Global sea-level rise is perhaps the most obvious manifestation of climate change in the oceans. The rate of sea-level rise has increased globally from about 1.7 mm per year over most of the last century to about 3.1 over the past two decades (National Research Council, 2012), and this rate is projected to increase in the future. The 2012 National Research Council report projects an average global sea-level rise of about one meter by 2100. The long-term impacts of an increasing rate of sea-level rise along the U.S. coast are becoming increasingly clear (NOAA, 2013b).

Sea-level rise will affect coastal communities and infrastructure through more frequent flooding and gradual inundation, as well as increased cliff, bluff, dune, and beach erosion. Coastal aquifers and ecosystems supporting coastal fisheries will also be affected. Coastal transportation corridors, coastal power and wastewater treatment plants, transfer and discharge systems, ports and harbors, other municipal infrastructure, and private development, including homes and businesses, will be affected (Russell and Griggs, 2012; Burkett and Davidson, 2012).

Implications for Coastal Management

Losses from long-term, chronic events such as progressive sea-level rise and large storms, as well as larger-scale natural disasters, such as tsunamis, continue to increase over time, due to increasing development in coastal communities (Hyndman and Hyndman, 2010). Recognizing, delineating, mapping, identifying, and publicizing the risks that they pose can enable coastal management or land-use decisions that will reduce future losses for public infrastructure and private development, as well as government funds spent on repetitive losses (Burkett and Davidson, 2012). Political, institutional, and public recognition of the risks posed by coastal hazards is necessary for advancing a sustainable approach to coastal management. Storms such as Katrina, Ike, and Sandy emphasize the severity and reality of such hazards and present an opportunity to reassess and reduce the exposure of coastal communities to storm surges and inundation. The densely populated shorelines of New York and New Jersey and the low lying areas of the southeastern Atlantic and Gulf coastal plains are among the most vulnerable to sea-level rise and storm surge and will only become more vulnerable with time (NOAA, 2013a).

Recommendations

- Geoscientists have a professional responsibility to inform government, the private sector, and the public about coastal hazards and the risks they pose, thereby encouraging and supporting responsible and sustainable policies and actions.
- Coastal and shoreline property damaged in past events or at risk from future events should be delineated and the risks determined and documented. Local governments should develop relocation or adaptation plans for existing at-risk development and infrastructure, whether public or private. Future sea-level rise and the exposure to coastal hazards, as well as the cost and lifetime of any proposed facility, should be factored into decisions about construction or reconstruction.
- Government agencies are responsible for using the best information and recommendations that the geoscience community can provide in land-use decisions, including regulation of

coastal construction and reconstruction, in order to develop resilient coastal communities and infrastructure in high-risk coastal areas and to reduce losses from recurring natural events.

- The U.S. must develop a vision for the future that accepts the natural processes of a high-energy, rapidly evolving coastal system and that seeks to live with the dynamics of change. This is essential in order to maintain sustainable coastal economies and preserve the natural resources upon which these economies are critically dependent.

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GSA FOUNDATION UPDATE

P. Geoffrey Feiss, GSA Foundation President

June is a perfect time to thank donors to the GSA Foundation and to remind you of the impact your generosity has on advancing the careers of young scientists. With your support, hundreds of students have access to experiences that enhance their scientific skills and establish relationships that will shape their professional path in the geosciences. The following are just a few of the important outcomes and opportunities made possible through your gifts and sponsorships:

- The GSA-managed GeoCorps™ America program annually places more than 100 geoscientists in temporary positions with natural resource agencies;
- GSA awards more than 300 research grants to master's and doctoral candidates every year;
- GSA will launch a corporate-sponsored geoscience career track program at the 125th Anniversary Annual Meeting, connecting hundreds of students with industry representatives; and
- Travel grants help hundreds of students attend GSA meetings.

It is important to remember that these programs were once only ideas, initiated through a spirit of innovation and delivered through investment in programs at GSA. Your financial partnership is the catalyst for providing access to experiences essential for the professional growth of earth scientists at all levels of expertise and from all sectors: academia, government, business, and industry.

