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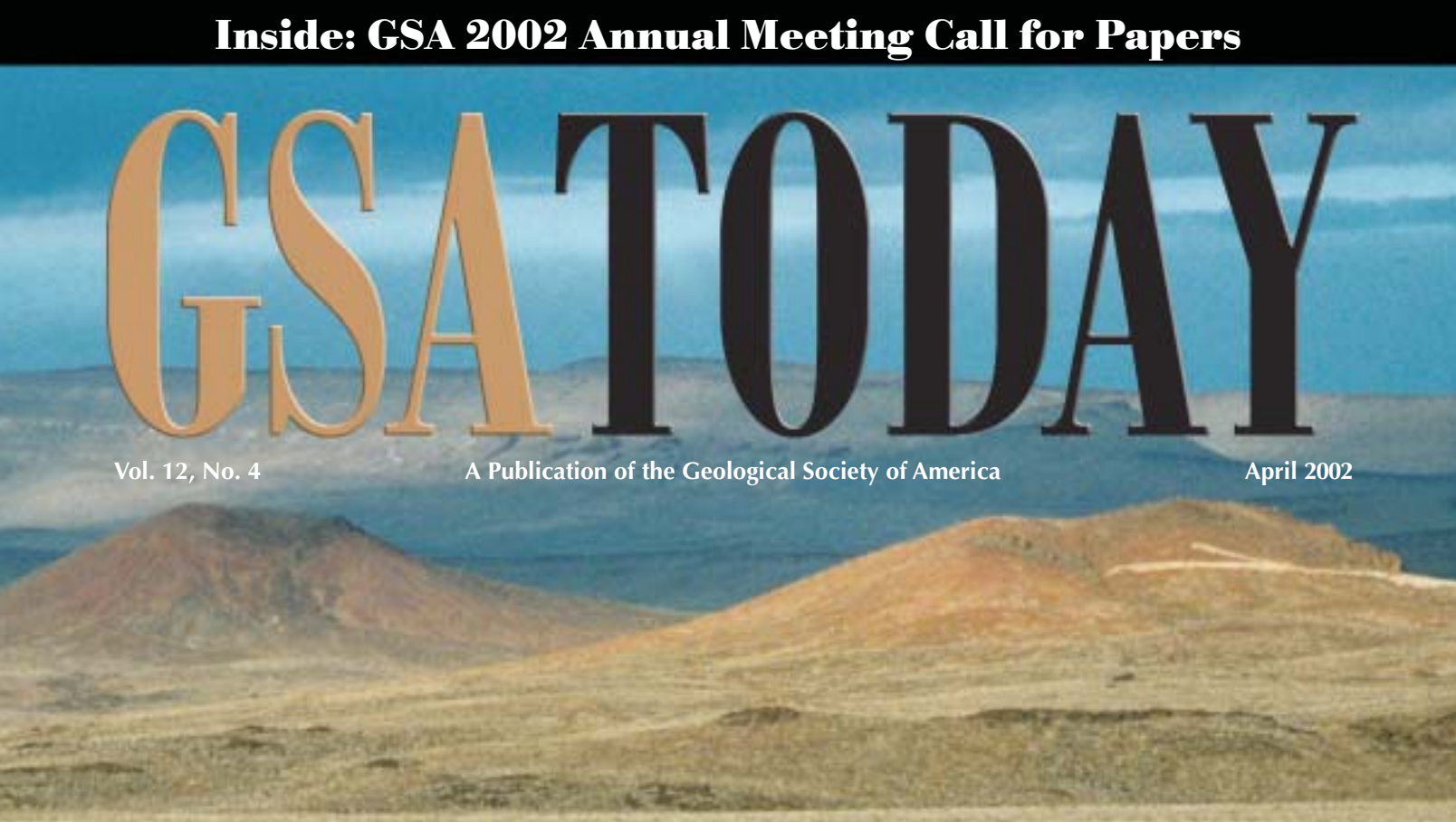

Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada

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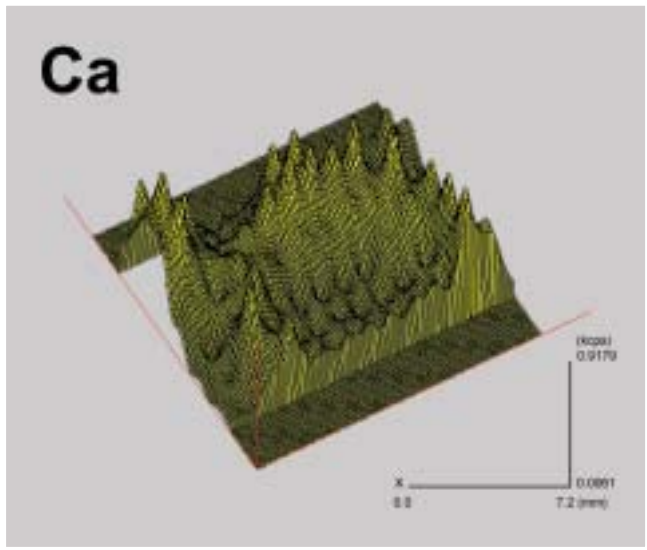

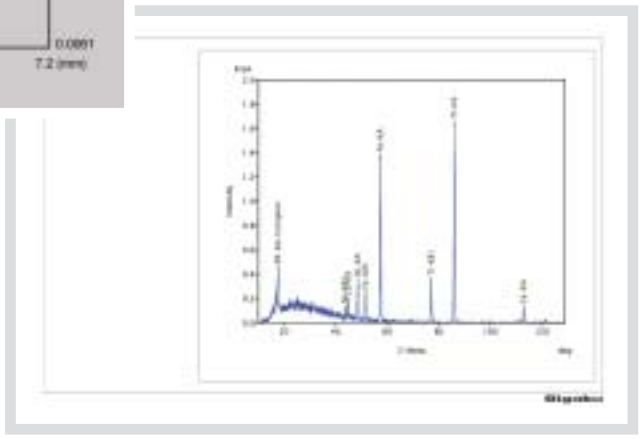

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science article

On the cover: Cinder cones (Black Cone, left, and Red Cone, right) and lava flows in Crater Flat. Yucca Mountain, site of the proposed high-level nuclear waste repository, is in the background. See "Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada," by E.I. Smith et al., p. 4–10.

Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada

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ABSTRACT

Determining the risk of future basaltic volcanism is one of many scientific studies required to evaluate the Yucca Mountain site in southern Nevada for long-term storage of high-level radioactive waste. These studies are of particular interest, because basaltic volcanism has occurred since 10.5 Ma in the Yucca Mountain area, and eight Quaternary alkali basalt volcanoes ranging in age from 1.0 Ma to 80 ka have erupted within 50 km of the proposed repository. The volcanoes near Yucca Mountain are part of a larger zone of basaltic volcanism that stretches from Death Valley, California, to the Lunar Crater field in central Nevada (the Crater Flat–Lunar Crater zone). Within this zone, volcanism is coeval and episodic with three peaks of volcanism occurring since 9.5 Ma; one between 9.5 and 6.5 Ma, the second between 4.5 and 3.5 Ma, and the last between 1.5 and 0.5 Ma. Periods of low activity separate these peaks and last for 1–2 m.y. At the present time, volcanism in this zone is relatively quiet, with only three eruptions occurring in the past 80 000 years.

A common driving force for magmatism is suggested by coeval volcanism along the entire length of the Crater Flat–Lunar Crater zone. We propose that hot mantle exists beneath the zone and provides the impetus for volcanic activity. Recent geochemical modeling suggests that melting beneath the Crater Flat–Lunar Crater zone was especially deep. For Lunar Crater, the melting column extends from 162 km up to 110 km and for Crater Flat from 133 km up to 115 km. Deep melting requires hot and buoyant mantle with mantle potential temperatures about 200 °C greater than those in the western Great Basin. Episodic volcanism in the Crater Flat–Lunar Crater zone may be related to episodic periods of rapid strain accumulation in the lithosphere.

Probability modeling, the basis of determining whether volcanism is an issue for the selection of the site, is based on knowledge of the recurrence rates of volcanism since at least 4.8 Ma. For the Yucca Mountain area, recurrence rates of 3.7–12 events per m.y. are commonly used in probability models. Our petrologic arguments imply that volcanism along the Crater Flat–Lunar Crater zone is linked to a common area of hot mantle. If this is correct, then Lunar Crater and Reveille Range recurrence rates (11 to >15 events per m.y.) are possible in the Yucca Mountain area. Furthermore, if the Crater Flat–Lunar Crater zone is underlain by hot mantle as suggested here, another peak of volcanic activity is possible. Considering that recurrence rates may be underestimated, the episodic pattern of volcanism, and the likelihood of hot mantle sustaining volcanism, we suggest that there is a greater uncertainty in the current recurrence rates than that used in present probability models. Despite decades of work and debate, the underlying cause of volcanism and temporal models for calculating recurrence rates of volcanism are not firmly established. In our opinion, understanding the process of volcanism is a prerequisite to having confidence in volcanic hazard studies. If too many unanswered questions remain at the time of site approval, then perhaps an alternative repository site should be chosen in an area without the risk of volcanism.

INTRODUCTION

In 1983, the U.S. Department of Energy (DOE) selected nine locations in six states for consideration as potential sites for permanent storage of high-level nuclear waste and spent nuclear fuel. In 1987, Congress amended the Nuclear Waste Policy Act and directed the DOE to study only the site at Yucca Mountain, about 160 km northwest of Las Vegas, Nevada. If a nuclear waste repository is constructed at Yucca Mountain, 70 000 metric tons of spent nuclear fuel from U.S. commercial nuclear power plants and high-level radioactive waste from DOE nuclear weapons complexes will be buried 300 m below the surface at Yucca Mountain. Some believe that the future of the nuclear power industry depends on building a repository. However, an alternative to a single nuclear waste repository is dry cask storage at or near nuclear reactors. Although not approved for permanent storage, this method, already licensed by the Nuclear Regulatory Commission (NRC), is in use today and would not require the transport of waste long distances along public highways. DOE investigators were given the task of demonstrating that natural and engineered barriers at the Yucca Mountain site would prevent the waste itself or contaminated fluids from escaping to surrounding areas for 10 000 years. The waste needs to be contained for at least 10 000 years because of the extreme hazard to public health and the environment associated with these radioactive materials.

Although studies have been under way for several decades, 2002 is a critical time for scientific studies at Yucca Mountain. This year, the DOE recommended the site for licensing as a nuclear waste repository. President Bush approved the recommendation on February 15, 2002. If this decision survives a veto by Governor Kenny Guinn of Nevada and a lawsuit filed by the State of Nevada, work would enter a phase of site approval and license application and leave the site

characterization stage. According to the DOE's schedule, if the repository is licensed, construction will begin in 2006 and waste accepted in 2010. Before the site characterization stage is completed, however, a variety of geological and hydrological studies must be finished to evaluate the Yucca Mountain site for long-term storage of high-level radioactive waste. Important issues related to site study range from transport of contaminants released from the repository in groundwater (e.g., Ferrill et al., 1999) to determining the risk of future basaltic volcanism and the consequences of eruption into or near the repository block. Studies of volcanic activity are of particular interest, because basaltic volcanism has occurred since 10.5 Ma in the Yucca Mountain area and eight Quaternary alkali basalt volcanoes ranging in age from ~1.0 Ma to 80 ka have erupted within 50 km of the proposed repository.

Volcanism studies by the DOE have been under way for over two decades (Crowe and Carr, 1980; Crowe et al., 1982, 1983a, 1983b, 1998; Geomatrix Consultants, 1996; Civilian Radioactive Waste Management System Management and Operating Contractor, 2000). In addition, oversight by the NRC and the State of Nevada has resulted in many important scientific contributions (e.g., Connor and Hill, 1995; Connor et al., 2000; Woods et al., 1999; Smith et al., 1990; Bradshaw and Smith, 1994; Ho and Smith, 1997, 1998). The DOE continued its probabilistic volcanic hazard studies by establishing a panel of 10 experts who evaluated past research and independently estimated the probability of future eruptions in the Yucca Mountain region (Geomatrix Consultants, 1996). The expert panel calculated the probability of magmatic disruption of the Yucca Mountain site at about 1.5×10^{-8} events per year. The DOE is currently using a probability of 1.6×10^{-8} (U.S. Department of Energy, 2001).

According to Environmental Protection Agency (EPA) guidelines, volcanism should not be considered an issue for site selection if there is less than 1 chance in 10 000 in 10 000 years of site disruption by volcanic eruption (Environmental Protection Agency, 1993). This requirement is reiterated in the new EPA rule for Yucca Mountain (Environmental Protection Agency, 2001). Although the number calculated by the expert panel is greater than this guideline value, the DOE and the NRC are continuing their studies of volcanism at the Yucca Mountain site (Macilwain, 2001). Substantial new information relating to volcanic probability and consequence has been published since the report of the expert panel in 1996. This paper focuses on studies completed since 1996 that may contribute to new probabilistic estimates of volcanic hazard assessment. It emphasizes that the final decision to place a repository at Yucca Mountain should be based on sound science. This important decision should not be rushed for political reasons or to satisfy program requirements.

