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Are Plutons Assembled over Millions of Years by Amalgamation from Small Magma Chambers?

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Cover: The Tuolumne Intrusive Suite in Yosemite National Park, California, comprises several nested plutons that become progressively younger and more felsic toward the interior of the body. The classic interpretation of this sequence is that it was produced by several pulses of magma spaced closely enough in time that younger pulses intruded still-mushy older ones. New precise U-Pb zircon geochronology demonstrates that the intrusive suite took as long as 10 m.y. to develop, and that a single mapped pluton, the Half Dome Granodiorite, accumulated over as long as 4 m.y. This implies that individual broadly homogeneous plutons must be cryptically composite, because even the largest plutons would cool below the solidus in less than 1 m.y. This view is across Tenaya Lake and the center of the Tuolumne Intrusive Suite to Mt. Conness; all rocks in the photo belong to the suite. Photo by Allen Glazner. See "Are plutons assembled over millions of years by amalgamation from small magma chambers?" by Glazner et al., p. 4–11.

SCIENCE ARTICLE

4 **Are plutons assembled over millions of years by amalgamation from small magma chambers?**

ALLEN F. GLAZNER, JOHN M. BARTLEY, DREW S. COLEMAN, WALT GRAY, AND RYAN Z. TAYLOR

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Are plutons assembled over millions of years by amalgamation from small magma chambers?

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ABSTRACT

Field and geochronologic evidence indicate that large and broadly homogeneous plutons can accumulate incrementally over millions of years. This contradicts the common assumption that plutons form from large, mobile bodies of magma. Incremental assembly is consistent with seismic results from active volcanic areas which rarely locate masses that contain more than 10% melt. At such a low melt fraction, a material is incapable of bulk flow as a liquid and perhaps should not even be termed magma. Volumes with higher melt fractions may be present in these areas if they are small, and this is consistent with geologic evidence for plutons growing in small increments. The large melt volumes required for eruption of large ignimbrites are rare and ephemeral, and links between these and emplacement of most plutons are open to doubt. We suggest that plutons may commonly form incrementally without ever existing as a large magma body. If so, then many widely accepted magma ascent and emplacement processes (e.g., diapirism and stoping) may be uncommon in nature, and many aspects of the petrochemical evolution of magmatic systems (e.g., in situ crystal fractionation and magma mixing) need to be reconsidered.

INTRODUCTION

Plutons are fundamental building blocks of the continental crust. Thought about plutons has been dominated by the tacit assumptions that plutons are largely molten during emplacement and that emplacement is geologically rapid (e.g., Buddington, 1959; Pitcher and Berger, 1972; Paterson et al.,

1996; Petford et al., 2000). If plutons are emplaced by bulk magmatic flow, then during emplacement, the magma must contain a melt fraction of at least 30–50 vol% (Vigneresse et al., 1996). At lower melt fractions, crystals in the melt are welded to their neighbors; thus, a low melt-fraction material probably is better regarded not as magma but as a solid with melt-filled pore spaces because bulk flow of such a material requires pervasive solid-state deformation.

The concept of plutons as large ascending molten blobs (Fig. 1) is widespread in geologic thought and commonly guides interpretation of field relations (e.g., Buddington, 1959; Miller et al., 1988; Clarke, 1992; Bateman, 1992; Miller and Paterson, 1999). A contrasting view is that diapiric ascent of magma is too slow and energetically inefficient to be geologically important, and large magma bodies only form at the emplacement level where they are fed by dikes (e.g., Clemens and Mawer, 1992; Petford et al., 2000). Several lines of evidence indicate that, regardless of the ascent mechanism, at least some plutons were emplaced incrementally over time spans an order of magnitude longer than the thermal lifetime of a large magmatic mass (Coleman et al., 2004). No more than a small fraction of such a pluton can have contained melt at a given time, and thus apparently continuous bodies of plutonic rock appear to have grown in situ by amalgamation from many small, probably dike-fed, increments.

Magma volumes of 1000 km³ or more clearly must exist at least ephemerally in the crust because ignimbrite eruptions of this size are well known from the geologic record (Lipman, 1984). However, it need not follow that large plutons were

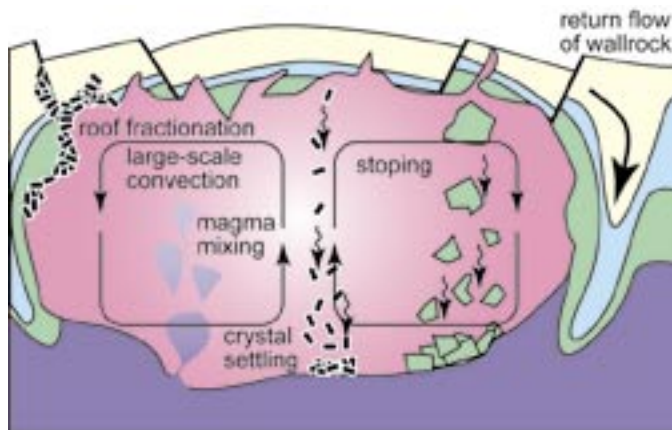


Figure 1. Sketch of the “big tank” magma chamber and a synopsis of the processes that are hypothesized to occur in and around rising magma bodies. Processes such as stoping, downward flow of wall rock, and ballooning (not explicitly represented) are invoked as material transfer and emplacement mechanisms. Processes such as sidewall crystallization, fractional crystallization, and magma mixing are invoked to account for geochemical variation of plutons and associated volcanic rocks. These processes all require large, highly molten magma chambers capable of flow as liquids.

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once large tanks of unerupted magma. Large ignimbrite eruptions, although geographically widespread, happen rarely compared to the much smaller eruptions that construct volcanoes. If construction of plutons resembles that of volcanoes, plutons may represent amalgamations of many small magmatic additions. If so, then we must reevaluate pluton emplacement mechanisms and, indeed, reevaluate the concept of a "pluton."

This perspective mirrors the development of thought about mid-ocean ridge magmatism. A spreading center once was thought to contain a large permanent magma chamber that underwent in situ crystal fractionation and recharge (Cann, 1974). However, seismic studies failed to locate such magma chambers (e.g., Detrick et al., 1990), and modeling suggests that it is thermally difficult to maintain even a small permanent magma chamber at any but the most rapidly spreading mid-ocean ridge (e.g., Lister, 1983). Accretion of the oceanic crust now is envisioned in terms of small ephemeral magma bodies that differentiate by complex processes at many sites (Sinton and Detrick, 1992).

In this paper, we summarize field, geochronologic, and geophysical evidence that many plutons were emplaced incrementally over significant time spans and argue that many of our fundamental assumptions regarding plutons and their relationships to host rocks must be reexamined.

EVIDENCE FOR INCREMENTAL EMPLACEMENT OF PLUTONS

Field Evidence

A growing body of data suggests that many plutons were assembled as a series of sheet-like intrusions that may be gently or steeply inclined. Wiebe and Collins (1998) described the progressive growth of large plutons by vertical stacking of intrusive sheets beneath a long-lived silicic magma cap and argued that a molten body of the size of the final pluton need never have existed. Similar large sheeted intrusions are now recognized worldwide and in many tectonic settings (e.g., Wiebe, 1993; Coleman et al., 1995; Brown and McClelland, 2000). Wiebe and Collins (1998) suggest that steeply dipping sheets at the margins of some plutons were emplaced subhorizontally

and then tilted at the margin of a sagging floor.

Other plutons preserve evidence for emplacement as a series of steep dikes (e.g., Pitcher, 1970; Hutton, 1992; McNulty et al., 1996). For example, the McDoogie pluton of the central Sierra Nevada displays compelling evidence for emplacement by dike amalgamation (Mahan et al., 2003). The pluton is compositionally layered parallel to its contacts and contains numerous thin concordant panels of wall rock that preserve consistent fabric orientations and tectonostratigraphic order. Wall-rock bodies inside the pluton are interpreted to have remained in place as the pluton was intruded incrementally as a plexus of dikes (Mahan et al., 2003; cf. Pitcher, 1970).

The Tuolumne Intrusive Suite of Yosemite National Park has long been thought to have crystallized from several large batches of magma that were emplaced in rapid succession (Bateman and Chappell, 1979). However, at many places, the outer margin of the Tuolumne is clearly composed of granodiorite dikes that invaded wall rocks (Fig. 2). At May Lake the outermost unit of the Tuolumne in that area (tonalite of Glen Aulin) intrudes a screen of metamorphic wall rocks and is choked with wall-rock xenoliths (Fig. 3A), ranging from 250 × 20 m down to decimeter scale, all of which contain foliation and lineation parallel to that in the main screen (Fig. 3B). The tonalite exhibits contact-parallel sheeting defined by variations in mineral proportions and grades over 5–25 m into the next inner and younger unit, the Half Dome Granodiorite. We interpret the xenoliths as in-place bodies of wall rock isolated by dikes that, where their contacts are not marked by xenoliths, are recorded by the compositional sheets.

The Half Dome Granodiorite near the contact also contains sheets of varying composition and tabular swarms of mafic enclaves, but grades inward to a more homogeneous rock. Here the occurrence of dikes or sheets is less certain. However, a pattern of dikes and sheets at the margins passing into a more homogenous interior is consistent with thermal models of incremental pluton growth that predict a transient sheeted-dike stage followed by forma-

tion of a central, possibly small, steady-state magma chamber (Hanson and Glazner, 1995).

The growth of sheeted intrusions is analogous to that of crack-seal veins (Ramsay, 1980). A crack-seal vein contains a superficially uniform fill that accumulated incrementally as the crack opened in a series of discrete events. Annealing of the vein fill can obscure evidence of individual fracturing events, and this also may apply to composite plutons. McDoogie granodiorite has the same coarse grain size from the center of the pluton to the thinnest dike, and shows no outcrop-scale evidence of chilling at any contact. Locally, truncated mafic enclaves reveal steep internal dike contacts but, away from truncated enclaves, the dike contacts become invisible (Mahan et al., 2003). These observations suggest that rock textures were homogenized by post-emplacement annealing that obscured internal contacts. The textural homogeneity of large plutons like the Half Dome Granodiorite could also reflect post-emplacement annealing of amalgamated dikes or sheets, and such a pluton thus might contain any number of cryptic contacts. As yet it is unclear how to recognize and to map such cryptic contacts to determine their prevalence and abundance.

Geochronologic Evidence

Thermal models clearly show that crustal magma bodies should solidify rapidly, with small plutons cooling below the solidus in thousands of years and even large plutons in hundreds of thousands of years (e.g., Jaeger, 1957; Harrison and Clarke, 1979; Stimac et al., 2001). Figure 4 illustrates a simple two-dimensional thermal model of emplacement of a large rectangular magma body, comparable in width to the exposed Tuolumne Intrusive Suite. Temperatures were calculated using the HEAT program of Wohletz (2003). The magma body, silicic with an initial temperature of 900 °C, is 5 km thick and 20 km wide, and its top is set at a depth of 15 km in a crust with a geothermal gradient of 20 °C/km. The program calculates conductive cooling with a finite-difference solution to the heat flow equation, with latent heat of fusion released throughout the crystallization interval.

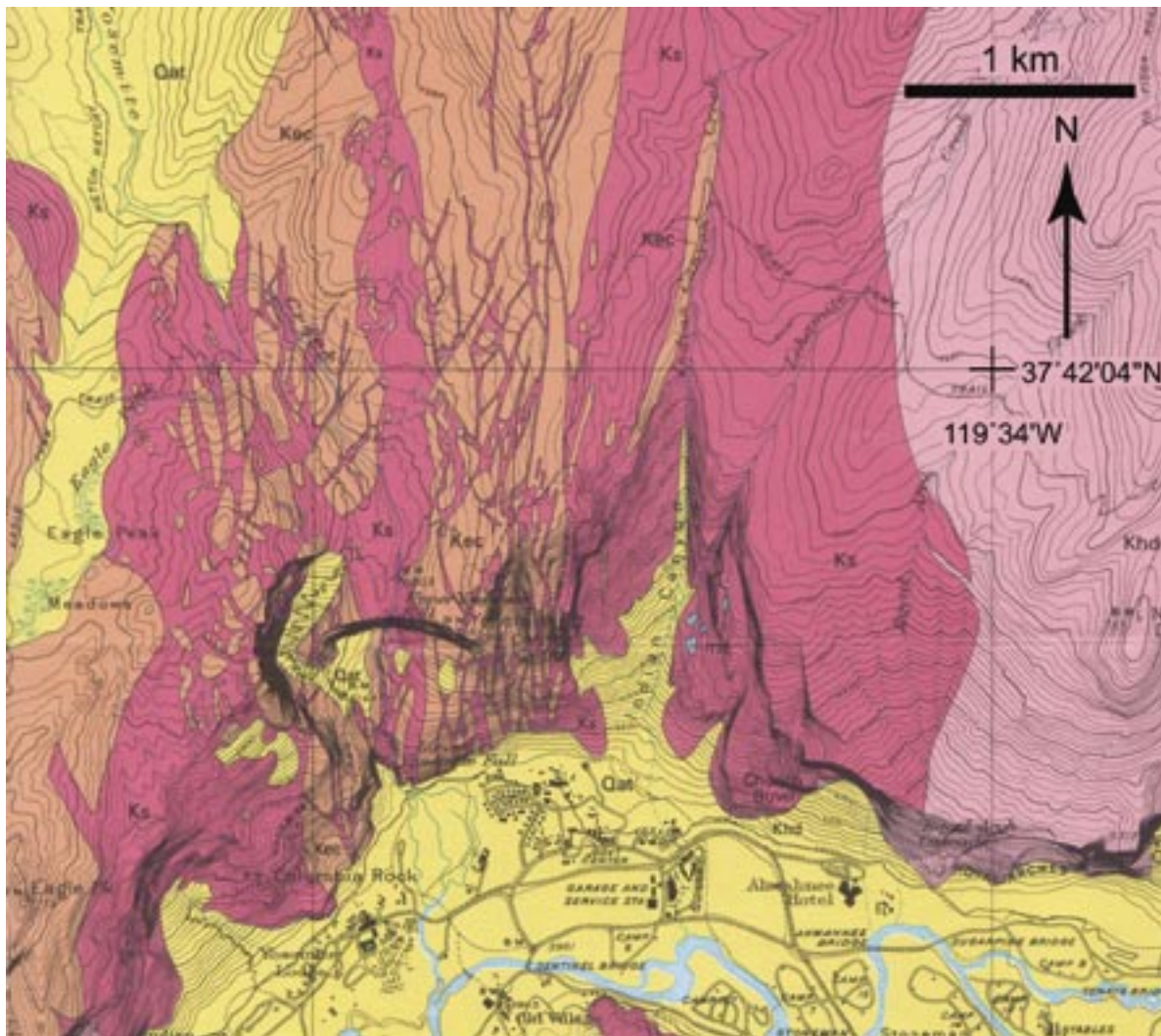


Figure 2. Geologic mapping around Yosemite Valley shows that outer, older units of the Tuolumne Intrusive Suite invaded older plutons as a series of dikes. Here, on the north side of Yosemite Valley near Yosemite Village, dikes of the outermost Tuolumne (here mapped as Sentinel Granodiorite, Ks) intruded and split off panels of the older El Capitan Granite (Kec). Map by Calkins (1985; mapped from 1913–1916); similar relations are shown farther north by Kistler (1973) and south of Yosemite Valley by Peck (2002). The mapped zone of dike emplacement stretches ~15 km along strike (Huber et al., 1989) and continues beyond the mapped zone (see text).

Figure 4 tracks the temperature at four points within the body. All fall below 750 °C within 500,000 years, and the volume fraction of the pluton above 750 °C falls linearly to zero in that time. If 750 °C is taken as an estimate of the temperature at which the magma is 50% crystallized (and thus no longer mobile), then the mobile fraction is gone by 500,000 years. We note that this two-dimensional model cools significantly more slowly than a fully three-dimensional model because there is no heat loss out the ends, and that convection of fluids in the wall rocks will speed cooling greatly.

Geochronologic data contradict these results. In particular, U-Pb zircon data from the Tuolumne Intrusive Suite (Coleman et al., 2004) demonstrate a regular time-space pattern of emplacement between 95 and 85 Ma, with the oldest intrusions at the margins and the youngest at the center (Fig. 5). The Half Dome Granodiorite was emplaced over a >3 m.y. period between 92.8 ± 0.1 and 88.8 ± 0.8 Ma, with older ages near

the outer contact and younger ages near the inner. The Half Dome Granodiorite is mapped as a single continuous pluton that locally grades into an inner porphyritic facies, but the data demonstrate a lifetime far longer than single-intrusion thermal models allow. Although the thermal modeling and geochronologic data permit the possibility that small volumes of partial melt may have persisted throughout the Half Dome during amalgamation, they do not permit the possibility that it intruded as a single batch of magma. The Half Dome thus must be cryptically composite and amalgamated from at least several discrete intrusions, the forms of which (e.g., dikes, subhorizontal sheets, blobs) are yet unknown. Pitcher (1993, p. 186) recognized multipulse plutonic systems that are emplaced over a significant time span, but stated that “the entire magmatic life of a multipulse pluton may not exceed a million years.” Similarly, modeling by Petford et al. (2000) predicts intrusion over 1000 to 10,000,000 years for a pluton the size of

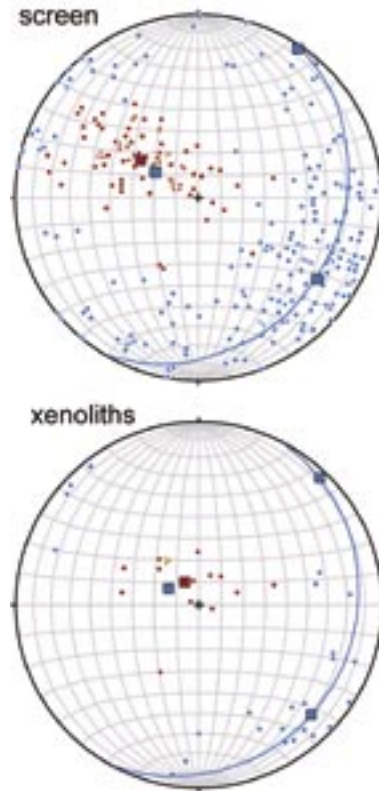
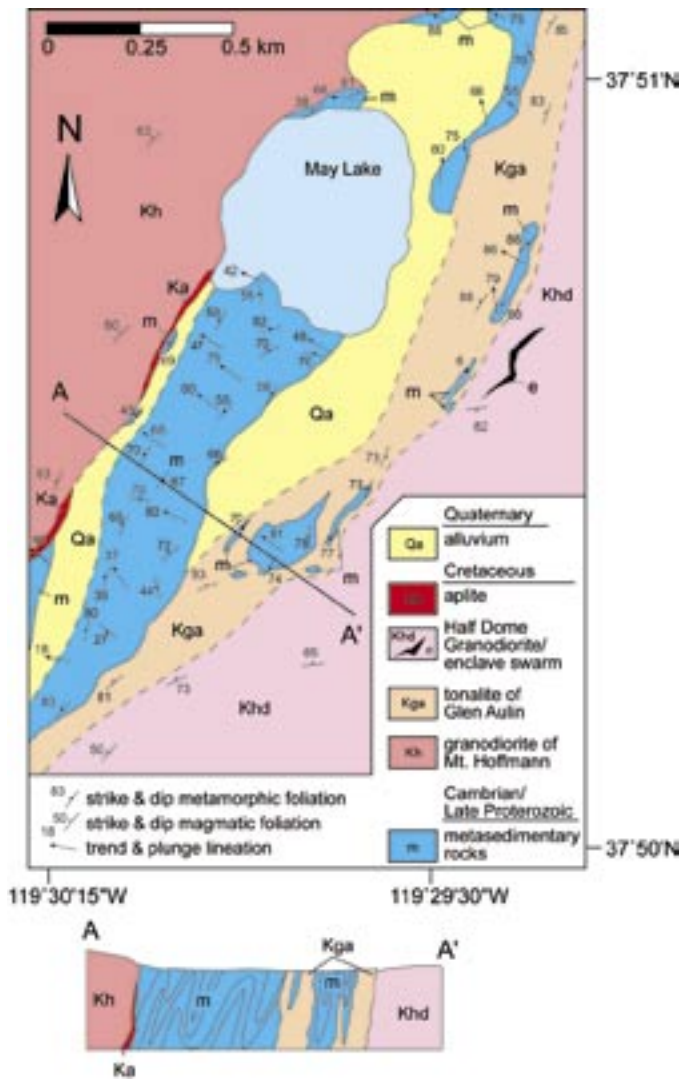


Figure 3. (A) Geologic map of the area around May Lake, Yosemite National Park, showing large xenoliths of metasedimentary rocks caught up in the outermost unit of the Tuolumne Intrusive Suite. From Taylor (2004). (B) Equal-area plots of structural data from May Lake. Lineation in red and poles to foliation in blue, with best-fit axes as squares. Data from the xenoliths, which are entirely enclosed in the tonalite of Glen Aulin, are consistent with data from the main metamorphic screen, indicating that the xenoliths were not reoriented during detachment, as would be expected of stopped blocks. These data are instead consistent with isolation of the xenoliths by diking. For foliation data, best-fit axes on girdle represent point maximum on girdle and the axis perpendicular to it.

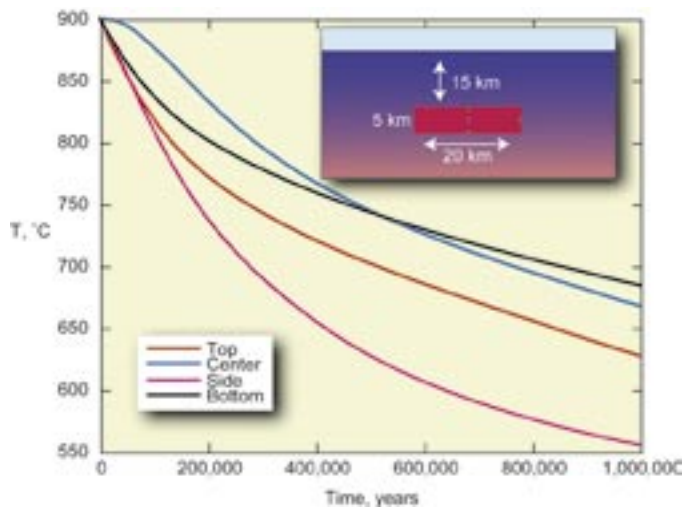


Figure 4. Evolution of temperatures in a two-dimensional magma body. Magma body, 5 km thick and 20 km wide, is emplaced at 15 km depth. Figure plots temperatures at four points in the body: 1 km below the top center, in the center, 1 km above the bottom center, and 1 km inside the side contact, vertically centered. The entire body is below 750 °C in ca. 500,000 years. The >3 m.y. lifetime of the Half Dome Granodiorite contradicts this single-pulse result.

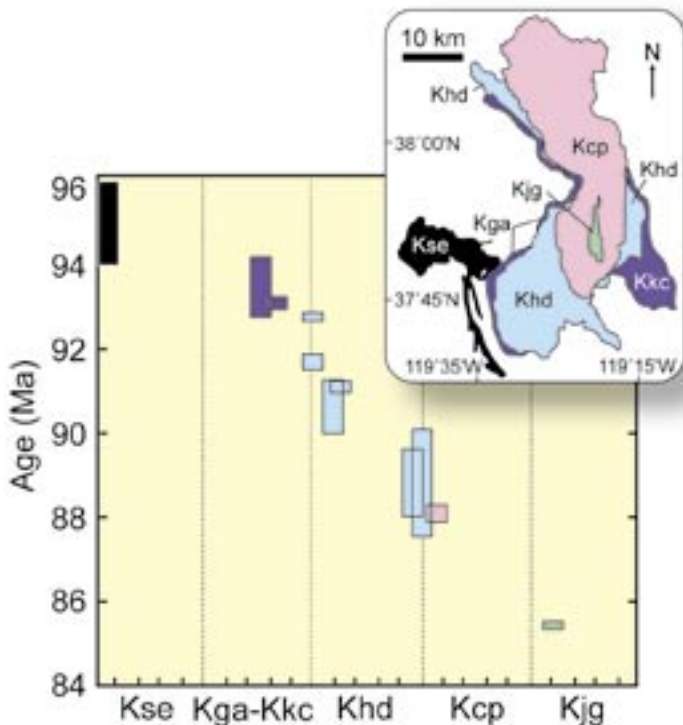


Figure 5. Summary of geochronologic data for the Tuolumne Intrusive Suite, modified from Coleman et al. (2004). Ages are from concordant U-Pb zircon data. Bar height is equal to $\pm 2\sigma$ error and bar color is keyed to rock unit color on inset map. Ages for units are arranged in sequence from outermost to innermost (Kse—Sentinel Granodiorite; Kga-Kkc—tonalite of Glen Aulin–Kuna Crest Granodiorite; Khd—Half Dome Granodiorite; Kcp—Cathedral Peak Granodiorite; Kjg—Johnson Granite porphyry). Horizontal scale is not linear distance, but places samples according to the fractional distance from outer to inner contact of individual units (see Coleman et al. [2004] for a complete discussion).

the Tuolumne, but the authors prefer timescales of less than 100,000 years for large plutons. Our data indicate a magmatic lifetime closer to 10 m.y. for the Tuolumne Intrusive Suite.

Plutons like the Half Dome Granodiorite may be common. When large plutons are dated multiple times by the U/Pb zircon method, it is fairly common for the resulting dates to disagree by more than analytical error (e.g., see Brown et al., 2000, for several examples). The prevailing view that plutons cool in less than a million years requires such conflicting ages to reflect problems in isotopic systematics. However, it may be that many such age differences are real and that the problem lies instead with assumptions about plutonic processes.

Seismic Evidence

Active crustal magma bodies should be locatable using seismic methods because magmatic liquids slow and attenuate seismic waves. Hammond and Humphreys (2000) showed via finite-element calculations that just 2 vol% melt in the upper mantle should reduce V_p by ~7% and V_s by ~16%. Because S-waves do not propagate through liquids, a body sufficiently molten to undergo bulk magmatic flow should not transmit S-waves and thus should produce a shadow zone.

Comprehensive surveys of major active volcanic areas have failed to turn up evidence for significant quantities of

highly molten (>50%) crustal magma (Iyer, 1984), and few clearly identifiable shadow zones are known in spite of careful surveys designed to find them (e.g., Sanders, 1993). Many areas are known worldwide in which partial melt is present, but decreases in P- and S-wave velocities are typically a few percent and rarely greater than 20% (Lees, 1992; Nelson et al., 1996; Schilling and Partzsch, 2001; Zandt et al., 2003). Silicic volcanic centers in the western United States are inferred to have only a few percent of dispersed melt beneath them (Iyer et al., 1990). In the Cascade Range, “anomalous structures attributable to active magma chambers are generally small and difficult to detect” (Iyer et al., 1990).

Schilling and Partzsch (2001) used both electrical and seismic methods to estimate the amount of melt in the crust under the central Andes. They conclude that at least 20% melt is required to explain observations, but that the absence of an S-wave shadow zone requires that such melt is localized in dikes and veins rather than forming large bodies of highly molten magma.

Therefore, wherever partially molten rocks have been seismically imaged, the melt fraction, at least over distances larger than the minimum resolution of the seismic data (typically 100–1000 m), is small enough that bulk flow would require deformation of a solid crystalline framework. This appears to contradict the widespread assumption that active volcanic areas are underlain by large magma bodies in the process of cooling to form plutons. However, bodies with higher melt fractions may yet be present if they are too small to resolve seismically. This possibility is compatible with the geologic evidence summarized above for plutons that formed in small increments.

We conclude that, as at mid-ocean ridges, seismic evidence for large magma bodies with a high melt fraction is rare or absent. Massive caldera-forming eruptions may reflect either large magma bodies that are ephemeral and develop only rarely, or eruption of silicate melt that is relatively dispersed rather than concentrated in a single magmatic mass.

WHY IS IT IMPORTANT TO RECOGNIZE INCREMENTALLY EMPLACED PLUTONS?