The GSA Diversity Committee, a group of committed member volunteers, has initiated the **On To the Future** program to engage more students from underrepresented groups in the geosciences. On To the Future will sponsor attendance for 125 geoscience students from underrepresented groups at the 125th Anniversary Meeting in Denver. These participants will benefit from the pivotal experience of participating in a professional meeting, helping them to visualize themselves as geoscientists and connecting with a community that will further their success in science.

The Foundation's vision is to sustain the On To the Future program over the next five years to bring 125 student attendees from underrepresented populations to each GSA Annual Meeting—a lasting tribute to GSA's 125th Anniversary, and one that will strengthen our profession for the *next* 125 years.

The GSA Foundation is excited to present On To the Future to our members and is committed to working with you to secure US\$50,000 and successfully launch On To the Future in 2013. We welcome your inquiries about how you can support this innovative effort to diversify and strengthen our profession and our Society.

<http://community.geosociety.org/OTF/Home/>

*Have a great summer and
thanks again for your support!*



Test your GSA knowledge!

- 1 Who was the first woman to hold elected office in GSA?
- 2 Who was the first woman to serve as GSA president?

ANNIVERSARY QUIZ

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

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

Call for Nominations

GSA DIVISION AWARDS

■ MINERALOGY, GEOCHEMISTRY, PETROLOGY, AND VOLCANOLOGY (MGPV) DIVISION DISTINGUISHED GEOLOGIC CAREER AWARD

Nominations due 15 July

This award honors an individual who has made distinguished contributions in one or more of the following fields of research: mineralogy, geochemistry, petrology, volcanology, with emphasis on multidisciplinary, field-based contributions. Geologic work is by nature generalistic and has an important field component, with Earth as the natural laboratory. Nominees need not be citizens or residents of the United States, and GSA membership is not required. The award will not be given posthumously.

Submit (1) a cover letter (no longer than 3 pages) from an MGPV Division member, summarizing the nominee's most important accomplishments in geologic approaches to mineralogy, geochemistry, petrology, and/or volcanology. Special attention should be paid to describing how the nominee's published work demonstrates field-based multidisciplinary geologic accomplishments of a ground-breaking nature. The letter should include the name, address, and contact information of the nominator as well as from whom letters of support can be expected; (2) curriculum vitae of the nominee; and (3) three letters of support either from members or non-members of GSA or the MGPV Division, to J. Alex Speer, Mineralogical Society of America, 3635 Concorde Pkwy, Suite 500, Chantilly, Virginia 20151-1110, USA; jaspeer@minsocam.org.

■ THE KERRY KELTS STUDENT RESEARCH AWARDS OF THE LIMNOGEOLOGY DIVISION

Award amount: US\$1,000

Deadline: 1 August

The Kerry Kelts Research Awards for undergraduate or graduate student research are named in honor of Kerry Kelts, a visionary limnogeologist and inspiring teacher. This year, one award is offered for research related to limnogeology, limnology, or paleolimnology. To apply, send a summary of the proposed research, its significance, and how the award will be used (five-page maximum) in PDF format along with a short (two-page maximum) CV to the chair of the Limnogeology Division, Amy E. Myrbo, amyrbo@umn.edu. Please include your name in all PDF file names that you send. Awards will be announced at the Limnogeology Division Business Meeting and Reception at the 2013 GSA Annual Meeting this October.

We hope to increase the number of these awards in the future; membership dues help with this important Division activity, but if you are interested in supporting this awards program more substantially, please send your donations, designated for the Kerry Kelts Research Awards of the Limnogeology Division, to GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, or visit www.gsa-web.org/makeadonation.html and select the Kerry Kelts Student Research Award.

GeoCorps™ America *Fall/Winter 2013–2014*



Kate Baustian, Congaree National Park.

GSA's GeoCorps America program provides paid, short-term geoscience opportunities on public lands managed by the National Park Service, the U.S. Forest Service, and the Bureau of Land Management. All levels of geologists—students, educators, professionals, retirees, and others—are encouraged to apply.

September 2013 through May 2014

Attention All Past/Current GeoCorps Participants!