DISTRIBUTION AND TIMING OF VOLCANISM

Volcanoes in the Yucca Mountain area are part of a larger zone of basaltic volcanism that stretches from Death Valley, California, to the Lunar Crater field in central Nevada (Vaniman and Crowe, 1981; Crowe et al., 1983b) (Fig. 1). This belt of Pliocene-Quaternary alkali basalt volcanoes lies along the axis of the Great Basin and is isolated from similar-aged basaltic volcanoes in the Basin and Range–Colorado Plateau transition zone to the east and volcanic fields along the eastern front of the Sierra Nevada Range to the west. In Figure 1, the distribution and age of Pliocene-Quaternary basaltic volcanoes in the area from Crater Flat near Yucca Mountain to Lunar Crater are shown. Volcanoes in the Death Valley area are not plotted because of poor age control; therefore, in the remainder of this paper, the zone will be referred to as the Crater Flat–Lunar Crater zone. Volcanism in the southern part of the zone at Crater Flat is coeval with volcanic activity to the north in the Reveille Range and at Lunar Crater.

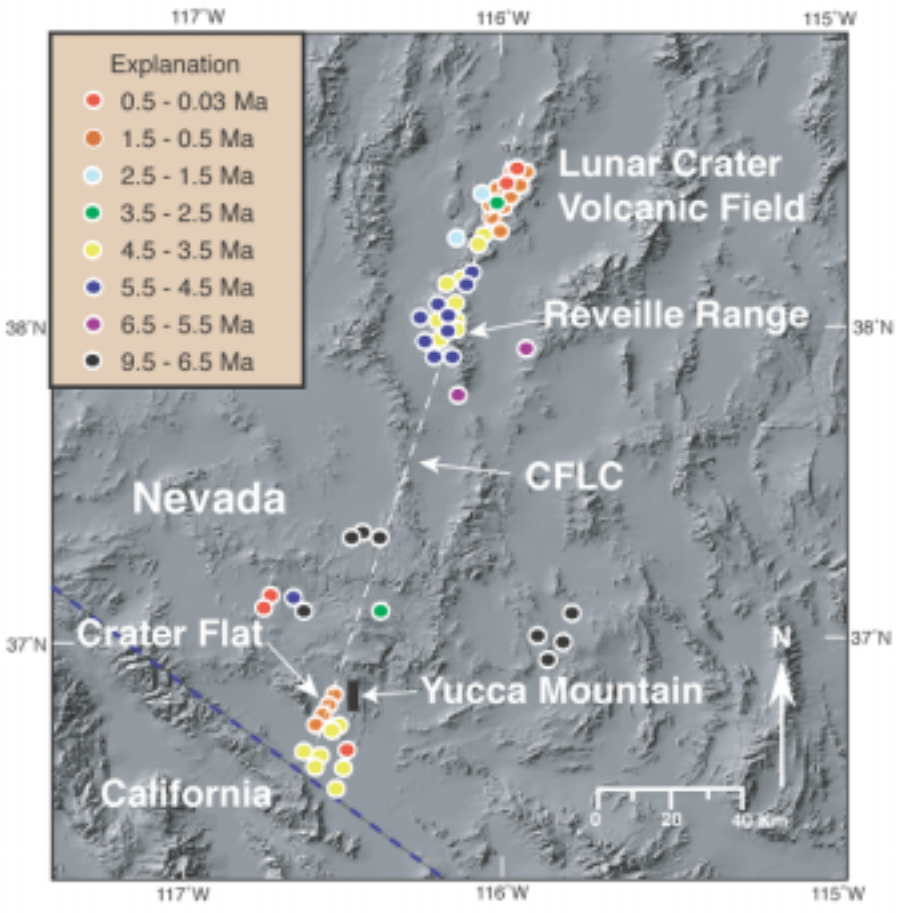

Figure 1. Age and distribution of Pliocene-Quaternary basaltic volcanoes in Crater Flat–Lunar Crater zone (CFLC).

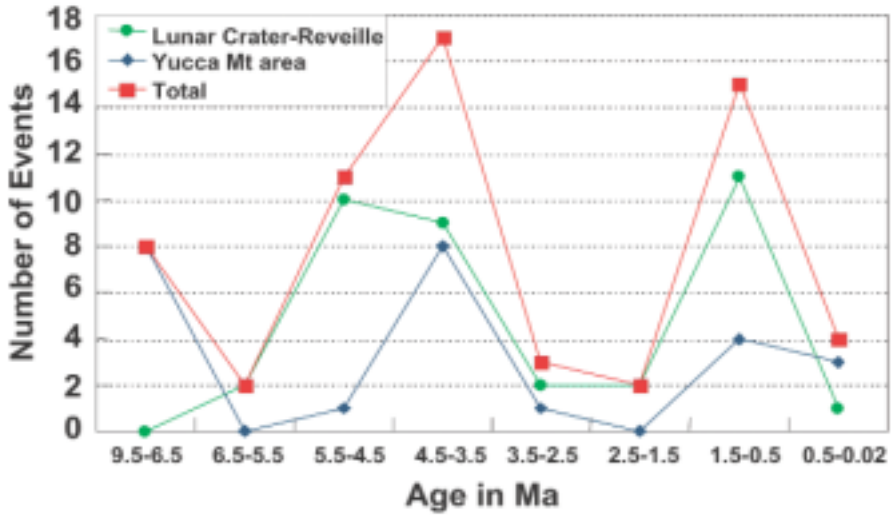

Figure 2. Time-event plot showing episodic nature of volcanism in Crater Flat–Lunar Crater zone.

Recurrence rates in the southern part of the Crater Flat–Lunar Crater zone near Yucca Mountain vary from 3.7 to 12 volcanic events per m.y. (Connor and Hill, 1995; Crowe et al., 1998; Connor et al., 2000). Recurrence rates in the northern part of the zone in the Reveille and Lunar Crater fields vary from 11 to >15 events per m.y. Furthermore, when volcanic events are plotted against time (Fig. 2), there is an episodic pattern. Since 9.5 Ma, there have been three peaks of volcanism: one between 9.5 and 6.5 Ma (only near Yucca Mountain), the second between 4.5 and 3.5 Ma, and the last between 1.5 and 0.5 Ma. Periods of relative quiet separate these peaks and last for 1–2 m.y. At the present time, volcanism in the Crater Flat–Lunar Crater zone is relatively quiet with only three eruptions in the past 100 000 years. The most recent eruptions occurred at the Lathrop Wells cinder cone (77.3 ± 6.0 ka; Heizler et al., 1999) at the southern tip of Yucca Mountain and from the Black Rock cones (two eruptions dated at 38.1 ± 9.7 ka, Shepard et al., 1995; E. Stickney, unpublished $^{40}Ar/^{39}Ar$ date) in the Lunar Crater volcanic field. The small number of eruptions, especially in the Yucca Mountain area, introduces uncertainty about the statistical significance of these trends. Nevertheless, these observations are based on all radiometrically dated volcanoes. Thus, we contend that observations related to coeval volcanism and episodic patterns within the Crater Flat–Lunar Crater zone are valid. Episodic patterns of volcanism were previously noticed by DOE volcanologists (Crowe et al., 1998). Additionally, based on Global Positioning System (GPS) surveys, Wernicke et al. (1998) suggested that the Yucca Mountain area is currently in a period of rapid strain accumulation and inferred that magmatic and tectonic events may be episodic with events lasting 100 000 years occurring every million years. These results were vigorously debated (Savage, 1998; Connor et al., 1998; Davis et al., 1998; Savage et al., 1999).

MANTLE CONTROL OF VOLCANISM?

Correlations of the timing of volcanism between the northern and southern parts of the Crater Flat–Lunar Crater zone infer a common driving force for magma generation. In the past, there was a reluctance to accept a common process to explain volcanism along the length of the zone because of geochemical data that demonstrate that basalt in the Reveille and Lunar Crater fields has high ε_{nd} and low $^{87}Sr/^{86}Sr$ while basalt near Yucca Mountain has lower ε_{nd} and higher $^{87}Sr/^{86}Sr$. The Reveille and Lunar Crater isotopic signatures are thought to represent melting of asthenospheric mantle (Foland and Bergman, 1992; Yogodzinski et al., 1996), whereas those in the Crater Flat area represent melts of the lithospheric mantle (Perry and Crowe, 1992). In support of different mantle sources for northern and southern parts of the Crater Flat–Lunar Crater zone, Yogodzinski and Smith (1995) defined the Amargosa Valley Isotopic Province for the southern part of the Crater Flat–Lunar Crater zone (including Death Valley) and suggested that because of its chemical properties, lithospheric mantle in the Amargosa Valley Isotope Province had a greater tendency to melt than surrounding mantle.

A recent study (Wang et al., 2002) bears directly upon the problems of magma generation in the Crater Flat–Lunar Crater zone and may provide a clue to the processes responsible for coeval episodic volcanism along the length of the zone. The study is based on approximately 400 samples of alkali basalt collected throughout the Great Basin. Techniques developed by Langmuir et al. (1992) quantify the depth and degree of mantle melting. All calculations assumed adiabatic ascent of dry mantle. Differentiation corrected values of FeO were used to constrain the base of the melting column and Na_2O the top. Based on these techniques, Wang et al. (2002) generated a melting profile across the Great Basin (Fig. 3) that showed shallow melting (50–75 km) in the west, deep melting in central Nevada in the Crater Flat–Lunar Crater zone (100–140 km) and somewhat shallower but still deep melting beneath the Colorado Plateau (>90 km). The tops of melting columns across the Great Basin roughly correspond to the asthenosphere-lithosphere contact determined by geophysical studies (Fig. 3). This model implies, therefore, that all melting occurred in the asthenosphere and that the lithospheric mantle did not melt. Melting beneath the Crater Flat–Lunar Crater zone was especially deep. For Lunar Crater, the melting column extends from 162 up to 110 km and for Crater Flat from 133 up to 115 km. According to Wang et al. (2002), deep melting requires hot and buoyant mantle with mantle potential temperatures about 200 °C greater than those in the western Great Basin. Further support for deep melting is the high Tb-Yb ratio in Crater Flat–Lunar Crater zone basalt. Tb/Yb is strongly sensitive to garnet in the source

because heavy rare earth elements like Yb are strongly compatible in garnet and stay in the source during partial melting. Garnet is stable in mantle peridotite at depths >~100 km. Therefore, if melting is deep and garnet is in the source, Tb/Yb will be high. The concept of a deep mantle source for basalt near Yucca Mountain is not new. Previously, Vaniman and Crowe (1981), Perry and Crowe (1992), and Bradshaw and Smith (1994) noticed steep rare earth element patterns (high La/Yb), low Sc, low SiO_2, high FeO, and nepheline-normative compositions and suggested deep melting in the garnet field. In addition to the work of Wang et al. (2002), there are several recent geochemical and geophysical studies that support the presence of hot, buoyant mantle beneath the Crater Flat–Lunar Crater zone. Smith et al. (1999) indicated that pyroxene compositions in peridotite xenoliths from the Black Rock flow in the Lunar Crater volcanic field record equilibrium temperatures 200 °C higher than other similar composition xenoliths in the western United States. They interpreted these data as evidence for a plume. Parsons et al. (1994) and Saltus and Thompson (1995) argued that the Yellowstone plume has left a broad anomaly of buoyant mantle centered in northern Nevada (beneath the northern part of the Crater Flat–Lunar Crater zone).

Central Nevada has lower than average S-wave velocities at a depth of 300 km, which might be expected from hot, deep mantle (van der Lee and Nolet, 1997). Dueker et al. (2001) indicated lower compressional-wave velocities at a depth of 100 km for central and southern Nevada suggesting the presence of warm asthenosphere. Savage and Sheehan (2000) noted unusual patterns of shear-wave splitting in the Great Basin, with a null region surrounded by a semicircular alignment of fast polarization. They argued that this pattern, along with other supporting evidence (high dynamic elevation and high mantle buoyancy) is consistent with active mantle upwelling. Lowry et al. (2000) showed that high dynamic elevation anomalies in central Nevada are spatially correlative with Quaternary volcanism. Dynamic elevation is the elevation response to asthenospheric mantle buoyancy and is calculated by subtracting surface loads, crustal mass anomalies, and mantle thermal anomalies from the observed topography (Lowry et al., 2000). The authors argued that high dynamic elevation might be due to upwelling of anomalously hot mantle (plume) and phase and/or phase boundary deflections supported by high heat flow.

Collectively, these studies suggest that hot, buoyant mantle exists beneath the Crater Flat–Lunar Crater zone. We suggest that this hot mantle provides the common driving force for magmatism along the length of the Crater Flat–Lunar Crater zone.