If long-lived incrementally assembled plutons are common, then many widespread assumptions about the behavior of magma in the crust must be modified. These include the following.

Pluton Ascent and Emplacement Mechanisms

Diapirism, ballooning, and stoping are widely accepted processes that have been inferred for many plutons (e.g., Pitcher, 1993; Paterson et al., 1996). These processes require that plutons represent frozen magma chambers with at least 50 vol% liquid throughout a volume comparable to the size the pluton. This is not viable for any pluton that accumulated in small increments such that, at any time during its emplacement, most of the pluton was largely solid.

Rates of Magmatic Processes

Rates of pluton growth must be compatible with space-making rates in the wall rock (Paterson and Tobisch, 1992). A diapir must rise slowly and displace wall rocks by ductile

creep (e.g., Miller et al., 1988). In contrast, the rate of magma ascent along dikes is rapid enough to allow construction of large plutons in as little as 10^3 – 10^4 yr (Clemens and Mawer, 1992; Petford et al., 2000). Such volumetric emplacement rates imply extreme wall-rock displacement rates of up to 0.1–1 m/yr, depending on the pluton shape and dilation pattern. However, a pluton may be incrementally assembled by dike injection at virtually any long-term rate, depending on the time between injection events. More detailed high-precision geochronologic studies of petrologically and tectonically diverse plutons are needed to discover the actual range of long-term pluton emplacement rates.

Timing and Rates of Tectonic Processes

If growth of an individual pluton can last millions of years, determining the ages of structures and fabrics by isotopic dating of cross-cutting plutons becomes less straightforward. A single pluton may both cut and be cut by structures if the pluton's magmatic lifetime overlaps deformation. These relationships could be exploited using careful isotopic dating to determine durations of events and to understand the interplay between intrusive and wall-rock processes.

Interpretation of Magmatic Fabrics

Interpretation of magmatic rock fabrics is controversial, and a review is beyond the scope of this paper. However, several plutons mentioned here (e.g., Half Dome, McDoogle) contain a magmatic fabric that appears continuous in the field in spite of field and geochronologic evidence that rocks containing the fabric crystallized at significantly different times. Such a fabric clearly is time-transgressive and implies notably uniform strain associated with emplacement increments added at significantly different times. In examples where a single magmatic fabric cuts contacts between mapped intrusive phases (e.g., Morgan et al., 2000), emplacing the plutons in small increments does not help resolve the problem but neither does it appear to increase the difficulties.

Magmatic Differentiation Processes

Large plutons commonly are compositionally zoned on length scales of

10^2 – 10^4 m. Such zonation has been interpreted to result largely from crystal fractionation (e.g., Bateman and Chappell, 1979; Tindle and Pearce, 1981; Sisson and Moore, 1994) and/or magma mixing (Kistler et al., 1986; Frost and Mahood, 1987). However, for plutons assembled over millions of years with only small parts molten at one time, in situ crystal fractionation and/or magma mixing cannot account for the zonation. In such cases, textural and chemical homogeneity of a pluton probably reflects processes operating deeper than the observed crustal level. Indeed, a remarkable aspect of the Sierra Nevada is that the plutonic zoning of the Tuolumne—an outer, medium-grained, equigranular mafic granodiorite, a medial granodiorite with conspicuous euhedral hornblende, biotite, and titanite phenocrysts, and an inner granodiorite with large K-feldspar megacrysts—is repeated several times along the length of the range (Tikoff and Teyssier, 1992) among plutons of similar age. This repetition cannot reflect derivation of the plutons from a common magma chamber and must instead reflect the recurrence of petrogenetic processes in the deeper crust.

Size and Nature of Magma Chambers

There is a fundamental discrepancy between geophysical images of “large magma chambers” with volumes on the order of 10^3 km³ but generally containing less than 10% melt (Iyer et al., 1990) and the common petrologic view of a magma chamber with comparable dimensions but a melt fraction in excess of 50%. Incremental emplacement of plutons by amalgamation of small intrusions is compatible with geophysical observations that indicate that magma chambers in the petrologic sense generally are small and transient.

Correspondence between Plutons and Caldera-Forming Eruptions

Caldera-forming eruptions with volumes on the order of 1000 km³ offer undeniable evidence that large magma bodies exist at least ephemerally in the crust. Growth of a magma body requires the rate of thermal input by magma to exceed the rate of thermal loss by cooling and eruption. In an area where the power input (Hildreth, 1981) is high, a

large magma body can develop; where power input is low, cooling prevents development of a large magma body and a pluton may form incrementally (Fig. 6). It may be that, when power input is sufficiently high to form a large magma body in the upper to middle crust, the roof fails and a caldera-forming eruption results, evacuating the magma chamber to leave behind only minor plutonic residues. Neogene magmatism in the Basin and Range (Best et al., 1993), Sierra Madre Occidental of Mexico (McDowell and Clabaugh, 1979), and Bolivian Andes (de Silva, 1989) reflects large power input, development of dozens of large, shallow magma chambers, and common caldera collapse, but it is unknown if significant plutons were emplaced at the same time. However, caldera resurgence may be the surface manifestation of continued incremental input of magma to form newly amalgamating plutons.

CONCLUSIONS

Field and geochronologic evidence indicate that at least some large, superficially homogeneous plutons formed by amalgamation of numerous small intrusions, and that the field or petrologic record of their composite origins may be subtle. Coupled with the lack of geophysical evidence for modern large bodies of magma, this suggests that plutons may commonly form in many small increments in a manner analogous to growth of crack-seal veins. The resulting internal contacts apparently can be cryptic, and thus we know little as yet about typical geometric forms of individual increments or how the increments combine to form a pluton. However, present examples include plutons composed mainly of subhorizontal (e.g., Wiebe and Collins, 1998) and mainly of subvertical (e.g., Hutton, 1992; Mahan et al., 2003) intrusive sheets. A pluton composed of subhorizontal sheets will be laccolithic in overall form and likely have a gently dipping roof defined by the structurally highest intrusive sheet. A pluton composed of dikes should have an irregular roof at which the pluton grades into wall rock injected by many dikes, as is observed at one end of the McDoogle pluton.

The data cited above suggest that our understanding of the emplacement of

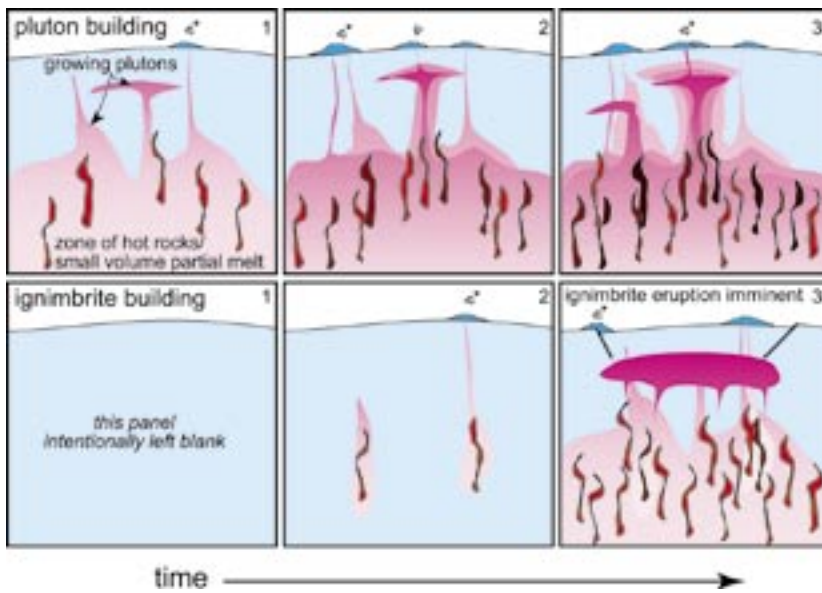


Figure 6. Sequence of sketches illustrating the differences between pluton building (top panels) and ignimbrite building (bottom panels). During pluton assembly, the flux of thermal energy (power; shown here schematically as new basalt intrusion—red dikes cooling to darker reds) is modest, yielding plutons assembled incrementally over millions of years and persistent volcanic activity. Only a small portion of the system need be liquid at any time (areas represented by darkest pinks). This model accounts for geochronologic, thermochronologic, and seismic observations discussed in text. Pluton growth is shown here via dike assembly at depth (perhaps preserved in plutons such as the McDoogle) feeding assembly of sheeted intrusions at shallower crustal levels (perhaps preserved in plutons such as the central Tuolumne). Initiation of an ignimbrite eruption is interpreted to result from rapid heat flux (high power) resulting in a large volume of high-percentage partial melt capable of eruption. We envision such magma chambers to be ephemeral features of the shallow lithosphere, erupting soon after formation. Note that for both sequences, the total energy input and silicic magma generated are intended to be approximately the same.

plutons and their chemical and structural evolution is incomplete, and the ideas presented here raise many questions and present testable hypotheses. Fruitful areas for future research might include:

- understanding the space-time pattern of incrementally emplaced plutons;
- reconsidering magmatic fabrics within the incremental growth framework;
- establishing clearer ties between the volcanic and plutonic records;
- understanding the chemical and petrologic evolution of plutons given that fractionation within, and mixing of, exposed units may be minimal;
- comparison of the emplacement rates of mafic versus felsic plutons; and
- comparison of incremental emplacement processes in varied tectonic settings.

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plutonic processes, although not all of them will agree with the ideas and conclusions that we present here. Thorough, critical, and creative reviews by Bernard Bonin, John Eichelberger, Rick Law, Calvin Miller, Robert Trumbull, and editor Keith Howard greatly improved both the science and presentation and gave us many new things to think about.

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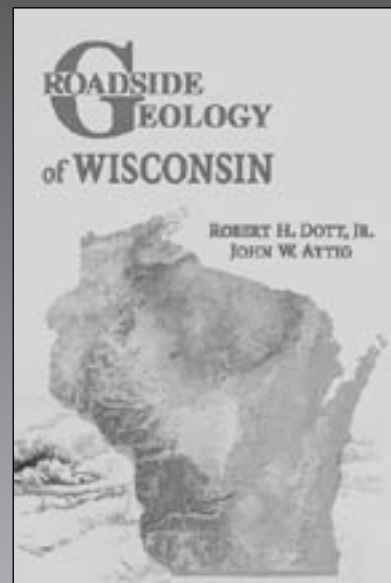
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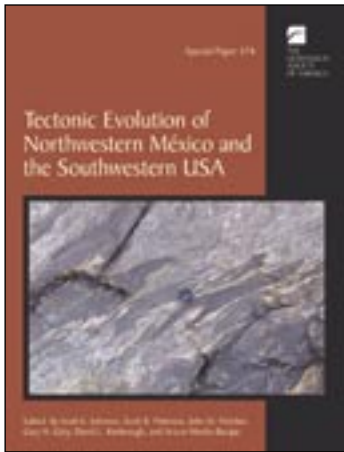


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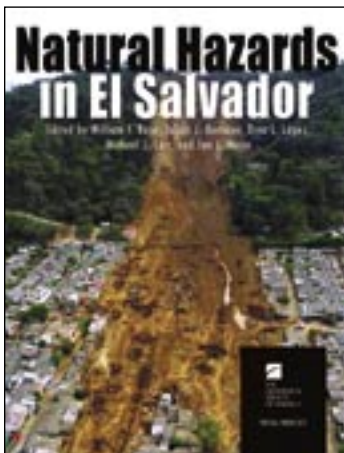
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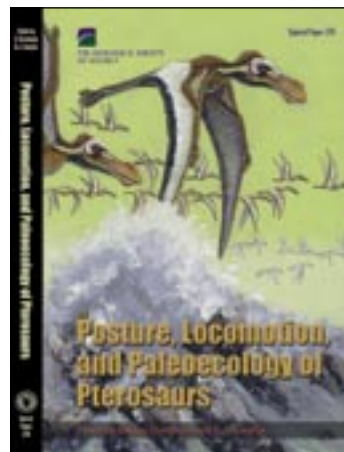
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INVITED PAPERS

The Pardee Keynote Symposia are made possible by a grant from the Joseph T. Pardee Memorial Fund.

These Pardee keynote sessions are special events of broad interest to the geoscience community. They represent hot issues on the leading edge in a scientific discipline or area of public policy, address broad fundamental issues, and are interdisciplinary. Selection was on a competitive basis. This year's eight Pardee Symposia were reviewed and accepted by the Annual Program Committee. (*All speakers are invited.*)

P1. Early Paleoproterozoic (2.5–2.0 Ga) Events and Rates: Bridging Field Studies and Models

Geochemical Society; Astrobiology Program; GSA Sedimentary Geology Division; SEPM—Society for Sedimentary Geology

Precambrian Geology; Paleoclimatology/Paleoceanography; Tectonics

Andrey Bekker, Geophysical Lab, Carnegie Institution of Washington, Washington, D.C.; Mark E. Barley, The University of Western Australia, Western Australia, Australia; Robert H. Rainbird, Geological Survey of Canada, Ottawa, Ontario

Field-oriented and modeling studies dealing with the 2.5–2.0 Ga Earth's evolution are invited. Session will be focused on relationships between tectonics, change in atmospheric composition, and climatic changes as well as the rates of these changes.

P2. Geoinformatics and the Role of Cyberinfrastructure in Geosciences Research

Geophysics/Tectonophysics/Seismology; Structural Geology; Tectonics

Randy Keller, University of Texas, El Paso, Texas; Lee Allison, Kansas Geological Survey, Lawrence, Kans.

This session consists of presentations on geoinformatics and the use of advanced information technology in support of research in the geosciences. The talks will provide an overview of cyberinfrastructure that is emerging and describe projects that are developing as well as using this cyberinfrastructure.

P3. Geoscientific Aspects of Human and Ecosystem Vulnerability

U.S. National Committee for Geosciences; GSA Critical Issues Caucus; GSA Geology and Public Policy Committee; GSA Geology and Society Division

Public Policy; Environmental Geoscience; Geoscience Information/Communication

Susan W. Kieffer, University of Illinois, Champaign-Urbana, Ill.; Grant Heiken, Los Alamos National Lab, Los Alamos, N.Mex.

Humans and the ecosystems on which they depend are vulnerable to a variety of natural hazards and their mismanagement. This session will explore the response to, and need for, mitigation of large-scale hazards with long time scales.

P4. Medical Geology

GSA Engineering Geology Division

Environmental Geoscience; Geoscience Education; Public Policy
Syed E. Hasan, University of Missouri, Kansas City, Mo.

Many health problems, including cancer, heart, and central nervous system diseases, etc., have links to geologic factors. Experts from geosciences, public policy, and health sciences will discuss new developments in the emerging field of medical geology.

P5. Adversity, Advantages, Opportunities: Phanerozoic Stromatolites as “Survivor” vs. “Disaster” Taxa

Paleontological Society

Paleontology/Paleobotany; Geomicrobiology; Sediments, Carbonates

Constance M. Soja, Colgate University, Hamilton, N.Y.; Robert Riding, University of Cardiff, Cardiff, United Kingdom

This interdisciplinary forum will reexamine the role of stromatolites in Phanerozoic ecosystems, particularly the importance of post-Cryptozoic microbial communities; the biotic and abiotic agents that contributed to their development, decline, and preservation; and their co-evolutionary history with metazoans.

P6. Pre-Mesozoic Impacts: Their Effect on Ocean Geochemistry, Magnetic Polarity, Climate Change, and Organic Evolution

GSA Planetary Geology Division; Paleontological Society

Planetary Geology; Paleontology/Paleobotany; Paleoclimatology/Paleoceanography

Charles A. Sandberg, U.S. Geological Survey, Denver, Colo.; Jared R. Morrow, University of Northern Colorado, Greeley, Colo.; Christian Koeberl, University of Vienna, Vienna, Austria

Pre-Mesozoic comet and meteorite impacts produced extreme oceanic and climate changes, causing mass extinctions followed by rapid radiation of surviving organisms. Thus, they were the driving mechanism in the early evolution of life on Earth.

P7. Seeing Mars with New Eyes: Active Missions, Science Results and Geoscience Education

GSA Planetary Geology Division; Geoscience Education Division

Planetary Geology; Geoscience Education

Eric B. Grosfils, Pomona College, Claremont, Calif.; Susan Sakimoto, NASA/GSFC, Greenbelt, Md.

In 2004, multiple spacecraft are exploring Mars simultaneously. This session will present some of the most recent and exciting science results and demonstrate how the available data can be used to enhance geoscience education activities.

P8. Weathering, Slopes, Climate, and Late-Quaternary Geomorphic Change in Arid and Semi-Arid Landscapes

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Glomorphology; Environmental Geoscience; Paleoclimatology/Paleoceanography

Leslie D. McFadden, University of New Mexico, Albuquerque, N.Mex.; Grant A. Meyer, University of New Mexico, Albuquerque, N.Mex.; Peter J. Fawcett, University of New Mexico, Albuquerque, N.Mex.

Dryland slopes are climatically sensitive because large changes in vegetation and weathering can result from modest changes in moisture. This session explores effects of late Quaternary and potential future climates on slope processes and forms.



CALL FOR PAPERS

Rocky Mountain National Park. Photo by Martin Miller.

TOPICAL AND DISCIPLINE SESSIONS

INVITED AND VOLUNTEERED PAPERS

ABSTRACTS DEADLINE: JULY 13 TOPICAL SESSIONS

Below is a listing of all approved topical sessions. These sessions are topically focused with a mix of invited and volunteered papers. Sessions are designed to promote the exchange of interdisciplinary, state-of-the-art information. Papers can be submitted to a specific topical session and you may choose up to three scientific categories. After each topical description below, the categories are identified as they appear on the abstract form. PLEASE SUBMIT ONLY IN THE MODE (oral or poster) AND CATEGORIES INDICATED in the description. An abstract submitted in the incorrect mode will be transferred automatically to a discipline session.

Abstracts Deadline: July 13

Please use the online electronic abstract form found on the GSA Web site, www.geosociety.org. An abstract submission fee will be charged. The fee is \$18 for students; \$30 for all others. If you cannot submit your abstract electronically, contact Nancy Carlson, (303) 357-1061, ncarlson@geosociety.org.

Discipline Sessions

From the list found on the electronic abstract form, you may choose up to three discipline categories you feel your abstract would fit best. Joint Technical Program Committee representatives organize the papers in sessions focused on disciplines (e.g., environmental geoscience, mineralogy).

T1. The Future of Hydrogeology

GSA Hydrogeology Division; International Association of Hydrogeologists U.S. National Committee; National Ground Water Association

Hydrogeology

Clifford I. Voss, U.S. Geological Survey, Reston, Va.

Visions of future science and practice in hydrogeology and related geosciences will be highlighted. Speakers include but are not limited to authors in upcoming issue of *Hydrogeology Journal* on "The Future of Hydrogeology." ORAL

T2. Upcoming Revolutions in Observing Systems: Implications for Hydrogeology

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

John L. Wilson, New Mexico Institute of Mining and Technology, Socorro, N.Mex.; Richard P. Hooper, Consortium

of Universities for the Advancement of Hydrologic Science, Inc., Washington, D.C.

Proposed environmental observing systems provide opportunities for hydrogeology to test concepts and to refine understanding of fundamental hydrologic processes. Papers are solicited that explore how such systems aid in model testing and conceptual development. ORAL

T3. History of Hydrogeology in the United States: Celebrating the Contributions of O.E. Meinzer, Stan Lohman, and John Ferris

GSA Hydrogeology Division; International Association of Hydrogeologists U.S. National Committee

Hydrogeology; History of Geology; Geoscience Education

John Ezra Moore, U.S. Environmental Protection Agency, Denver, Colo.; Philip LaMoreaux, Tuscaloosa, Ala.

The session will describe the historical basis for the development of hydrogeology (1885–1985) in the United States. ORAL

T4. Over 40 Years of Influence in Environmental Hydrogeology: In Honor of Dick Parizek

GSA Hydrogeology Division

Hydrogeology; Environmental Geoscience; Engineering Geology

Ward E. Sanford, U.S. Geological Survey, Reston, Va.; E. Scott Bair, Ohio State University, Columbus, Ohio

After 40 years of research and advising 100 graduate students in environmental hydrogeology, Dick Parizek is being honored for his contributions to water-resource exploration, wastewater treatment, mining hydrology, karst hydrology, and nuclear waste disposal. ORAL

T5. Groundwater Depletion and Overexploitation in the Denver Basin Bedrock Aquifers

GSA Hydrogeology Division; International Association of Hydrogeologists U.S. National Committee; GSA Public Policy

Hydrogeology; Engineering Geology; Geoscience Information/Communication

Peter Barkmann, Colorado Geological Survey, Denver, Colo.; John Ezra Moore, U.S. Environmental Protection Agency, Denver, Colo.

Southeast Denver relies on bedrock aquifers to supply water for new housing developments. The developers told home buyers that the aquifers would supply water for 100 years. It now appears that in many areas the supply will be depleted in less than 10 years. ORAL

T6. Hydrologic Impacts of Urbanization and Suburbanization on Water Resources

GSA Hydrogeology Division; GSA Engineering Geology Division

Hydrogeology; Environmental Geoscience; Engineering Geology

Anne E. Carey, The Ohio State University, Columbus, Ohio; W. Berry Lyons, The Ohio State University, Columbus, Ohio; John E. McCray, University of Texas, Austin, Texas; John M. Sharp, The University of Texas, Austin, Texas

By 2005, approximately 65% of Earth's population will inhabit urban areas and cause drastic effects on hydrologic sys-

tems. This session details the consequences of urbanization on water supply, water quality, ecosystem health, and land-use planning. ORAL

T7. The Occurrence, Storage, and Flow of Groundwater in Mountainous Terrain

GSA Hydrogeology Division; U.S. Geological Survey

Hydrogeology; Environmental Geoscience; Geochemistry, Aqueous

Andrew H. Manning, U.S. Geological Survey, Denver, Colo.; Jonathan Saul Caine, U.S. Geological Survey, Denver, Colo.

Because mountain hydrologic studies have traditionally focused on surface water, little is known about groundwater in mountainous terrain. This session focuses on new and integrated approaches to understanding the physical controls on these complex systems. ORAL

T8. Mountain Watershed Pollutant Transport and Water Quality Issues, Including Groundwater Surface-Water Interplay in Pollutant Transfer

GSA Hydrogeology Division

Hydrogeology

Geoffrey D. Thyne, Colorado School of Mines, Golden, Colo.; John E. McCray, University of Texas, Austin, Texas

This session invites topics in all aspects of mountain watershed pollutant transport and water-quality issues including groundwater surface-water interplay in pollutant transfer, impact mechanisms in environmentally sensitive watersheds, and innovative solutions to related environmental problems. ORAL

T9. Sustainable Management of Water Resources

GSA Geology and Public Policy Committee

Hydrogeology; Environmental Geoscience

Bridget R. Scanlon, University of Texas, Austin, Texas; Marios Sophocleous, The University of Kansas, Lawrence, Kans.

This session will focus on research related to management of water resources in a sustainable manner to meet human and ecosystem needs taking into account potential impacts of climate change, land use change, and projected population and water consumption increases on water resources. ORAL and POSTER

T10. Comprehensive Monitoring Approaches at Regional and Statewide Levels—Advantages and Limitations

GSA Hydrogeology Division; Association of Ground Water Scientists and Engineers, a Division of the National Ground Water Association

Hydrogeology; Geoscience Information/Communication

David R. Wunsch, Concord, N.H.; Charles J. Taylor

Regional and statewide groundwater monitoring is challenging because of the magnitude of scale, heterogeneity, and other hydrogeologic unknowns. We welcome contributions that describe advantages and limitations of monitoring schemes, technologies, and interagency collaboration. ORAL

T11. Hydraulic and Geochemical Behavior of Man-Made Aquifers

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous

Joseph J. Donovan, West Virginia University, Morgantown, W.Va.; Mary Stoertz, Ohio University, Athens, Ohio

Anthropogenic aquifers formed by mining, waste disposal, and geotechnical projects create environmental impacts that may persist for years. This session will present investigations of their hydraulic and geochemical behavior, including remediation and/or beneficial use aspects. ORAL

T12. Fluid Flow and Solute Transport in Fractured Rocks

GSA Hydrogeology Division

Hydrogeology

Paul A. Hsieh, U.S. Geological Survey, Menlo Park, Calif.

Advances in quantitative analysis of field investigations in fractured rocks over a broad range of length scales, from contaminant sites to regional systems. ORAL

T13. Modeling Flow and Transport in Chemically and Physically Heterogeneous Media

GSA Hydrogeology Division

Hydrogeology

Zhenxue Dai, Wright State University, Dayton, Ohio; Robert W. Ritzi, Wright State University, Dayton, Ohio

Advances in characterizing and modeling groundwater flow and chemical transport will be shared by researchers and practitioners toward better describing and understanding transport processes in heterogeneous flow systems. ORAL and POSTER

T14. Applications of Geophysics to Groundwater Resource Management

GSA Geophysics Division; GSA Hydrogeology Division

Hydrogeology; Geophysics/Tectonophysics/Seismology; Environmental Geoscience

Dennis L. Harry, Colorado State University, Fort Collins, Colo.; David W. Hyndman, Michigan State University, East Lansing, Mich.

This session showcases integrated geophysical and geological studies as applied to groundwater issues. It will include case studies of successful field programs and reports on new data acquisition and analysis techniques. ORAL

T15. How Effectively Are We Using Advanced Groundwater Modeling Tools in Practice?

GSA Hydrogeology Division

Hydrogeology

David L. Rudolph, University of Waterloo, Waterloo, Ontario; Rene Therrien, Université Laval, Quebec City, Quebec

This session addresses current pitfalls, misuses, and limitations of fluid flow and solute transport models for groundwater investigations. Improving advanced model applications and assessing the value of input data are also examined. ORAL

T16. Linking Groundwater Models and Watershed Models

GSA Hydrogeology Division; GSA Engineering Geology Division

Hydrogeology; Environmental Geoscience

Tom Winter, U.S. Geological Survey, Lakewood, Colo.

This session is intended to present the latest developments in integrating surface water into groundwater models and groundwater into watershed models, and to perhaps lay the foundations for new directions in these efforts. ORAL

T17. Aquitard Studies: Understanding Geologic Constraints on Flow and Transport in Groundwater Flow Systems

GSA Hydrogeology Division

Hydrogeology; Environmental Geoscience

Kenneth R. Bradbury, Wisconsin Geological and Natural History Survey, Madison, Wis.; Beth Parker, University of Waterloo, Waterloo, Ontario; David Hart, Wisconsin Geological and Natural History Survey, Madison, Wis.; Timothy T. Eaton, Wisconsin Geological and Natural History Survey, Madison, Wis.

This session focuses on recent advances in the hydrogeology of both near-surface and deeply-buried aquitards, including physical characterization, contaminant transport, geochemistry, monitoring, and modeling. ORAL

T18. Characterization, Attenuation, and Remediation of Contaminants in Runoff

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

Thomas Boving, University of Rhode Island, Kingston, R.I.; William Blanford, Louisiana State University, Baton Rouge, La.

This session encourages papers on novel approaches regarding the survey, characterization, attenuation, and remediation of organic and inorganic contaminants in runoff from urban, industrial, and agricultural land, including the deposition of airborne soot. ORAL

T19. Innovative Tracer Applications in Hydrogeology: New Techniques, Design and Interpretation Methods, and Case Studies

GSA Hydrogeology Division; International Association of Hydrogeologists—International Commission on Tracers

Hydrogeology; Geochemistry, Other

Craig E. Divine, Colorado School of Mines, Golden, Colo.; Jeffrey McDonnell, Oregon State University, Corvallis, Ore.

The use of tracers in hydrogeology has significantly increased in recent years. This session is open to papers that describe new techniques, methods for tracer test design and interpretation, and case studies in any hydrogeological application. ORAL

T20. Dissolved Gases as Indicators of Geochemical and Hydrogeologic Processes

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous; Geomicrobiology

D. Kip Solomon, University of Utah, Salt Lake City, Utah; Stephen J. Van der Hoven, Illinois State University, Normal, Ill.