Please consider attending this fall's GSA Annual Meeting, which will feature the third annual GeoCorps Alumni Reception, plus a GeoCorps topical session at which you are encouraged to present your GeoCorps work.

▶ **Application deadline: 1 July** ◀

www.geosociety.org/geocorps/



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Help Celebrate GSA's Role in Advancing the Geosciences through Your Gifts of Time and Talent

2014–2015 COMMITTEE VACANCIES

Deadline to apply or submit nominations: 15 July

GSA invites you to volunteer or nominate one of your fellow GSA members to serve on a Society committee or as a GSA representative to another organization. Learn more about each committee and access the nomination form at www.geosociety.org/aboutus/committees/. You can also download the form and send a hardcopy nomination to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1074; phone +1-303-357-1044 or +1-800-472-1988, ext. 1044; pfistell@geosociety.org. **Terms begin 1 July 2014** (unless otherwise indicated).

COMMITTEE, SECTION, AND DIVISION VOLUNTEERS:

Council Thanks You!

GSA Council acknowledges the many member-volunteers who, over the years, have contributed to the Society and to our science through involvement in the affairs of the GSA. Your time, talent, and expertise help build a solid and lasting Society.

COMMITTEE	No. of Vacancies	Length of Term
Academic and Applied Geoscience Relations (AM, T/E)	three	3 years
Annual Program (AM, B/E)	two	4 years
Arthur L. Day Medal Award (T/E)	two	3 years
Diversity in the Geosciences (AM, T/E)	four	3 years
Education (AM, B/E, T/E)	two	4 years
	one	2 years
eGSA (AM, T/E)	two	3 years
Geology and Public Policy (AM, B/E, T/E)	one	3 years
	one	2 years
Joint Technical Program (T/E)	two	2 years, starts 1 Dec. 2013
Membership (B/E)	three	3 years
Nominations (B/E, T/E)	one	3 years
Penrose Conferences and Field Forums (T/E)	one	3 years
Penrose Medal Award (T/E)	two	3 years
Professional Development (T/E)	two	3 years
Publications (AM, B/E, T/E)	three	4 years
Research Grants (B/E, C)	eleven	3 years
Young Scientist Award (Donath Medal) (T/E)	one	3 years
GSA REPRESENTATIVES TO OTHER ORGANIZATIONS		
GSA Representative to the AAAS Consortium of Affiliates for International Programs (CAIP) (B/E)	one	3 years, starts 1 Jan. 2014
GSA Conferee to the AAPG Publication Pipeline Committee (B/E)	one	3 years
GSA Representative to the AGI Environmental Geoscience Advisory Committee (EAGC) (AM, T/E)	one	3 years, starts 1 Jan. 2014
North American Commission on Stratigraphic Nomenclature (NACSN) (AM, possibly B/E)	one	3 years, starts 1 Nov. 2014

AM—Meets at the Annual Meeting • B/E—Meets in Boulder or elsewhere

C—Extensive time commitment required during application review period (15 Feb.–15 Apr. 2015) • T/E—Communicates by phone or electronically

GSA GeoVentures

Announcing 2014 GeoVentures and Field Camps!

Our 2013 trips filled so quickly that it's already time to start thinking about which 2014 GSA GeoVenture and/or K-12 Field Camp you will attend!

2014 LOCATIONS INCLUDE

Hawaii • Australia • Iceland
Rocky Mountain Field Camp • Illinois Basin Field Camp

*There's more to come—Stay tuned
for dates and prices.*

For information on GeoVentures, email Gary Lewis at glewis@geosociety.org. For information on Field Camps, e-mail Davida Buehler at dbuehler@geosociety.org.



Australia GeoVenture.