QUESTIONS AND DISCUSSION

We realize that our observations and conclusions are controversial and anticipate that many questions will be asked about both temporal and mantle melting models. This section portrays some of the continuing scientific debates about the volcanism issue and presents the scientific uncertainties and controversies about both recurrence rates and causes of volcanism. Important questions yet to be answered about temporal models are:

1. Is the interval between times of peak volcanic activity (1–2 m.y.) too

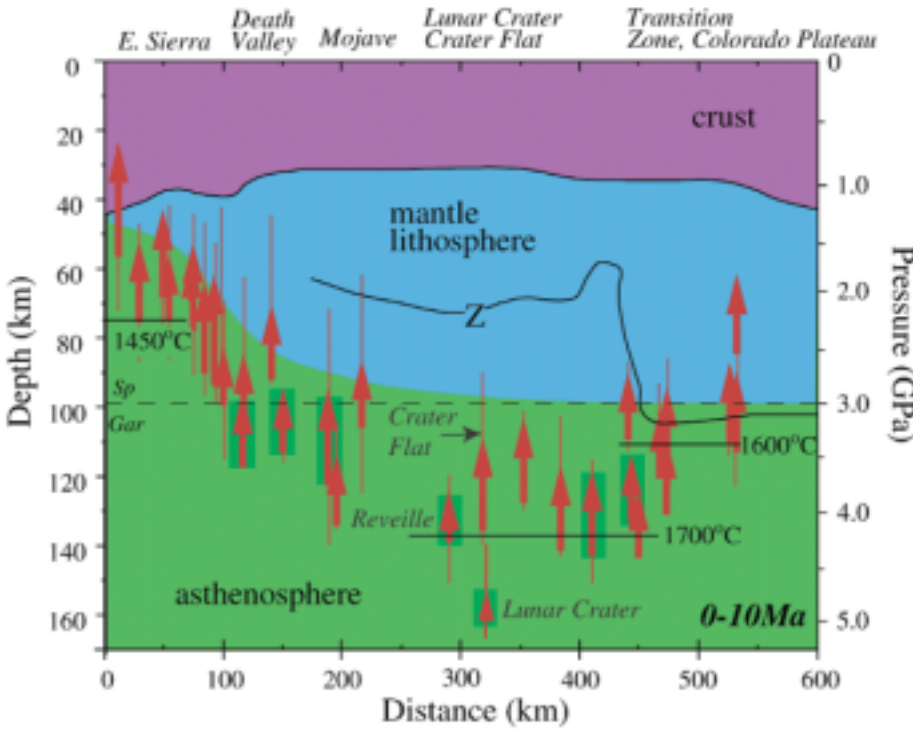

Figure 3. Melting profile across Basin and Range modified from Wang et al. (2002). Profile was constructed by projecting volcanic fields in Great Basin to a northeast-trending line extending from southern California through southern Nevada to southwestern Utah. Red arrow represents melting column calculated for each volcanic field, based on most primitive FeO and Na_2O compositions. Bottom of arrow marks onset of melting at solidus and is function of mantle temperature, while top of arrow marks end of decompression melting, presumably due to change in rheology near lithosphere-asthenosphere boundary. Thin line extension to arrows includes depth estimates and errors using Fe8.0 (see Wang et al., 2002, for details). Crustal thickness was compiled from Das and Nolet (1998). Blue-colored lithosphere is based on lithosphere thickness (Lm+Moho) estimates in Jones et al. (1996). Alternative boundary for base of lithosphere (marked with Z) based on P-wave residuals from Zandt et al. (1995). Spinel-garnet (Sp, Gar) transition in peridotite after Klemme and O'Neill (2000) and Robinson and Wood (1998). Dark green bars are for melting columns with average ε_{nd} of >+0.5. Temperatures given are solidus temperatures of adiabatically ascending mantle. Pressure axis calculated assuming 35 km crust with 2.85 g/cc density overlying mantle of 3.25 g/cc density.

long to be used with confidence for statistics that try to predict what might happen in the next 10 000 years? The answer to this question depends on whether the present day lies at the beginning, middle, or end of the current period of low activity. Although today's position within the eruption-low activity sequence is unknown, we observe that it has been nearly 1 m.y. since the last peak of activity and three eruptions have occurred (in the Crater Flat–Lunar Crater zone) in the past 80 000 years. Speculatively, these observations may indicate the end of the current period of low activity and an increase in the rate of eruption in the near future.

2. Does the magmatic system in the Crater Flat–Lunar Crater zone have the potential of producing another eruption peak? An answer to this question may lie in the mantle-melting model proposed by Wang et al. (2002). New eruption peaks, by this model, are possible and would be sustained by hot mantle.

3. Why is volcanic activity episodic? Periods of volcanism may be related to epochs of rapid strain accumulation in the lithosphere. According to Wernicke et al. (1998), elastic strain accumulation related to magmatic events may be episodic with events lasting 100 000 years occurring every million years. Cause-and-effect relationships between magmatism and accumulated strain in this model are unclear. Does magmatism cause rapid strain accumulation (as suggested by Wernicke et al., 1998) or does excess strain created by nearby faults provide an environment favorable for magma ascent? Nevertheless, patterns predicted by Wernicke et al. (1998) are similar to those depicted in Figure 2 except that both periods of observed eruption and low activity are of longer duration.

In regard to the mantle-melting model, we foresee three important questions:

1. Is a dry mantle-melting model valid? It could be argued that the data reflect variations in the water content of the mantle source rather than variations in depth of melting. Hornblende phenocrysts in basalt from Crater Flat suggest that the mantle source contained up to 0.5 wt% water (Hill et al., 1995). Although we agree that there is some water and/or CO_2 in the source of these basalts, melting of a hydrated source yields melts with lower FeO and higher SiO_2 than dry melting (Hirose and Kawamoto, 1995; Gaetani and Grove, 1998). Wet melting, therefore, may not explain the high FeO and low SiO_2 of Crater Flat–Lunar Crater zone basalts.

2. How does the model explain the isotopic differences between the northern and southern parts of the Crater Flat–Lunar Crater zone? Perry and Crowe (1992) and other authors indicate that the high $^{87}Sr/^{86}Sr$ and low ε_{nd} of alkali basalt near Yucca Mountain at the southern end of the zone reflect partial melting of lithospheric mantle at a relatively shallow depth. While we accept that lithospheric mantle melted prior to 10 Ma to produce voluminous calc-alkaline silicic volcanism in the Great Basin (the ignimbrite flare-up), we argue that melting of lithospheric mantle late during a volcanic and extensional episode is very difficult. Harry and Leeman (1995) showed difficulties in sustaining melting in the mantle lithosphere. Because the mantle lithosphere is generally too cold to melt, the only reasonable source of melts would be components with a lower solidus temperature than dry peridotite, such as mafic veins or hydrous components (e.g., amphibole or phlogopite peridotite). Harry et al. (1993) and Harry and Leeman (1995) argued that these components will produce melts during initial phases of extension, and may be responsible for the widespread silicic volcanism during the Oligocene. During further extension, however, these lithospheric components are exhausted, and melting continues largely in the asthenosphere, generating the predominantly basaltic volcanism during the past 10 Ma that we discuss here. Additionally, Gallagher and Hawkesworth (1992) and Hawkesworth et al. (1995) pointed out that lithospheric mantle will melt only if it contains volatiles (mainly water –0.5 wt%). They suggest that if hot mantle is brought in contact with cold lithosphere, lithospheric mantle will melt before the asthenospheric mantle. The authors postulated that calc-alkaline magmatism in Oligocene and Miocene is due to the melting of hydrous lithospheric mantle (in addition to subsequent magma mixing and/or commingling and fractional crystallization). They concluded that after a certain amount of lithospheric extension, asthenosphere will melt by decompression thus forming most of the Pliocene and Quaternary basaltic fields. Their models predicted that during the Quaternary, very little melt can be generated in the lithospheric mantle (even for high rates of sustained extension), and that it is more probable that melts are generated in the asthenospheric mantle. Both of these studies, therefore, point to difficulties in melting lithospheric mantle late during a magmatic-extension event. Thus the question remains as to why basalts in the southern part of the Crater Flat–Lunar Crater zone have high $^{87}Sr/^{86}Sr$ and low ε_{nd}. Lee et al. (2000) suggested that basalt with this isotopic signature may be related to either contamination of deep mantle magma as it passes through the lithospheric mantle or to the overprinting of asthenospheric mantle melts with fluids and/or melt derived from subducted crustal material. We speculate that the isotopic signature of magmas in the southern Crater Flat–Lunar Crater zone may be related to similar processes.

3. Does hot mantle exist beneath the Crater Flat–Lunar Crater zone? We present evidence here to support this assertion, but there is much disagreement. For example, Perry and Crowe (1992) pointed out that high $^{87}Sr/^{86}Sr$ and low ε_{nd} have been a common feature of magmatism in the Yucca Mountain area since at least 10 Ma. Miocene and Pliocene mafic magmas were generated by melting lithospheric mantle; it is unreasonable to assume a different process for younger (late-Pliocene and Quaternary) magmatism. Hawkesworth et al. (1995) and Bradshaw et al. (1993) also argued against a mantle plume for the following reasons: (a) although the average elevation in the central Great Basin is anomalous, "the present-day topography is unlike the symmetrical domes which are inferred to characterize lithosphere underlain by a mantle plume" (Hawkesworth et al., 1995, p. 10 280); (b) the position of the Yellowstone plume lies well to the

north of the central Great Basin; and (c) small to moderate volumes of magmatism, especially that with ocean-island basalt chemistry, dispute the presence of a mantle plume. Wang et al. (2002) countered the last point by arguing that the volume of magmatism is dependent on the total length of the magma column and not magma temperatures alone. Thick lithosphere, like that present in central Nevada, will cap the melting column and lead to small volumes of magma.

IMPLICATIONS

The probability of magmatic disruption of the repository (Prdr) is defined as a conditional probability: Prdr = Pr(E2 given E1)Pr(E1) (Crowe et al., 1982). E1 is the volcanic recurrence rate and E2 the probability of the intersection of the repository by a dike or volcanic conduit. A knowledge of recurrence rates is crucial to the calculation of probability of magmatic disruption. We contend that there is more uncertainty in recurrence rate estimates than assumed by the DOE, the expert panel, and the NRC. Our petrologic data suggest that volcanic fields in the Crater Flat–Lunar Crater zone are linked to a common area of hot mantle. Also, we show that volcanism is episodic with a good possibility of a new peak of activity occurring in the future. These observations imply that volcanism is not dead in the Yucca Mountain area and that a future pulse of activity could have recurrence rates equivalent to those recorded in the Lunar Crater–Reveille area of the Crater Flat–Lunar Crater zone. Specifically, the DOE and the NRC have used recurrence rates of from 3.7 to 12 events per m.y. to calculate probability of volcanic disruption (Connor and Hill, 1995; Crowe et al., 1998; Connor et al., 2000). Based on our arguments, recurrence rates of 11 to >15 events per m.y. are possible. Because higher recurrence rates raise the likelihood of magmatic disruption of the repository, we recommend that future probability studies factor these higher rates into probability models.

CONCLUSIONS

Our principal point is that Pliocene-Quaternary volcanism in the Crater Flat–Lunar Crater zone is episodic and sustained by an area of hot mantle. Our petrologic arguments suggest that recurrence rates of volcanism used by the DOE and the NRC may be underestimated and that higher rates typical of the Lunar Crater–Reveille part of the Crater Flat–Lunar Crater zone may be applicable to the Yucca Mountain area. Moreover, if models of hot mantle are correct, volcanism is not dead and another eruption peak is possible. These statements are supported by several recent geochemical and geophysical studies. We suggest that future calculations of volcanic risk take into account higher recurrence rates and patterns of volcanism directly determined by examining the geological record. Despite decades of work on volcanism, there are still many unanswered questions related to the suitability of Yucca Mountain to store nuclear waste. Sound science should take precedence over politics and program requirements when making the decision to place a repository at Yucca Mountain. If too many questions remain unanswered, then perhaps another repository site should be selected in an area without the risk of volcanism.

ACKNOWLEDGMENTS

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DIALOGUE

Jack Hess

Today's GSA: Membership and Partnership

Jack Hess, *Executive Director, GSA*

As I write this column, I have been at the helm of GSA for two months. What do I find? I find a Society and headquarters staff that has all the ingredients of a vibrant, growing organization that provides excellent service to its members and acts as a platform for geoscientists to be of service to society. Yes, we have our financial management challenges as described by GSA President Tony Naldrett in this column in February. We also have great opportunities to advance the science such as the journal aggregate described by Sharon Mosher in November and last month. The fundamental strength of GSA lies with you, GSA's members and your active participation in all aspects of Society business to meet GSA's mission.