Dissolved gases have been used to investigate a variety of hydrogeologic processes (e.g., redox reactions, groundwater travel times, rates of recharge, denitrification, paleorecharge, etc.). Field, laboratory, and modeling studies will be included. ORAL and POSTER

T21. Vadose Zone Nitrogen: Sources, Fate and Transport

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous; Geomicrobiology
Scott W. Tyler, University of Nevada, Reno, Nev.; W. Mike Edwards, Oxford University, Oxford

This session seeks to bring together hydrologists, soil physicists, soil chemists, and microbiologists to shed light on the fate and transport of nitrogen species in environments ranging from such diverse environments as domestic septic tank discharge to the hyperarid nitrate deposits of the Atacama Desert. ORAL and POSTER

T22. Assessing the Importance of Colloids in Natural Waters

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

James F. Ranville, Colorado School of Mines, Golden, Colo.; John C. Seaman, The University of Georgia, Aiken, S.C.

Colloids occur in most natural waters. A limited understanding of colloid abundance and characteristics hampers assessing their importance. Papers which describe new approaches to characterize colloids, model contaminant sorption, or model colloid migration are sought. ORAL and POSTER

T23. Sources, Transport, Fate, and Toxicology of Trace Elements in the Environment

International Association of Geochemistry and Cosmochemistry

Geochemistry, Aqueous; Environmental Geoscience; Geomicrobiology

David T. Long, Michigan State University, East Lansing, Mich.; LeeAnn Munk, University of Alaska Anchorage, Alaska; W. Berry Lyons, The Ohio State University, Columbus, Ohio

Papers are invited on the study of trace elements in the environment related to sources, transport, controls on mobility, toxicological consequences, ecology (e.g., food web dynamics, as limiting nutrients) and accumulation in sediments and soils. ORAL

T24. Organic Compounds in Near-Surface Environments as Drivers on the Redox-Reaction Highway: A Tribute to the Career of Mary Jo Baedecker

GSA Hydrogeology Division

Hydrogeology; Geochemistry, Organic; Geomicrobiology

Isabelle M. Cozzarelli, U.S. Geological Survey, Reston, Va.; Janet S. Herman, University of Virginia, Charlottesville, Va.; Robert P. Eganhouse, U.S. Geological Survey, Reston, Va.

Elucidating fundamental redox reactions driven by organic matter in subsurface environments, focusing on hydrogeologic systems impacted by human activities, has been the major career contribution of Mary Jo Baedecker. Presentations building on her work are invited. ORAL and POSTER

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T25. Stable Isotope Tracers of Water Balance and Biogeochemical Cycling in Large River Basins

GSA Quaternary Geology and Geomorphology Division

Geochemistry, Aqueous; Environmental Geoscience; Geochemistry, Other

Leonard I. Wassenaar, Environ Canada, Saskatoon, Saskatchewan; John Gibson, Environ Canada, Victoria, British Columbia

This session explores the application of stable isotope tracers of water, gases, and dissolved inorganic species in river discharge as a tool for examining spatio-temporal evolution of hydrologic and biogeochemical processes in large river basins. ORAL and POSTER

T26. Seasonal and Long-Term Groundwater Quality Changes in Alluvial Aquifer Systems

GSA Hydrogeology Division

Geochemistry, Aqueous; Hydrogeology; Environmental Geoscience

Wendy A. Timms, University of New South Wales; Manly Vale, New South Wales, Australia

Seasonal and long term (decadal) groundwater quality trends related to urban and agricultural development may downgrade beneficial use. Causal factors may be identified by demonstrating correlation, consistency, responsiveness and a physical process. ORAL and POSTER

T27. Characterization and Representation of Flow through Karst Aquifers

GSA Hydrogeology Division

Hydrogeology; Sediments, Carbonates; Environmental Geoscience

Allan D. Woodbury, University of Manitoba, Winnipeg, Manitoba; Ron Green, Southwest Research Institute, San Antonio, Texas

The overall theme of the session is to examine enhanced capabilities for karst aquifer characterization and flow representation to support the quantitative evaluation and management of the water resources of karst systems. We seek original contributions in new modeling tools, guidelines for applications of either new or existing tools, and improved understanding of data collection needs to support modeling efforts. ORAL

T28. New Perspectives in Karst Geomicrobiology and Redox Geochemistry

GSA Hydrogeology Division; Karst Waters Institute; GSA Geobiology and Geomicrobiology Division

Hydrogeology; Geomicrobiology; Geochemistry, Other

Annette Engel, The University of Texas, Austin, Texas; Toby Dogwiler, Winona State University, Winona, Minn.; Diana Northup, University of New Mexico, Albuquerque, N.Mex.

In the ten years since the Karst Waters Institute-sponsored conference, there has been considerable progress in understanding microbial systems, geochemical processes, and the interactions between them in cave and karst settings. We welcome contributions that highlight these major achievements and latest advances. We encourage interdisciplinary participation from related hydrogeologic and biogeochemical settings. ORAL and POSTER

T29. From Subterranean Crawlways to Scientific Hallways: Research on Our Public Cave and Karst Lands

National Park Service; National Cave and Karst Research Institute

Quaternary Geology/Geomorphology; Hydrogeology; Environmental Geoscience

Louise D. Hose, National Cave and Karst Research Institute, Carlsbad, N.Mex.; Penelope J. Boston, New Mexico Institute of Mining and Technology, Socorro, N.Mex.

Public lands provide unique natural laboratories and have facilitated important advancements in our understanding of cave and karst systems. This session focuses on both fundamental and significant discoveries to applied research in publicly managed karst terrains. ORAL and POSTER

T30. New and Multidisciplinary Approaches to Dating Cave Deposits

GSA Archaeological Geology Division; Karst Waters Institute

Archaeological Geology; Quaternary Geology/Geomorphology; Geochemistry, Other

Donald McFarlane, The Claremont Colleges, Claremont, Calif.; Joyce Lundberg, Carleton University, Ottawa, Ontario

Addressing the integration of technological and methodological advances in the dating of cave deposits, with the experimental and/or successful application of multiple and/or innovative techniques to resolve long and complex speleological records. ORAL and POSTER

T31. Impacts of Water Storage and Consumption on Watershed Processes

GSA Quaternary Geology and Geomorphology Division; GSA Engineering Geology Division

Quaternary Geology/Geomorphology

Sara L. Rathburn, Colorado State University, Fort Collins, Colo.; Ellen E. Wohl, Colorado State University, Fort Collins, Colo.

Water storage and consumption structures dictate water and sediment delivery to most watersheds. The myriad responses of watersheds to the imposed regulation informs us of the resilience and future of our fluvial systems. ORAL

T32. Geological Mapping: Providing for Successful Water and Land Resource Planning (Posters)

GSA Quaternary Geology and Geomorphology Division; GSA Engineering Geology Division; GSA Geology and Society Division; GSA Geology and Public Policy Committee; GSA Hydrogeology Division; Association of American State Geologists

Quaternary Geology/Geomorphology; Hydrogeology; Engineering Geology

Richard C. Berg, Illinois State Geological Survey, Champaign, Ill.; Harvey Thorleifson, Minnesota Geological Survey, St. Paul, Minn.; Peter T. Lytle, U.S. Geological Survey, Reston, Va.

Geological mapping is a key to environmental protection and management of water and land resources. The session will highlight innovative mapping products that are being used by an increasingly broad range of users. POSTER

T33. Geologic Disposal of Radioactive Waste: Rising to the Challenge of Regulatory Requirements and Environmental Protection at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, and the Yucca Mountain Site, Southern Nevada

GSA Hydrogeology Division; U.S. Department of Energy; GSA Geology and Public Policy Committee

Public Policy; Environmental Geoscience; Hydrogeology

Robert A. Levich, U.S. Department of Energy, Las Vegas, Nev.; Russell L. Patterson, Carlsbad, N.Mex.; Ronald M. Linden, Las Vegas, Nev.

Recertification of WIPP and license application submittal for Yucca Mountain present technical and regulatory challenges concerning repository performance. Presentations highlight science and engineering supporting the development and safe operation of geologic repositories for radioactive waste. ORAL

T34. Monitoring to Confirm Performance Assessment of Nuclear Waste and Decommissioning Sites: Geoscience Input to Monitoring System Design through Identification and Measurement of Critical Features, Events, and Processes

GSA Hydrogeology Division

Environmental Geoscience; Hydrogeology; Public Policy

George V. Last, Pacific Northwest National Lab, Richland, Wash.; Tom Temples, University of South Carolina, Columbia, S.C.; Van Price, Advanced Environmental Solutions, LLC, Lexington, S.C.

Critical geo-input to be obtained and retained in computer models for performance assessment. Case histories. Focus positive—identify critical features and measurements and assure that these are represented and updated in site (performance) models. ORAL

T35. Assessment and Characterization of Geologic Formations for Long-Term CO₂ Storage (Sequestration)

GSA Geology and Public Policy Committee

Stratigraphy; Hydrogeology; Structural Geology

Jonathan J. Kolak, U.S. Geological Survey, Reston, Va.; Sean Brennan, U.S. Geological Survey, Reston, Va.

This session will explore novel approaches to assess the capacity and integrity of geologic formations for long-term CO₂ storage (sequestration). These approaches may include aspects of geochemistry, hydrogeology, geospatial analysis, or other innovative methods. ORAL

T36. Geophysical Solutions for Characterizing and Locating Geological Sites for Carbon Dioxide Sequestration

GSA Geophysics Division

Geophysics/Tectonophysics/Seismology; Engineering Geology; Public Policy

John H. McBride, Brigham Young University, Provo, Utah; James A. Drahovzal, University of Kentucky, Lexington, Ky.; Hannes E. Leetaru, Illinois State Geological Survey, Champaign, Ill.; John Rupp, Indiana Geological Survey, Bloomington, Ind.

Papers are solicited on using geophysical and geological subsurface remote sensing for locating, characterizing, and mapping buried structures that could serve as sites for carbon dioxide sequestration as well as on the societal issues involved. ORAL

T37. GIS, GPS, and Remote Sensing in Geologic Hazard Assessment

GSA Engineering Geology Division

Engineering Geology; Remote Sensing/Geographic Information System; Public Policy

William C. Haneberg, Haneberg Geoscience, Seattle, Wash.; Norman S. Levine, Charleston, S.C.

Case histories and research using geographic information system, Global Positioning System, or remote sensing (including LiDAR [light detection and ranging], InSAR [interferometric synthetic aperture radar], digital elevation models, or hyper-spectral imaging) for mapping or simulating landslides, debris flows, floods, neotectonic and volcanic processes, subsidence, karst, and other hazards. ORAL and POSTER

T38. Rural Source Water Protection—Stakeholder Needs, Public Policy, and Hydrogeologic Realities for Small Systems

GSA Hydrogeology Division; U.S. Environmental Protection Agency, Office of Water

Environmental Geoscience; Geoscience Information/Communication; Hydrogeology

John All, Western Kentucky University Technical Assistance Center for Water Quality, Bowling Green, Ky.; Chris Groves, Hoffman Environmental Research Institute, Bowling Green, Ky.; Stephen Kenworthy, Western Kentucky University Technical Assistance Center for Water Quality, Bowling Green, Ky.

Clean drinking water is a fundamental requirement for human health. Supplies depend on hydrogeologic, economic, and cultural variables and rural systems face particular challenges. We solicit papers on source water protection strategies serving these goals. ORAL

T39. Current Perspectives in Environmental Biogeochemistry

GSA Hydrogeology Division; GSA Geobiology and Geomicrobiology Division

Environmental Geoscience; Geochemistry, Aqueous; Hydrogeology

Dibyendu Sarkar, University of Texas, San Antonio, Texas; Rupali Datta, University of Texas, San Antonio, Texas

This session will promote interchange of scientific information among earth scientists interested in environmental biogeochemical issues. It will provide a forum for researchers to present recent findings that can stimulate development of future interdisciplinary research. ORAL

T40. Hydrogeomorphology, Chemistry, Archaeology, and Evolution of Coastal Plain Depressions and Related Features

GSA Hydrogeology Division

Hydrogeology; Quaternary Geology/Geomorphology; Stratigraphy

C. William Zanner, University of Nebraska, Lincoln, Nebr.; Andrew H. Ivester, University of West Georgia, Carrollton, Ga.

This session explores current understanding of the geomorphologic and hydrologic histories of Carolina bays and related depressional features. ORAL and POSTER

T41. The Gulf of Mexico—Past, Present, and Future: Relating Ecology to Geology

Marine/Coastal Science; Environmental Geoscience; Quaternary Geology/Geomorphology

Charles W. Holmes, Center for Coastal Geology, St. Petersburg, Fla.; John W. Tunnell, Harte Institute for Gulf of Mexico Research, Corpus Christi, Texas

The session's goal is twofold: (1) to update the status of geologic knowledge in the Gulf of Mexico, and (2) to relate the surface geologic processes to the ecology of various regions. ORAL and POSTER

T42. Authigenic Minerals in Modern and Ancient Terrestrial Aquatic Environments

GSA Limnogeology Division; GSA Sedimentary Geology Division

Limnogeology; Sediments, Carbonates; Sediments, Clastic

Daniel Larsen, University of Memphis, Memphis, Tenn.; Daniel Deocampo, California State University, Sacramento, Calif.

This session will present new ideas and concepts toward understanding and interpreting authigenic mineral processes in ancient and modern terrestrial aquatic environments, ranging from riverine or wetland to deep lacustrine settings. ORAL

T43. Hydrologic and Paleoclimatic Significance of Nonmarine Microbial Carbonates (Tufas, Microbialites, Stromatolites and Thrombolites)

GSA Limnogeology Division

Limnogeology; Sediments, Carbonates; Paleoclimatology/Paleoceanography


Michael R. Rosen, U.S. Geological Survey, Carson City, Nev.; Robin Renaut, University of Saskatchewan, Saskatoon

This session explores the sedimentological record of nonmarine microbial carbonates and demonstrates the diversity of records that can be derived from these deposits. Emphasis is on lacustrine systems, but other nonmarine microbial carbonates will be considered. ORAL

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T44. Lacustrine Records of Landscape Evolution

GSA Limnogeology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division

Limnogeology; Quaternary Geology/Geomorphology; Sediments, Clastic

Jeffrey T. Pietras, BP Exploration Alaska, Inc., Anchorage, Alaska; Eric C. Carson, San Jacinto College, Houston, Texas; Alan R. Carroll, University of Wisconsin, Madison, Wis.

Lacustrine strata contain a bountiful archive of terrestrial geomorphic, tectonic, and climatic events. This session addresses the intersections of geomorphology, sedimentology, and stratigraphy for interpreting the lacustrine geologic record of terrestrial landscape change, focusing on the Cenozoic. ORAL

T45. Alkaline Evaporative Lakes and Playas: Insights into Microbial Physiology and Mineral Facies in Semiarid Settings

GSA Geobiology and Geomicrobiology Division; Limnogeology and Sedimentary Geology

Geomicrobiology; Geochemistry, Aqueous; Limnogeology

David Finkelstein, Indiana University, Bloomington, Ind.; Thomas R. Kulp, U.S. Geological Survey, Menlo Park, Calif.; Lisa M. Pratt, Indiana University, Bloomington, Ind.

This session will elucidate the role of alkaline solutions in weathering, evaporite precipitation, and microbial physiology. Topics will focus on the geochemical and isotopic signatures of alkaliphilic microbes, mineral facies, and redox gradients. ORAL and POSTER

T46. Biomineralization in Terrestrial Hot Springs: The Preservation of Thermophiles in Past and Present-Day Systems

GSA Geobiology and Geomicrobiology Division

Geomicrobiology; Paleontology/Paleobotany; Geochemistry, Aqueous

Paul A. Schroeder, University of Georgia, Athens, Ga.; Sherry L. Cady, Portland State University, Portland, Ore.

This session invites those who study modern terrestrial hot springs with an eye for mineral-microbe relationships and how evidence for life might be preserved. Analog studies of ancient hot spring deposits are also welcomed. ORAL

T47. Ocean Chemistry through the Precambrian and Paleozoic

Paleoclimatology/Paleoceanography; Sediments, Carbonates; Geochemistry, Other

Matthew R. Saltzman, The Ohio State University, Columbus, Ohio; Michael C. Pope, Washington State University, Pullman, Wash.

Considerable evidence reveals significant changes in the chemistry of the oceans during the Precambrian and Paleozoic. These changes have implications for Earth's climate and biosphere. We will focus on a combined data-modeling approach. ORAL

T48. Unraveling the History of Ocean Crust Production: Evidence For and Against Changes in Seafloor Spreading Rates Since the Mesozoic

Paleoclimatology/Paleoceanography; Tectonics; Geochemistry, Other

Jenney M. Hall, Yale University, New Haven, Conn.; David B. Rowley, University of Chicago, Chicago, Ill.; Mark Pagani, Yale University, New Haven, Conn.

This session invites evidence for and against changes in the rate of seafloor crust production as well as implications regarding the global carbon cycle and secular changes in seawater chemistry from both modeling results and empirical data. ORAL and POSTER

T49. Stable Isotopes in Fossils and Paleosols: Records of Late Cenozoic Environmental Change

Geochemistry, Other; Paleoclimatology/Paleoceanography; Paleontology/Paleobotany

Yang Wang, Florida State University and National High Magnetic Field Laboratory, Tallahassee, Fla.; Pennilyn Higgins, University of Florida, Gainesville, Fla.

Stable isotope analysis has been established as a valuable tool for reconstructing past terrestrial environments. This session will examine isotopic records to better understand the links among biological, climatic, and tectonic change. ORAL

T50. Marine Hard Substrates: Colonization and Evolution

Paleontological Society

Paleontology/Paleobotany; Marine/Coastal Science; Stratigraphy

Stephen K. Donovan, National Natuurhistorisch Museum, Leiden, Netherlands; Paul D. Taylor, The Natural History Museum, London, United Kingdom

Marine hard substrates represent a distinct suite of habitats that have seen a range of evolutionary innovations during the Phanerozoic. This meeting will review new data and ideas on these ecosystems and their evolution. ORAL

T51. Protistan Paleobiodiversity: Understanding Evolutionary Patterns

Cushman Foundation

Paleontology/Paleobotany; Paleoclimatology/Paleoceanography; Geomicrobiology

Susan T. Goldstein, University of Georgia, Athens, Ga.; Brian T. Huber, Smithsonian Institution, Washington, D.C.

Rich and well-documented, the protistan fossil record provides the foundation for diverse global change studies. This session focuses on understanding the evolutionary mechanisms and phylogenetic relationships underpinning protistan biodiversity in modern and ancient systems. ORAL

T52. The Hunters and the Hunted: Predation On and By Gastropods

Paleontological Society

Paleontology/Paleobotany

Patricia H. Kelley, University of North Carolina, Wilmington, N.C.; Thor A. Hansen, Western Washington University, Bellingham, Wash.; Gregory P. Dietl, University of North Carolina, Wilmington, N.C.

Fossil gastropods preserve evidence of predator-prey interactions useful in studying the ecological and evolutionary consequences of predation. Presentations will address predation on and by fossil gastropods and Recent taxa useful in interpreting the fossil record. ORAL

T53. Critical Events in the Evolution of Terrestrial Arthropods

Paleontological Society; GSA Geobiology and Geomicrobiology Division

Paleontology/Paleobotany; Sediments, Clastic; Stratigraphy

Robert E. Nelson, Colby College, Waterville, Maine; Dena M. Smith, University of Colorado, Boulder, Colo.; S. Bruce Archibald, Harvard University, Cambridge, Mass.

Insects and terrestrial arthropods comprise >90% of all named animal species on Earth. Their fossil record is far less well-known. What are the events that have led to the evolution of terrestrial arthropod clades? ORAL and POSTER

T54. The Evolution and Expansion of C4 Plants

Paleontology/Paleobotany; Paleoclimatology/
Paleoceanography; Geochemistry Organic

Mark Pagani, Yale University, New Haven, Conn.; Darren Grocke, McMaster University, Hamilton, Ontario

The evolutionary history and expansion of C4 plants impact our interpretation of atmospheric CO₂ concentrations, temperature, and seasonal aridity. This session explores the history of C4 photosynthesis during the Mesozoic and Cenozoic. ORAL and POSTER

T55. Anatomy of an Anachronistic Period: The Early Triassic Environment and Its Effect on the History of Life

Paleontological Society

Paleontology/Paleobotany; Sediments, Carbonates;
Paleoclimatology/Paleoceanography

Adam D. Woods, California State University, Fullerton, Calif.; Frank Corsetti, University of Southern California, Los Angeles, Calif.

The Early Triassic was one of the most unique periods in Earth's history. This session will examine the usual nature of environmental conditions during the period as well as paleobiological trends across the critical interval between the End-Permian extinction and initiation of the biotic recovery in the early Middle Triassic. ORAL

T56. Paleontology and Stratigraphy of the Late Eocene Florissant Formation, Colorado

Paleontological Society

Paleontology/Paleobotany; Geoscience Information/
Communication; History of Geology

Herbert W. Meyer, Florissant Fossil Beds National Monument, Florissant, Colo.; Dena Smith, University of Colorado, Boulder, Colo.

This session will explore the paleontology, stratigraphic setting, and historical study of the late Eocene plants, insects, and vertebrates from Florissant, including recent work in taxonomy, taphonomy, paleoecology, lithostratigraphy, magnetostratigraphy, conservation, and applications of information technology. ORAL

T57. The Concept of Layer-Cake Stratigraphy—Then and Now

GSA History of Geology Division; GSA Sedimentary Geology Division

History of Geology; Stratigraphy

Charles W. Byers, University of Wisconsin, Madison, Wis.

The concept of layer-cake (time-parallel) stratigraphy was widely accepted during the nineteenth century. It was eclipsed by the facies concept for decades but has made a resurgence in the guise of sequence and event stratigraphy. ORAL

T58. Sedimentary and Stratigraphic Principles and Concepts Applied to the Study of Metamorphic Terranes and Igneous Provinces

North American Commission on Stratigraphic Nomenclature

Petrology, Metamorphic; Sediments, Clastic; Economic Geology

Lisa Lytle, Golden, Colo.; Thomas R. Fisher, Golden, Colo.

This session will focus on integration of modern sedimentologic and stratigraphic concepts with studies of metamorphic and igneous provinces. These methods may improve our understanding of continental accretion, paleoplacers, ore deposits, and layered mafic intrusions. ORAL

T59. Resolving the Late Paleozoic Gondwanan Ice Age in Time and Space: Comparison of Southern and Northern Hemisphere Records

Stratigraphy; Sediments, Clastic; Sediments, Carbonates

Christopher R. Fielding, University of Nebraska, Lincoln, Nebr.; Tracy D. Frank, University of Nebraska, Lincoln, Nebr.

This session aims to bring together stratigraphers, sedimentologists and geochemists who are working on the climate record of the Carboniferous and Permian systems worldwide. Emphasis will be placed on integrating geochemical with lithostratigraphic archives. ORAL

T60. Sedimentary Geology and Earth History: Retrospective and Prospective: In Honor of the Career and Contributions of Robert H. Dott Jr.

GSA Sedimentary Geology Division; GSA History of Geology Division

Stratigraphy; History of Geology; Geoscience Education

Joanne Bourgeois, University of Washington, Seattle, Wash.; Marjorie A. Chan, University of Utah, Salt Lake City, Utah; Gary Kocurek, University of Texas, Austin, Texas

Bob Dott's career has spanned important changes in sedimentary geology and Earth's history and in the philosophy of geology. Students and colleagues of Bob Dott will reflect on those changes, and on his research and educational contributions. ORAL and POSTER

T61. Frontier in Understanding the Geologic Record of Climate Change: A Session in Honor of William W. Hay

GSA Sedimentary Geology Division; GSA Geobiology and Geomicrobiology Division; GSA Limnogeology Division; GSA Structural Geology and Tectonics Division

Paleoclimatology/Paleoceanography; Marine/Coastal Science; Paleontology/Paleobotany

Eric J. Barron, Pennsylvania State University, University Park, Pa.; Robert DeConto, University of Massachusetts, Amherst, Mass.

A remarkable revolution has taken place in the geosciences associated with a growing understanding of climate and climate change. This revolution is providing context for much of our interpretation and understanding of the earth system. ORAL and POSTER

T62. Wild Coal Fires: Burning Questions with Global Consequences?

GSA Coal Geology Division

Coal Geology; Environmental Geoscience; Engineering Geology

Glenn Blair Stracher, East Georgia College, University System of Georgia, Swainsboro, Ga.; Ed Heffern, Cheyenne, Wyo.

This session will feature presentations and discussions about all aspects of these catastrophic fires, including global consequences. ORAL

T63. Raton Basin: From Coal to Coalbed Methane

GSA Coal Geology Division

Coal Geology; Tectonics; Hydrogeology

Gretchen K. Hoffman, New Mexico Institute of Mining and Technology, Socorro, N.Mex.; Christopher J. Carroll, Colorado Geological Survey, Denver, Colo.

This session is designed to highlight the latest regional coal geology, tectonic, geochemistry and hydrologic research being done throughout the Raton Basin. The session will be dedicated to Charles Pillmore. ORAL and POSTER

T64. Genetic Links among Syngenetic Metal Accumulations in Sedimentary Basins: Giant Sediment-Hosted Metal Deposits to Metalliferous Black Shales

Society of Economic Geologists

Economic Geology

Poul Emsbo, U.S. Geological Survey, Denver, Colo.; Eric E. Hiatt, University of Wisconsin, Oshkosh, Wis.

This multidisciplinary session will explore the origin of sediment-hosted metal accumulations, the conditions that result in formation of diverse types in correlative strata, and their links to secular variations in ocean chemistry. ORAL

T65. Stable Isotopes of Ore-forming Metals: Analysis and Applications

Economic Geology; Geochemistry, Other; Environmental Geoscience

Jamie J. Wilkinson, Imperial College London, London

The aim of this session is to bring together researchers who are at the cutting edge of the new field of transition metal iso-

tope geochemistry, applying metal isotope systematics to understanding problems in ore deposit genesis. ORAL

T66. Widespread Importance of Immiscible H₂O-CO₂ Fluids for Petrologic and Geochemical Processes in Low to Moderate Temperature Crustal Environments

Geochemical Society

Geochemistry, Aqueous; Geochemistry, Other; Petrology, Metamorphic

John P. Kaszuba, Los Alamos National Lab, Los Alamos, N.Mex.; David R. Janecky, Los Alamos National Lab, Los Alamos, N.Mex.

Geochemical reaction models include CO₂ as a major ligand and precipitate, but have generally neglected multiphase fluid implications. This session is intended to explore and contrast the evidence and behavior of high CO₂ natural systems. ORAL

T67. Advanced Characterization of the Structures and Behaviors of Minerals

Mineralogical Society of America

Mineralogy/Crystallography

Peter J. Heaney, Pennsylvania State University, University Park, Pa.; Jeffrey E. Post, Smithsonian Institution, Washington, D.C.; Michael C. Carpenter, Tucson, Ariz.

Innovations in microanalytical and microstructural characterization techniques are providing a deeper understanding of the factors that control mineral reaction mechanisms. This session invites contributions that explore the relation between atomic scale structure and macroscale behavior. ORAL

T68. Nano-Geochemistry and Nano-Structures in Earth Systems

Geochemistry, Other; Mineralogy/Crystallography; Environmental Geoscience

Huifang Xu, University of New Mexico, Albuquerque, N.Mex.

Nano-structures and self-assembled nano-structures can provide information about their formation. Geochemical reactions in confined nanopores are different from those in bulk systems. This session will focus on nano-scale processes in geological environments. ORAL and POSTER

T69. Looking Forward to the Past: A Session in Honor of Paul Ribbe and the Reviews in Mineralogy and Geochemistry

Mineralogical Society of America

Mineralogy/Crystallography; Petrology, Experimental; Petrology, Metamorphic

Ross Angel, Virginia Tech, Blacksburg, Va.; Nancy Ross, Virginia Tech, Blacksburg, Va.