*Because the Best Geologists
Have Seen the Most Rocks!*

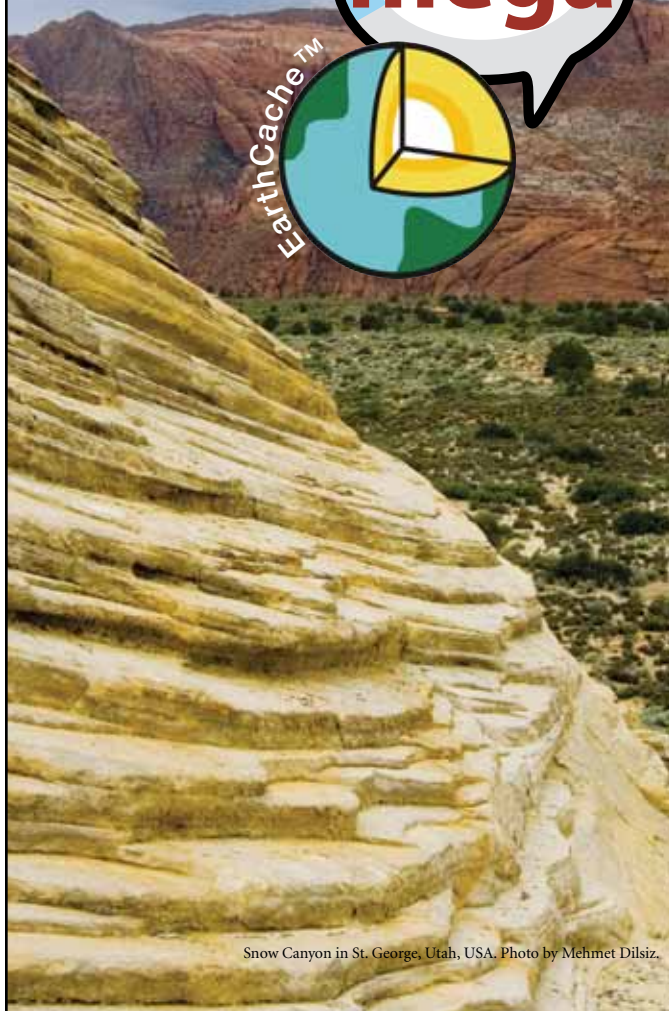
2nd International EarthCache™ Mega Event

St. George, Utah, USA
Sat., 7 Sept. 2013

EarthCaching gets people out in the field to learn about their planet first-hand. Participants in this annual event will learn all about EarthCaching, interact with EarthCachers from around the globe, meet EarthCache developers and reviewers, find local EarthCaches, and engage in many other exciting and educational activities.

For details, go to www.earthcache.org,
www.facebook.com/earthcache,
or contact Gary Lewis at glewis@geosociety.org.

Let *EARTH* be your teacher!



Snow Canyon in St. George, Utah, USA. Photo by Mehmet Dilsiz.



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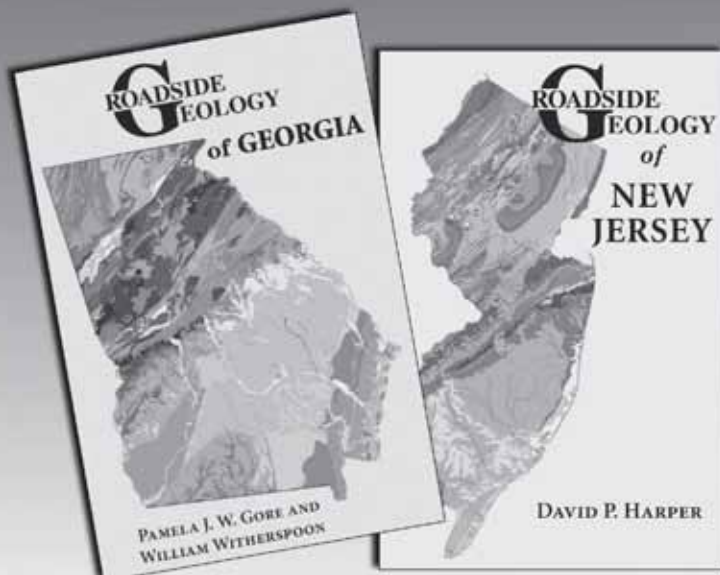
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Classified Rates—2013

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

Classification	Per Line for 1st month	Per line each add'l month (same ad)
Positions Open	\$9.00	\$8.75
Fellowship Opportunities	\$9.00	\$8.75
Opportunities for Students		
First 25 lines	\$0.00	\$4.75
Additional lines	\$4.75	\$4.75