The mission of GSA is to advance the geosciences, to enhance the growth of its members, and to promote the geosciences in the service of humankind. GSA's vision is to be a broad, unifying scientific society fostering the human quest for understanding Earth, planets and life; catalyzing new scientific ways of thinking about natural systems; and applying geoscience knowledge and insight to human needs and aspirations and stewardship of Earth.

It is you, the members of the Society, who provide both the reason for our existence and foundation upon which we build a viable and financially stable organization. I believe that one of the keys to the future of GSA is the recruitment and retention of members. A growing membership base provides the resources (geoscientists and finances) to allow the Society to increase the vitality of our meetings and conferences, lead the way in innovative publishing and promote geoscience in the service of society. All of you can help grow our membership by encouraging other geoscientists to join and remain active members of GSA. Explain to them that they can advance their careers, their research, and their profession by belonging to GSA, the premier earth science society in the United States. You can also provide greatly needed support by volunteering to serve on GSA committees, in your Section, or with a Division.

A second key to GSA's future is to build strong and meaningful partnerships with other societies and organizations around the world. Together we must leverage our societies' and organizations' strengths for the greater good in meetings, publications, and education and outreach activities. GSA does not need to reinvent the wheel. Where other organizations are doing a great job, let us support them. In other cases, GSA will take the lead. A recent reorganization of headquarters staff places greater emphasis on strategic partnerships in this country and internationally.

As I look to the future, my vision for GSA is that it will be a strong, growing scientific and professional society serving the needs of members and will be a leader in developing society's understanding of the importance of the geosciences. My goals are to create an environment where the staff and Council can excel with appropriate resources provided for the advancement of the science, to develop strong and meaningful relationships with other societies and organizations around the world, and to facilitate GSA's role in the education of students, the public, and policy makers.

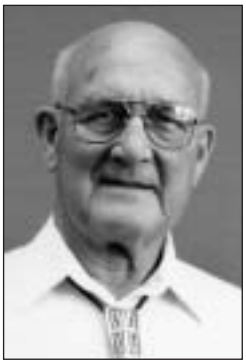
I am honored to be your new executive director. GSA has been my primary geoscience "home" ever since I joined as a graduate student many years ago. Over the years, I have participated in the Society's business through service on various committees and the Hydrogeology Division Management Board. I challenge you to join me in greater service to GSA and the broader geosciences community.

GSA Foundation Update

Donna L. Russell, *Director of Operations*

Expansion of the Foundation's Board of Trustees

At the Boston meeting, the Board voted to expand the number of Trustees from 14 to 17. George Sharp, William R. Muehlberger, and James S. Kahn have accepted five-year positions on the Board. Over the next few issues, I will share their profiles.



William R. Muehlberger

William Muehlberger is most known for his work with NASA. He served as principal investigator for field geology for the *Apollo 16* and *Apollo 17* lunar landings for three years. He was also co-investigator for the NASA Visual Observations Experiment in Skylab and the Apollo-Soyuz Missions. He was responsible for global tectonics, giving lectures to astronauts, debriefing them after missions, and offering advice on changes during the mission. He has also been teaching geology to newly assigned astronauts and crews with the space shuttle.

Born in New York City in 1923, Muehlberger grew up in Hollywood, California. He earned his B.S. and M.S. degrees from Caltech in 1949 and his Ph.D. in 1954. He joined the faculty at the University of Texas at Austin in 1954 and remained there until his retirement in 1992, when he became a professor emeritus. He also served as director of the Crustal Studies Laboratory at the University of Texas and was chairman of the department.

Muehlberger is a regional geologist whose scale of observation ranges from outcrops to satellite images. He is a structural geologist by trade and has studied brittle fault zones and fracture systems worldwide, but especially in Texas, Turkey, Israel, New Zealand, and Guatemala. He also studied cores and cuttings from wells to basement, correlated geophysical data, and compiled the first map of the buried basement geology of the United States. He studied the internal structure of salt domes in Texas and Louisiana as a guide to possible sites for radioactive waste disposal, and he also studied glacial geomorphology in New England. With his extensive observations of the character of Earth, he was the ideal person to compile the "Tectonic Map of North America," published by the American Association of Petroleum Geologists (AAPG).

Muehlberger has published more than 200 articles in international journals and collected volumes, and he has received many honors and awards from the profession for his contributions to the science. He received The Ohio State University First Award for a Television Teaching Series, the AAPG's George C. Matson Award, and NASA's Medal for Exceptional Scientific Achievement and the Public Service Medal. He has served on many committees, including those for the National Research Council, GSA, AAPG, and the American Geophysical Union. He has also served as associate editor for the *GSA Bulletin* and for *Geophysical Research Letters*. Married since 1949, he has two children and lives in Austin, Texas.

Tom Fouch, Foundation President, commented "We are fortunate to have a person of Bill's stature and integrity serve on the Board of Trustees. His presence lends credibility to the Society and importance to the role of the Foundation in serving GSA members."

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In 1948 in the Scottish Highlands, I vainly tried to convince a Canadian geologist of continental drift. His name was John Tuzo Wilson.

—Rudolf Trumpy

A Special Thanks to the GSA Membership

Donna L. Russell, *Director of Operations*

On behalf of the Foundation, I extend sincere appreciation to the GSA membership for responding to the Foundation's appeal on the dues statement renewals. Thank you so much—your contributions to the "Greatest Need" for GSA are valued immensely.

And, a very special thank you goes to all 1,671 new donors to the GSA Foundation during 2001. We are most grateful for your support of the Foundation and GSA programs.

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Letters to *GSA Today* on the following topic are posted at www.geosociety.org/pubs/gsatoday/letters.

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Texas High School Science Requirements: A Work in Progress

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In 1999, the Texas legislature passed SB 103, which required that, in order to graduate, every high school student must pass an exit science examination (TAKS) in the eleventh grade covering "at least biology and integrated chemistry and physics." The State Board of Education (SBOE) responded by eliminating earth science from the list of courses accepted for core science graduation credit. SB 103 also provided that statewide testing of earth science comprehension would be shifted from the eighth grade to the fifth grade. As usual, the earth science community allowed these changes to occur without demur.

Last fall, the American Geological Institute, under the leadership of Marcus Milling and Ed Roy, organized a letter-writing campaign to the chair of the SBOE urging a revision of the core science requirements for high school graduation and a concomitant revision of TAKS. More than 50 letters were received by SBOE members.

At the urging of David Dunn, Geraldine Miller, Chair of the SBOE Committee on Instruction, agreed to hold a public hearing on the issues raised by the letter writers. Milling, Roy, Dunn, and Stan Pittman constituted a working group to solicit testimony and orchestrate the presentations. On January 10, 2002, the hearing was held in Austin, Texas. Thirty witnesses testified in favor of reinstating earth science as a high school core science course for graduation credit; none opposed the idea.

Points stressed in the testimony were that the Texas economy is critically dependent on the activities of earth scientists, the National Science Standards recognize earth science as a core K–12 educational requirement, the understanding of many societal issues requires earth science input, and billions of dollars in the Permanent School Fund and Permanent University Fund were generated by the natural resources discovered and produced on state lands by practicing earth scientists.

Those who testified are firmly convinced that the inclusion of earth science in the curriculum of Texas high schools is critical to the intellectual development of our citizens as well as to the economic growth of the state, the nation, and the world. They represent leaders in their respective fields at the state, national, and, in many cases, international levels. Present were representatives from industries that explore for and/or produce oil and gas, coal, stone, aggregate materials, and minerals. Also present were individuals who represent hydrology, environmental, and soils issues as well as those who link Earth and space, including one of America's astronauts. The education community was represented by faculty and administrators from some of the finest higher education institutions in the state, by a number of truly dedicated middle and high school teachers, and by two recent high school graduates who are currently in college. In addition, two people not from Texas presented their views from a national perspective. The common thread that binds those who testified is their passion for seeing that the schoolchildren of Texas are properly educated in earth science during their K–12 education and particularly in high school.

Longtime observers of Texas SBOE hearings commented that they had never seen such a convincing presentation, and that Committee Chair Miller said she was "awed by the status of the presenters." In her summary statement, Miller concluded that earth science was important and that the Texas SBOE needed to determine how to implement the requested changes in the high school curriculum. She indicated that she favored the creation of a task force before the "sunset of Chapter 19 TAC 74 on March 24." The task force would be charged to recommend a revision in graduation requirements (details at www.tea.state.tx.us/rules/tac/chapter074/ch074b.html#74.12).

The efforts of the Milling-Roy-Dunn-Pittman team will now shift to the composition and charge of the proposed task force.

Among the 30 witnesses who testified in favor of reinstating earth science as a high school core science course at a Texas State Board of Education Committee on Instruction hearing were 15 GSA members and Fellows. A complete witness list, along with the testimony given, is posted at www.agiweb.org/education/texas.html.

Steven Bergman, University of Texas at Dallas

Patricia Wood Dickerson*, NASA, Lyndon B. Johnson Space Center

David E. Dunn*, University of Texas at Dallas

James A. Gibbs, Five States Energy Company

Arthur R. Green*, ExxonMobil Exploration Company

G. Randy Keller*, University of Texas at El Paso

Charles W. Kreitler*, LBG-Guyton Associates

Marcus Milling*, American Geological Institute,
for Michel T. Halbouty*, Michel T. Halbouty Energy

Sharon Mosher*, University of Texas at Austin

Edward C. Roy Jr.*, Trinity University

Michael J. Smith, American Geological Institute

Celina Suarez, Trinity University (student)

Marina Suarez, Trinity University (student)

James Westgate, Lamar University

John S. Wickham, University of Texas at Arlington

*GSA Fellow

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Deadline and Nomination Information Nomination forms for the 2002 Biggs Earth Science Teaching Award are posted at www.geosociety.org (go to "About Us," then "Awards and Medals"). Or, contact Leah Carter, (303) 357-1037, lcarter@geosociety.org. Nominations must be received by May 1, 2002.

Mail nomination packets to:

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

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Information: John D. Kiefer, kiefer@kgs.mm.uky.edu, or James C. Cobb, cobb@kgs.mm.uky.edu, (859) 257-5500.

ROCKY MOUNTAIN SECTION
May 7–9, 2002
Southern Utah University Campus, Cedar City, Utah.
Information: Robert Eves, (435) 586-1934, eves@suu.edu.

SOUTH-CENTRAL SECTION
April 11–12, 2002
Sul Ross State University Center, Alpine, Texas.
Information: Kevin Urbanczyk, (915) 837-8110, kevinu@sulross.edu.

CORDILLERAN SECTION
May 13–15, 2002
Oregon State University, Corvallis, Oregon.
Information: Robert S. Yeats, (541) 737-1226, yeatsr@geo.orst.edu.

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C.W. PASSCHIER, *University of Mainz, Germany; and* **R.A.J. TROUW,** *Federal University of Rio de Janeiro, Brazil*

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Models and Algorithms

C. LANTUEJOUL, *Ecole des Mines, Fontainebleau, France*

This book deals with the estimation of natural resources using a Monte Carlo methodology. It includes a set of tools to describe the morphological, statistical, and stereological properties of spatial random models. Furthermore the author presents a wide range of spatial models, including random sets and functions, point processes and object populations applicable to the geosciences. Also includes a library of FORTRAN simulation program.

2002 / 270 PP., 185 ILLUS.
HARDCOVER WITH CD-ROM / $54.95
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New –

SOFT PLATE AND IMPACT TECTONICS

A. RIBEIRO, *University of Lisboa, Portugal*

This monograph gives an historical perspective of plate tectonics. Furthermore, it discusses the foundations of rigid plate tectonics and the limitations of this approach. This classic approach can explain the data to a level of 95% precision. Emphasis is placed on the limitations of the rigid plate tectonics theory of the earth.

2002 / APPROX. 260 PP., 112 ILLUS. / HARDCOVER
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ORIGIN OF IGNEOUS ROCKS
The Isotopic Evidence

G. FAURE, *Ohio State University, Columbus, OH*

Explains the petrogenesis of igneous rocks as a consequence of tectonic processes resulting from interactions between asthenopheric plumes and the overlying lithospheric mantle. The relevant principles of isotope geochemistry are explained in chapter one. The relevant isotopic data are presented in diagrammatic form. In addition, the text avoids the use of acronyms.

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G. CHRISTAKOS, *Center for the Advanced Study of the Environment, Chapel Hill, NC; et al.*

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New –

REMEDIATION OF ABANDONED SURFACE COAL MINING SITES
A NATO-Project

A. MUDROCH, *University of Toronto, ON, Canada; et al. (Eds.)*

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OCEAN FORECASTING
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Provides the first consistent overview of methods and applications of ocean forecasting around the world. This sector of marine science and technology is developing rapidly due to the increasing need for reliable, multidisciplinary information about the marine system, allowing the sustainable usage of coastal resources and the mitigation of global change effects. The book also includes examples of modeling/forecasting systems currently in use or being set-up in the ocean for different space and time scales.