Contributions that reflect on any past, present or future aspect of the topics that have been covered by the *Reviews in Mineralogy and Geochemistry* are invited for this mineralogy session in honor of Paul Ribbe. ORAL and POSTER

T70. Modeling Grain-Scale Processes in Metamorphic Rocks

Mineralogical Society of America; GSA Structure and Tectonics Division

Petrology, Metamorphic; Structural Geology; Mineralogy/Crystallography

W.D. Carlson, University of Texas, Austin, Texas; C.T. Foster, University of Iowa, Iowa City, Iowa

This session will synthesize recent advances stemming from a broad range of approaches to modeling deformation and reaction processes at the mm to cm scale in metamorphic rocks. ORAL and POSTER

T71. Granitic Pegmatites: Recent Advances in Mineralogy, Petrology, and Understanding

Mineralogical Society of America

Petrology, Igneous; Mineralogy/Crystallography; Geochemistry, Other

David London, University of Oklahoma, Norman, Okla.

Recent contributions to the mineralogy, petrology, and genesis of granitic pegmatites are welcome. Topics to be covered include mineral chemistry and stability, melt inclusions, experimental petrology, numerical models, field geology, and mining. ORAL and POSTER

T72. Impact Geology

GSA Planetary Geology Division

Planetary Geology

David King, Auburn University, Auburn, Ala.; Jared Morrow, University of Northern Colorado, Greeley, Colo.

A session devoted to the emerging field of impact studies, including astronomy, impact-related archaeology, cratering, impact modeling, shock metamorphism, mass extinctions, meteoritics, tektite studies, and ejecta stratigraphy. ORAL and POSTER

T73. Early Paleoproterozoic (2.5–2.0 Ga) Events and Rates: Bridging Field Studies and Models

Precambrian (At Large); Geochemical Society; GSA Sedimentary Geology Division, SEPM—Society for Sedimentary Geology, Astrobiology Program

Precambrian Geology; Paleoclimatology/Paleoceanography; Tectonics

Andrey Bekker, Geophysical Lab, Carnegie Institution of Washington, Washington, D.C.; Mark E. Barley, The University of Western Australia, Western Australia, Australia; Robert H. Rainbird, Geological Survey of Canada, Ottawa, Ontario

Field-oriented and modeling studies dealing with the 2.5–2.0 Ga Earth's evolution are invited. Session will be focused on relationships between tectonics, change in atmospheric composition, and climatic changes as well as the rates of these changes. ORAL

T74. 1500 to 2500 Ma: A Period of Changing Mantle Regimes in Earth History?

Precambrian (At Large); GSA Geophysics Division

Precambrian Geology; Tectonics; Paleoclimatology/Paleoceanography

Kent C. Condie, New Mexico Institute of Mining and Technology, Socorro, N.Mex.; Dallas Abbott, Lamont-Doherty Earth Observatory, Palisades, N.Y.

This session will focus on change and interaction of earth systems between 1500 and 2500 Ma. Papers are especially solicited that deal with mantle dynamics, crustal evolution, the supercontinent cycle, and paleoclimatic regimes. ORAL

T75. A Xenolith Perspective on the Physical and Chemical Evolution of Continental Lithosphere

GSA Structural Geology and Tectonics Division; Mineralogical Society of America; GSA Geophysics Division

Geochemistry, Other; Geophysics/Tectonophysics/Seismology; Petrology, Metamorphic

Jane Selverstone, University of New Mexico, Albuquerque, N.Mex.; Roberta L. Rudnick, University of Maryland, College Park, Md.

We seek contributions from a diversity of disciplines to examine the role that mantle and crustal xenolith studies play in constraining the composition, age, physical properties, and petrologic evolution of continental lithosphere. ORAL and POSTER

T76. Pre-EarthScope Synthesis of the Rocky Mountains I: Framing the Key Geological, Geophysical, and Geodynamic Controversies

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Rocky Mountain Association of Geologists; Colorado Scientific Society; EarthScope

Tectonics; Geophysics/Tectonophysics/Seismology; Quaternary Geology/Geomorphology

Karl E. Karlstrom, University of New Mexico, Albuquerque, N.Mex.; Rick Aster, New Mexico Institute of Mining and Technology, Socorro, N.Mex.

Synthesis of controversies related to lithospheric evolution of the Rocky Mountain region, with linkages among the geology, geophysics, geomorphology, and geodynamics communities to help shape an interdisciplinary approach to a still-embryonic EarthScope science program. ORAL and POSTER

T77. Pre-EarthScope Synthesis of the Rocky Mountains II: Surface Processes, Geodynamics, and the Roles of Neotectonics and Climate in Development of Modern Topography

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; GSA Quaternary Geology and Geomorphology Division; Rocky Mountain Association of Geologists; Colorado Scientific Society; EarthScope

Tectonics; Geophysics/Tectonophysics/Seismology; Quaternary Geology/Geomorphology

Eric Kirby, Pennsylvania State University, University Park, Pa.

Studies of rock and surface uplift and development of the present topography, including studies of paleoelevation, mantle to surface interconnections, geodynamics of intracratonic deformation, and relative importance of neotectonics versus climate in development of relief. ORAL and POSTER

T78. Pre-EarthScope Synthesis of the Rocky Mountains III: New Advances in Laramide Deformation and Tectonics of Rocky Mountain Basement-Involved Structures: In Honor of Donald L. Blackstone Jr.

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Wyoming Geological Association; Rocky Mountain Association of Geologists; Colorado Scientific Society; EarthScope

Structural Geology; Tectonics; Geophysics/Tectonophysics/Seismology

Eric Erslev, Colorado State University, Fort Collins, Colo.; David Lageson, Montana State University, Bozeman, Mont.; Arthur Snoke, University of Wyoming, Laramie, Wyo.

This session honors Don Blackstone's pioneering work on Rocky Mountain structures by presenting new geological and geophysical studies of Laramide structures that provide important insights into the linkage between basement-involved foreland structures and lithospheric processes. ORAL and POSTER

T79. Pre-EarthScope Synthesis of the Rocky Mountains IV: New Ideas on Late Paleozoic Intraplate Orogenesis: The Greater Ancestral Rocky Mountains

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Friends of the Ancestral Rocky Mountains; EarthScope

Tectonics; Stratigraphy; Structural Geology

Charles F. Kluth, Colorado School of Mines, Golden, Colo.; Gerylyn S. Soreghan, University of Oklahoma, Norman, Okla.

This session will provide a forum for new data and interpretations on late Paleozoic tectonics and tectonic-climatic interactions in western Pangea, enabling integration of ideas from diverse geographic settings and scientific disciplines. ORAL and POSTER

T80. Pre-EarthScope Synthesis of the Rocky Mountains V: New Insights in Basement Tectonics, Deep Crustal Structure and Precambrian Tectonic Evolution

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Rocky Mountain Association of Geologists; Colorado Scientific Society; EarthScope

Tectonics; Geophysics/Tectonophysics/Seismology; Quaternary Geology/Geomorphology

Michael Williams, University of Massachusetts, Amherst, Mass.; Karl E. Karlstrom, University of New Mexico, Albuquerque, N.Mex.

Studies of processes of accretion of juvenile lithosphere, location of major sutures, lithospheric stabilization and reactivation processes, and cumulative tectonic evolution of the basement leading to today's geophysical state of the crust and upper mantle. ORAL and POSTER

T81. Regional Geology of the Northern Rockies: A Session Honoring Betty Skipp

GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; SEPM—Society for Sedimentary Geology

Tectonics; Structural Geology; Stratigraphy

Paul K. Link, Idaho State University, Pocatello, Idaho; Susanne Janecke, Utah State University, Logan, Utah; David Lageson, Montana State University, Bozeman, Mont.

For 50 years, Betty Skipp, U.S. Geological Survey, has, learned, taught, and led by example in understanding the paleontological, sedimentary, and structural development of the northern Rocky Mountains. Historical syntheses, state-of-the-art ideas, and student papers are welcomed. ORAL and POSTER

T82. Bill Braddock's Backyard—Proterozoic to Recent Geology of the Northern Colorado Front Range

GSA Structural Geology and Tectonics Division

Precambrian Geology; Structural Geology; History of Geology

James C. Cole, U.S. Geological Survey, Denver, Colo.; William Nesse, University of Northern Colorado, Greeley, Colo.

An eclectic session reflecting the broad interests and accomplishments of one of Colorado's premier field geologists in one of the most scenic and geologically diverse outdoor laboratories. A tribute to the career of William A. Braddock. ORAL

T83. Cordilleran Arc Magmatism, BATHOLITHS and Continental Crustal Genesis

GSA Geophysics Division; GSA Structural Geology and Tectonics Division

Tectonics; Petrology, Igneous; Geophysics/Tectonophysics/Seismology

Mihai N. Ducea, University of Arizona, Tucson, Ariz.; Christopher Andronicos, University of Texas, El Paso, Texas; Paul Wetmore, University of Arizona, Tucson, Ariz.

Petrologists, geochronologists, structural geologists, and geophysicists will present data and models on the evolution of continental arcs, with a special emphasis on the Coast Mountains batholith and preliminary data from the National Science Foundation Continental Dynamics project BATHOLITHS. ORAL

T84. Terrane Translation, Orogenesis, and Plate Interactions in the Late Mesozoic to Early Cenozoic North American Cordillera, and Implications for Paleogeographic Reconstructions

GSA Geophysics Division; GSA Structural Geology and Tectonics Division

Tectonics; Stratigraphy; Geophysics/Tectonophysics/Seismology

Paul Umhoefer, Northern Arizona University, Box 4099, Flagstaff, Ariz.; Sandra Wyld, University of Georgia, Athens, Ga.; James E. Wright, University of Georgia, Athens, Ga.

Session will focus on the interrelations among terrane translation, orogenesis, and plate motions; the amount and sense of terrane displacements; and the implications of new and existing data for paleogeographic and tectonic reconstructions. ORAL and POSTER



Title Sponsor of the 2004 GSA Annual Meeting.

T85. Whence the Mountains? New Developments in the Tectonic Evolution of Orogenic Belts: Celebrating the Dynamic Career of Raymond A. Price at the 50-Year Mark

GSA Structural Geology and Tectonics Division; Geological Association of Canada

Tectonics; Structural Geology; Geophysics/Tectonophysics/Seismology

James W. Sears, University of Montana, Missoula, Mont.; Tekla A. Harms, Amherst College, Amherst, Mass.; Carol Evenchick, Natural Resources Canada, Vancouver, British Columbia

An investigation into the tectonic evolution of ancient and active mountain belts from around the globe, using traditional and innovative methods at all scales of observation. ORAL and POSTER

T86. Ribbon Continents: Their Origin, Development, and Role in Rifting and Orogenesis

GSA Structural Geology and Tectonics Division; GSA Geophysics Division

Tectonics; Structural Geology; Geophysics/Tectonophysics/Seismology

Phil J.A. McCausland, University of Michigan, Ann Arbor, Mich.; Stephen T. Johnston, University of Victoria, Victoria, British Columbia

Ribbon continents, long assemblages of rifted continental fragments and intraoceanic arcs, are a locus of crustal deformation and growth. This session explores their occurrence and role in the evolution of continental margins and orogenic belts. ORAL

T87. Recent Advances in Himalayan Geology

GSA Structural Geology and Tectonics Division

Tectonics; Volcanology; Geophysics/Tectonophysics/Seismology

Elizabeth J. Catlos, Oklahoma State University, Stillwater, Okla.; Richard A. Marston, Oklahoma State University, Stillwater, Okla.

Recent discoveries regarding the evolution of the Himalayas will be examined with the goal of disseminating and exploring broader implications of information gained from this type locality of continent-continent convergence. ORAL

T88. Thrust Belts and Plateaus: The Anatomy of Convergent Systems

GSA Structural Geology and Tectonics Division; GSA Geophysics Division

Tectonics; Geophysics/Tectonophysics/Seismology; Structural Geology

Delores M. Robinson, University of Alabama, Tuscaloosa, Ala.; Nadine McQuarrie, California Institute of Technology, Pasadena, Calif.

We encourage papers that explore the linkage between foreland fold-thrust belts and adjacent hinterland plateaus in orogenic systems through deformation and elevation histories and mechanisms, rates of uplift and erosion, kinematic processes, and morphology. ORAL and POSTER

T89. Tectonic Evolution of the Arctic Basin and its Margins

GSA Structural Geology and Tectonics Division

Tectonics; Geophysics/Tectonophysics/Seismology; Marine/Coastal Science

Jaime Toro, West Virginia University, Morgantown, W.Va.; Jeffrey M. Amato, New Mexico State University, Las Cruces, N.Mex.

This session highlights the tectonic evolution of one of the least understood regions of Earth: the Arctic oceanic basin and the surrounding margins and continental terranes. ORAL and POSTER

T90. Low-angle Normal Faults and Faulting: Field Studies, Fault Rocks, Mechanics, and Weakening Mechanisms

GSA Structural Geology and Tectonics Division; GSA Geophysics Division

Structural Geology; Tectonics; Petrology, Metamorphic

Robert E. Holdsworth, University of Durham, Durham, United Kingdom; Darrel S. Cowan, University of Washington, Seattle, Wash.; Cristiano Collettini, Università di Perugia, Perugia, Italy

An interdisciplinary session where field geologists, experimentalists, seismologists, geodynamicists, and others can present observational evidence and theoretical insights on low-angle normal faults and faulting. ORAL and POSTER

T91. Paleomagnetism and Rock Magnetism Perspective of Shear Zone Kinematics

GSA Geophysics Division; GSA Structural Geology and Tectonics Division

Geophysics/Tectonophysics/Seismology; Tectonics; Structural Geology

Tim F. Wawrzyniec, University of New Mexico, Albuquerque, N.Mex.; Mike Petronis, University of New Mexico, Albuquerque, N.Mex.

Integrated studies of shear-zone processes benefit greatly from applied paleomagnetic and rock magnetic investigations. The goal of this session is to demonstrate from a geophysical perspective the applications and caveats of applied paleomagnetism and rock magnetic studies in understanding shear zone kinematics. ORAL and POSTER

T92. Neotectonics and Earthquake Potential of the Eastern Mediterranean Region

GSA Structural Geology and Tectonics Division; GSA Geophysics Division

Geophysics/Tectonophysics/Seismology; Neotectonics/Paleoseismology; Tectonics

Ibrahim Çemen, Oklahoma State University, Stillwater, Okla.; Eric Sandvol, University of Missouri, Columbia, Mo.; Omer Emre, MTA, Ankara, Turkey

Different research groups have been studying neotectonics and earthquake potential of major tectonic features of different portions of the eastern Mediterranean region. This session plans to provide a formal discussion on problems related to neotectonics of the region. ORAL and POSTER

Q. On What Fossilized Creature Would You Find a Pygidium?

Like trivia? Get a team together and battle it out during GSA's first Geoscience Trivia Night at the GSA Annual Meeting in Denver!

GEOSCIENCE TRIVIA NIGHT

Tuesday, November 9, 2004
8-10 p.m.

(Location to be announced.)

Put your knowledge to the test in this competition with your peers and friends on more than 100 geoscience trivia questions.

For more information and team registration, e-mail Gary Lewis at glewis@geosociety.org.

Answer: Trilobite

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T93. Crustal Seismic Anisotropy as a Measure of Regional Tectonic Deformation (Posters)

GSA Geophysics Division; GSA Structural Geology and Tectonics Division

Geophysics/Tectonophysics/Seismology; Tectonics; Structural Geology

David Okaya, University of Southern California, Los Angeles, Calif.; Nikolas Christensen, University of Wisconsin, Madison, Wis.

This session explores how crustal seismic anisotropy may serve as a proxy for intracrustal deformation by combining tectonic formation and regional distributions of shear and metamorphic fabrics, anisotropic material properties, and observations of seismic waves. POSTER

T94. Geoinformatics and Geological Sciences: The Next Step (Posters)

GSA Geophysics Division

Geophysics/Tectonophysics/Seismology; Tectonics; Geoscience Information/Communication

Ramon Arrowsmith, Arizona State University, Tempe, Ariz.; Charles Meertens, UNAVCO, Inc., Boulder, Colo.

Present results of geoinformatics projects in the geoscience community, in particular from those associated with distributed data and computational resource integration efforts. Explore areas where information technology developments can address geoscience problems. POSTER

T95. Differentiating Climatic from Tectonic Controls on Landscape Evolution (Posters)

GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics

Quaternary Geology/Geomorphology; Tectonics; Structural Geology

Claudia J. Lewis, Los Alamos National Lab, Los Alamos, N.Mex.; Eric V. McDonald, Desert Research Institute, Reno, Nev.; John Gosse, Dalhousie University, Halifax, Nova Scotia

Dynamic response of mountainous landscapes to climate-driven denudation bedevils determination of tectonic uplift. We seek papers that quantify landscape and lithospheric responses to climatic and tectonic forcing in active orogens and mountain belts undergoing postorogenic exhumation. POSTER

T96. Records of Late Quaternary Climatic Change from the Americas: Interhemispheric Synchronicity or Not

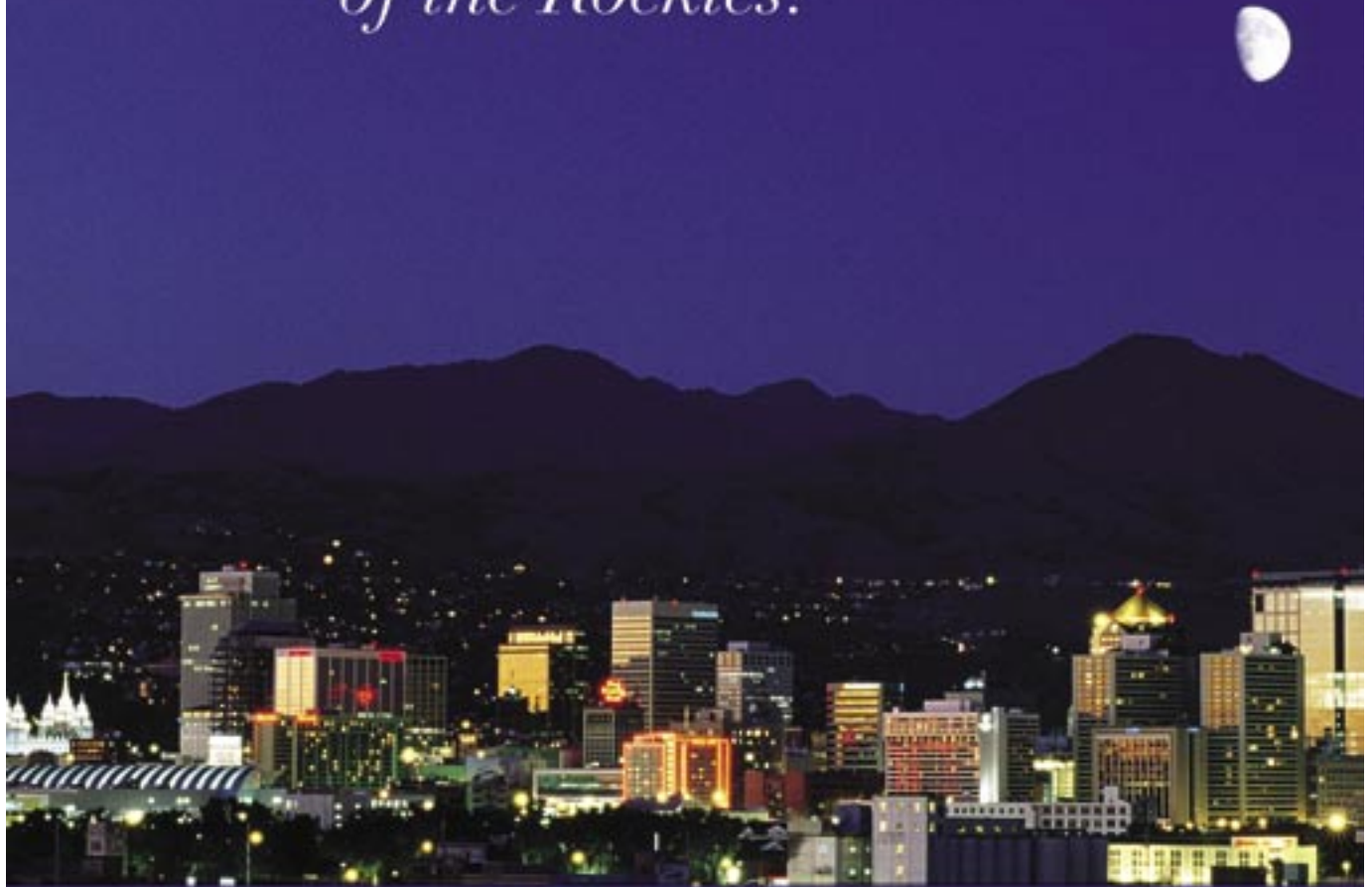
GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Paleoclimatology/Paleoceanography

Donald T. Rodbell, Union College, Schenectady, N.Y.; John T. Andrews, University of Colorado, Boulder, Colo.; Geoffrey O. Seltzer, Syracuse University, Syracuse, N.Y.

We seek papers that review high-resolution physical, chemical, and biological archives of climate change during the past ~30,000 years from the Americas, and also including Antarctica and Greenland. Our focus is mainly on terrestrial evidence,

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of the Rockies!*



117th Annual Meeting and Exposition!

*Salt Lake City, Utah
October 16–19, 2005*



Sunset skyline of Salt Lake, photo by Steve Greenwood. Used with permission from the Salt Lake Convention & Visitors Bureau.

but we also welcome near-shore marine records that directly record terrestrial events. ORAL and POSTER

T97. Geologic History and Processes of the Colorado River

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Environmental Geoscience; Stratigraphy

Keith A. Howard, U.S. Geological Survey, Menlo Park, Calif.;
Cassandra Fenton, Tucson, Ariz.

The history of the Southwest's Colorado River has intrigued scientists and the public for over a century. This session will explore Cenozoic geologic history and processes of the river from the Rockies to Mexico. ORAL and POSTER

T98. Evolution of the Great Plains Landscape

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology

Joseph A. Mason, University of Wisconsin, Madison, Wis.;
James B. Swinehart, School of Natural Resources, Lincoln, Nebr.;
J. Elmo Rawling, University of Wisconsin, Platteville, Wis.

This session will highlight research on late Cenozoic landscape evolution of the Great Plains. Topics will include rates and causes of stream incision, drainage network development, and the evolution of tablelands, badlands, dunefields, and playas. ORAL and POSTER

T99. The Midwest from Deglaciation to Settlement

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Paleoclimatology/
Paleoceanography; Limnogeology

Kathy J. Licht, Indiana University–Purdue University
Indianapolis, Indianapolis, Ind.; Tom Lowell, University of
Cincinnati, Cincinnati, Ohio

This interdisciplinary session will explore the landscape impacts of deglaciation, the postglacial transition and Holocene environments from the prairie-woodland boundary to the Appalachians. Investigations of lacustrine, loess, fluvial, and vegetation records are welcome. ORAL

T100. Glacial Outburst Floods: Causes and Consequences

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology

Amir Mokhtari Fard, Stockholm University, Stockholm, Sweden

This session would consider the less-explored causes and consequences of sudden and catastrophic events of release of large volumes of melt water from a glacier or glacier-dammed lake. ORAL

T101. The Red River Raft of Louisiana

GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Engineering Geology;
Hydrogeology

Nalini Torres, U.S. Army Corps of Engineers, Vicksburg, Miss.;
Danny W. Harrelson, U.S. Army Engineer Research and
Development Center, Vicksburg, Miss.

This is a review and description of the historic and current geomorphic evolution of the Red River to the development and removal of the raft. ORAL

T102. Quaternary Paleoenvironments of the Middle East: Proxy Records, Human Prehistory, and Regional Cross-Correlation

GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Archaeological
Geology; Paleoclimatology/Paleoceanography

Carlos E. Cordova, Oklahoma State University, Stillwater, Okla.;
Caroline Davies, University of Missouri, Kansas City, Mo.

This session will bring together Quaternary geoscientists and geoarchaeologists working in Middle Eastern countries to present and discuss paleoenvironmental records, and their application to issues of climate change chronologies, human prehistory, and regional geomorphological evolution. ORAL

T103. Documenting the Geomorphic and Ecosystem Evolution of National Park Landscapes Using Repeat Photography

*GSA Quaternary Geology and Geomorphology Division;
National Park Service, Natural Resources Program Center;
Geologic Resources Division*

Quaternary Geology/Geomorphology; Environmental
Geoscience; Remote Sensing/Geographic Information System

Harold S. Pranger, Denver, Colo.

Repeat photographs often clearly document recent historic changes to native and disturbed landscapes. National Parks are ideal locations for using repeat photographs to understand natural and anthropogenic changes to geomorphic and ecological systems. ORAL and POSTER

T104. Unveiling the Hidden Components in Archaeological Landscapes—The Role of Geoscience Techniques in Archaeological Site Analysis

GSA Archaeological Geology Division

Archaeological Geology; Quaternary Geology/
Geomorphology; Environmental Geoscience

Cynthia A. Stiles, University of Wisconsin, Madison, Wis.

A forum for research emphasizing integration of physical and geochemical techniques used in the geosciences field with archaeological studies to gain a better understanding of the interactive role humans have had with their environment. ORAL and POSTER

T105. Archaeological Geology of Stratigraphically Complex Localities

GSA Archaeological Geology Division

Archaeological Geology; Quaternary Geology/
Geomorphology; Sediments, Clastic

E.A. Bettis III, University of Iowa, Iowa City, Iowa

Stratigraphically complex localities contain some of the most complete and important archaeological records on Earth. This session addresses the interpretation of the complex array of

sedimentological, pedological, biological, and human factors that interact to form these records. ORAL

T106. Geological Context of Early Humans from Ethiopian Rift Basins

GSA Archaeological Geology Division; GSA Sedimentary Geology Division; GSA Limnogeology Division

Archaeological Geology; Stratigraphy; Paleontology/Paleobotany

Jay Quade, University of Arizona, Tucson, Ariz.; Jonathon Wynn, University of Oregon, Eugene, Ore.

Basin deposits in the Ethiopian rift are the richest source of fossil hominins in the world. This session will bring together recent research by expedition geologists on the geological context of these finds. ORAL

T107. Toward Effective Interdisciplinary Education in Archaeological Geology: Progress and Prospects

GSA Archaeological Geology Division; GSA Geoscience Education Division

Archaeological Geology; Geoscience Education; Quaternary Geology/Geomorphology

Jennifer R. Smith, Washington University, St. Louis, Mo.

Educators and geoscience professionals share their perspectives on the “ideal” training for archaeological geologists and on overcoming the particular philosophical and bureaucratic challenges of developing interdisciplinary curricula at the graduate and undergraduate levels. ORAL

T108. Geoarchaeology, Geoconservation, and Georesources: Integrated Approaches to Investigating, Conserving, and Managing Past and Present Landscapes

GSA Archaeological Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; GSA Geology and Public Policy Committee

Environmental Geoscience; Archaeological Geology; Geoscience Education

Jasper Knight, Loughborough University, Loughborough, United Kingdom

This session explores relationships between geology, geomorphology, human activity and landscape, and implications for management and conservation of landscape resources. Methodological and field-based papers using mapping, stratigraphic analysis, dating, geographic information system, and modeling are all invited. ORAL and POSTER

T109. Geology, Decisionmakers, and the Public: Challenges in Communication

GSA Geology and Society Division; GSA Geology and Public Policy Committee

Public Policy; Environmental Geoscience; Geoscience Information/Communication

Thomas J. Evans, University of Wisconsin—Extension, Madison, Wis.; John Kiefer, Kentucky Geological Survey, Lexington, Ky.

The engagement of geology in public policy relies upon effective communication. This session will focus on examples of successful and unsuccessful communication experiences. Both invited and volunteered presentations will be included. ORAL

T110. Information Technology Initiatives in the Geosciences: Policy, Strategy, and Management Issues

Geoscience Information/Communication; Public Policy; Geoscience Education

Soumava Adhya, University at Albany, SUNY, Albany, N.Y.