Positions Open**VISITING ASSISTANT PROFESSOR, GEOLOGY
MISSOURI STATE UNIVERSITY**

Missouri State University, Springfield, Missouri, USA. The Dept. of Geography, Geology and Planning anticipates an opening for a 9-month, non-tenure-track **Visiting Assistant Professor of Geology** to begin in August 2013. Ph.D. or ABD in Geology or closely related field required at time of appointment. Teaching responsibilities will include upper-division undergraduate courses for geology majors in at least two of the following three areas: Mineralogy, Structural Geology, and Technical Report Writing in Geol-

ogy. Additional teaching responsibilities will include General Education courses in Principles of Geology and/or Environmental Geology.

Apply online at www.missouristate.edu/academicopenings. Attach a letter of application, curriculum vitae, and contact information for 3–5 professional references to the electronic employment application. The evaluation of applications will begin **6 May 2013** and will continue until a successful candidate is found. Further information about our department and programs can be obtained from our web site at geosciences.missouristate.edu, or call +1-417-836-5800. Women and minority candidates are encouraged to apply. Employment will require a criminal background check at University expense. EO/AA employer.

**PETROLOGIST/STRUCTURAL GEOLOGIST
VISITING ASSISTANT PROFESSOR
ST. LAWRENCE UNIVERSITY**

St. Lawrence University seeks a broadly trained petrologist/structural geologist to teach courses that are essential to our program. The successful candidate for this visiting assistant professor position must have a Ph.D. in petrology or a related field with a broad background in petrology and structural geology and related field experience. Teaching responsibilities will include the major core courses petrology and structural geology, an introductory course in environmental geology, and

one or more electives in the candidate's specialty. Our program in petrology is supported by a diverse rock collection, scanning electron microscopy with analytical capabilities and cathodoluminescence, an X-ray diffraction unit, and by four colleagues with interdisciplinary research interests.

Candidates interested in the position and who meet these basic requirements should forward: (1) a cover letter that addresses their qualifications for the position; (2) a statement describing their teaching philosophy; (3) a statement of research interests; (4) a complete curriculum vitae; and (5) letters from three professional referees who know the candidate well and understand the expectations of a competitive liberal arts college. Application materials should be directed to Ms. Sherrie Kelly (skelly@stlawu.edu), Petrology Search, Geology Department, St. Lawrence University, Canton, NY 13617, USA. Digital copies are appreciated. Review of applications will begin on 15 May 2013 and continue until the position is filled.

St. Lawrence University's Geology Department has a nationally recognized program which emphasizes broad training in geosciences preparing students for a variety of professional careers in geology and environmental science. An active Geology Club and chapter of the Earth Science Honor Society, *Sigma Gamma Epsilon*, encourage students to undertake professional activities at the local and national levels.

Located in Canton, New York, St. Lawrence University is a coeducational, private, independent liberal arts institution of about 2,400 students. The educational opportunities at St. Lawrence inspire students and prepare them to be critical and creative thinkers, to find a compass for their lives and careers, and to pursue knowledge and understanding for the benefit of themselves, humanity and the planet. Through its focus on active engagement with ideas in and beyond the classroom, a St. Lawrence education leads students to make connections that transform lives and communities, from the local to the global. For additional information about St. Lawrence, please visit SLU's homepage at <http://www.stlawu.edu>.

SLU is an Affirmative Action/Equal Employment Opportunity employer.

**GEOLOGIST/EARTH SCIENTISTS
FULL-TIME/PART-TIME ADJUNCT FACULTY
OCCIDENTAL COLLEGE**

The Department of Geology at Occidental College invites applications for (a) a one year (with potential for renewal) full time adjunct faculty position, and (b) one or more part-time adjunct faculty positions. We seek broadly educated geologists (Ph.D. preferred) with the academic training to teach a selection of the following courses: sedimentary geology, sedimentology, either paleoclimatology or a general course on Earth's climate, and introductory geology. Courses taught by the successful applicant should enhance students' use of quantitative skills. Applications and inquiries should be submitted to geosearch2@oxy.edu and must include (1) a letter of interest demonstrating a commitment to academic excellence in a liberal arts environment, highlighting teaching experience; (2) a curriculum vitae; and

**Faculty Position
Geofluids
Department of Earth Science
Rice University**

The Department of Earth Science at Rice University anticipates hiring a full-time, tenure track assistant professor in the broadly defined area of geofluids with relevance to the deep Earth, crust, hydrosphere, atmosphere or their interfaces.