2002 / APPROX. 496 PP., 154 ILLUS. / HARDCOVER
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Fourth Edition

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CALL FOR PAPERS

The Geological Society of America

Science at the Highest Level

Denver 2002

Greetings!

Ask anyone what Denver, Colorado, brings to mind and you'll get responses ranging from the nearby skiing, to the Broncos and Avalanche, to the Brown Palace, to the microbrew capital of North America, to great nearby geology (of course!). Bring up Denver with music historians and the immediate response is "Oh purple mountains, majesty!" The Front Range of Colorado between Denver and Colorado Springs provided the setting for Katharine Lee Bates' "America the Beautiful," written in 1893 after a trip to the area. Rising from the Great Plains halfway west through Colorado, the Front Range, with Denver at its feet, has attracted many, including the Arapaho long before the discovery of gold on the South Platte in 1858. We return to Denver for the GSA 2002 Annual Meeting with the hope of making this meeting an even greater success than its predecessor in 1999, when more than 6,300 geoscientists attended.

The theme for the 2002 meeting—Science at the Highest Level—emphasizes the quality of vibrant and current research presented at GSA annual meetings. The meeting's Pardee Keynote Symposia and topical sessions represent an extreme diversity of geoscience and highlight the interdisciplinary nature of many, if not most, facets of our science. We strongly encourage you to participate in the Denver meeting. Strengthen the quality and diversity of Denver 2002: Science at the Highest Level by submitting an abstract. Remind your colleagues to do so! As always, quality field trips and short courses, informative and/or controversial Hot Topics, and an array of exhibitors form an integral part of the meeting.

With its ever-changing and vibrant downtown and its wide range of cultural attractions, dining, and nightlife, Denver is as close to a perfect venue for a GSA annual meeting as you'll find. The geologic surroundings are magnificent; plan to participate in a field trip to prove it to yourself. If you want more reasons to come to Denver for the 2002 Annual Meeting—other than great science and interactions with friends and colleagues—e-mail me!

You can also find out more about Denver and its history, sights, attractions, lodging, and dining at www.denvergov.org.

John W. Geissman
Technical Program Chair
jgeiss@unm.edu

Annual Meeting & Exposition

Colorado Convention Center
October 27–30, 2002

UPCOMING DEADLINES
Abstracts deadline: July 16
Preregistration deadline: Sept. 20
Cancellation deadline: Sept. 27

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Photo by John Karachewski.

ABSTRACTS DEADLINE: JULY 16

Beginning this year, the GSA Annual Meeting will open on Sunday and end on Wednesday. "Why?" you ask! We shifted things forward one day with benefits to you in mind.

1. You can save in airfare costs with a Saturday night stay for a Sunday opening day.
2. You can save money from spending one less day out of the office—the meeting runs on three weekdays instead of four.
3. The Exhibit Hall will be open during the entire Technical Program, with tech sessions running concurrently with open exhibits.

GSA expects that this new schedule will make the Annual Meeting more cohesive and energized! So, mark your calendar now: October 27–30, 2002, in the Mile High City.

IMPORTANT DATES AND TIMES

Premeeting Field Trips: Oct. 22–26

Short Courses and Workshops: Oct. 25–26

K–16 Workshops: Oct. 26–27

Presidential Address: Oct. 27, 4–6 p.m.

Welcome Party, Exhibits Open: Oct. 27, 6–8 p.m.

Exhibits Open:
Oct. 28–30, 9 a.m.–5:30 p.m.

Technical Program:
Sun.–Wed., Oct. 27–30
Oct. 27, 8 a.m.–noon, 1–3:45 p.m.
Oct. 28–30, 8 a.m.–noon, 1:30–5:30 p.m.

Postmeeting Field Trips:
Oct. 31–Nov. 2

EXHIBIT SPACE IS PRIME REAL ESTATE

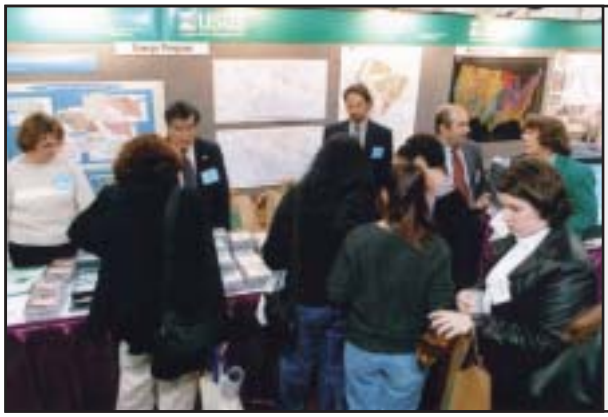
Our Boston 2001 Annual Meeting and Exposition was a huge success. In the aftermath of September 11, we weren't sure how the meeting would be affected. It was victorious, thanks to our exhibitors! We are grateful for our exhibitors' continued support and presence at the meeting.

Now we are looking ahead to 2002 when we'll be on our home turf in Denver. GSA's annual meeting is a major event for our organization. We are excited about our meetings in Denver because they consistently draw high attendance. We expect 6,500 geoscientists this year and record-breaking numbers of exhibiting companies and organizations.

Exhibitors have told us that GSA's annual meetings are the most dynamic and definitely the "meeting of choice" for geoscience professionals who are interested in the earth, education, science, research, and the environment. Take advantage of this great exposure to develop new customers, increase sales, and educate current customers about the benefits of your organization.

Exhibit with us in 2002; it will be a successful and rewarding experience for everyone!

Contact Brenda Martinez, Exhibit Sales, (303) 357-1038, or bmartinez@geosociety.org. The Exhibitor Prospectus is available at www.geosociety.org/meetings/2002.



Why does USGS always exhibit at GSA?

"GSA attendees are a major audience for our new scientific publications!"
—Martha Kiger, U.S. Geological Survey

GSA ASSOCIATED SOCIETIES

American Association of Stratigraphic Palynologists

American Institute of Professional Geologists

Association for Women Geoscientists

Association of American State Geologists

Association of Earth Science Editors

Association of Engineering Geologists

Association of Geoscientists for International Development

Council on Undergraduate Research—Geosciences Division

Cushman Foundation

Geochemical Society

Geoscience Information Society

History of the Earth Sciences Society

Mineralogical Society of America

National Association for Black Geologists and Geophysicists

National Association of Geoscience Teachers

National Earth Science Teachers Association

National Ground Water Association

Paleontological Research Institution

Paleontological Society

Sigma Gamma Epsilon

SEPM—Society for Sedimentary Geology

Society of Economic Geologists

Society of Vertebrate Paleontology

Need Top-Notch Geology Students?

Draw the best students to your institution through GSA's Graduate School Information Forum! Reserve space now for the Colorado Convention Center in Denver, October 28–30, 2002.

The Graduate School Information Forum is an effective way to attract graduate students to your program. GSA student members are enthusiastic and serious about geology—that's why 1,600 of them attended our 2001 annual meeting in Boston. We expect even more to attend in Denver this year! It's no wonder more than 50 universities in the United States send representatives to the forum year after year.

The three-day Graduate School Information Forum will be conveniently located in the Exhibit Hall adjacent to the exhibitors and posters session area. Take advantage of the excellent visibility for your institution and reserve space for one, two, or all three days of the forum.

When you reserve space, your program will also be promoted in three places:

- The October issue of *GSA Today*
- GSA's Web site
- The 2002 Annual Meeting program

Would you like to participate? Contact Brenda Martinez, Exhibit Sales, (303) 357-1038, bmartinez@geosociety.org.

"We will definitely see you in Denver! We have few opportunities at a national meeting to advertise our graduate program to a broad spectrum of potential grad students."

—Larry Brown, Director of Graduate Studies, Cornell University

ATTENTION

All GSA Associated Society and GSA Division Leaders!

If you are in charge of planning and organizing a business meeting, social event, or alumni reception at the GSA Annual Meeting in Denver, make your plans now to complete the Event Space Request Form online. We would like to draw your attention to the new event planning policies as procedures have changed from last year.

Step 1. Start planning NOW.

Step 2. Go to www.geosociety.org.

Step 3. Click on "Meetings" and look for the "Event Space Request Form."

Step 4. Complete the Event Space Request Form online or download the PDF version, print it out, and fax to GSA at 303-357-1072.

Thank You!

Student Volunteer Opportunities

If you are a geology student and are planning on attending the GSA Annual Meeting in Denver this October, consider volunteering your time.

As a student volunteer, you can offset some of your cost of attending the annual meeting. If you volunteer just 12 hours of your time, you get one free meeting registration. If you volunteer 15 or more hours, you get one free meeting registration and one free *Abstracts with Programs* volume. In addition, GSA will award student volunteers a stipend of $20 for each half day (or 4 hours) of time volunteered.

For more information, please contact Kevin Ricker at kricker@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, contact your GSA Section secretary.

Cordilleran:
Joan E. Fryxell, (909) 880-5311, jfryxell@csusb.edu

Rocky Mountain:
Kenneth E. Kolm, (303) 273-3932, kkolm@mines.edu

North-Central:
Robert F. Diffendal Jr., (402) 472-7546, rfd@unl.edu

Northeastern:
Stephen G. Pollock, (207) 780-5350, pollock@usm.maine.edu

South-Central:
Elizabeth Y. Anthony, (915) 747-5483, eanthony@geo.utep.edu

Southeastern:
Donald W. Neal, (252) 328-4392, neald@mail.ecu.edu

PARDEE KEYNOTE SYMPOSIA
Invited Papers

The Pardee Keynote Symposia, made possible by a grant from the Joseph T. Pardee Memorial Fund, are *special events* of broad interest to the geoscience community. They represent topics 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 seven Pardee Keynote Symposia were reviewed and accepted by the Annual Program Committee. **(All speakers are invited.)**

Fault surface. Rocky Mountain National Park. Photo by Martin Miller.

K1 Earth Sciences Challenges in the National Problem of High-Level Radioactive Waste Disposal

John S. Stuckless, Evergreen, Colo.; William W. Dudley, Lakewood, Colo.

This session examines major issues regarding the geologic and hydrologic suitability of a mined geologic nuclear-waste repository and confidence in predictive modeling of natural components of the repository system.

K2 Evolution of the Early Atmosphere, Hydrosphere, and Biosphere: Constraints from Ore Deposits

Society of Economic Geologists; Geochemical Society; NASA Astrobiology Division. Hiroshi Ohmoto, Astrobiology Research Center, University Park, Penn.; Stephen Kesler, University of Michigan, Ann Arbor, Mich.

Review of the role of new information on banded iron formation, uranium-bearing conglomerate, and laterite and exhalative deposits, and their role in constraining estimates of the composition of early Earth's atmosphere, hydrosphere, and biosphere.

K3 Flood Hazard on Dynamic Rivers: Human Modification, Climate Change, and the Challenge of Non-Stationary Hydrology

GSA Quaternary Geology and Geomorphology Division; American Geological Institute. Nicholas Pinter, Southern Illinois University, Carbondale, Ill.; Jeffrey F. Mount, University of California, Davis, Calif.

Geomorphic and hydrologic evidence suggests that many rivers worldwide are dynamic, not static, systems. This change is manifested on some rivers by systematic increases in flooding. Themes of the symposium include: documenting hydrologic change, human magnification of flooding, climate change, and flood-frequency assessment in dynamic systems.

K4 Geologic and Ecologic Responses to Landscape Disturbances

GSA Quaternary Geology and Geomorphology Division. Jon J. Major, U.S. Geological Survey, Vancouver, Wash.; Frederick J. Swanson, Oregon State University, Corvallis, Ore.

This session is intended to expand the awareness of practicing scientists, educators, and land managers on the commonalities and differences that exist among landscape responses to a spectrum of disturbances and to highlight the symbiosis that exists between physical and ecological responses.

K5 The Role of the Earth Sciences in Fostering Global Equity and Stability

GSA International Division; U.S. National Committee for the Geological Sciences; U.S. National Committee for Geodesy and Geophysics. Eldridge M. Moores, University of California, Davis, Calif.; W.G. Ernst, Stanford University, Stanford, Calif.; Grant H. Heiken, Los Alamos, N.Mex.; Susan M. Landon, Golden, Colo.; P. Patrick Leahy, U.S. Geological Survey, Reston, Va.

This session will bring together a broad spectrum of earth scientists, policy makers, and ethicists to discuss the role of the earth sciences in achieving a global sustainable society, global equity, and stability.

K6 There and Back Again: Terrestrial Approaches to Extraterrestrial Problems

GSA Planetary Geology Division. Tracy K.P. Gregg, University at Buffalo, State University of New York, Buffalo, N.Y.; Louise Prockter, Johns Hopkins University Applied Physics Lab.

A diverse group of planetary and terrestrial scientists brought together to discuss extraterrestrial dilemmas and their terrestrial analogs. Topics include oceans, life, volcanism, and tectonism on the terrestrial planets.