This session focuses on the experiences of the geosciences community regarding barriers and enablers to adoption and implementation of emerging information technologies, particularly on knowledge about and experiences with policy, strategy, and management. ORAL

T111. Geoscience Information and Librarianship in a Global Context

Geoscience Information Society

Geoscience Information/Communication; Geoscience Education

Linda R. Musser, Pennsylvania State University, University Park, Pa.

As geoscience becomes more global in scope, the tools librarians provide must also adapt. How well have traditional tools and processes changed to meet these new demands? What changes still need to be made? ORAL and POSTER

T112. Geologic Time and CHRONOS: Databases, Tools, Outreach, Education, and the Geoinformatics Revolution

Geoscience Information Society; Paleontological Society; CHRONOS

Geoscience Information/Communication; Stratigraphy; Geoscience Education

Cinzia Cervato, Iowa State University, Ames, Iowa; Walter S. Snyder, National Science Foundation, Arlington, Va.

Talks and posters will present results from the efforts of the geoinformatics community on database and data networking projects, demonstrate analytical and visualization tools, and illustrate community involvement and educational activities related to Earth's history. ORAL and POSTER

T113. Geology in the National Forests—Stewardship, Education, and Research

USDA Forest Service, Minerals and Geology Management Program

Geoscience Information/Communication; Environmental Geoscience; Geoscience Education

Joe T. Gurrieri, USDA Forest Service, Butte, Mont.; Andrew H. Rorick, USDA Forest Service, Sandy, Ore.; Jim Gauthier-Warinner, USDA Forest Service, Arlington, Va.

This session will explore some of the many aspects of geology conducted on the National Forests. Topics include paleontology, cave and karst geology, engineering geology and natural-hazard mitigation, hydrogeology, interpretive and recreational geology, geoecology, and more. ORAL

T114. Geology in the National Parks: Research, Mapping, and Resource Management

National Park Service

Geoscience Information/Communication; Paleontology/Paleobotany; Marine/Coastal Science

Bruce A. Heise, National Park Service, Geologic Resources Division, Lakewood, Colo.; Tim Connors, National Park Service, Denver, Colo.; Rebecca Beavers, National Park Service, Denver, Colo.; Greg McDonald, National Park Service, Lakewood, Colo.; Jeff Mow, Florissant Fossil Beds National Monument, Florissant, Colo.

This session will address the role of geoscience in the National Parks. Presentations are invited on geologic research, geologic mapping, paleontology, shoreline geology, and resource management in National Parks, Monuments, Seashores, and Historic Sites. ORAL

T115. The Keys to Opportunities with the National Park Service

National Park Service; Geological Society of America; American Geological Institute; Association for Women Geoscientists

Public Policy; Geoscience Information/Communication; Geoscience Education

Judy Geniac, Denver, Colo.; Gary Lewis, GSA Education and Outreach, Boulder, Colo.; Ann Beenbow, Alexandria, Va.; Marguerite Toscano

Discover the growing number of geoscience opportunities in national parks for professors, students, retirees, organizations, universities, and companies. Examine and discuss existing partnerships and access to research, programs, projects, and volunteer and paid positions. ORAL

T116. Geology for the Masses: Engaging the Public through Informal Geoscience Education in Parks, Monuments, Open Spaces, and Public Lands

GSA Geoscience Education Division; National Park Service; Bureau of Land Management; Association of Earth Science Editors

Geoscience Education; Geoscience Information/Communication; Environmental Geoscience

Jim Wood, National Park Service, Denver, Colo.; Allyson Mathis, National Park Service, Grand Canyon, Ariz.; Marion Malinowski, Bureau of Land Management, Lakewood, Colo.; Carol Ruthven, Association of Earth Science Editors, Lexington, Ky.; Monica Gaiswinkler Easton, Ministry of Northern Development and Mines, Sudbury, Ontario

This session will explore programs and products (e.g., displays, publications, signs, Web sites, virtual and real field trips) for effective informal science education about the geology of parks, monuments, open spaces, and public lands. ORAL and POSTER

T117. Innovative Approaches to Teaching “Geology of National Parks”: Tales from the Classroom, Field, Page, Web, and Beyond

GSA Geoscience Education Division; National Association of Geoscience Teachers

Geoscience Education; Geoscience Information/Communication

Robert J. Lillie, Oregon State University, Corvallis, Ore.; Carol J. Ormand, Wittenberg University, Springfield, Ohio; Joseph F. Reese, Edinboro University of Pennsylvania, Edinboro, Pa.

This session will bring together those who teach geology by using examples from National Parks to share their expertise, exercises, written and electronic resources, techniques, and strategies for successfully educating students on park geology. ORAL

T118. The Science of Sustainability: How Can We Most Effectively Educate Students, the Public, and Policymakers?

Critical Issues Caucus, GSA Geology and Public Policy Committee

Geoscience Education; Environmental Geoscience; Public Policy

Paul H. Reitan, SUNY at Buffalo, Buffalo, N.Y.; Christine V. McLelland, GSA Education and Outreach, Boulder, Colo.

Public understanding about the role of earth systems is central to a sustainable future. We have a special obligation to communicate this effectively in schools and for the public and policymakers. How can we do this? ORAL

T119. Sigma Gamma Epsilon Student Research (Posters)

Sigma Gamma Epsilon

Environmental Geoscience

Donald W. Neal, East Carolina University, Greenville, N.C.; Charles Mankin, Oklahoma Geological Survey, Norman, Okla.

All students are welcome to present their research in any area of geology. POSTER

T120. Integrative Interdisciplinary Undergraduate Research in the Earth Sciences (Posters)

Council on Undergraduate Research—Geosciences Division Geoscience Education

Edward C. Hansen, Hope College, Holland, Mich.; Karen H. Fryer, Ohio Wesleyan University, Delaware, Ohio

This session highlights examples of research involving undergraduates that straddles traditional disciplinary boundaries both within and beyond the earth sciences. Presentations should concentrate on the process of doing such research including the challenges and rewards. POSTER

T121. Involvement of Undergraduates in Geological Research: Critical Tools for Background Enrichment (Posters)

GSA Geoscience Education Division

Geoscience Education

Nazrul I. Khandaker, York College of CUNY, New York, N.Y.

This session invites posters on geological/environmental topics involving field, computer-assisted, and laboratory-oriented investigations. Topics may include a wide spectrum of various geological and environmental aspects. Student participation should be dominant. Undergraduate and K–12 students are encouraged to submit abstracts. POSTER

T122. Inspiring First-rate Research through Undergraduate Teaching: A Special Session in Honor of John B. Reid Jr.

National Association of Geoscience Teachers; GSA Quaternary Geology and Geomorphology Division

Quaternary Geology/Geomorphology; Petrology, Igneous; Geoscience Education

Eric J. Steig, University of Washington, Seattle, Wash.; John Eichelberger, University of Alaska, Fairbanks, Alaska; Daniel P. Murray, University of Rhode Island, Kingston, R.I.

This session will explore ways in which students at any level (K–12 through graduate) have been engaged in the research process, whether through innovative inquiry-based teaching methods, access to equipment, interaction with more advanced students, or simply through excellent mentoring. ORAL

T123. Teaching Structural Geology in the 21st Century

GSA Structural Geology and Tectonics Division; National Association of Geoscience Teachers; On the Cutting Edge

Geoscience Education; Structural Geology

Barbara Tewksbury, Hamilton College, Clinton, N.Y.; Robert Burger, Smith College, Northampton, Mass.; Jan Tullis, Brown University, Providence, R.I.; Michael Williams, University of Massachusetts, Amherst, Mass.

We invite abstracts that showcase effective methods of teaching structural geology in the classroom, laboratory, and field. This session will also present outcomes from the 2004 workshop, Teaching Structural Geology in the 21st Century (<http://dlesecommunity.carleton.edu/NAGTWorkshops/structure04/index.html>). ORAL and POSTER

T124. Using Field Observations and Field Experiences to Teach Geoscience: An Illustrated Community Discussion (Posters)

National Association of Geoscience Teachers; GSA Education Division

Geoscience Education

David W. Mogk, Montana State University, Bozeman, Mont.; Cathryn A. Manduca, Carleton College, Northfield, Minn.; Barbara Tewksbury, Hamilton College, Clinton, N.Y.

Presentations will demonstrate ways that field observations and experiences can be used to enhance students' understanding of geoscience. Contributions can document both successful teaching practice and potential use of field research to enhancing students' learning. POSTER

T125. Using Digital Geological Maps to Build Deeper Understanding of Earth Science Relationships (Posters)

Geoscience Education; Geoscience Information/Communication

Andrew H. Wulff, Western Kentucky University, Bowling Green, Ky.

This session will focus on the use of digital geological maps; specifically how to make these interactive data sets more accessible and how their use may facilitate the deeper understanding of geological relationships. POSTER

T126. Teaching Geology and Human Health: Expanding the Curriculum

National Association of Geoscience Teachers; GSA Geoscience Education Division

Geoscience Education

Jean M. Bahr, University of Wisconsin, Madison, Wis.; H. Catherine W. Skinner, Yale University, New Haven, Conn.; Jill K. Singer, SUNY—College at Buffalo, Buffalo, N.Y.

This session is designed to provide an opportunity for those involved in development of course materials linking geology and human health to share instructional practices and case studies across the geoscience curriculum. ORAL and POSTER

T127. STEMS: Science Teaching Enhanced with Museums and Surveys

GSA Geoscience Education Division; National Association of Geoscience Teachers

Geoscience Education

Sarah D. Zellers, Central Missouri State University, Warrensburg, Mo.; Ann Molineux, University of Texas, Austin, Texas

Museums, state and national surveys, and departments have scientists, data and collections to enhance educational opportunities. This session will showcase outreach and curriculum design utilizing collections, data, and scientific expertise to complement earth science education. ORAL and POSTER

T128. Integration of Geoscience into Programs of Integrated Science and Math

GSA Engineering Geology Division; GSA Geoscience Education Division

Geoscience Education; Environmental Geoscience; Engineering Geology

John D. Rockaway, Northern Kentucky University, Highland Heights, Ky.; Denice N. Robertson, Northern Kentucky University, Highland Heights, Ky.

Presentations discussing the incorporation of geoscience into programs integrating science and math for the purpose of introducing students to the sciences and for encouraging them to think outside their nonscience disciplines. ORAL

T129. Innovative and Unique Advanced Geology/Geoscience Courses at the K–12 Level

GSA Geoscience Education Division; National Association of Geoscience Teachers

Geoscience Education; Geoscience Information/Communication

Steve Kluge, Fox Lane High School, Bedford, N.Y.

Session features presentations by K–12 teachers of advanced geology/geoscience courses. Presenters will highlight those aspects of their courses that make them unique and discuss affiliations with colleges/organizations that lend legitimacy to their programs. ORAL

T130. Authentic Research Collaborations: Bringing Scientific Researchers, K–12 Schools, and Other Community Groups Together in the Scientific Endeavor

GSA Geoscience Education Division; National Association of Geoscience Teachers

Geoscience Education

William Slattery, Wright State University, Dayton, Ohio; Dave Mayo, California State University, Los Angeles, Los Angeles, Calif.

This session will highlight the efforts of scientific researchers, K–12 educators and other community groups participating as partners in authentic collaborative research. The topic will be explored from the perspectives of those different groups. ORAL

T131. Online Geoscience Education at Two-Year Colleges: Hybrid or Strictly Distance Learning Instruction for Nontraditional Students

GSA Geoscience Education Division

Geoscience Education; Geoscience Information/Communication; Remote Sensing/Geographic Information System

Suzanne G. Traub-Metlay, Front Range Community College, Boulder County Campus, Longmont, Colo.

How do online geoscience educators provide meaningful field or laboratory experiences for college students who do not report to a classroom? Online instructors can successfully teach adults about earth science and related topics—learn how! ORAL

T132. Why Earth Science Curriculum: National Science Foundation–Funded Projects for Improving Earth Science Education

GSA Geoscience Education Division; American Geological Institute, National Science Foundation

Geoscience Education

Roderic Brame, American Geological Institute, Alexandria, Va.; Michael Smith, American Geological Institute, Alexandria, Va.

Geoscience educators and curriculum developers are taking critical steps for improving earth science education in all academic levels with support of the National Science Foundation. Curriculum has been developed and implemented to build science literacy across the nation. POSTER

T133. Current Research on Situated Teaching and Learning in Geoscience: Field-Based, Case-Based, Problem-Based, Place-Based

National Association of Geoscience Teachers; GSA Geoscience Education Division

Geoscience Education; Geoscience Information/Communication; Public Policy

Steven Semken, Arizona State University, Tempe, Ariz.; Eric Riggs, San Diego State University, San Diego, Calif.

Situated teaching methods are thought to improve learning in geoscience, enhancing relevance and context by building on the physical locality and local culture, events, and problems. This session features quantitative and qualitative research into the theory and effectiveness of these methods. ORAL and POSTER



T134. We Can Do Better: Alternatives to the Same Old Lab-Lecture Format in the College Classroom

GSA Geoscience Education Division; National Association of Geoscience Teachers

Geoscience Education

Elizabeth M. King, Illinois State University, Normal, Ill.; Dexter Perkins, University of North Dakota, Grand Forks, N.Dak.

During the past decade, it has become increasingly clear that there are many excellent alternatives to the standard lab-lecture format used by most college science teachers. This session will provide a chance to share innovations in teaching style. ORAL and POSTER

T135. Improving Delivery in Geoscience Education (IDIG): A Session Celebrating Dorothy LaLonde Stout

National Association of Geoscience Teachers; GSA Geoscience Education Division

Geoscience Education; Public Policy

Marilyn J. Suiter, National Science Foundation, Arlington, Va.; Phillip R. Romig Jr., Colorado School of Mines, Golden, Colo.

In this session, IDIG participants/associates will present the outcomes of their implemented plans for improving the delivery of geoscience education. The session goal is to share and disseminate the practices IDIG educators have found effective. ORAL

T136. Electronic Student Response Technology in the Geoscience Classroom: Is it a Valuable Teaching and Learning Tool?

National Association of Geoscience Teachers; GSA Geoscience Education Division

Geoscience Education

Lisa Greer, Washington and Lee University, Lexington, Va.; Peter J. Heaney, Pennsylvania State University, University Park, Pa.

Electronic student response technology has been cited as a method for overcoming barriers to engagement and effective learning in the classroom. This session will explore the implementation and assessment of SRT in the geoscience classroom. ORAL

GSA EMPLOYMENT SERVICE

GSA will again offer its Employment Interview Service, which matches employers with job seekers during three days of onsite interviews. Each year, this program, together with the Careers Roundtable Discussions (see page 44), provides valuable networking opportunities across all applied and academic areas of the geosciences.

For more information, see www.geosociety.org/profdev/empsvc1.htm, or e-mail membership@geosociety.org.

T137. Minorities, Women, and Persons with Disabilities in the Geosciences: Continuing Issues and Innovative Solutions

GSA Geoscience Education Division; GSA Committee on Minorities and Women in the Geosciences

Geoscience Education; Public Policy; Geoscience Information/Communication

Maya Elrick, University of New Mexico, Albuquerque, N.Mex.; Marc Carrasco, University of California, Berkeley, Calif.; John William Pennington, Oregon State University, Corvallis, Ore.; Cassandra Runyon, College of Charleston, Charleston, S.C.

This session will address the current issues confronting minorities, women, and persons with disabilities in the geosciences and explore new and existing ideas and programs that seek to attract and retain members of these underrepresented groups. ORAL and POSTER

T138. New Methods and Technologies in Teaching Geology to Nontraditional and Disabled Students—The Aspects of Change to Incorporate Technology and Hands-On Methods

GSA Geoscience Education Division

Geoscience Education; Geoscience Information/Communication; History of Geology

Mark Howe, Arizona State University, Tempe, Ariz.; Connie Gibb, University of Nebraska, Lincoln, Nebr.

The geological sciences are heavy in math, physics, chemistry, and procedures. Today, more older, nontraditional and disabled people are taking courses in the sciences. This session focuses on the “geoteaching” and the processes that entail. ORAL and POSTER

T139. Geoscience Education Strategies and Methods that Encourage ALL Students (Especially Students with Disabilities) to Participate in the Geosciences

GSA Geoscience Education Division; National Science Foundation; National Aeronautics and Space Administration
Geoscience Education

Roderic Brame, American Geological Institute, Alexandria, Va.; Wendi Williams, University of Arkansas at Little Rock, Little Rock, Ark.

Geoscience educators with support of the National Science Foundation are on the forefront of inclusion and accessibility

in science. This session will highlight advances in accessibility and the impact it is having on the geoscience education community. ORAL

T140. Beyond Video Games—Promoting Active Learning for All Students

Geoscience Education

Terry L. Oroszi, Biological Sciences, Wright State University, Dayton, Ohio; Heidi J. Turner, CLASS—Wright State University, Dayton, Ohio

A selection of science activities designed for the participation of ALL students is solicited. Available technologies/equipment that encourage active learning from students with disabilities will be discussed. ORAL

T141. Building a Digital Library that Supports Diversity: Goals, Lessons Learned, and Future Directions

National Association of Geoscience Teachers; Geoscience Information Society; GSA Geoscience Education Division

Geoscience Education; Geoscience Information/Communication; Public Policy

Mary R. Marlino, University Corporation for Atmospheric Research (UCAR), Boulder, Colo.; Rajul E. Pandya, UCAR, Boulder, Colo.

The session will explore current and ongoing efforts to promote diversity in the Digital Library for Earth System Education (DLESE), focusing on early successes, lessons learned, and strategies for moving the library forward. ORAL and POSTER

T142. Building Strong Geoscience Departments: Opportunities, Successes, and Challenges

National Association of Geoscience Teachers; GSA Geoscience Education Division

Geoscience Education

R. Heather Macdonald, College of William and Mary, Williamsburg, Va.; Cathryn A. Manduca, Carleton College, Northfield, Minn.; Randall M. Richardson, University of Arizona, Tucson, Ariz.

This session seeks examples of successful departmental activities or discussions of critical issues facing departments in undergraduate and/or graduate curriculum; recruiting, retaining, and advising students; retaining faculty; integrating research and education, and/or departmental planning. ORAL and POSTER

T143. Pre-Mesozoic Impacts: Their Effect on Ocean Geochemistry, Magnetic Polarity, Climate Change, and Organic Evolution (Posters)

GSA Planetary Geology Division; Paleontological Society

Planetary Geology; Paleontology/Paleobotany; Paleoclimatology/Paleoceanography

Charles A. Sandberg, U.S. Geological Survey, Denver, Colo.; Jared R. Morrow, University of Northern Colorado, Greeley, Colo.; Christian Koeberl, University of Vienna, Vienna, Austria

Pre-Mesozoic comet and meteorite impacts produced extreme oceanic and climate changes, causing mass extinctions followed by rapid radiation of surviving organisms. Thus, they were the driving mechanism in the early evolution of life on Earth. POSTER

HOW TO SUBMIT YOUR ABSTRACT

Please use the online abstract form found on the GSA Web site, www.geosociety.org. An abstract submission fee of \$18 for all students and \$30 for all others will be charged. If you cannot submit your abstract electronically, contact Nancy Carlson, (303) 357-1061, ncarlson@geosociety.org.

From the home page of www.geosociety.org, click on "Submit an Abstract" and follow the steps given. If you lose your Internet connection before you are finished, you can resume making a submission when you log back on.

You and your coauthors will be provided (by e-mail) with a record of the abstract identification number and password, and you can access your abstract and revise it as necessary from any Internet connection up until the published abstract submission deadline date. The system supports the submission of complex abstracts that contain subscripts, superscripts, italic and boldface type, tables, Greek letters, and equations.

You can include a table with your abstract, but understand that the table might reduce the number of words allowed in your abstract. Taken together, the body of the abstract should take up no more space than would be occupied by roughly 2,000 characters alone.

Check the spelling of the abstract's body and title using your own word processor. Then read it again and make sure that it is something the whole world should see. (We won't check or edit it for you.)

For typing and pasting, add an extra line between paragraphs or they will run together when displayed (you can do this before copying, after pasting, or while typing).

SCIENTIFIC CATEGORIES

Determine if your paper would fit neatly under one of the topical sessions. If it doesn't, please submit your abstract for inclusion in the general discipline sessions. The available choices are:

Archaeological Geology
 Coal Geology
 Economic Geology
 Engineering Geology
 Environmental Geoscience
 Geochemistry, Aqueous
 Geochemistry, Organic
 Geochemistry, Other
 Geomicrobiology
 Geophysics/Tectonophysics/Seismology
 Geoscience Education
 Geoscience Information/Communication
 History of Geology
 Hydrogeology
 Limnogeology
 Marine/Coastal Science
 Mineralogy/Crystallography
 Neotectonics/Paleoseismology
 Paleoclimatology/Paleoceanography
 Paleontology/Paleobotany
 Petrology, Experimental
 Petrology, Igneous
 Petrology, Metamorphic
 Planetary Geology
 Precambrian Geology
 Public Policy
 Quaternary Geology/Geomorphology
 Remote Sensing/Geographic Information System
 Sediments, Carbonates
 Sediments, Clastic
 Stratigraphy
 Structural Geology
 Tectonics
 Volcanology

Presentation Modes

Select your preferred mode of presentation: oral, poster, or either (no preference). **Please Note:** The program organizers will do their best to fit you into your preferred mode. However, they will override your original mode selection if they feel your paper would fit well in a particular session with other compatible abstracts. The decision of the program organizers is final.

Oral Mode. This is a verbal presentation before a seated audience. The normal length of an oral presentation is 12 minutes, plus three minutes for discussion.

Poster Mode. Each poster session presenter is provided with one horizontal, freestanding display board approximately 8' wide and 4' high. Precise measurements will appear in the Speaker Guide, which will be posted on the GSA Web site in September. Speakers must be at their poster booths for at least two of the four presentation hours.

Papers for discipline sessions may be submitted in either oral or poster mode. Papers for topical sessions are to be submitted *only* in the mode noted in the session description. If a topical abstract is submitted in the incorrect mode, the abstract will be transferred automatically to a discipline session.

Abstract Body

Please keep the abstract body to 2,000 characters or fewer. The online abstract system will reject it if it exceeds this limit.

Abstracts Fee

Once the abstract is in place, a window to submit payment will appear. The nonrefundable submission fee is \$18 for students; \$30 for all others.

You May Present Only One Volunteered Abstract

- Please submit only one *volunteered* abstract as speaker or poster presenter in topical and/or discipline sessions. This helps avoid speaker-scheduling conflicts and gives everyone an equal opportunity to be heard. **Multiple submissions as speaker-presenter will result in rejection of all abstracts.**
- This limitation does not apply to, nor does it include, *invited* contributions to keynote symposia or topical sessions.

JTPC to Finalize Program in Early August

The Joint Technical Program Committee (JTPC) selects abstracts and determines the final session schedule. All authors will be notified in August. The JTPC includes representatives from those GSA Associated Societies and Divisions participating in the technical program. GSA Council approved the JTPC technical program chairs.

Abstracts Deadline: July 13

Title Sponsor of the 2004 GSA Annual Meeting.



DENVER 2004 FIELD TRIPS

Come experience the Rockies! The 2004 GSA Annual Meeting in Denver will provide abundant opportunities for field trips viewing the geology of the southern Rocky Mountains. A full array of trips will be offered, ranging from multi-day excursions delving into the tectonic development of northern New Mexico to one-day trips visiting Dinosaur Ridge. These trips will minimize the impact of possible Rocky Mountain snowstorms by emphasizing one-day trips in the eastern slope of the Rockies and multi-day trips to southern locations with warmer and dryer weather. Some trips will be unaffected by inclement weather: underground, the cool temperatures of the Henderson Mine are constant regardless of the weather and the heat from underground coal fires can be quite pleasant when combined with a little Rocky Mountain powder snow. If a blizzard requires that GSA cancel a field trip, we will return your field trip fee and provide information on the abundant in-town opportunities for exploration, from the Denver Museum of Nature &

Science to the Wynkoop Brewery, which was cofounded by geologist John Hickenlooper, the current mayor of Denver.

Most trips will start and end in Denver. Air travel plans that include a Saturday night stay over can substantially offset field trip costs. The following list is tentative and subject to change. Further details will be given when registration for the meeting begins in June.

The field trip co-chairs for the Denver 2004 meeting are Eric Erslev, Department of Geosciences at Colorado State University, and Eric Nelson, Department of Geology and Geological Engineering at Colorado School of Mines. For more information about the trips, please contact the field trip leader or Eric Erslev, Department of Geosciences, Colorado State University, Fort Collins, CO 80523, (970) 491-5661, fax 970-491-6307, erslev@cnr.colostate.edu.

PREMEETING FIELD TRIPS

Navajo Sand Sea of Near-Equatorial Pangea: Tropical Westerlies, Slumps, and Giant Stromatolites

Tues.–Sat., Nov. 2–6. David Loope, Dept. of Geosciences, University of Nebraska, Lincoln, NE 68508, (402) 472-2647, fax 402-472-4917, dloope1@unl.edu; Len Eisenberg; Erik Waiss. Max.: 15. Cost: \$475.

Strike-Slip Tectonics and Thermochronology of Northern New Mexico

Thurs.–Sat., Nov. 4–6. Eric Erslev, Dept. of Geosciences, Colorado State University, Fort Collins, CO 80523, (970) 491-5661, fax 970-491-6307, erslev@cnr.colostate.edu; Steven Cather; Seth Fankhauser; Matt Heizler; Rob Sanders. Max.: 40. Cost: \$255. *Begins and ends in Denver or Santa Fe, New Mexico.*

Geology of the Silvercliff–Rosita Hills Mining District and Spanish Peaks Area

Fri. and Sat., Nov. 5–6. Cosponsored by *GSA Sedimentary Geology Division*. Paul R. Krutak, P. Krutak Geoservices International, P.O. Box 369, 2118 Main Street, Rye, CO 81069-0369, (719) 489-2282 (phone and fax), pkrutakgeos@hotmail.com; John R. Barwin; Marty Horn. Max.: 36. Cost: \$185.

Hyperpycnal Wave-Modified Turbidites of the Pennsylvanian Minturn Formation, North-Central Colorado.

Fri. and Sat., Nov. 5–6. Paul M. Myrow, Dept. of Geology, Colorado College, Colorado Springs, CO 80903, (719) 389-6789, fax 719-389-6910, pmyrow@coloradocollege.edu; Karen Houck; Charles Kluth; Michael Lamb; Claire Lukens; Jeff Parsons. Max.: 36. Cost: \$155.

Structural Implications of Underground Coal Mining in the Mesaverde Group, Somerset Coal Field, Delta and Gunnison Counties, Colorado

Fri. and Sat., Nov. 5–6. Christopher J. Carroll, Colorado Geological Survey, 1313 Sherman St., Room 715, Denver, CO 80203, (303) 866-3501, fax 303-866-2461, Chris.Carroll@state.co.us; Greg Hunt; Wendell Koontz; Eric Robeck. Max.: 20. Cost: \$240.

A New K-T Boundary in the Denver Basin

Sat., Nov. 6. Kirk Johnson, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205-5732, (303) 370-6448, fax 303-331-6492, kjohnson@dmns.org; Richard Barclay. Max.: 45. Cost: \$105.

Buried Paleo-Indian Landscapes and Sites in the High Plains of Northwestern Kansas and Eastern Colorado

Sat., Nov. 6. Cosponsored by the *GSA Archaeological Geology Division*. Rolfe D. Mandel, Kansas Geological Survey, 1930 Constant Avenue, Lawrence, KS 66047-3726, (785) 864-2171, fax 785-864-5317, mandel@kgs.ku.edu; Jack Hofman; Steve Holen. Max.: 36. Cost: \$85.

Colorado Front Range—Anatomy of a Laramide Uplift

Sat., Nov. 6. Karl Kellogg, U.S. Geological Survey, P.O. Box 25046, Denver Federal Center, Denver, CO 80225, (303) 236-1305, fax 303-236-0214, kkellogg@usgs.gov; Bruce Bryant; Jack Reed. Max.: 36. Cost: \$100.

Continental Accretion—Colorado Style: Proterozoic Island Arcs and Back Arcs of the Central Front Range

Sat., Nov. 6. Lisa R. Lytle, Dept. of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, (303) 478-9427, fax 303-273-3859, lfiniol@mines.edu; Thomas R. Fisher. Max.: 36. Cost: \$90.