Successful candidates are expected to direct an active research program, supervise graduate research, and teach courses for undergraduate and graduate students. Details about the department and its facilities can be found at <http://earthscience.rice.edu>.

Please send a CV, research and teaching statements, and names of five or more references to:

Search Committee Chair
Department of Earth Science, MS-126
Rice University, PO Box 1892
Houston, TX 77251-1892.

Rice is an equal opportunity affirmative action employer.

All required application materials submitted by Aug 31, 2013 are ensured full consideration.

(3) contact information for three referees. Review of applications will begin as received and continued until positions are filled. Occidental College is a nationally ranked liberal arts college recognized for its outstanding undergraduate research program, and an equal opportunity employer; members of underrepresented groups are strongly encouraged to apply.

OPEN POSITION, BRIGHAM YOUNG UNIVERSITY

The Department of Geological Sciences at Brigham Young University invites applications for a tenure track Professorial Faculty position beginning as early as January of 2014 in the following areas: fine-grained clastic sedimentology, methanogenesis in unconventional reservoirs, and economic geology. An interest and ability to contribute to our summer field course is a plus. A Ph.D. at the time of appointment is required. Implementation of a vigorous, externally funded research program is required. The successful candidate will teach undergraduate and graduate courses in their area of expertise as well as introductory geology courses as assigned.

Excellent research infrastructure exists within the department, including laboratories and field equipment that support a wide-range of geophysical, geochemical, isotopic, petrologic and petrographic studies. Excellent computational facilities are also available within the Department and University.

The Department consists of 12 professorial faculty and 3 professional faculty, and offers B.S. and M.S. degrees. Research areas include petroleum geology, continental magmatism, geophysics (shallow and deep), structure and tectonics, stratigraphy, paleontology, planetary geology, mineral surface chemistry, hydrogeology, and climate studies.

Interested applicants should fill out an online application at <https://yjobs.byu.edu>. At this site, please also attach a curriculum vita, graduate transcripts, a statement of research experience and goals, a description of teaching philosophy, and the names and contact information for three references.

Brigham Young University, an equal opportunity employer does not discriminate on the basis of race, color, gender, age, national origin, veteran status, or against qualified individuals with disabilities. All faculty are required to abide by the university's honor code and dress and grooming standards. Preference is given to qualified candidates who are members in good standing of the affiliated church, The Church of Jesus Christ of Latter-day Saints.

PETROGRAPHER/CONSULTANT SIMPSON GUMPERTZ & HEGER (SGH) WALTHAM, MASS., USA

Simpson Gumpertz & Heger (SGH) is actively recruiting an experienced candidate for a position as Petrographer/Consultant in our Waltham, Mass., USA, office. SGH is a nationally known civil and structural engineering firm that works in all aspects of design, investigation, and rehabilitation of structures. At SGH, petrographers provide front-line collaborative support to our investigative teams as well as for external clients, including other engineering

firms. The successful candidate will work on investigations of concrete, masonry, stone, and related construction materials.

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To learn more about SGH and to apply for this position, please visit our website at www.sgh.com or email your resume to Stella Mereves-Carolan, Corporate Recruiter at smereves-carolan@sgh.com or Apply online at www.sgh.com.

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The Geological Society of America logo is at the top, featuring a diamond shape with the text 'THE GEOLOGICAL SOCIETY OF AMERICA' and '1888 125 Years 2013'. Below the logo is a purple banner that reads 'CELEBRATING ADVANCES IN GEOSCIENCE'. The background is a scenic photograph of a mountain range with snow-capped peaks and evergreen trees. At the bottom of the image, the text 'www.geosociety.org/125/' is displayed in white on a dark blue background.