K7 Toward a Better Understanding of the Complicated Earth: Insights from Geologic Research, Education, and Cognitive Science

National Association of Geoscience Teachers. Cathryn A. Manduca, Carleton College, Northfield, Minn.; David W. Mogk, Montana State University, Bozeman, Mont.

Geoscientists integrate visual, theoretical, experimental, and model data in complicated ways to understand Earth. This session addresses how we can increase our ability to learn about Earth by better understanding the learning process. Discussion will focus on maps, visualizations, and models as learning tools for researchers and students.

TOPICAL AND DISCIPLINE SESSIONS
(Invited and Volunteered Papers)

ABSTRACTS DEADLINE: JULY 16

Topical Sessions

The approved topical sessions listed below 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.

Discipline Sessions

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

Abstracts deadline: July 16

TOPICAL SESSIONS

T1 Application of GIS and Remote Sensing to Archaeological Geology

GSA Archaeological Geology Division. William C. Johnson, University of Kansas, Lawrence, Kans.; Kenneth L. Kvamme, University of Arkansas, Fayetteville, Ark.

Archaeological Geology; Remote Sensing/Geographic Info System; Quaternary Geology/Geomorphology

Recent advancements in computer technology, explosive growth of digital databases, and increased sophistication of software have combined to produce an unprecedented opportunity for those conducting research in archaeological geology. This session focuses on various state-of-the-art applications of GIS and remote sensing to archaeological geology. ORAL

T2 Nature, Effects, and Control of Groundwater at Archaeological Sites

GSA Archaeological Geology Division; GSA Hydrogeology Division. David P. Gold and Richard R. Parizek, Pennsylvania State University, University Park, Penn.

Archaeological Geology; Hydrogeology; Engineering Geology

The central themes for the session are the effects of a rising and permanently high groundwater table at many archaeological sites, the methods for dewatering during excavations, and the strategies for controlling groundwater to prevent further degradation of ancient artifacts, monuments, and buildings. ORAL and POSTER

T3 Obsidian Sources and the Distribution of Archaeological Sites from These Sources

GSA Archaeological Geology Division. Mark L. Howe, Arizona State University, Tempe, Ariz.

Archaeological Geology

The session will cover the characteristics of obsidian sources and the archaeological utilization of these. Examination of source dating and the distribution of artifacts as seen in the archaeological record will be analyzed. Papers will address sites, obsidian artifacts, and the distribution as seen from in situ source perspectives. ORAL and POSTER

T4 Coal Resource and Utilization Issues

GSA Coal Geology Division. Peter D. Warwick and Margaret S. Ellis, U.S. Geological Survey, Reston, Va.

Coal Geology; Economic Geology

Multidisciplinary examinations of coal resource issues, including availability of future resources, coal quality, coal utilization, coal-bed methane, and the mitigation of potential environmental impacts of coal utilization. ORAL and POSTER

T5 Wetlands Paleoecology Through Time

GSA Coal Geology Division; Paleontological Society. Stephen F. Greb, Kentucky Geological Survey, Lexington, Ky.; William A. DiMichele, National Museum of Natural History, Washington, D.C.

Coal Geology; Paleontology/Paleobotany

Multidisciplinary examination of wetland paleoecology through time. ORAL and POSTER

T6 Chemostratigraphy: An Emphasis on Metal-Rich Black Shale Deposits

Department of Geography and Environmental Planning, Elmhurst College. Richard B. Schultz, Elmhurst College, Elmhurst, Ill.

Economic Geology; Stratigraphy; Geochemistry, Organic

This session strives to expand upon our knowledge of metal constituents in organic-rich shales within a stratigraphic framework. ORAL and POSTER

T7 Diverse Origins of Sedimentary Rock-Hosted Disseminated Gold Deposits: A Global Perspective

Society of Economic Geologists; U.S. Geological Survey. Albert H. Hofstra, U.S. Geological Survey, Denver, Colo.

Economic Geology

Sedimentary rock–hosted disseminated gold deposits are often lumped together and called Carlin-type even though they form in different geologic settings, from diverse fluids, and under various conditions. This session will elucidate similarities and differences among these deposits to better classify them and improve understanding of their origins. ORAL and POSTER

T8 Evolution of the Early Atmosphere, Hydrosphere, and Biosphere: Constraints from Ore Deposits

Society of Economic Geologists; Geochemical Society; NASA Astrobiology Division. Hiroshi Ohmoto, Astrobiology Research Center, University Park, Penn.; Stephen Kesler, University of Michigan, Ann Arbor, Mich.

Economic Geology; Geochemistry, Other; Paleoclimatology/Paleoceanography

Review of the role of new information on banded iron formation, uranium-bearing conglomerate, and laterite and exhalative deposits, and their role in constraining estimates of the composition of early Earth's atmosphere, hydrosphere, and biosphere. ORAL

T9 Mining in the Twenty-First Century: Meeting the Environmental Challenges

Society of Economic Geologists. Craig A. Johnson, U.S. Geological Survey, Denver, Colo.; Murray W. Hitzman, Colorado School of Mines, Golden, Colo.; Geoffrey S. Plumlee, U.S. Geological Survey, Denver, Colo.

Economic Geology; Environmental Geoscience; Geochemistry, Other

Maintaining mineral supplies for the growing global population while protecting the natural environment is a goal that many consider to be unachievable. This session will examine opportunities in the exploration-production-mine closure cycle where innovative thinking by earth scientists might help resolve the mining vs. environment conflict. ORAL

T10 Role of Mafic Magmas in the Generation of Porphyry Copper Deposits

Society of Economic Geologists. Alexandra Skewes, University of Colorado, Boulder, Colo.; Jeffrey Keith, Brigham Young University, Provo, Utah.

Economic Geology; Petrology; Igneous; Volcanology

This session will focus on the relationship between mafic magmas and copper mineralization in porphyry copper deposits and experimental evidence suggesting that mafic magmas can carry enough water, sulfur, and copper to form such deposits. ORAL

T11 Society of Economic Geologists Special Session: The Global Tectonic Setting of Ore Deposits—Present Understanding and New Advances

Society of Economic Geologists. Richard J. Goldfarb and Carol Finn, U.S. Geological Survey, Denver, Colo.

Economic Geology; Tectonics

The session will include broad talks on Earth's evolution and metallogeny, discussions of ore deposits in specific tectonic settings, and examples of plate reconstructions and their implications to defining regional metallogenic patterns. ORAL

T12 The Changing Vision of Marine Minerals

Society of Economic Geologists. Peter A. Rona, Rutgers University, New Brunswick, N.J.; David S. Cronan, Imperial College, University of London, London, UK.

Economic Geology; Marine/Coastal Science; Geomicrobiology

Change in our vision of marine minerals from pre–plate-tectonic view of ocean basins as passive sinks for material eroded from land to post–plate-tectonic view as active sources of mineralization and chemosynthesis. ORAL

T13 Case Studies in Landslide Problem Solving, Landslide Monitoring, and Alarm Methodology: In Honor of David J. Varnes

GSA Engineering Geology Division; Association of Engineering Geologists. Lynn Highland, U.S. Geological Survey, Denver, Colo.; Scott Burns, Portland State University, Portland, Ore.

Engineering Geology; Environmental Geoscience; Quaternary Geology/Geomorphology

Landslide hazard evaluation benefits from many diverse approaches. The first half of this session will be devoted to case studies in landslide hazard assessment and mitigation. Part two of this session will provide presentations on new and/or proven approaches to landslide monitoring and alarm system methodology. ORAL

T14 Integrated Studies of the Effects of Abandoned Mines on the Environment

GSA Engineering Geology Division; GSA Hydrogeology Division. Katherine Walton-Day, U.S. Geological Survey, Denver, Colo.; Mary W. Stoertz, Ohio University, Athens, Ohio; Joseph J. Donovan, West Virginia University, Morgantown, W.Va.; David A. Nimick, U.S. Geological Survey, Helena, Mont.; Stanley E. Church, U.S. Geological Survey, Denver, Colo.

Environmental Geoscience; Geochemistry, Aqueous; Hydrogeology

This session includes presentations illustrating how integrated, multidisciplinary studies have helped improve the understanding of environmental effects of historical mining and mineral processing. Integrated studies that have guided remediation decisions and planning are also encouraged. ORAL

T15 Decay and Conservation of Stone Buildings and Monuments

GSA Engineering Geology Division; Stone Weathering and Atmospheric Network. Alice V. Turkington, University of Kentucky, Lexington, Ky.; Mark Liebman, AMEC Earth and Environmental Inc., Kirkland, Wash.

Engineering Geology; Environmental Geoscience; Archaeological Geology

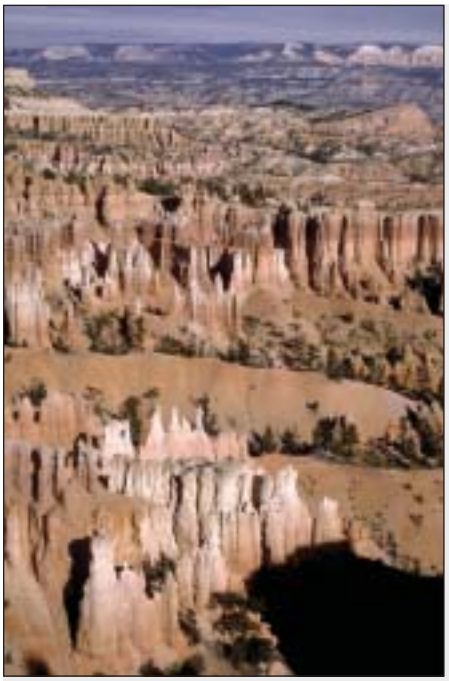
An overview of research into stone decay processes and their effects on stone buildings and monuments, evaluation of conservation strategies, and identification of current research priorities to promote appreciation and preservation of our cultural heritage. ORAL

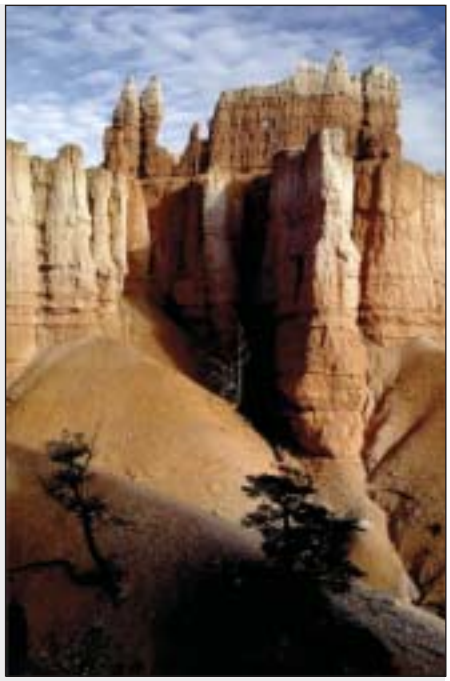
T16 Evaporite Karst and Engineering and Environmental Problems in the United States

GSA Engineering Geology Division; GSA Hydrogeology Division; GSA Quaternary Geology and Geomorphology Division. Kenneth S. Johnson, Oklahoma Geological Survey, Norman, Okla.; James T. Neal, Prescott, Ariz.

Engineering Geology; Environmental Geoscience; Hydrogeology

Evaporite karst (EK) includes sinkholes, caves, and subsidence-collapse structures formed by natural or manmade dissolution of evaporites, mainly salt and/or gypsum-anhydrite. EK produces engineering and environmental hazards, such as damage or collapse of homes, buildings, dams, bridges, highways, and farmlands. ORAL and POSTER





Eocene Claron Formation, Bryce Canyon National Park, Utah. Photos by Martin Miller.

T17 Expansive Bedrock—A Primary Engineering Geologic Hazard of Colorado's Front Range Urban Corridor

GSA Engineering Geology Division; Association of Engineering Geologists, Rocky Mountain Section. Stephen Hart, Colorado School of Mines, Lakewood, Colo.; David Noe, Colorado Geological Survey, Denver, Colo.

Engineering Geology; Geoscience Information/Communication; Public Policy

One of the most widespread and destructive engineering geologic hazards of the Colorado Front Range urban corridor is highly expansive, steeply dipping bedrock. This hazard is the subject of an extensive public education campaign by Colorado geologists. ORAL

T18 Geohazards and Transportation Routes

GSA Engineering Geology Division. John F. Shroder, University of Nebraska, Omaha, Nebr.

Engineering Geology; Quaternary Geology/Geomorphology

Landslides, floods, snow avalanches, and other geological hazards interrupt traffic and cause accidents on highways and railroads. Engineering geological and geomorphological expositions to geohazards on transportation routes will be presented, with special attention to using forensic techniques in accident reconstruction. ORAL

T19 Groundwater and Hardrock Mining

GSA Hydrogeology Division; International Association of Hydrogeologists. Mike Wireman, Carol Russell, and John Moore, U.S. Environmental Protection Agency Region 8, Denver, Colo.