Eco-Geo-Hike along the Dakota Hogback North of Boulder, Colorado

Sat., Nov. 6. Peter Birkeland, Dept. Geological Sciences (retired), University of Colorado, Boulder, CO 80309, birkelap@colorado.edu; Ven Barclay; Edwin Larson; Ralph Shroba. Max.: 20. Cost: \$45. *Begins and ends in Boulder.*

Geological Reconnaissance of Dinosaur Ridge, Red Rocks, and Front Range of the Rocky Mountains near Morrison, Colorado

Sat., Nov. 6. Norbert E. Cygan, Friends of Dinosaur Ridge, 16831 W. Alameda Parkway, Morrison, CO 80456, (303) 697-3466, fax 303-697-8911, necygan@aol.com; T. Caneer; Harald Drewes and other volunteers from Dinosaur Ridge, www.dinoridge.org. Max.: 45. Cost: \$90. *Also offered as post-meeting trip.*

Glenwood Springs, Colorado Coal Fire—Observations, Discussion, and Field Data Collection Techniques

Sat., Nov. 6. Glenn B. Stracher, Dept. of Science and Mathematics, East Georgia College, Swinsboro, GA 30401; (478) 289-2073, fax 478-289-2080, stracher@ega.edu; Gary Colaizzi; Steve Renner; Janet L. Stracher; Tammy P. Taylor. Max.: 45. Cost: \$105.

Overview of Laramide Structures along the Northeastern Flank of the Front Range

Sat., Nov. 6. Vince Matthews, Colorado Geological Survey, 1313 Sherman St., Room 715, Denver, CO 80203, (303) 866-3028, fax 303-866-2461, vince.matthews@state.com.us. Max.: 38. Cost: \$120.

Paleoclimate, Paleohydrology, and Paleocology of the Morrison Formation in the Front Range of Colorado

Sat., Nov. 6. Stan Dunagan, Dept. of Geology, Geography & Physics, University of Tennessee, Martin, TN 38238, (731) 587-7959, fax 731-587-1044, sdunagan@utm.edu; Christine Turner; Fred Peterson; Tim Demko. Max.: 30. Cost: \$105.

Paleontology and Volcanic Setting of the Florissant Fossil Beds

Sat., Nov. 6. Herb Meyer, National Park Service, Florissant Fossil Beds National Monument, P.O. Box 185, Florissant, CO 80816, (719) 748-3253, fax 719-748-3253, herb_meyer@nps.gov; Steven Veatch. Max.: 36. Cost: \$125.

Stratigraphy and Paleobiology of Mammoth Sites in the Denver Area

Sat., Nov. 6. Russ Graham, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205, (303) 370-6047, fax 303-331-6492, rgraham@dmns.org; Bart Weis; Jim Dixon. Max.: 36. Cost: \$95.

HALF DAY—DURING THE MEETING

Tour of U.S. Geological Survey National Earthquake Information Center, Golden, Colorado

Wed., Nov. 10, 12:30–5 p.m. Peter J. Modreski, U.S. Geological Survey, MS 150, Box 25046, Denver Federal Center, Denver, CO 80225-0046, (303) 202-4766, fax 303-202-4767, pmodreski@usgs.gov; Lynn M. Highland; Pat Schassburger; Stephen J. Vandas; Lisa Ann Wald; Pamela J. Benfield; Waverly J. Person; Jill McCarthy. Max.: 45. Cost: \$25.

POSTMEETING FIELD TRIPS

Upper Cambrian and Lower Ordovician Stratigraphy of West Texas and Southern New Mexico

Wed.–Sat., Nov. 10–13. John F. Taylor, Geoscience Dept., Indiana University of Pennsylvania, Indiana, PA 15705, (724) 357-4469, fax 724-357-5700, jftaylor@iup.edu; Raymond L. Ethington; James D. Loch; Paul R. Myrow; Robert L. Ripperdan. Max.: 20. Cost: \$325. *Begins and ends in El Paso, Texas.*

Ancient Depositional Environments Control Modern Aquifer Quality: Stratigraphy of Groundwater Resources in the Denver Area

Thurs., Nov. 11. Robert G.H. Raynolds, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205, (303) 370-6047, fax 303-331-6492, denverbasin@dmns.org. Max.: 22. Cost: \$110.

Cenozoic Geology and Fossils of the Pawnee Buttes Area, Northeast Colorado

Thurs., Nov. 11. Emmett Evanoff, Dept. of Geological Sciences, Campus Box 399, University of Colorado, Boulder, CO 80309-0399, (303) 444-2644 (phone and fax), emmettevanoff@earthlink.net. Max.: 36. Cost: \$85.

Consequences of Living with Geology: A Model Field Trip for the General Public

Thurs., Nov. 11. Cosponsored by *GSA Engineering Geology Division, GSA Geoscience Education Division, and American Institute of Professional Geologists*. David M. Abbott Jr., Consulting Geologist, 2266 Forest St., Denver, CO 80207, (303) 394-0321, fax 303-394-0543, dimageol@msn.com; David C. Noe. Max.: 40. Cost: \$100.

Eldorado Canyon: Shorefront Property and Birthplace of Mountains

Thurs., Nov. 11. Lin Murphy, 3625 Catalpa Way, Boulder, CO 80304, (303) 447-0656, lin6@earthlink.net; Alan Lester. Max.: 36. Cost: \$90.

Geological Reconnaissance of Dinosaur Ridge, Red Rocks, and Front Range of the Rocky Mountains near Morrison, Colorado

Thurs., Nov. 11. Norbert E. Cygan, Friends of Dinosaur Ridge, 16831 W. Alameda Parkway, Morrison, CO 80456, (303) 697-3466, fax 303-697-8911, necygan@aol.com; T. Caneer; Harald Drewes and other volunteers from Dinosaur Ridge, www.dinoridge.org. Max.: 45. Cost: \$90. *Also offered as pre-meeting trip.*

Laramide Horizontal Shortening in the Rockies: Faulting and Folding in Oblique Backlimb-Tightening Structures of the Northeastern Flank of the Front Range, Colorado

Thurs., Nov. 11. Eric Erslev, Dept. of Geosciences, Colorado State University, Fort Collins, CO 80523, (970) 491-6375, fax 970-491-6307, erslev@cnr.colostate.edu. Max.: 24. Cost: \$100.

Underground Tour of Henderson Molybdenum Mine

Thurs., Nov. 11. Eric Nelson, Dept. of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, (303) 273-3811, fax 303-273-3859, enelson@mines.edu; Robert Golden; Jim Shannon. Max.: 15. Cost: \$140.

Walking with Dinosaurs along Colorado's Front Range

Thurs., Nov. 11. Joanna Wright, Dept. of Geography and Environmental Sciences, University of Colorado, Denver, CO 80217-3363, (303) 556-6007, fax 303-556-6157, jwright@carbon.cudenver.edu. Max.: 36. Cost: \$85.

DENVER 2004 SHORT COURSES

GSA-SPONSORED SHORT COURSES

STANDARD REGISTRATION DEADLINE: SEPTEMBER 30

Registration information and course descriptions will be published in the June issue of *GSA Today*. For additional information, contact Edna Collis, GSA headquarters, ecollis@geosociety.org, or see GSA's Web site, www.geosociety.org.

Evaporites: A Practical Approach

Fri. and Sat., Nov. 5–6. Cosponsored by *GSA Sedimentary Geology Division*. John Warren, University of Brunei Darussalam. Fee: \$365. CEU: 1.6.

Introduction to Geographic Information Systems (GIS), Using ArcGIS9 for Geological Applications

Fri. and Sat., Nov. 5–6. Cosponsored by *GSA Geoscience Education Division* and *Environmental Systems Research Institute*. Ann B. Johnson and Dave Fosdek, ESRI, Denver. Fee: \$240. CEU: 0.8.

Multi-Temporal Stereo Aerial Photography

Fri. and Sat., Nov. 5–6. Cosponsored by *GSA Engineering Geology Division* and *U.S. Army Corps of Engineers*. John C. Jens, U.S. Army Corps of Engineers, Alexandria, Va. Fee: \$420. CEU: 1.6.

Calibrated Peer Review Training for Faculty and Teaching Assistants: Writing Exercises for Large and Small Classes without the Pile of Papers to Grade

Sat., Nov. 6. Cosponsored by *GSA Geoscience Education Division* and *National Association of Geoscience Teachers*. Elizabeth Heise, University of Texas at Brownsville, Brownsville, Texas; Cinzia Cervato, Iowa State University, Ames, Iowa; Amanda Palmer-Julson, Blinn College, Bryan, Texas. Fee: \$340. CEU: 0.8.

Characterization and Toxicity Assessment of Mine-Waste Sites

Sat., Nov. 6. Cosponsored by *Geochemical Society of America*. Sharon Diehl, LaDonna Choate, David Fey, Phil Hageman, Bruce Smith, Kathy Smith, U.S. Geological Survey, Denver, Colo.; Jim Ranville, Tom Wildeman, Colorado School of Mines, Golden, Colo.; Jim Herron, Abandoned Mined Land Program. Fee: \$300. CEU: 0.8.

Estimating Rates of Groundwater Recharge

Sat., Nov. 6. Cosponsored by *GSA Hydrogeology Division*. Rick Healy, U.S. Geological Survey, Denver, Colo.; Bridget Scanlon, University of Texas at Austin. Fee: \$270. CEU: 0.8.

Hydrogeologic Field Methods

Sat., Nov. 6. Cosponsored by *GSA Hydrogeology Division*. John E. Moore, Consultant, Denver, Colo. Fee: \$245. CEU: 0.8.

Management and Leadership Skills for Academic Administrators in the Geosciences

Sat., Nov. 6. Cosponsored by *GSA Geoscience Education Division* and *National Association of Geoscience Teachers*. Lee J. Suttner, Indiana University, Bloomington, Ind.; Sheila M. Moore, Training Concepts, Chattanooga, Tenn. Fee: \$265. CEU: 0.8.

Practical Geoscience Ethics: Elements and Examples

Sat., Nov. 6. Cosponsored by *GSA Engineering Geology Division* and *American Institute of Professional Geologists*. David M. Abbott Jr., Consulting Geologist, Denver, Colo. Fee: \$250. CEU: 0.8.

OTHER COURSES AND PANELS

Registration and information can be obtained from the contact person listed.

Sequence Stratigraphy for Graduate Students

Fri. and Sat., Nov. 5–6. Free short course for graduate students. Cosponsored by *British Petroleum (BP)* and *ExxonMobil*. Instructors: Art Donovan (BP) and Kirt Campion (ExxonMobil). Information and registration: Art Donovan, donovan@bp.com, or Kirt Campion, kirt.m.campion@exxonmobil.com.

Biological Revolutions in the Neoproterozoic and Cambrian

Sat., Nov. 6. Sponsored by *Paleontological Society*. Organizers: Ben Waggoner, Dept. of Biology, University of Central Arkansas, Conway, AR 72035-5003, (501) 450-5037, fax 501-450-5914, benw@mail.uca.edu; Jere Lipps, Museum of Paleontology, University of California, Berkeley, CA 94720-4780, (510) 642-9006, fax 510-642-1822, jlipps@uclink4.berkeley.edu.

K-16 PROGRAM Attention College Faculty, K-12 Teachers, Teacher Trainers, and Pre-Service Teachers:

Look for the K-16 Education Workshops listing in the June issue of *GSA Today*. Questions? Contact Christine McLelland, cmcllland@geosociety.org or (303) 357-1082, for more information.



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Volume 32, May 2004

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Additionally, volunteers receive a stipend of \$25 for each half-day (5 hours) volunteered at the meeting. (Stipends can only be issued to students who have a U.S. government-issued Social Security Number, Green Card, or Student Work Visa.) New this year: optional partial food stipend available.

Students: Sign Up to Volunteer and Reap the Rewards

DENVER 2004 REGISTRATION INFORMATION

EARLY BIRD REGISTRATION DEADLINE: JULY 13
STANDARD REGISTRATION DEADLINE: SEPTEMBER 30
CANCELLATION DEADLINE: OCTOBER 7

NEW! GSA has changed its pricing structure to include “Early Bird” registration (June through July 13). Register by July 13—which is also the abstract submission deadline—for significant discounts. Registration information will be available in the June issue of *GSA Today* and on the GSA Web site, www.geosociety.org, in early June. Online registration and information regarding Subaru-sponsored grants for Colorado-based graduate students and two-year college faculty also will be available in early June.

NOT A GSA MEMBER?

You can save a substantial amount on your registration fee by becoming a GSA member; it’s almost like joining GSA for free! GSA is on a calendar-year membership cycle, so join now to reap the benefits of GSA membership for the rest of 2004. For further information or to join, go to www.geosociety.org/members/ or contact GSA Sales and Service, gsaservice@geosociety.org, 1-888-443-4472, or (303) 357-1000, option 3.

REGISTRATION FEES

	Early Bird (by 7/13)	Standard (7/14–9/30)	Late/Onsite (after 9/30)
Professional Member—Full Meeting	\$275	\$295	\$375
Professional Member—1 Day	–	\$190	\$200
Professional Member (70 or older)—Full Meeting	\$220	\$240	\$315
Professional Member (70 or older)—1 Day	–	\$135	\$145
Professional Nonmember—Full Meeting	\$350	\$375	\$465
Professional Nonmember—1 Day	–	\$215	\$225
Student Member—Full Meeting	\$60	\$90	\$120
Student Member—1 Day	–	\$60	\$60
Student Nonmember—Full Meeting	\$80	\$120	\$150
Student Nonmember—1 Day	–	\$75	\$75
K–12 Professional—Full Meeting	\$35	\$40	\$40
Field Trip or Short Course Only	–	\$40	\$40
Guest or Spouse	\$70	\$80	\$80

LODGING

Denver offers high-quality, affordable hotel rooms for meeting attendees. GSA has booked rooms at eight hotels, offering special convention rates ranging from \$105 to \$160 per night. The co-headquarters hotels are the Denver Marriott City Center and the Hyatt Regency Denver. Most activities will take place at the Colorado Convention Center and the two headquarters hotels. Additional housing information will be included in the June issue of *GSA Today*.

Guests Invited!

GSA extends a warm welcome to all spouses, family members, and friends to register for the Guest Program. Registration for the Guest Program begins in June.

The guest or spouse registration fee of \$80 per person (\$70 if you register by July 13) is for non-geologist spouses or family members and friends of professional and/or student registrants to the GSA Annual Meeting. The guest registration fee is required to attend guest activities, gain entrance to the Exhibit Hall, attend seminars and workshops (to be listed in the June issue of *GSA Today*), and take advantage of refreshments in the Guest Hospitality Suite. Formal tours (also listed in the June issue of *GSA Today*) will be offered at an additional cost. Fees cover the cost of professional tour guides, round-trip transportation, admission fees, and gratuities. Reservations for all tours will be accepted on a first-come, first-served basis. Since the tour operator requires a final guarantee weeks in advance, most tours have attendance minimums and maximums. Please register early to guarantee your spot.

Tours may be canceled if minimum attendance is not met.

The guest registration fee will NOT provide access to all technical sessions. However, guests can sign in with the hostess in the Guest Hospitality Suite and get visitor badges that allow them to attend a specific presentation.

Make plans now to participate in the GSA Guest Program at the Annual Meeting in Denver. After sightseeing trips, exploring Denver, and browsing in the Exhibit Hall, you’ll appreciate having a quiet place to sit down and have a beverage!

Guest Hospitality Suite Hours

Sun.–Wed., Nov. 7–10

8 a.m.–5:30 p.m.

Look for registration information in the June issue of *GSA Today*, or register online at

www.geosociety.org.

GSA MENTOR PROGRAMS

at the GSA Annual Meeting

ATTENTION

Students Pursuing a Hydrogeology Career Path!

The new Mann Mentors in Applied Hydrogeology Program makes it possible for up to 25 students to attend the distinguished Hydrogeology Division Luncheon and Awards Presentation luncheon, without cost to the students. Eligible students will have the chance to meet some of the nation's top hydrogeologists and observe the presentations of the coveted O.E. Meinzer Award, the Student Research Grants Awards, and the Distinguished Service Award from the membership of the GSA Hydrogeology Division. Eligible students are those who have indicated their professional interest in hydrology/hydrogeology on their GSA membership applications and who register for the GSA Annual Meeting by September 30, 2004. FREE tickets will be awarded to the first 25 students who respond to an e-mail invitation, based on the eligibility criteria above. Registration is required. Time and location to be announced.

For more information, contact
Karlton Blythe,
kblythe@geosociety.org.

Seeking Employment?

Plan to attend the Careers Roundtable Discussions (formerly the Employment Opportunities in the Geological Sciences Roundtable Discussions). Along with getting a new name, this event has expanded, with mentors offering one-on-one career advice. These mentors hail from a broad range of geoscience-related careers representing academics, industry, and government agencies. If you are seeking employment now, or will be in the future, join this group for networking opportunities and job-market perspectives.

This FREE come-and-go event is open to everyone. Registration is not required.

For more information, contact Karlton Blythe,
kblythe@geosociety.org.

Careers Roundtable Discussions

Sat., Nov. 6, 1–3 p.m.

Ballroom 1 (adjacent to GSA Employment Services)

Students: Check Out the Geology in Government Mentor Program!

Plan to arrive early for this FREE lunch for undergraduate and graduate students. This popular annual event will feature a select panel of mentors representing various government agencies. Mentors will invite questions, offer advice about preparing for a career, and comment on the prospects for current and future job opportunities with their agencies.

Registration is not required; however, every student registered for the GSA Annual Meeting will receive a ticket to this event along with their badge. Limited attendance—arrive early!

For more information, contact Karlton Blythe,
kblythe@geosociety.org.

Geology in Government Mentor Program

Mon., Nov. 8, 11:30 a.m.–1 p.m.

Location TBA

Find us on the Web at www.geosociety.org.

STUDENTS: Apply for Travel Grants Today



The GSA Foundation has awarded \$4,500 in grants to each of the six GSA sections. The money, when combined with equal funds from the sections, is used to help GSA undergraduate Student Associates and graduate Student Members travel to GSA meetings. For information and deadlines, please visit the Web sites from each Section listed below or contact the Section secretary directly.

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Call for Applications and Nominations for *Geology* Co-Editor

GSA is soliciting applications and nominations for the position of co-editor of *Geology*, an international geosciences journal for rapid publication of leading research. The co-editor will serve a four-year term, beginning in January 2005 (exact start date to be negotiated), and will be one of a three-editor team. A co-editor with expertise and broad interests in tectonics/structural geology would best complement the continuing editors' strengths, but fields are flexible.

Desirable characteristics for the successful candidate include:

1. Broad interest and experience in geosciences
2. International recognition
3. Progressive attitude; willing to take risks and encourage innovation
4. Familiar with many earth scientists and their work
5. Sense of perspective and humor
6. Organized and productive
7. Willing to work closely with GSA headquarters staff
8. Able to make decisions
9. Familiar with new trends in geosciences
10. Willing to consider nontraditional research in geosciences

GSA provides the editor with a small stipend, as well as expenses for administrative assistance, mail, and telephone/online. The editor will work out of his/her current location at work or home—no move is necessary.

If you wish to be considered, please submit a curriculum vitae and a brief letter describing why you are suited for the position. If you wish to nominate another, please submit a letter of nomination and the individual's permission and CV. Send nominations and applications to Jon Olsen, Director of Publications, GSA, P.O. Box 9140, Boulder, CO 80301, jolsen@geosociety.org, no later than September 7, 2004.

Geoindicators Update: Growing Interest in Tracking Rapid Geological Change

A.R. Berger, Victoria, British Columbia

As the evidence for abrupt climatic and environmental change grows, the task of assessing the effects of rapid geological processes is becoming more important. Interest is growing in tracking and reporting landscape changes that take place within a normal human lifetime (<100 years), especially where there are high risks from natural hazards.

With support from GSA, the International Union of Geological Sciences is working to emphasize the importance of tracking rapid geological change in State of the Environment (SoE) reporting, national park management, long-term ecosystem monitoring and environmental impact assessments in general. Using the geoindicator framework developed primarily for non-geologists, a series of workshops and related activities has been held over the past five years to review and promote geological monitoring in Lithuania, Poland, Zambia, Egypt, Mauritania, Australia, Argentina, Peru, Colombia, the United States, and Canada. Further meetings are being planned for the Arctic, Algeria, Mozambique, Turkey, and Southeast Asia.

Despite the current global trend to reduce government services, including many national efforts to monitor and assess environmental change, there are encouraging signs. In the United States, the National Park Service has been

engaged for several years in a series of meetings to identify geological processes of importance to park ecosystems and management. This process includes scoping out the human influences on landscape components. Ways to include geoindicators in monitoring the ecological integrity of national parks are also being developed in Canada. In Colombia, geoindicators are assisting in designing a national system to assess the environmental impacts of mining and quarrying. In Australia and Argentina, national networks are being developed to promote the tracking of abiotic landscape change. The geoindicators framework is proving to be helpful in setting the background for understanding more fully the ways in which past settlements and societies have responded to rapid landscape change. This is being done in cooperation with a major international project titled "Dark Nature—Rapid Natural Change and Human Responses" and a similar effort by International Geological Correlation Programme (IGCP) Project 490 ("The Role of Holocene Environmental Catastrophes in Human History"). The goal is to inform current efforts to adapt and mitigate the landscape effects of climate warming. For further information, see www.geoindicator.org and www.brunel.ac.uk/depts/geo/igcp490/igcp490home.htm.

CALL FOR NOMINATIONS

Thirteenth Annual

Biggs Award

for Excellence in Earth Science Teaching
for Beginning Professors

The Biggs Award was established by GSA to reward and encourage teaching excellence in beginning professors of earth science at the college level.

Eligibility

Earth science instructors and faculty from all academic institutions engaged in undergraduate education who have been teaching full-time for 10 years or fewer. (Part-time teaching is not counted in the 10 years.)

Award Amount

An award of \$750 is made possible as a result of support from the Donald and Carolyn Biggs Fund (maintained by the GSA Foundation), the GSA Geoscience Education Division, and GSA's Education and Outreach Programs. In addition, this award also includes up to \$500 in travel funds to attend the award presentation at the GSA Annual Meeting.

Deadline and Nomination Information

Nomination forms for the 2004 Biggs Earth Science Teaching Award are posted at www.geosociety.org/aboutus/awards/biggs.htm. Or, contact Diane Lorenz, (303) 357-1028, dlorenz@geosociety.org. Nominations must be received by May 1, 2004.

Mail nomination packets to:

Diane Lorenz
Program Officer, Grants, Awards, and Medals
GSA
P.O. Box 9140
Boulder, CO 80301-9140

LITHOPROBE

Canada's National Geoscience Project
Le projet national en sciences de la terre

THE LITHOPROBE CELEBRATORY CONFERENCE: From Parameters to Processes - Revealing the Evolution of a Continent

Since 1984, LITHOPROBE has been investigating the key tectonic structures associated with the Canadian landmass and the processes involved in its evolution. Now LITHOPROBE is drawing to a conclusion and we are highlighting its many achievements with a celebratory conference.

When? 2004: October 12 (evening reception), 13, 14 and 15 (meeting days)

Where? Ontario Science Centre, Toronto, Ontario, Canada

Registration fee: CAD\$200 or US\$160; includes 3 lunches & the Banquet on Oct 14

Objectives: (1) Highlight the scientific achievements of LITHOPROBE during the past 20 years, focusing on the parameters, structures and processes associated with continental evolution; (2) Provide a forum for comparisons of results from studies in geologically similar environments; (3) Provide an opportunity for LITHOPROBE and other scientists to demonstrate how their research addresses the themes below; and (4) Bring the results of LITHOPROBE and the importance of the Earth sciences to the attention of the public through a Media Morning and a Public Lecture

Scientific themes: (1) The Early Earth - Establishing the Cratons; (2) The Middle Earth - Stitching the Cratons and Other Events; (3) The Late Earth - Young Orogenic Belts; (4) Processes in the Earth - How the Planet Works; (5) The Resonant Earth - Seismicity & Endangering Life on the Planet

Format: 30 min. invited talks, presentations from key LITHOPROBE contributors and international keynote speakers for each theme; contributed poster presentations from LITHOPROBE scientists and other participants

Further information: On the web: www.lithoprobe.ca;
e-mail: lit@lithoprobe.ubc.ca; or contact Ron Clowes, Director,
LITHOPROBE at 604-822-4138.



The conference is supported by funding to Lithoprobe from the Natural Sciences and Engineering Research Council of Canada

GEOVENTURES 2004:

April Showers Bring May Deadlines

Sign up now for GeoVentures to Iceland, Mongolia, Colorado, or Yellowstone! Visit www.geosociety.org or see the March issue of *GSA Today* for details.

Don't delay—

GRADUATE SCHOOL INFORMATION FORUM

Meet face-to-face with prospective students in a relaxed, informal setting by participating in the Graduate School Information Forum (GSIF) during the GSA Annual Meeting. Take advantage of this excellent opportunity to promote your school to more than 1,500 students.

Located just inside the entrance to the Exhibit Hall, next to the poster sessions, the GSIF booths are in a highly visible area. The forum will be open Sunday, 8 a.m.–8:30 p.m. This coincides with the Welcoming Reception in the Exhibit Hall on Sunday evening. The hours for Monday through Wednesday are 8 a.m.–5:30 p.m. You may choose from one day to all four days. Space is limited, and Sunday and Monday will be the first to sell out. Those schools

reserving multiple days will be assigned first and to the most visible booths.

Participating schools will be promoted in the October *GSA Today* (pending submittal date of your reservation form), the 2004 Annual Meeting Program, and e-mail links on the GSA Web site so that prospective students may schedule appointments prior to the Annual Meeting.

Go online to reserve your space at
https://rock.geosociety.org/forms/xGSIF_form.asp.

For more information, contact Kevin Ricker at
(303) 357-1090 or kricker@geosociety.org.

Reserve your space now!



PENROSE CONFERENCE SCHEDULED

Secular Variation in Tectonics and Allied Fields

October 22–28, 2004

St. George, Utah

Conveners:

Dwight Bradley, U.S. Geological Survey, 4200 University Drive, Anchorage, AK 99508, (907) 786-7434, fax 907-786-7401; dbradley@usgs.gov

John Dewey, Geology Department, University of California, One Shields Avenue, Davis, CA 95616, (530) 754-7472, fax 530-752-0951, jfdewey@blue.ucdavis.edu

Plate reconstructions are a time-honored approach to synthesizing earth history. Geologic, paleomagnetic, and paleontological data have together revealed the broad outlines of global paleogeography and plate interactions back to the late Paleozoic. But the plate-reconstruction approach has two shortcomings: robust reconstructions are impossible for the deep past (because not enough rocks have survived), and even the best reconstructions do not reveal much about the past workings of the earth system.

This Penrose Conference will highlight a complementary approach to the study of earth history, which might be referred to as *secular analysis*. This involves the tracking of individual geologic variables as a function of geologic age. One such variable is Earth's radiogenic heat production, which has declined exponentially since 4.5 Ga and thus has slowed the tectonic engine. Others include the strontium-isotopic composition of seawater, K/Na ratios of shales, ages of juvenile continental crust, and abundances of key rock types such as komatiites, blueschists, and redbed-copper deposits. To the growing number of practitioners, two advantages of secular analysis stand out: (1) many broad-scale problems are tractable despite the scarcity of rocks of certain ages; and (2) any viable explanation for a particular secular trend must also honor all other trends—hence the value of an encyclopedic approach.

Information on secular variation is now widely scattered, much of it in specialized literature, and it has never been synthesized on the scale that we visualize for this conference. Participants will be sought who can shed light on secular variations in the following broad areas.