Be a part of GSA's
125th Anniversary!

AUSTRALIAN ACADEMY OF SCIENCE AWARDS FOR SCIENTIFIC EXCELLENCE



Nominations are sought for the 2014 HADDON FORRESTER KING MEDAL

sponsored by Rio Tinto for research
in mineral exploration

The Medal is one of the Academy's
prestigious career awards for life-long
achievement and outstanding
contribution to science.

Criteria can be found at www.science.org.au/awards/awards/haddon.html

Please contact awards@science.org.au
for further information

Closing date 29 July 2013

Call for Nominations: 2014 Officers and Councilors

Deadline: 15 July

The GSA Committee on Nominations requests your recommendations for GSA Officers (Vice President/President Elect and Treasurer) and Councilors to serve beginning in 2014. Each nomination should be accompanied by basic data and a description of the individual's qualifications. You can access the online nomination form at www.geosociety.org/aboutus/officers.htm or you may send nomination materials to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, pfistell@geosociety.org.

Echo Lake with Mount Evans in the background, photo by Richard Grant. Used with permission from Denver Metro Convention & Visitors Bureau.

Association for Women Geoscientists
Come Visit us at Booth 844
 during GSA's Annual Meeting in Denver!



Upcoming AWG Events

AWG at GSA, Denver, Colorado

*Women in Geology Mentoring
 AWG Networking Breakfast
 Women in AEG AWG Breakfast*

AWG at AEG, Seattle, Washington

AWG and AEG Breakfast, September 2013



Encourage Exchange Enhance

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 AWG E-News • Field trips • Gaea newsletter
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 Chrysalis Scholarship • Chapter Scholarships
 Minority Scholarship • Brunton Award
 Crawford Field Camp Scholarship
 Takken Travel Award • Sand Travel Award
 Student Awards for Geoscience Excellence (SAGE)
 International Science and Engineering Fairs (ISEF)
 Regional Science Fairs • Girl Scout Activities Funds

**FUTURE
 GSA ANNUAL MEETINGS**

Vancouver, British Columbia, Canada:

19–22 October 2014

Baltimore, Maryland, USA:

1–4 November 2015

Denver, Colorado, USA:

25–28 September 2016

Seattle, Washington, USA:

22–25 October 2017

Indianapolis, Indiana, USA:

4–7 November 2018

Denver, Colorado, USA:

October 2019 (dates TBD)



GSA Bulletin's
**125TH Anniversary
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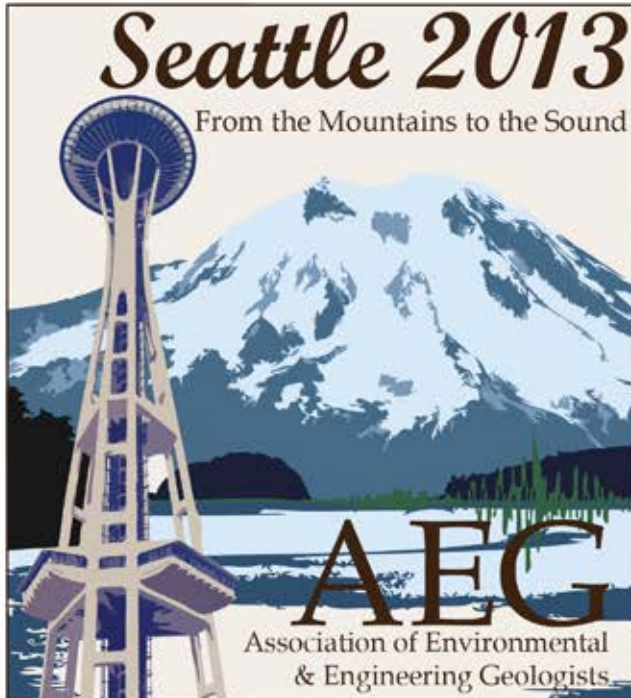
BULLETIN

Join us at the **56th Annual Meeting in 2013**
as the Washington Section celebrates its 50th Anniversary!