Geochemistry, Aqueous; Hydrogeology; Environmental Geoscience

The Rocky Mountains of the western United States have tens of thousands of abandoned, inactive, and active sites related to precious-metal mining. Mining activities often resulted in mobilization of and transport of associated heavy metals that can pose a significant threat to aquatic communities in mountain streams. ORAL and POSTER

T20 Man as a Geologic Agent: In Honor of George Kiersch

GSA Engineering Geology Division. Judy Ehlen, USA Engineer Research and Development Center, Alexandria, Va.; William C. Haneberg, Haneberg Geoscience, Port Orchard, Wash.; Robert A. Larson, Los Angeles County Department of Public Works, Alhambra, Calif.

Engineering Geology; Environmental Geoscience; Quaternary Geology/Geomorphology

This session in honor of the late George Kiersch explores human impact on the geologic environment. We will look at what humans have done to their environment and, when their goals were not achieved, what they did to fix the problem. ORAL

Black Canyon of the Gunnison, Colorado. Photo by Martin Miller.

T21 Remote Sensing and Geographic Information Systems in the New Millennium: Their Use in Environmental and Engineering Geology

GSA Engineering Geology Division. Norman S. Levine and Robert K. Vincent, Bowling Green State University, Bowling Green, Ohio.

Environmental Geoscience; Engineering Geology; Remote Sensing/Geographic Info System

Papers should focus on analysis, interpretation, and visualization techniques and future directions in geologic remote sensing and/or GIS or on remote sensing and/or GIS case studies for environmental and engineering geology problems. ORAL

T22 Rumbling in Below the Radar: Earthquake Hazards in Areas Where Seismic Potential is Underrecognized

GSA Engineering Geology Division. Paul M. Santi, Colorado School of Mines, Golden, Colo.; Vincent Matthews, Littleton, Colo.

Neotectonics/Paleoseismology; Engineering Geology; Quaternary Geology/Geomorphology

This session will focus on assessments of seismic hazards in regions that have not been extensively studied. Speakers will address problems such as liquefaction, compaction, strain softening, landslides, rockfall, and effects of strong ground motion, with the goal of raising the level of awareness of these hazards and quantifying their intensity. ORAL

T23 Working with Geological Chaos: Characterization, Design, and Construction Problems of Fault Rocks, Mélanges, Saprolites, and other Block-in-Matrix Rocks (Bimrocks)

GSA Engineering Geology Division. Edmund Medley and Elizabeth L. Mathieson, Exponent® Failure Analysis Associates, Menlo Park, Calif.; Gunter Riedmueller, Technical University Graz, Austria.

Engineering Geology; Structural Geology; Environmental Geoscience

This session will present research and case history experience of investigation, characterization, and construction in geological mixtures of relatively strong blocks of rock surrounded by weaker matrix. ORAL

T24 Human Health Sciences and Geosciences: Bridging the Gap

Joseph E. Bunnell, U.S. Geological Survey, Reston, Va.; Thomas L. Ziegler, U.S. Geological Survey, Denver, Colo.

Environmental Geoscience

The interaction of human health scientists and geoscientists at this session will give unique insight into the research conducted on naturally occurring everyday lifestyle hazards. Topics include concerns with water quality, dust exposure, human health application of remote sensing and/or vector ecology, and biomedical perspectives on geological issues. ORAL

T25 Modern and Ancient Tidal Flats Reflecting Environmental and Climate Changes for Past and Future

Nora Noffke, Old Dominion University, Norfolk, Va.

Environmental Geoscience; Paleoclimatology/Paleoceanography; Paleontology/Paleobotany

Knowledge of physical, chemical, and biological processes that take place at tidal depositional surfaces permit reconstruction of environmental and climate changes through time and permit conclusions for the future development. ORAL

T26 Sigma Gamma Epsilon Student Research

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

Environmental Geoscience

All undergraduate and graduate students are encouraged to share the results of their research activities by way of this poster session. POSTER

T27 From Geochemistry of the Geosphere, Atmosphere, and Cosmos to Forensic Environmental Geochemistry: A Tribute to Ian Kaplan

Geochemical Society; Organic Geochemistry Division of the Geochemical Society. Ronald J. Hill, U.S. Geological Survey, Denver, Colo.; Ken Peters, ExxonMobil Upstream Research Co., Houston, Tex.

Geochemistry, Organic; Environmental Geoscience; Geochemistry, Other

In recognition of Ian Kaplan's pioneering work and continued contributions to a range of disciplines, this symposium is focused on the application of organic, inorganic, and isotope geochemistry to geologic, oceanographic, petroleum, atmospheric, extraterrestrial, and forensic environmental problems. ORAL

T28 Geochemical and Mineralogical Records from Ancient Lake Sediments

GSA Sedimentary Geology Division; GSA Limnogeology Division. Daniel M. Deocampo, Smithsonian Institution, Washington, D.C.; Robin W. Renaut, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Geochemistry, Aqueous; Sediments, Carbonates; Sediments, Clastic

This session will focus on the use of geochemical and mineralogical proxies in lacustrine sediments as tools for understanding ancient environments and climates. Papers are invited concerning modern process, core, or outcrop studies from a diversity of tectonic, climatic, and geochemical regimes around the world. ORAL and POSTER

T29 Sources, Transport, Fate, and Toxicology of Trace Elements in the Environment: A Tribute to Gunter Faure

International Association of Geochemistry and Cosmochemistry. David T. Long, Michigan State University, East Lansing, Mich.; W. Berry Lyons, Ohio State University, Columbus, Ohio.

Environmental Geoscience; Geochemistry, Aqueous; Geomicrobiology

Papers are encouraged on trace elements in the environment related to sources, transport, mobility, and fate, including transfer through the food chain, toxicological consequences, microbiological interactions, and historical records in sediments and soils. ORAL

T30 Microbial Sulfur Transformations Throughout Earth's History: Development, Changes, and Future of the Biogeochemical Sulfur Cycle

GSA Geobiology and Geomicrobiology Division. Jan P. Amend, Washington University, Saint Louis, Mo.; Katrina Edwards, Woods Hole Oceanographic Institution, Woods Hole, Mass.

Geomicrobiology; Geochemistry, Aqueous; Environmental Geoscience

Papers will be given that describe the effects of microorganisms on the transformations of aqueous, gaseous, and crystalline sulfur compounds. Emphasis will be on metabolic processes, bioenergetics, isotopic fractionation, and biomineralization on both small and global scales throughout Earth's history. ORAL

T31 Micropaleontological Applications to Problems of Urbanization

Cushman Foundation. David B. Scott, Dalhousie University, Halifax, Nova Scotia, Canada; Pamela Muller Hallock, St. Petersburg, Fla.

Geomicrobiology; Environmental Geoscience; Paleontology/Paleobotany

This session will address micropaleontological techniques for assessing impacts on modern environments from the effects of urbanization, which can include, but are not limited to, pollution, water diversion, excess sedimentation, or human-caused climate-atmospheric shifts. ORAL

T32 Magnetic Mapping of North American Geology

Mark Pilkington, Geological Survey of Canada, Ottawa, Ontario, Canada; Carol Finn, U.S. Geological Survey, Denver, Colo.; Israel Hernandez, Consejo de Recursos Minerales, Pachuca, Mexico.

Geophysics/Tectonophysics/Seismology; Structural Geology; Tectonics

Magnetic anomaly data has proven to be a powerful tool in determining the structure, geologic processes, and tectonic evolution of the North American continent. With the release of a new, updated digital database of magnetic anomaly data for North America, we invite papers on the utility and application of magnetic data for such studies. POSTER

T33 New Views of Extensional Basins and Related Volcanic Fields using Geophysics and Remote Sensing

GSA Geophysics Division. V.J.S. Grauch, U.S. Geological Survey, Denver, Colo.; G. Randy Keller, University of Texas, El Paso, Tex.

Geophysics/Tectonophysics/Seismology; Structural Geology; Volcanology

This session examines the structural architecture of extensional basins, the interrelation of igneous and sedimentary units within basins, and the configuration of basin margins through new insights provided by aeromagnetic and electromagnetic surveys, gravity data, high-resolution seismic methods, and remote-sensing techniques. ORAL and POSTER

T34 The Anisotropy of Magnetic Susceptibility of Granitic Rocks: New Methodological Developments, Interpretations, and Challenges

GSA Structural Geology and Tectonics Division. Eric C. Ferré, University of Wisconsin, Madison, Wis.; Michel de Saint-Blanquat, OMP Université Paul Sabatier, Toulouse, France; R.D. Law,

Virginia Polytechnic Institute and State University, Blacksburg, Va.

Geophysics/Tectonophysics/Seismology; Structural Geology; Tectonics

This session on granitic rocks will address the limits of the AMS method, the significance of weak AMS, the relationship between AMS and other magnetic anisotropies and its dependence on deformation mechanisms and/or regimes. ORAL

T35 Design and Assessment of Computer-Based Instructional Materials for the Geosciences

GSA Geoscience Education Division; National Association of Geoscience Teachers; National Earth Science Teachers Association. Jacqueline Huntoon, Michigan Technological University, Houghton, Mich.; Gary Novak, California State University Los Angeles, Los Angeles, Calif.

Geoscience Education; Geoscience Information/Communication

Computer-assisted education materials are now available for many geoscience disciplines. In this session, presenters will describe newly developed materials and the methods used to assess the impact of computer-based materials on student learning. ORAL

T36 Digital Libraries as Vehicles for Systemic Educational Change

National Association of Geoscience Teachers. Mary Marlino, DLESE Program Center, Boulder, Colo.; Cathryn Manduca, Carleton College, Northfield, Minn.; Edward Geary, Colorado State University, Fort Collins, Colo.

Geoscience Education; Geoscience Information/Communication

This session will provide attendees with an overview of the various pedagogical dimensions, the community participation vehicles, and the implementation issues attendant to effective use of educational digital libraries. A range of digital library collections, services, and community-related issues will be presented. ORAL and POSTER

T37 Educational Issues in Teaching and Research at Two-Year Colleges

National Association of Geoscience Teachers. Laura A. Guertin, Penn State Delaware County, Media, Penn.; Brittina Argow, SUNY/Westchester Community College, Valhalla, N.Y.

Geoscience Education

This session will allow faculty at two-year colleges to exchange ideas and discuss the issues faced at two-year colleges. Abstracts may include, but are not limited to, effective teaching methods, doing research with students, research equipment, field trips, and partnerships and collaborations on campus and with four-year colleges. ORAL

T38 Geology in the National Parks: Research, Mapping, Education, and Interpretation

Bruce A. Heise and James F. Wood, National Park Service, Lakewood, Colo.

Geoscience Education; Environmental Geoscience; Geoscience Information/Communication

This session will address the role national parks have played and continue to play in the geosciences. Presentations are invited on geologic research and mapping in parks, the use of parks as outdoor classrooms, and historical perspectives on past geologic investigations. ORAL

T39 Geoscience Research Partnerships as a Strategy for Engaging K–16 Students and Teachers in Inquiry-Based Learning

National Association of Geoscience Teachers. Paul G. Harnik and Robert M. Ross, Paleontological Research Institution, Ithaca, N.Y.

Geoscience Education; Geoscience Information/Communication

Involvement in authentic research is a powerful strategy for engaging students and teachers in inquiry-based geoscience. This approach may be particularly effective in precollege, introductory, and nonmajor courses. This session will highlight different research models, with an emphasis on data quality and learning assessment. ORAL

T40 Special Session I in Honor of John C. Butler: Water Where the Grass Is Greener—Emerging Uses of Technology in Geoscience Education

National Association of Geoscience Teachers. Warren D. Huff, University of Cincinnati, Cincinnati, Ohio; Michelle N. Lamberson, WebCT, Inc., Vancouver, British Columbia, Canada.

Geoscience Education; Geoscience Information/Communication

To honor John Butler's commitment to geoscience education, this session highlights innovative ways that educators are using technology to achieve pedagogical goals. Examples include Internet applications, GIS, and the application of technology to address disabilities. ORAL

T41 Special Session II in Honor of John C. Butler: Multimedia in Earth Science Education—Creation, Use, and Limitations

National Association of Geoscience Teachers. James D Myers, University of Wyoming, Laramie, Wyo.; Scott R. Linneman, Western Washington University, Bellingham, Wash.

Geoscience Education; Geoscience Information/Communication

To honor John Butler's pioneering use of multimedia in geoscience education, this session will bring together multimedia content developers and users. Individuals will describe current technologies, highlight successful use of multimedia, and discuss problems associated with creating and using educational multimedia. ORAL

T42 Undergraduate Research in the Geosciences: Faculty and Student Perspectives

Council of Undergraduate Research: Geoscience Division. Edward C. Hansen, Hope College, Holland, Mich.; Karen H. Fryer, Ohio Wesleyan University, Delaware, Ohio.