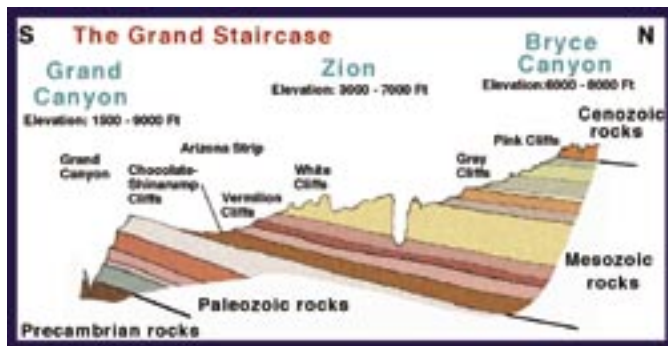
- Earth's tectonic regime
- particular tectonic settings
- plate reconstructions and plate-mosaic evolution
- the sedimentary record
- the igneous record
- the metamorphic record
- structural geology
- the fossil and organic record
- ore deposits
- paleoclimate
- atmospheric composition
- paleo-oceanography
- sea-level and continental hypsometry
- extraterrestrial events and forcings
- geodynamics
- global heat production
- geochemical cycles
- mantle evolution
- crustal growth and recycling

The meeting will cover the state of knowledge, working hypotheses, and key questions in long-term secular variation within these fields and perhaps others not listed. The goal is to achieve an atmosphere for new ideas, cross fertilization, and identification of new research opportunities. It will not be a surprise if huge gaps in knowledge are revealed, especially in structure and regional tectonics. In keeping with the complexity of the earth system, and mindful of the interplay between tectonics and most other fields, the conference is intentionally broad in scope. The focus will be on long time scales, ranging from the entire span of earth history down to a few hundred million years. Problems involving preservation, age assignments, sampling bias, and real versus apparent secular variation will be aired. Participants will be asked to key their data to an agreed-upon current geologic time scale, and, for ease of comparison, to plot results using a standardized time axis.

Planned Volume on Secular Variation. A separate call for papers will follow for contributions to a multi-chapter, post-conference volume, *Secular Variation in Tectonics and Allied Fields*. The deadline for papers will be around December 2005 and the target date for publication around December 2006. Contributors need not attend the conference. Contact editor Dwight Bradley to express an interest.

Venue and Logistics. The conference will be cosponsored by the U.S. Geological Survey, and it will be held at the Holiday Inn in St. George, southwestern Utah. This is a spectacular part of the world, only 42 miles from Zion National Park and 165 miles from the Grand Canyon. The estimated registration fee of \$975 will cover lodging, meals, and the field trip, but will not cover transportation to the meeting site. The closest large airport is in Las Vegas, 120 miles to the south.

Field trip through the Grand Staircase. There is no better place than the Colorado Plateau to be reminded of the



From Ron Blakey's Web site (http://jan.ucc.nau.edu/~rcb7/Grand_Staircase_topo.jpg)

vastness of geologic time. Two out of the five meeting days will be devoted to a field trip through the "Grand Staircase" when we'll visit the North Rim of the Grand Canyon, Zion National Park, Bryce Canyon National Park, and other locales. The formations of the Grand Staircase represent most of Phanerozoic time and were deposited in tectonic settings that include passive margin and foreland basin—all laid out in spectacular exposures.

To Apply. Contact the co-conveners by e-mail for application materials. We encourage interested graduate students to apply; some partial subsidies will be available. The conference will be limited to 75 participants.

Application deadline: July 1, 2004

Abstract deadline: September 1, 2004

Registrants with Special Needs. GSA is committed to making Penrose Conferences accessible to all. If you require special arrangements or have special dietary concerns, please contact one of the conveners.

University of Urbino Summer School in Paleoclimatology



**July 12-20, 2004
Urbino, Italy**

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For more information:
<http://www.uniurb.it/USSP>

Application deadline
April 15, 2004

Rocky Mountain–Cordilleran Sections Joint Meeting

May 3–5, 2004 • Boise Centre on the Grove, Boise, Idaho

Information: C.J. Northrup, Boise State University,
Department of Geosciences, 1910 University Dr.,
Boise, ID 83725, (208) 426-1009, cjnorth@boisestate.edu

Students: If you have career-related questions, plan to attend the Shlemon Mentor Program at the Cordilleran–Rocky Mountain Sections Joint Meeting to chat one-on-one with practicing geoscientists. These volunteers will answer your questions and share insights about how to get a job after graduation. Each day's program will offer a different set of mentors. These programs are made possible by the Roy J. Shlemon Fund, administered by the GSA Foundation.

Shlemon Mentor Program

Mon. and Tues., May 3–4, 11:30 a.m.–1 p.m.

Perch Room, Boise Centre on the Grove

Students will receive a **FREE LUNCH** ticket along with their registration badge to attend each Shlemon Program. However, space is limited. First come, first served.

www.geosociety.org/sectdiv/sections.htm



PENROSE CONFERENCE REPORT

Neogene-Quaternary Continental Margin Volcanism

January 12–16, 2004

Metepec, Puebla, México

Conveners:

Gerardo J. Aguirre-Díaz, *Centro de Geociencias, Universidad Nacional Autónoma de México—Juriquilla, México*; **José Luis Macías** and **Claus Siebe**, *Instituto de Geofísica, Universidad Nacional Autónoma de México—México D.F., México*

Reporter: Grant Heiken, *Freeland, Washington, USA*

The Mexican volcanic belt crosses México from the Pacific to the Gulf of Mexico and is composed of hundreds of Neogene-Quaternary volcanoes, ranging from humble scoria cones to the great composite cones of Popocatepetl and Citlaltépetl (Orizaba). Holocene and Historic eruptions continue to affect the peoples of México; for example, eruptions changed the course of history between Classic and Post-Classic cultures when the valleys of México and Puebla were subjected to tephra fallout and secondary lahars (volcanic mudflows). Understanding magma evolution and eruption dynamics are critical to México in that modern urban agglomerations ranging in size from 2.2 to 20 million people will be affected by future eruptions.

The purpose of this Penrose Conference was to evaluate the present state of knowledge of the source and evolution of magmas that formed the Neogene-Quaternary continental-margin volcanic belt associated with the Mexican portion of the "Ring of Fire." Discussions included the complexities of volcanic styles that promote explosive eruptions, sector collapse of volcanoes, volcanoclastic sedimentation, and related volcanic hazards. The case of México was compared with continental-margin volcanism at other places in the Americas, such as the Andes in Colombia and the Cordillera and Cascades of the western United States.

Working upward from the roots of continental margin volcanic belts, keynote speakers Charles Langmuir and Gerhard Wörner reviewed the latest interpretations of processes at

convergent plate margins. Using compositional data mostly from the trans-Mexican volcanic belt lavas and thermal melting models of the subduction process, Langmuir proposed that controls of the degree of melting include wedge geometry and thermal structure, source compositions, and convergence rates. Working with samples from the well-exposed eruption sequences of the central Andes, Wörner concluded that magma genesis through space and time was controlled by crustal heterogeneity and thickening since the Miocene. The posters covered mostly recent petrological studies of volcanic complexes in México, Central America, the Cascades, and New Zealand. Stephen Grand described a newly funded project to image the Mexican convergent margin with a 50+ seismometer array, a work that should tie well into the many petrological transects of the volcanic belt.

Based on the Smithsonian database for the 1926 Mexican volcanoes, Jim Luhr concluded that the three main magmatic suites in México are (1) calc-alkaline magmas of the trans-Mexican volcanic belt and Northern Mexican Extensional Province, (2) lamprophyres of the western trans-Mexican volcanic belt, and (3) intraplate type mafic alkaline rocks of the Northern Mexican Extensional Province and Pacific Islands. Sixteen posters covered a wealth of new work on the petrology of trans-Mexican volcanic belt volcanoes, including the Chichinautzin volcanic field, which rims the southern end of the Valley of México. Xitle, one of the Chichinautzin monogenetic volcanoes, produced a lava flow with a ^{14}C age of 1665 years B.P., which partly buried Cuicuilco pyramid and now underlies the campus of the National University.

While pungent smells from Popocatepetl occasionally swept the conference complex at Metepec, Fraser Goff and James Gardner gave keynote lectures on the physical role of gases in continental margin volcanism. Given the great depth of Popocatepetl's crater and the possibility of eruptions at any time, in-situ gas sampling has been impossible. Therefore, most of Goff's data were from simultaneous FTIR and COSPEC measurements of eruption plumes. Like most volcanoes at convergent margins, emissions from Popocatepetl are mostly water vapor with high values of S_{total} , F, As, and Hg (with respect to Cl). Over a four-year period, the HCl/SO₂ ratio has been increasing and HF/SO₂ ratios have been decreasing. CO₂ fluxes range from 40,000 t/day to >100,000 t/day. Plume emissions also contain SiF₄. The observed range of gas ratios indicates temperatures of 200 ± 20 °C, which may indicate reaction of gases with conduit walls or with ash particles in the cooling plume.

With an emphasis on rhyolites, James Gardner reviewed the dynamics of bubble growth in magmas, integrating observation with experiments. The pumice, ash, and gases erupted are all products of bubble nucleation, growth, and degassing. Bubble interactions and partial connectivity can produce coexisting bubbles that differ in size by more than 20 times. During the roundtable discussion, it was noted that there is passive degassing between eruptive phases.

Zimmer and Erzinger's continuous measurements of fumaroles at Merapi, Indonesia, demonstrate the influence of rainfall on gas flux and temperatures; during the dry season, fumarole temperatures are constant. Using data from Mount Pinatubo, Philippines, Hammer concluded that the explosive eruption



Conference participants at Tlamacaz mountaineering lodge on the upper slopes of Popocatepetl. Iztaccíhuatl volcano (5,272 m) in the background.

of dense, microlite-rich, partly-degassed tephra, along with vesicular, microlite-free pumice during pulsatory eruptions reflects variable magma travel times.

Having constructed the volcanoes, the meeting moved on to their destruction via sector collapse, avalanches, and lahars. This session was an excellent introduction to the field trip during the last day of the meeting to deposits left by at least three sector collapses of the Paleo-Popocatepetl cone; the youngest of these deposits is ~23,000 yr B.P. Hummocky terrain and debris avalanche deposits south-southwest of Popocatepetl cover over 300 km² and have a cumulative volume of >30 km³. The youngest of the avalanche deposits are overlain by blast and pyroclastic flow deposits. Preliminary studies indicate that runout was at least 70 km south of the cone. Sector collapse and debris avalanches have occurred at nearly all large Mexican composite cones.

In the Cascade Range of the United States, the dense forest makes documentation of lahar (volcanic mudflow) deposits extremely difficult. Kevin Scott is now documenting the extent and magnitude of lahar deposits with lidar imagery. This application has enhanced evaluation of lahar hazards, which in the past have been very conservative. He explained that lahar mobility is difficult to demonstrate to disaster planners and has found that comparing it with water floods gets the message across. Lahar warnings are possible. Survivors of the

Nevado del Ruiz catastrophe felt ground tremors before the lahar arrived. On that basis, acoustic flow monitors have been installed in the valleys around Mount Rainier to provide at least a 45-minute warning to downstream towns.

In the panel discussion it was agreed that the sector collapse, avalanche, and mudflows that were generated by the 1980 eruption of Mount St. Helens was the turning point in recognizing this widespread hazard. Since 1980, 300 sector collapse deposits have been identified at volcanoes along continental margins; their volumes range from 0.1 to 5 km³ (Lee Siebert). Hot research themes include the transition of sector collapse avalanches to debris flows and why some debris avalanches stop and others liquefy and keep moving; for example, the lahars formed during the last eruption of Cotopaxi reached the sea, 300 km downstream. The sedimentary aftermath of a large-scale eruption may be a hazard larger than the eruption itself. James White described eruptions on the North Island of New Zealand that buried entire drainage systems and created lakes. Subsequent failure of the tephra dams produced high-concentration flows that swept downstream areas now occupied by cities.

México has some of the largest ignimbrite deposits in the world. For example, in the Sierra Madre Occidental, ignimbrite sequences can be thousands of meters thick and have volumes of hundreds or even thousands of km³. Most

are associated with Miocene calderas and may have been erupted during the opening of the Gulf of California. Much work needs to be done on this province in spite of the difficulties offered by the terrain and isolation. Mike Branney provided a summary of what is known about massive ignimbrite deposits ("large explosive eruptions" were defined by Branney as those with volumes of >1 km³ to >1000 km³). Most are characterized by high mass flux sustained for hours or days and associated caldera collapse. The pyroclastic density currents produced during these eruptions can be fully dilute or granular-fluid-based, based on conditions near the lower flow boundaries. Complex deposit architectures are affected by the nature of the density current and the complexity of underlying terrain.

Within volcanic provinces with large volumes of rhyolite, it is often difficult to distinguish between densely-welded rheomorphic ignimbrites and clastogenic lava flows. Using examples from the Snake River Plain, Bill Bonnicksen described transitions from non-welded ignimbrites to high-grade rheomorphic ignimbrites to clastogenic lava flows and on out to domes having little evidence for fragmentation.

Dealing with a deadly but much smaller-scale eruption type than the large ignimbrites, the session on block and ash flows associated with dome collapse focused on recent eruptions at volcanoes like Colima, México, and



Conference participants inspecting the 14,000 yr B.P. "Tutti Frutti" sequence at Popocatepetl during the field trip.

Montserrat. Block and ash flows begin with dome collapse and formation of decameter-sized blocks (Marcus Bursik). In the final deposit the same blocks have been fragmented into particles ranging in size from 1 mm to 2 m. High on the dome slopes (~35°), the deposits are 1 to 2 m thick, but in distal regions with slopes of 10° to 20° they are up to 8 m thick. Many are preceded by pyroclastic surges. Much of the mechanical crushing seems to occur at breaks in slope. Bursik also discussed modeling of these flows but emphasized "numerical models are useless without field observation."

The last link in the chain of discussions that began with magma genesis was that of reducing risk at continental-margin volcanoes. The mitigation issues reviewed by Robert Tilling are:

- increasing population growth and air traffic;
- no capability to reliably predict explosive eruptions;
- the fact that most volcanoes are not monitored;
- a low frequency of destructive events; and
- effective communication between scientists, civil authorities, news media, and the population is at risk.

A major quandary concerns monitoring parameters versus time; when do you force local officials to make decisions? There is also the dilemma of acquiring funding for monitoring for infrequent but catastrophic activity. Hazard maps are useful for those who understand how to read them, but don't work well for the public. Public lectures and pamphlets are useful but reach only about 1% of the public. Visualization of processes and videotapes of actual events are more effective, but not if the media will not present them to the public. Methods of reaching the public were discussed during the roundtable, with the suggestion that a system similar to that used by the weather service for tornado warnings be implemented.

Gavilanes noted that mixed signals put the population at risk during eruptions of Volcán de Colima during 1999–2003. There were many conferences in the villages, but conflicting signals from the authorities and the army created confusion and frustration among the residents. He also noted the great need for sociologists to work with volcanologists for effective hazard mitigation.

In slightly less than one week, this dynamic group of 104 workshop participants (including about 30 students) went from the mostly academic pursuit of petrology to the sociological aspects of volcanic disaster mitigation. What was evident is that all of the pieces are available to complete the puzzle, but that the volcanological community has a long way to go to assemble those pieces and to mitigate volcanic hazards. There is hope for increased volcanological research and successful disaster mitigation in México; at this Penrose Conference it was evident that, in addition to the well-respected Mexican volcanological community, there are many talented students at Mexican universities who will carry this work into the future.

For more information on the conference, visit <http://tepetl.igeofcu.unam.mx/penrose/index.html>. A GSA publication is also in preparation (*Volcanic hazards in the México City metropolitan area from eruptions at Popocatepetl, Nevado de Toluca, and Jocotillán stratovolcanoes and monogenetic scoria cones in the Sierra Chichinautzin volcanic field*, by C. Siebe and J.L. Macias).

Additional Sponsoring Organizations:

- International Association of Volcanology and Chemistry of the Earth's Interior
- Coordinación de la Investigación Científica, Universidad Nacional Autónoma de México (UNAM)
- Instituto de Geofísica, UNAM
- Instituto de Geología, UNAM
- Centro de Geociencias (Juriquilla, Querétaro), UNAM
- Centro Universitario para la Prevención de Desastres, Benemérita Universidad Autónoma de Puebla
- Gobierno del Estado de Puebla, México
- Volkswagen de México (Puebla)

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Nancy Riggs
Jaime Roldan-Quintana
Andrea Rossotti
Genji Saito
Damiano Sarocchi
Peter E. Schaaf
Hans-Ulrich Schmincke
Kevin M. Scott
Michael F. Sheridan
Claus Siebe
Lee Siebert
Robert B. Stewart
Susanne M. Straub
Roberto Sulpizio
Robert Ingersoll Tilling
José Ramón Torres
Hernández
Margarito Tristan González
Martin Ulrike
Gabriel Valdez Moreno
Greg A. Valentine
Nick Varley
Guadalupe Velazquez-Oliman
Michael West
James D. L. White
Wendi J. W. Williams
Luke Wooller
Gerhard Wörmer
Sabine Wulf
Araceli Zamora-Camacho
Martin Zimmer



REMINDER: PENROSE CONFERENCE SCHEDULED

Mass Redistribution in Continental Magmatic- Hydrothermal Systems

September 6–12, 2004

Yellowstone National Park and Butte (Fairmont Hot Springs), Montana

Conveners:

John H. Dilles, Department of Geosciences, Wilkinson Hall 104, Oregon State University, Corvallis, Oregon 97331-5506, USA, (541) 737-1245, fax: 541-737-1200, dillesj@science.oregonstate.edu

Greg B. Arehart, Department of Geological Sciences, University of Nevada, Reno, Nevada 89557-0138, USA, (775) 784-6470, arehart@unr.edu

Peter I. Nabelek, Department of Geological Sciences, University of Missouri, Columbia, Missouri 65211, USA, (573) 884-6463, fax 573-882-5458, nabelek@missouri.edu

Todd C. Feeley, Department of Earth Sciences 4 Hitching Post Road, Montana State University, Bozeman, Montana 59717-0348, USA, (406) 994-6917, fax 406-994-6923, tfeeley@montana.edu

Application Deadline: June 1, 2004

For complete information on this conference, see the December 2003 issue of *GSA Today* (also posted at www.geosociety.org/pubs/gsatoday/) or visit www.geosociety.org/penrose/.



GSA Foundation Update

Donna L. Russell, Director of Operations



James Slosson

James E. Slosson Joins GSA Foundation Board of Trustees

Lee J. Suttner, Chair, Board of Trustees

The GSA Foundation is pleased to announce the addition of GSA Fellow James Slosson, chief engineering geologist and president of Slosson & Associates to its Board of Trustees.

Slosson received his entire formal academic training in geology at the University of Southern California. Prior to starting his company, which specializes in various areas of applied geoscience, including hazard mitigation and prevention, forensic geology, earthquake/seismic studies, and groundwater geology, he was state geologist for

California and chief of the California Division of Mines in Geology. He has also spent over 35 years teaching in academic institutions.

Slosson has served on a number of local, state, and national commissions and advisory boards. He has also authored more than 100 papers, chiefly on natural and human-caused geologic hazards and their consequences. The Society has bestowed on him its Richard Jahns Distinguished Lecturer Award, the Distinguished Practice Award, and the E.B. Burwell, Jr., Award, the latter for his coauthored book *Forensic Engineering*. He was the first to be chosen as a GSA Roy J. Shlemon Applied Geology Mentor.

The Board will benefit greatly from the wisdom and associations Slosson has obtained during his broad and successful career in applied geoscience. Please join me in expressing appreciation to him for assuming this important responsibility.

Thank You, 2003 Donors!

Please see the special insert in this issue listing those who contributed to the GSA Foundation during 2003. GSA and the GSA Foundation thank you for your support of GSA programs.



Most memorable early geologic experience:

In late June (about 1970) Clarence Hall and I met Ben Page and Tom Dibblee in the central coast range to talk geology. Tom confirmed the legend that he supplemented his field diet with vegetables that fell off produce trucks!

—W.G. Ernst

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GSA FOUNDATION SEEKS PRESIDENT



The Foundation of the Geological Society of America seeks a geoscientist, preferably with national recognition for achievements in the geosciences and administration, to be its president. The individual should have a strong interest and experience in, or working knowledge of, fund raising and development. Primary responsibilities will include oversight and direct participation in fund raising for GSA programs and activities; identifying, cultivating and soliciting major donor prospects including individuals, corporations, and foundations; stewardship of funds; and staff administration. This person will be expected to have a major role in designing and implementing a strategic fund raising and development plan for the Foundation, and to closely and regularly interact with the executive director of the Geological Society of America and members of its staff, the GSA Foundation Board of Trustees, and the GSA Council. The president will report to the GSA Foundation Board of Trustees and be assisted in the Foundation by a full-time director of operations and a data manager.

The position will be approximately half time, with a flexible schedule and with the bulk of the activities to be conducted from the Society's headquarters in Boulder, Colorado, although full-time relocation to the Boulder area may not be required. A range of compensation options exists, depending on experience and qualifications of the candidate, and the length of the appointment. Interested persons should electronically transmit a letter of application, resume/vita, and the names, addresses, and telephone numbers of three references to Lara Womack, GSA Human Resources Director, lwomack@geosociety.org, or, if unable to transmit electronically, mail the information to **GSAF President Search Committee**, c/o Lara Womack, P.O. Box 9140, Boulder, CO 80301-9140. Nominations of potential candidates by members of the geoscience community are also encouraged. Effective closing date for the applications is May 15, 2004, with a target starting date of September 1, 2004. The GSA Foundation is a non-profit corporation and an Equal Opportunity, Affirmative Action Employer.

KARST HYDROLOGY

June 14-June 19, 2004

This is the 25th year for this successful, "Hands-on" course/workshop offered in Bowling Green, KY. It deals with groundwater monitoring techniques, tracers, and the movement of contaminants through karst aquifers. Other topics include methods for preventing or treating sinkhole flooding and collapse. A primary objective of this course is to provide a "state-of-the-practice" information and experience for dealing with groundwater problems of karst regions.

Instructors:

William B. White
Nicholas C. Crawford

Offered by the

Center for Cave and Karst Studies

Applied Research and Technology
Program of Distinction
Western Kentucky University

Additional Courses Offered:

Cave & Karst Stewardship

(Carlsbad, NM) **June 6-12**

Karst Geomorphology **June 13-19**

Cave Geomicrobiology **June 13-19**

Hydrology of Edwards Aquifer **June 13-19**

(San Antonio, TX) **June 13-19**

Cave Survey & Cartography **June 20-26**

Cave Ecology **June 20-26**

Karst Stormwater Management **June 28-July 3**

(Bowling Green, KY)

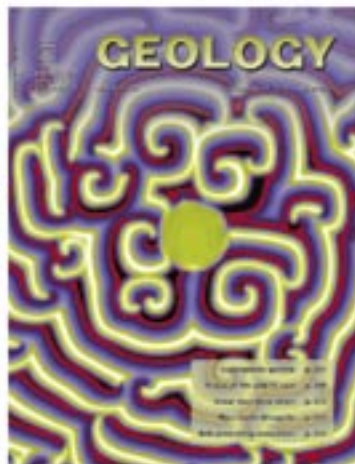
For more information, contact:

Center for Cave and Karst Studies

Phone: 270-745-3252 or visit caveandkarst@wku.edu



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IN APRIL GEOLOGY

Superplastic garnet
A case of 4He said 14C said
Shear slips show strain
Mars meets Mongolia
Belt-wrenching restoration



IN MARCH/APRIL

GSA BULLETIN

Idaho pahoehoe flow
Prefolded joints: What a concept!
Hawaiian dating tool?
Erstwhile Ertzberg mining

Journal Highlights

To subscribe, contact gsaservice@geosociety.org, 1-888-443-4472, or (303) 357-1000, option 3.

ANNOUNCEMENTS

2004

- May 21–23 67th Annual Friends of the Pleistocene (Northeastern Section) meeting, The Deglaciation of the Great Bend Region of Northeastern Pennsylvania. Information: www.climatechange.umaine.edu/friends/, Duane Braun, dbaun@bloomu.edu.
- May 24–25 5th Annual Coalbed & Coal Mine Methane, Denver, Colorado. Information: Strategic Research Institute, (888) 666-8514 (within the U.S.), (646) 336 7030 (outside the U.S.), info@srinstitute.com, www.srinstitute.com/cg113.
- July 25–29 GML (Geography Markup Language) Days 2004, Vancouver, British Columbia. Information: www.gmldays.com, (604) 484-2750, info@gmldays.com.
- October 20 Ohio River Valley Soils Seminar XXXV—Rock engineering and tunneling, Louisville, Kentucky. Information: Tom Rockaway, University of Louisville, Department of Civil and Environmental Engineering, Louisville, Kentucky 40292, (502) 852-3272, trockaway@louisville.edu. (*Abstract deadline: May 1, 2004.*)
- Oct. 31–Nov. 4 International Annual Meetings of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA) and Soil Science Society of America (SSSA) with the Canadian Society of Soil Science: Science to Secure Food and the Environment, Seattle, Washington, USA. Information: Keith Schlesinger, kschlesinger@agronomy.org, www.asa-cssa-sssa.org/anmeet, (608) 273-8080. (*Title–Summary Form deadline: May 3, 2004.*)

2005

- November 6–10 International Annual Meetings of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA) and Soil Science Society of America (SSSA), Salt Lake City, Utah, USA. Information: Keith Schlesinger, kschlesinger@agronomy.org, www.asa-cssa-sssa.org/anmeet, (608) 273-8080.

2006

- November 12–16 International Annual Meetings of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA) and Soil Science Society of America (SSSA), Indianapolis, Indiana, USA. Information: Keith Schlesinger, kschlesinger@agronomy.org, www.asa-cssa-sssa.org/anmeet, (608) 273-8080.

Visit www.geosociety.org/calendar/ for a complete list of upcoming geoscience meetings.

History of Geology Division Initiates Student Award

GSA's History of Geology Division is soliciting proposals for a student award for the amount of \$500 for a paper to be given at the national GSA meeting. It may be a history of geology paper or a literature review of ideas for technical work.

Are you interested in where the ideas that you work with came from? How do you know your research is original? What ideas have been prominent in the literature review you have done for your thesis or dissertation? Were there ideas that didn't work out? Why? Is your portion of our science "refining the numbers" and extending observations, or are you working on

a novel theory? Is there part of geology whose origins you would like to investigate?

The History of Geology Division would like to hear from you! Mentors are available to help you with this process, or you may work with your own faculty. For proposal guidelines and application forms, contact: Professor William Brice, wbrice@pitt.edu, Geology and Planetary Science, University of Pittsburgh at Johnstown, Schoolhouse Road, Johnstown, PA 15904.

Due date for proposals and application is **May 1, 2004**, so that content and the official GSA abstract can be refined. The Division award committee will make the selection.

Science Fellowship at the Library of Congress

The Nielsen & Bainbridge Corporation, a leading manufacturer of products to preserve art work, will sponsor a fellowship in conservation science at the Library of Congress. The 12-month fellowship will begin in the fall of 2004 and offer a \$35,000 stipend.

The goal of the fellowship, located in Library Services, Preservation Directorate, Research and Testing Division, will be to conduct research into the effects of zeolites (molecular sieves) on the long-term stability of library materials and to develop practical library applications for this technology. An important element of the fellowship involves working closely with scientists from

In Memoriam

Francis R. (Joe) Boyd Jr.

Washington, D.C.
January 12, 2004

Tudor T. Davies

Woodbridge, Virginia
November 27, 2003

Jose R. Dominguez

Caracas, Venezuela
January 14, 2004

Renaud M. DuDresnay

Rabat, Morocco
November 9, 2003

Sidney S. Galpin

Clarksburg, Washington
November 17, 2003

William R. Moran

La Canada, California
January 22, 2004

Edward L. Reed

Midland, Texas
November 27, 2003

Donald W. Peterson

Albuquerque, New Mexico
December 12, 2003

Clay T. Smith

Socorro, New Mexico
November 20, 2003

Wilhelmus T. Van Middelaar

Stamford, Connecticut
January 23, 2003

Robert A. Vargo

California, Pennsylvania
January 9, 2004

the Getty Conservation Institute in Los Angeles who have conducted important research into zeolites.