SEPTEMBER 8TH-15TH, 2013

The Westin Hotel in the Heart of Seattle



- **Field Trips:** Mt. Rainier, Environmental & Engineering Geology of Seattle, Pleistocene Power in the North Cascades (one-day) and Methow Valley via Mountain Bike (two-day option), New Paleoseismic Evidence for the AD 900-930 Seattle Fault Earthquake, Whidbey Island: Glacial and Periglacial Stratigraphy and Geomorphology, Seattle Tunnels, Nile Valley Landslide and I-90 Rock Slope Engineering, and Field Drilling & Sampling Workshop for Students and Young Professionals.
- **Symposia:** Tunnel Projects, Modern Engineering Geology, Pacific Northwest Volcanic Hazards, Pacific Northwest Seismic Hazards, Fisheries Improvement Projects, Geological Engineering of Transportation Projects, Environmental Geology of Energy Development, Climate Change Impacts on Rivers and Infrastructure Management, and Lessons Learned for Western U.S. from Recent Tsunamis.
- **Technical Sessions:** Groundwater and Karst, Landslides, Rock Mechanics, Seismic Hazards, Mine Reclamation and Waste Management, Subsidence, Engineering Geology and Forestry, Environmental Site Characterization and Remediation, Flooding and Coastal Hazards, Licensure and Professional Practice, Geologic Resource Management, Dam Rehabilitation and Modifications, Geologic Issues with Risk-Based Assessments and Geophysics.
- **Guest Tours:** 1) Boeing Museum of Flight and South Seattle, 2) Olympic Sculpture Park, Ballard Locks and Theo Chocolate Tour, and 3) Washington State Ferry, Bainbridge Island and Bloedel Reserve.
- **Special Event:** A reception/dinner at MOHAI, Seattle's newest unique museum.
- **Short Courses including:** Rock Slope Stability Analysis & Mitigation, Landslide Inventory Mapping from LiDAR, Engineering Geophysics, Professional Ethics, Peat Characterization.
- **Walk to Pike Place Market, and enjoy Museums, Restaurants, Shopping, the Space Needle, the new Wheel on the Waterfront, and Seattle's Unique Natural Setting.**

For more information and registration visit: www.aegweb.org

New Workshop Debuts at

2013 Annual Meeting in Denver

What's Your Problem; What's Your Point?

An Early Career Workshop on Writing Scholarly Papers

Learn how to best prepare scholarly papers for submission to scholarly journals in a workshop aimed at recent Ph.D.s and graduate students, as well as early-career geoscientists, post-docs, and tenure-track faculty.

Led by GSA journal science editors, this workshop's three presentations will be followed by roundtable discussions and a question and answer period.

Before You Begin

Learn how to define your purpose, communicate the major points of your paper, and frame your arguments. Find out what editors look for, such as whether your introduction serves its purpose and whether the paper fits the scope of the journal to which it was submitted.

Writing and Revising

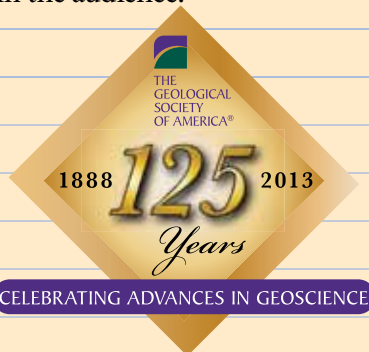
Find out what makes a well-prepared manuscript, from an attention-getting cover letter to clear prose and appropriate, well-thought-out figures and tables that communicate your ideas. Learn steps to avoid frustrating your paper's reviewers. Then learn how to submit your paper online and what to expect during the publication process.

Reviewing and Being a Part of the Scholarly Community

What is a good review? Peer review is integral to publishing, so both reviewing and being reviewed are essential parts of your role as a scientist. What can you give and what can you get out of it?

Apply to Attend

Space is limited for this workshop. Please e-mail editing@geosociety.org for an application. Our science editors will review applications with the goal of a demographic balance in the audience.



When: Monday, 28 Oct., 7–8:30 a.m. | **FREE** (but an application is required) —*Light breakfast included*

Ideas.....

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