Individuals interested in applying for the fellowship should submit a cover letter describing their interest in this opportunity, a resume that outlines pertinent experience and the names of three references who can attest to their qualifications. Applications should be sent to Mark Roosa, Director for Preservation, Library of Congress, 101 Independence Ave. S.E., Washington, DC 20540-4500. Applications received by May 15, 2004, will be given first consideration.

For additional information, visit www.loc.gov/preserv.

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Ethical Guidelines for Publication

Society publications are the vehicle in which the results of scientific inquiry, guided by the scientific method, are shared with other geoscience researchers and made available to a wider public audience. Results presented in Society publications advance research, inform governmental policy decisions, educate students, and assist the private sector in a wide range of endeavors. Thus it is important for the Society to maintain a level of quality and integrity in its publication process. This responsibility rests with all involved in the publication process—authors, reviewers, editors, GSA officials, and GSA staff. The following document outlines a set of ethical guidelines for all those involved in GSA publications (journals, books, maps, abstracts, electronic media). Adherence to these guidelines should promote fair treatment of manuscripts through the peer review process.

This document draws heavily on ethical guidelines prepared by other scientific societies, most notably the American Chemical Society. The list of sources below also includes more general documents on ethics in science consulted in preparation of these guidelines.

- National Academy of Sciences: On Being A Scientist: Responsible Conduct In Research (stills.nap.edu/html/obas)
- American Chemical Society (Reprinted [in part] with permission from “Ethical Guidelines to Publication of Chemical Research,” *Chem. Rev.* 2001, 101, p. 13A–15A. Copyright 1985, 1989, 1995, 2001 American Chemical Society.)
- American Physical Society (www.aps.org/statements/02_2.html)
- American Geophysical Union (www.agu.org/pubs/pubs_guidelines.html)
- American Mathematical Society (www.ams.org/secretary/ethics.html)

1. Society Officers, Councilors, and Society Staff

1.1. Council is responsible for setting policy for all GSA publications and appointing editors of books and journals. The Publications Committee, as an appointed committee of Council, offers advice and makes recommendations on publication policy to Council.

1.2. The Executive Director is responsible for ensuring that publications policies enacted by Council are carried out.

1.3. Editors of books and journals are expected to carry out editorial duties in a manner consonant with policies set by Council and consistent with the Bylaws of the Society. They should work closely with the Executive Director and appropriate GSA headquarters staff (e.g., Director of Publications, Managing Editors, etc.).

1.4. Editors have full responsibility for editorial and technical decisions on journal and book content. Society Officers, Councilors, and headquarters staff (including the Executive Director) should not intervene or comment on editorial decisions on individual manuscripts.

1.5. Inquiries from Councilors and Officers on manuscripts under consideration will be handled in the same manner as communications from the general membership, which reflects the editorial staff's standard practices. Communications from Officers and Councilors about editorial business are considered official Society business, unless otherwise identified. Official inquiries will receive prompt and complete action that becomes part of the Society's official record.

2. Editors, Associate Editors, and Guest Editors of Books

The term Editor as used below refers to Editors, Associate Editors, Guest Editors of books, and Editorial Board members when delegated to serve in an editorial capacity.

2.1. Editors will give manuscripts unbiased consideration.

2.2. Editors should process manuscripts rapidly.

2.3. The Editor has sole responsibility for acceptance or rejection of a manuscript. Manuscripts should have peer review, but the Editor may reject or accept for cause (inappropriate for journal, clearly of poor quality, contents previously published elsewhere, etc.).

2.4. The Editor and editorial staff should not disclose information about submitted manuscripts except to reviewers, Associate Editors, Editorial Board members, and GSA publications staff. Information about a manuscript may be shared, with the author's permission, once a manuscript is accepted and scheduled for publication (e.g., new releases, pre-publication posting of the abstract, or inclusion in a list of contents, etc.).

2.5. Responsibility for manuscripts submitted by the Editor should be delegated to another Editor, Associate Editor, or Editorial Board member.

2.6. The Editor should not handle manuscripts for which there is a real or perceived conflict of interest. Examples include, but are not restricted to, past (within the last 5 years) or current collaboration, personal friend, employer or employee, family relationship, institutional relationship, past or present graduate advisor or advisee, someone with whom the reviewer has had a past or ongoing scientific controversy, or situations where the Editor could stand to gain economically by publication or rejection of the manuscript. Editorial responsibility should be delegated to another Editor, Associate Editor, or Editorial Board member.

2.7. The Editor should not use information, data, theories, or interpretations of submitted manuscript in her/his own work until that manuscript is in press or published unless the author has given permission to do so.

2.8. If an Editor is presented with convincing evidence that the main

substance or conclusions of a publication are erroneous, he/she should facilitate publication of a report (e.g., correction, follow-up manuscript, or other appropriate means) pointing out the error and, if possible, correcting it. The report may be written by the person who discovered the error or by the original author.

3. Authors and Co-authors

3.1. Manuscripts should contain original, new results, data, ideas and/or interpretations not previously published or under consideration for publication elsewhere (including electronic media and databases).

3.2. Authors should be encouraged to avoid fragmentation of their published submitted work where practical.

3.3. Authors should inform the Editor of related manuscripts under consideration elsewhere and provide copies if requested.

3.4. Fabrication of data, results, selective reporting of data, theft of intellectual property of others, and plagiarism are unethical practices and unacceptable.

3.5. Information obtained privately (e.g., in conversation, correspondence, or discussion with third parties) should not be used or reported in a manuscript without explicit permission from the party with whom the information originated. Information obtained in the course of confidential services (e.g., refereeing manuscripts or grant applications) should be treated similarly.

3.6. Manuscripts will contain proper citation of works by others, especially publications of the original hypotheses, ideas, and/or data upon which manuscript is based.

3.7. Data and/or samples (especially unusual or rare materials) upon which a publication is based should be made available to other scientists, except in special circumstances (patent protection, privacy, etc.), in the manuscript or through accessible data repositories, databases, museum

collections, or other means when requested.

3.8. Authorship

3.8.1. Authorship should be limited to those who have made significant contributions to the concept, design, execution or interpretation of the work reported in a manuscript; others who have contributed should be acknowledged.

3.8.2. Author order should be agreed on by all authors as should any changes in authors and order that occur while the manuscript is under review or revision. Changes in authorship must be submitted to the Editor in writing and must be signed by all authors involved.

3.8.3. Authors and co-authors should review and ensure the accuracy and validity of results prior to submission; co-authors should have opportunity to review manuscript before submission.

3.9. Authors should reveal to the Editor any potential conflict of interest (e.g., a consulting or financial interest in a company), that might be affected by publication of the results contained in a manuscript. The authors should ensure that no contractual relations or proprietary considerations exist that would affect the publication of information in a submitted manuscript.

3.10. Authors are encouraged to disclose major funding sources (e.g., government agencies, private foundations, private industry, universities) for reported research.

3.11. Prepublication via Internet or other methods is prohibited.

4. Reviewers

4.1. A reviewer should disclose real or perceived conflict of interests to the Editor **before** agreeing to write a review. Examples include, but are not restricted to, past (within the last 5 years) or current collaboration, personal friend, employer or employee, family relationship, institutional relationship, past or present graduate advisor or advisee, someone with

whom the reviewer has had a past or on-going scientific controversy, or situations where the reviewer could stand to gain economically by publication or rejection of the manuscript. The Editor will decide if the conflict is severe enough to prevent the reviewer from writing a fair, objective review.

4.2. A reviewer should decline to review a manuscript if she/he feels technically unqualified, if a timely review can't be done, or if the manuscript is from a scientific competitor with whom the reviewer has had an acrimonious professional relationship, or a conflict of interest as defined above (section 4.1).

4.3. Reviewers should be encouraged, but not required, to sign reviews. The Editor will preserve anonymity of reviewers should a reviewer elect to remain anonymous.

4.4. Reviewers should treat the manuscript as confidential.

4.5. Reviewers should ask the Editor for permission to discuss the paper with others for specific advice, giving names and reasons for such consultation.

4.6. Reviewers should not pass the manuscript to another to carry out the review without permission from the Editor.

4.7. Reviewers should not use information, data, theories, or interpretations of the manuscript in their own work until that manuscript is in press or published unless the author has given permission to do so.

4.8. Reviewers should clearly support and justify the basis for their review analysis.

4.9. Reviewers should alert the Editor to similar manuscripts published or under consideration for publication elsewhere in the event they are aware of such. However, it is the responsibility of the Editor, not the reviewer, to decide on the proper course of action once so informed.

Complete information for authors is posted at www.geosociety.org/pubs/. Submit articles to *Geology* and *GSA Bulletin* at www.gsjournals.org (go to "Online Journals"). Submit articles for *GSA Today* to Gerry Ross, lavaboy@verizon.net, or Keith Howard, khoward@usgs.gov, and for *Environmental & Engineering Geology* to Alan E. Fryar, afryar1@uky.edu. Submit book proposals to Abhijit Basu, gsa@indiana.edu, and digital and printed map proposals to J. Douglas Walker, jdwalker@ukans.edu. Members of the GSA Publications Committee are listed at www.geosociety.org (go to "About GSA").

The Geological Society of America and
The Geological Association of Canada present...



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Jack Farmer, jack.farmer@asu.edu

Second Circular
November 2004

Registration opens
February 2005

CALL FOR THEME SESSION PROPOSALS

EMERGENCE OF A PARADIGM

Once considered vast and unconnected, Earth's surface environment is now seen as finite and highly interconnected by a complex web of feedbacks among the biota, oceans, atmosphere, lithosphere, and cryosphere. This Earth systems paradigm is being shaped by geoscientists and their colleagues in diverse disciplines of the natural sciences. Together we are seeking a better understanding of the nature of these feedbacks in the modern world, how they have emerged and evolved over Earth history, and how they will respond to human perturbations in the future.

The Geological Society of America (GSA) and the Geological Association of Canada (GAC) are combining their resources, as GSA did with the Geological Society of London in 2001, to co-convene a broad, interdisciplinary meeting to discuss the advances made in the last four years in our understanding of Earth System Processes.

THE THEMES

Ancient Earth Systems will explore the controversial hypotheses describing the nature and drivers of environmental and biotic evolution on geologic time scales, some of which involve extra-terrestrial influences and exchange with Earth's deep interior. As we clarify the processes that drive evolution of the Earth system, we come closer to understanding our origins and the future of our planet. We also learn how to refine our search for habitable environments and life elsewhere in the universe.

Modern Earth System Processes will delve into the processes that link the components of the Earth system across all scales of space and time. Interdisciplinary studies are just now beginning to elucidate these feedbacks through observation, experimentation, and modeling. These studies provide the phenomenological basis for the investigation of the evolution and future of the Earth system.

Earth System Futures will address important questions about the Earth's future. Can we understand the interactions of the Earth system well enough to

predict how human-induced and natural changes in one component will affect other components over the next century to millennium? Can we make scientific, social and economic decisions that will minimize the likelihood of catastrophic stress on the biosphere?

THE VENUE

Earth System Processes 2 will be held at the spacious and well-appointed Westin Hotel in Calgary, Alberta, Canada. Calgary is strikingly beautiful in its high plains setting just beyond the foothills of the Canadian Rockies, and the comfortable, friendly city is well known for welcoming visitors from all over the globe. Plan to travel with family or friends and include a vacation to explore all the classic geology, paleontology and geomorphology that Alberta offers. Enjoy August in Calgary and the Rockies—long, sunny days, crisp clear nights—a perfect spot to gather with fellow scientists and advance our understanding of Earth system processes.

CALL FOR THEME SESSION PROPOSALS

The organizing committee seeks your help in putting together a suite of theme sessions that represents cutting-edge research on the general themes of the meeting. Theme sessions may fit squarely into one of the three general themes or may cut across them. They should attract a core representation from the geosciences, but should also draw in our colleagues from other disciplines.

Proposals for Theme Sessions should be submitted electronically at the ESP2 website, and include:

1. A brief description of the theme.
2. A justification for inclusion in ESP2, including indications that the session will draw sufficient abstracts and be well attended.
3. A list of possible invited speakers and the topic they would likely discuss.

Theme Session Proposals must be submitted electronically and received by September 15, 2004. If you have questions, please contact one of the technical program chairs or any of the members of the technical program committee.

Ads (or cancellations) must reach the GSA Advertising office one month prior. Contact Advertising Department, (303) 357-1053, 1-800-472-1988, ext. 1053, fax 303-357-1070, acrawford@geosociety.org. Please include address, phone number, and e-mail address with all correspondence.

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Positions Open

GLACIAL GEOLOGIST

The Department of Earth Sciences and The Climate Change Institute of the University of Maine seek to hire an entry-level tenure track Assistant Professor to begin in the Fall of 2004. The opening is to fill a retirement position, and will be in the area of Glacial and Quaternary Geology. The successful candidate will have an appointment that is approximately 70% research and 30% teaching. She/he will be expected to teach undergraduate geology courses and develop and teach graduate courses in her/his specialty. He/she will be expected to advise graduate students. A completed Ph.D. in Geology will be required by September 1, 2004. Other criteria include a record of publication, evidence of commitment to funded research, and excellent teaching ability. Established research interests in the region comprising New England, the Maritimes, and adjacent areas will be a plus, but willingness to direct student projects in the region is a must. The University of Maine is located in a region of outstanding Pleistocene glacial and glaciomarine landforms and stratigraphy, complex land-sea level interactions, and key sections for unraveling timing and processes of climate interactions. The successful candidate will have research interests in glacial geology such as glacial processes, glacial landforms, Quaternary stratigraphy, dating and mapping. The Department and Institute have a tradition of strong interdisciplinary interactions among geologists, glaciologists, paleoecologists, historians, climate modelers, and anthropologists on campus, at the Maine Geological Survey, and internationally. The successful candidate will have a demonstrated record and interest in continuing interdisciplinary Quaternary science collaborations.

Applicants should send a cover letter, curriculum vitae, and the names, addresses, phone numbers (and e-mail addresses, if possible) of three referees to: Chair, Glacial Geologist Search Committee, Department of Earth Sciences, University of Maine, 111 Bryard Global Sciences Building, Orono, ME 04469-5790. Reviews of applications will begin April 16, 2004, and continue until the position has been filled. For additional information, visit our websites at: <http://www.geology.um.maine.edu/> and <http://www.ume.maine.edu/iceage/>. The University of Maine is an equal opportunity/affirmative action employer. We seek applications from qualified women and minorities.

As required by the Clery Act, the University of Maine's Annual Security Report includes statistics on reported crimes that have occurred on or near campus, as well as University policy concerning campus security. Copies of the Report are available on request from the Director of Public Safety, Mail Service, University of Maine, 5761 Keyo Public Affairs Bldg., Orono, ME 04469-5761, or Phone: (207) 581-4048, or on the web at www.umaine.edu/security.

STRUCTURAL GEOLOGY/TECTONICS SCHOOL OF GEOLOGY AND GEOPHYSICS COLLEGE OF GEOSCIENCES UNIVERSITY OF OKLAHOMA

The University of Oklahoma invites applications and nominations for a tenure-track faculty position in Structural Geology/Tectonics. The holder of this position is expected to (1) conduct research in structural analysis

using any combination of theoretical, experimental, field, and seismic approaches; and (2) educate students in the area of structural concepts and techniques.

The University is seeking to fill this position at the Assistant or Associate Professor level. The successful candidate should have an excellent demonstrated or developing research record and the vision to establish a strong research program in pure and/or applied structural geology/tectonics. The candidate must also be an excellent educator, with commitment to both undergraduate and graduate (M.S. and Ph.D.) education. A Ph.D. degree is required for this position. Salary and benefits will be competitive and commensurate with experience and future potential.

Initial screening of applicants will begin in Spring of 2004. The position will be available as early as Fall 2004, and the search will remain open until the position is filled. Applicants are encouraged to submit a complete vita/resume, statement or research and teaching interests, and a list of five references, including names, phone numbers, e-mail addresses, and complete mailing addresses. Questions or requests for additional information may be addressed to Dr. Shankar Mitra, Chair of the Structural Geology/Tectonics Search Committee, at (405) 325-4462, or smitra@ou.edu. Applications and nominations should be addressed to: Structural Geology Search Committee, School of Geology and Geophysics, University of Oklahoma, 100 E. Boyd Street, Room 810, Norman, OK 73019-1008.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women and Minorities are encouraged to apply.

POSTDOCTORAL RESEARCH POSITIONS NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS (NCED) UNIVERSITY OF MINNESOTA

NCED has funding for several (3-6) positions for postdoctoral researchers in Earth-surface dynamics. The Center's research focus is channels and channel networks, with a strong emphasis on linking ecology and morphodynamics.

The postdoctoral researchers hired under this announcement will form the nucleus of NCED's Synthesis Group, playing a lead role in synthesizing NCED research results into models and modeling algorithms. Quantitative proficiency and a taste for collaborative research are essential; experience in morphodynamics and/or ecology, especially with a modeling emphasis, highly desirable.

Synthesis Group postdocs may be held at any NCED research institution: St Anthony Falls Laboratory (University of Minnesota), University of California Berkeley, University of Wyoming, Massachusetts Institute of Technology, or Princeton University. Regardless of where each postdoc is based, activities of the Synthesis Group are expected to be highly collaborative. All members of the Synthesis Group will maintain close contact with each other and all NCED researchers via regular meetings and videoconferencing.

Applicants should send a CV with names of three references to Rochelle Storfer, National Center for Earth Surface Dynamics, St. Anthony Falls Laboratory, 2 Third Ave S.E., Minneapolis, MN 55414.

The University of Minnesota is an equal opportunity educator and employer.

SENIOR LEVEL EXECUTIVE AMERICAN GEM SOCIETY LABORATORIES

American Gem Society Laboratories (www.agslab.com), known for its diamond Cut Grade and Cut Grade research, is currently looking for a senior level executive to implement growth plans, develop lab products and services, and maintain AGS diamond grading standards. Must have exceptional gemological knowledge and experience, BS in Business and/or 10-15 years of management experience in a related field. Excellent benefits. Drug Free Environment/EOE. Send resumes with salary history to: careers@agslab.com or fax (702) 255-9861.

LECTURER/LAB MANAGER IN GEOLOGY CLEMSON UNIVERSITY

The Department of Geological Sciences in the School of the Environment at Clemson University invites applications for the position of Lecturer/Lab Manager in Geology. This is a full-time position, with benefits, and is renewable annually, but it is not a tenure-track position. Primary duties include teaching introductory courses, managing teaching laboratories and materials, developing curricula, and participating in the department's outreach efforts. The appointment has a starting date of August 15, 2004.

The Department of Geological Sciences has the responsibility of providing introductory courses that fulfill several university science and general education requirements. Large numbers of non-science majors take these

courses, with their associated laboratory classes, each semester. Position duties will include teaching two or three lecture sections per semester of physical geology, earth resources, or environmental science, coordinating and facilitating laboratory instruction for these courses, supervising graduate teaching assistants, and assisting with departmental outreach efforts.

The successful applicant must have at least a master's degree in geology, environmental science, or a related field. Preference will be given to candidates with prior teaching experience and to those familiar with general and geology software packages. Nine-month starting salary will range from \$28,000 to \$35,000 depending on qualifications. Opportunities exist for collaboration in geoscience education research and summer teaching support.

Interested candidates should send a letter of application, curriculum vitae, statement of teaching philosophy, and the names and addresses of three persons who may be contacted as professional references to the Chair, Search Committee, Department of Geological Sciences, Room 340 Brackett Hall, Clemson University, Clemson, S.C. 29634-0919. Review of applications will begin on April 1, 2004, and continue until the position is filled.

Clemson University is an equal opportunity, affirmative action employer. Women and minority candidates are encouraged to apply.

BRADLEY UNIVERSITY TEMPORARY ASSISTANT PROFESSOR OR INSTRUCTOR OF GEOLOGY

The Department of Geological Sciences at Bradley University is seeking candidates for a Temporary Full-Time Assistant Professor or Instructor for a one year term beginning in August, 2004 for the 2004-2005 school year.

Responsibilities: Serve as a full-time faculty member in the Department of Geological Sciences. Teach courses in introductory physical geology, introductory physical geology laboratory, geomorphology, and weather elements (i.e. elementary meteorology). The teaching schedule would require no more than three preparations a semester.

Qualifications: A broad background in geology with any specialization(s) and a Ph.D. in geology or successful completion of a Ph.D. program except for an accepted dissertation and a thesis defense.

Applicants should forward a letter of application, a current complete resume, undergraduate and graduate transcripts, and three letters of recommendation to: Dr. Merrill W. Foster, Department of Geological Sciences, Bradley University, Peoria, IL 61625, 309-677-2352, fossil@bradley.edu.

Primary consideration will be given to applicants who respond by April 30, 2004. Applications will be accepted until the position is filled.

Bradley University is an Equal Opportunity, Affirmative Action Employer encouraging diversity.

ENVIRONMENTAL GIS POSITION TEXAS CHRISTIAN UNIVERSITY

Texas Christian University (TCU) invites applications for an Assistant Professor position in **Environmental GIS**, beginning August 2004. The appointment will be a tenure track position in the Department of Geology. The successful candidate will liaise with the Center for Remote Sensing and GIS and the Institute of Environmental Studies. Candidates must possess a strong background and track record in environmental and geoscience GIS applications. Responsibilities will include building upon an existing GIS/ Remote Sensing curriculum through development of introductory and advanced ArcGIS courses. Other teaching duties will reflect departmental needs, GIS background and scientific expertise of the individual. Candidates should demonstrate an equal commitment to both teaching and research. This is an opportunity-rich appointment; the candidate will be expected to foster cross-campus collaborations, and bridge the link between the university and a very active regional GIS community.

Applicants should send a vita, statement of teaching and research interests, and contact information for three references to: R.N. Donovan, Chair, Department of Geology, Box 298830, Texas Christian University, Fort Worth, TX 76129. Review of applications will begin April 1 and continue until the position is filled. TCU is an AA/EEO employer and encourages a diversity of applicants.

Opportunities for Students

Graduate Assistant Funding, Wesleyan University, Middletown, CT. The Department of Earth and Environmental Sciences announces a graduate assistantship for a Master's degree in Earth Sciences. We are a small department with history of collaborative research on broad range of topics in earth and environmental sciences. Areas of departmental expertise include earth-

surface processes, remote sensing, planetary geology, geochemistry, clastic sedimentology, paleoceanography, volcanology, structure, and tectonics. Graduates of our program have gone on to successful positions in Ph.D. programs, government agencies, and private industry. The successful applicant will receive 9-month stipend the first year and a 12-month stipend the second year, of not less \$14,181 and \$18,908 respectively. Interested candidates should contact: Dr. Suzanne O'Connell at (860) 685-2263, soconnell@wesleyan.edu. Application information is available at: <http://www.wesleyan.edu/ees/graduateprogram.html>.

Masters Graduate Assistantships. Eastern Kentucky University. The Dept. of Earth Sciences, Eastern Kentucky University (www.earthscience.eku.edu) has Teaching Assistantships available for the 2004–2005 academic year for Masters students. These assistantships offer 9 months of stipend support, generally for two academic years. Students must apply for graduate assistantships no later than 1 June 2004. Please contact Dr. Melissa Dieckmann, Director of Graduate Studies (859-622-1276; melissa.dieckmann@eku.edu) for further information. Our department offers individual instruction from a geology faculty of seven with research opportuni-

ties in geochemistry, hard rock petrography, karst hydrology, ocean science, sedimentation and stratigraphy, and tectonics. Our location in central Kentucky offers an excellent natural laboratory in the surrounding region and in surrounding states. EKU is an EEO/AA institution that values diversity in faculty, staff, and student body. In keeping with this commitment, our department welcomes applications from diverse candidates.

Masters Research Opportunity. Eastern Kentucky University. Dr. Walter S. Borowski has financial support available for Master's thesis research at the Dept. of Earth Sciences, Eastern Kentucky University (www.earthscience.eku.edu). This research involves sulfur extractions from authigenic sulfide minerals residing in deep-sea sediments, and subsequent measurement of sulfur isotopic composition. Students will be supported for summer research contingent on their acceptance as a graduate assistant within the department. These assistantships offer 9 months of stipend support, generally for two academic years (please refer to the companion advertisement). Students must apply for graduate assistantships no later than 1 June 2004. Please contact Walter Borowski (859-622-1277; w.borowski@eku.edu) for further information. EKU is an

EEO/AA institution that values diversity in faculty, staff, and student body. In keeping with this commitment, the department welcomes applications from diverse candidates.

The Yellow Springs Instruments Environmental PhD Fellowship. Wright State University is pleased to announce a new YSI Environmental Sciences PhD Fellowship. The Research Fellowship is for \$25,000 with tuition and fee waivers. This prestigious award will be given to a highly qualified applicant accepted into the Environmental Sciences PhD Program at WSU. Students may apply with either a BS or MS degree from a relevant major (e.g., biology, chemistry, geology, physics, toxicology, environmental health sciences). The program provides a strong interdisciplinary focus both in the course work and dissertation research, with a focus on contaminant fate and effects in three areas of faculty expertise: environmental toxicology and chemistry, environmental stressors, and environmental geophysics and hydrogeology. Review of applications for the 2004–2005 Academic Year will begin in January, 2004, and continue until the position is filled. For more information on the curriculum, faculty research areas and application materials see <http://www.wright.edu/academics/envsci>.



GEOSCIENCE DIRECTORY

Books—Used & Rare

Recent, Rare, and Out-of-print Books. Find our catalogs at <http://booksgeology.com> for books on geoscience, paleontology, mineralogy, mining history, ore deposits, USGS publications, petroleum, remote sensing and metallurgy. E-mail: msbooks@booksgeology.com. We purchase books and entire collections. MS Book and Mineral Company, P.O. Box 6774, Lake Charles, LA 70606-6774 USA

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Water-Rock-Life Labs—a comprehensive analytical contract facility providing metal analyses on a variety of environmental matrices (e.g., EPA 200.8, EPA 6020) by DRC-ICP-MS. Laser ablation ICP-MS also available. Contact Dr. Robyn Hannigan (870-972-3086; hannigan@astate.edu) or <http://www.cas.astate.edu/geochemistry> for more information.

Distance Learning

Advanced Diploma in Geochemistry. Flexible study programme offered through School of Earth Sciences, Birbeck, University of London, UK. CD-ROM based materials, supported through Virtual Learning Environment. Contact The Information Centre, enquiries@lon.ac.uk; www.londonexternal.ac.uk.

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Summer Schools

University of Urbino First Summer School in Paleoclimatology. July 12–20. Lectures on the various aspects of the multidisciplinary field of paleoclimatology. Closing date for application: April 15, 2004. www.uniurb.it/ussp; email: ussp@uniurb.it.

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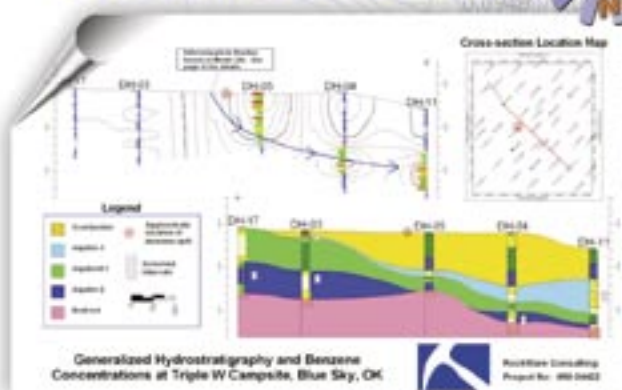
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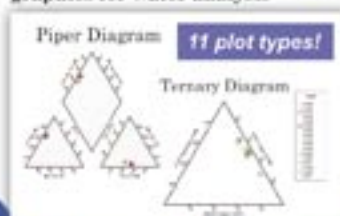
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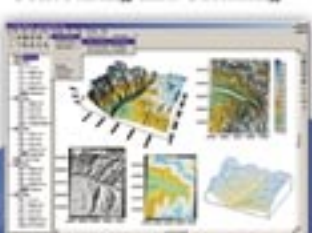
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