Geoscience Education

What are the advantages, challenges, and pitfalls of involving undergraduates in research? What has worked and what has not? This session focuses on examples of research projects involving undergraduate students. When possible, the perspective of both students and faculty should be included, and we encourage submissions with student coauthors. POSTER

T43 Urbanizing Geoscience Education

Center for the Advancement of Science and Technology Education, Middle Tennessee State University. Mark J. Abolins, Middle Tennessee State University, Murfreesboro, Tenn.

Geoscience Education; Environmental Geoscience; Public Policy

This session focuses on the challenges commonly encountered by geoscientists providing education and outreach to urban populations. ORAL and POSTER

T44 New Heights in Geoscience Information: Access and Technology

Geoscience Information Society. Lisa G. Dunn and Joanne V. Lerud, Colorado School of Mines, Golden, Colo.

Geoscience Information/Communication; Geoscience Education; Public Policy

New technologies and changes in information-seeking behavior have a powerful influence over how we manage geoscience

information. This session focuses on innovations in accessibility, creative applications of technology, and information's impact on the geoscience community. ORAL

T45 Implementing Geoinformatics for Knowledge Integration and Decision Management

A. Keith Turner, Colorado School of Mines, Golden, Colo.

Geoscience Information/Communication; Environmental Geoscience; Hydrogeology

This session addresses how geoinformatics facilitates the capture, management, and integration of geoscience knowledge. Presentations will focus on how technology and applied geoscience are merging to formalize the geoscience modeling process and improve predictions for society. ORAL

T46 Contributions of American Geologists to Theoretical Tectonics on the Basis of Research Done West of the 100th W Meridian in the Latter Half of the 19th Century

GSA History of Geology Division. A.M. Celâl Şengör, Istanbul Technical University, Istanbul, Turkey; Michele L. Aldrich, Hatfield, Mass.

History of Geology; Tectonics; Structural Geology

A session to describe and evaluate the internationally influential work of the geologists who worked in the western United States in the latter half of the 19th century. ORAL

T47 Advances in Karst Modeling

GSA Hydrogeology Division. John J. Quinn, Argonne National Laboratory, Argonne, Ill.; Carol M. Wicks, University of Missouri, Columbia, Mo.

Hydrogeology; Environmental Geoscience

This session will showcase recent advances in conceptual, analytical, numerical, geochemical, statistical, and visualization modeling of karst. These advances are improving our understanding of how karstic aquifers function. POSTER

T48 Application of Biological and Hydrochemical Tracers in Groundwater Quality Investigations

GSA Hydrogeology Division. Brian G. Katz, U.S. Geological Survey, Tallahassee, Fla.; Ralph Davis, University of Arkansas, Fayetteville, Ark.

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

Session will focus on novel applications of environmental tracers including biological and/or chemical tracers to characterize groundwater flow patterns, interactions between groundwater and surface water, and other biogeochemical processes that influence water quality and microbial ecology. ORAL

Meandering river, eastern Colorado. Photo by Martin Miller.

T49 Artificial Recharge: Hydrologic, Hydrogeochemical, and Microbiologic Aspects

GSA Hydrogeology Division. Jean M. Bahr, University of Wisconsin, Madison, Wis.

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

This session will examine hydrologic, hydrogeochemical, and microbiologic processes that affect artificial recharge employing infiltration systems, injection wells, aquifer storage and recovery technology, and other methods that are in current use or development. ORAL

T50 Characterizing Geochemical Processes: When is There Sufficient Information?

GSA Hydrogeology Division. William L. Dam, U.S. Nuclear Regulatory Commission, Washington, D.C.; Lauren Browning, Southwest Research Institute, San Antonio, Tex.; John Bradbury, U.S. Nuclear Regulatory Commission, Washington, D.C.

Geochemistry, Aqueous; Geochemistry, Organic; Environmental Geoscience

Geochemical site characterization information on disposal sites affects regulatory decisions. We will discuss case studies where regulators have decided when data collection and modeling studies are sufficient or insufficient. ORAL and POSTER

T51 Delineation of Contributing Areas for Wells in Challenging Hydrogeologic Settings: Methods, Uncertainty, and Verification

GSA Hydrogeology Division. Kenneth R. Bradbury, Wisconsin Geological and Natural History Survey, Madison, Wis.; Todd W. Rayne, Hamilton College, Clinton, N.Y.

Hydrogeology; Environmental Geoscience

This session will present state-of-the-art methods and/or examples of delineation of zones of contribution (ZOCs) for pumping wells, with an emphasis on complex hydrogeologic settings, quantification and communication of uncertainty, and ZOC verification. ORAL

T52 Denver Basin Bedrock Aquifers—Past, Present, and Future

GSA Hydrogeology Division; Colorado Ground-Water Association. John Moore, U.S. Environmental Protection Agency Region 8, Denver, Colo.

Hydrogeology; Stratigraphy; Sediments, Clastic

The Denver Basin Bedrock Aquifer session will bring together technical experts with public officials to present aspects of water production from the vast, yet complex groundwater system underlying the Colorado Front Range metropolitan area. ORAL

T53 Experimental, Field, and Modeling Studies of Geological Carbon Sequestration

GSA Hydrogeology Division; Geochemical Society. Chen Zhu, University of Pittsburgh, Pittsburgh, Penn.; Eric Oelkers, Directeur de Recherches de CNRS, Toulouse, France; Curt White, National Energy Technology Lab, Pittsburgh, Penn.

Geochemistry, Aqueous; Hydrogeology; Mineralogy/Crystallography

Geological carbon sequestration—the storage of CO_2 in deep geological formation—is proposed as a long-term storage of the greenhouse gas. This session focuses on recent advancements in experimental, field, and modeling studies of the water-CO_2-brine-rock interactions. ORAL

T54 Flow and Transport in Fractured Aquifers—From Field Characterization to Model Construction

GSA Hydrogeology Division. Todd Halihan, Oklahoma State University, Stillwater, Okla.; David Benson, Desert Research Institute, Reno, Nev.

Hydrogeology; Environmental Geoscience; Engineering Geology

Although great advances have occurred, the complexity of fractured aquifers makes their quantitative assessment a continuing problem. This session addresses the advances linking field data and theoretical work. ORAL

T55 Geophysical Evaluation of Aquifer Properties

GSA Hydrogeology Division; GSA Sedimentology Geology Division; GSA Geophysics Division. Jo Leslie Eimers, U.S. Geological Survey, Raleigh, N.C.; Gary S. Weissmann, Michigan State University, East Lansing, Mich.; Gregory S. Baker, University at Buffalo, Buffalo, N.Y.

Hydrogeology; Geophysics/Tectonophysics/Seismology

Geophysical measurements provide a way to characterize aquifer properties and relate hydraulic and water-quality parameters derived from sampling wells to subsurface lithology and flowpaths. Topics include fractured, carbonate, and clastic environments, vadose- and saturated-zone studies. ORAL

T56 Groundwater Depletion and Overexploitation: A Global Problem

GSA Hydrogeology Division; International Association of Hydrogeologists. Leonard F. Konikow, U.S. Geological Survey, Reston, Va.; Lois K. Ongley, Lewiston, Maine.

Hydrogeology; Environmental Geoscience; Engineering Geology

The volume of fresh groundwater in storage has decreased significantly during the past century, but the magnitude and global impacts are uncertain. This session solicits papers on magnitude and effects of groundwater mining, methods to quantify depletion, U.S. and international case studies, status and future trends, and management solutions. ORAL

T57 Hydrogeologic Framework and Basin Hydrology of the Desert Southwestern United States

U.S. Geological Survey. Donald S. Sweetkind, U.S. Geological Survey, Denver, Colo.; Keith A. Howard, U.S. Geological Survey, Menlo Park, Calif.

Hydrogeology; Stratigraphy; Tectonics

This session presents geologic, geophysical, hydrologic, and hydrochemical investigations that bear on the hydrogeologic framework that controls groundwater behavior in basins of the desert southwestern United States at scales of investigation ranging from regional syntheses to detailed studies of individual hydrogeologic basins. ORAL and POSTER

T58 Hydrogeology and Water Resources of the High Plains Aquifer: Issues for Public Policy Over the Next 50 Years

GSA Hydrogeology Division; High Plains Aquifer Coalition of State Geological Surveys. Alan R. Dutton, University of Texas, Austin, Tex.; Richard R. Luckey, U.S. Geological Survey, Denver, Colo.

Hydrogeology; Public Policy; Stratigraphy

Topics pertaining to the High Plains aquifer including hydrogeology, paleoclimatology, recharge, surface-water–groundwater interaction, riparian ecosystems, hydrobiogeological controls on water quality, geoscience education, and public policy issues. ORAL

T59 Mass and Energy Transport in Groundwater: In Memory of Patrick Domenico

GSA Hydrogeology Division. Alan E. Fryar, University of Kentucky, Lexington, Ky.; Frank W. Schwartz, Ohio State University, Columbus, Ohio.

Hydrogeology; Environmental Geoscience; Engineering Geology

Pat Domenico made substantial contributions to a broad range of topics that are still relevant in hydrogeology, such as land subsidence, heat transport, solute dispersion, and abnormal fluid pressures. We are soliciting talks on the history and state of the science of these and related topics and applications of Pat's work to theory and practice. ORAL

T60 Rivers in Karst: Processes and Applications

GSA Hydrogeology Division; Karst Waters Institute; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division. Ira D. Sasowsky, Office for Terrestrial Records of Environmental Change, Akron, Ohio; Gregory S. Springer, Colorado State University, Fort Collins, Colo.

Hydrogeology; Quaternary Geology/Geomorphology; Paleoclimatology/Paleoceanography

Contributions are sought on the morphology, hydrology, physico-chemical processes, contamination, and surface-water–groundwater interaction of streams in karst. This includes subsurface conduit streams or surface streams traversing karst areas. Karst-based studies that advance research in other disciplines are especially encouraged. ORAL and POSTER

Triassic Moenkopi-Shinarump contact, Dinosaur National Monument, Colorado. Photo by Martin Miller.

T61 The Platte River Basin of Colorado, Nebraska, and Wyoming: Where Geology, Hydrology, Endangered Species, People, and Politics Attempt to Coexist

GSA Hydrogeology Division. Richard R. Luckey, U.S. Geological Survey, Denver, Colo.; Gary L. Lewis, Parsons Engineering Science, Inc., Denver, Colo.; Duane A. Woodward.

Hydrogeology; Environmental Geoscience

This multidisciplined session will focus on geohydrology, geomorphology, sedimentation, surface-water hydraulics, groundwater–surface-water interactions, water use, water availability models, vegetation, endangered species, and water planning and policy in the Platte River Basin, with special emphasis on the competition for natural resources between endangered species and people. ORAL

T62 The Role of Analytic Elements in Groundwater Modeling

GSA Hydrogeology Division. Hendrik M. Haitjema, Indiana University, Bloomington, Ky.; Randy J. Hunt, U.S. Geological Survey, Middleton, Wis.

Hydrogeology; Environmental Geoscience; Engineering Geology

The analytic element method is gaining popularity for solving groundwater flow problems of varied complexity and scale. For example, the U.S. Environmental Protection Agency is using the method for its wellhead protection programs. In addition to giving an overview of the method, the session will focus on applications to local and regional groundwater flow. ORAL

T63 The Terrestrial-Aqueous Interface: Multidisciplinary Research and Opportunities

GSA Hydrogeology Division. F. Edwin Harvey, University of Nebraska, Lincoln, Nebr.; Donald I. Siegel, Syracuse University, Syracuse, N.Y.

Hydrogeology; Geochemistry, Aqueous; Environmental Geoscience

Aqueous ecosystem health depends upon complex hydrological, biological, and geochemical feedbacks. This session focuses on how multidisciplinary study clarifies our understanding of aqueous ecosystem evolution, processes, and management at the land-water interface. ORAL and POSTER

T64 The What, When, Why, and How Much of Chemical (Nutrient) Supplements for Bioremediation

GSA Hydrogeology Division. J.F. Devlin and J.R. Rogers, University of Kansas, Lawrence, Kans.

Hydrogeology; Environmental Geoscience

Overview of research and case study experience with the addition of chemical supplements for bioremediation and microbial strategies for obtaining limiting substances in the absence of such amendments. ORAL

T65 Characterization, Attenuation, and Remediation of Subsurface Organic Contaminants in Heterogeneous Chemical or Physical Settings

GSA Hydrogeology Division; Geochemical Society. John E. McCray, Colorado School of Mines, Golden, Colo.; Thomas B. Boving, University of Rhode Island, Kingston, R.I.

Hydrogeology; Geochemistry, Aqueous; Geochemistry, Organic

Complex heterogeneities affect the characterization, natural attenuation, and remediation efforts at many contaminated sites. This session focuses on innovative practical solutions and research that elucidates the fundamental physics and chemistry associated with these problems. ORAL

T66 Fate, Transport, and Treatment of Pollutants from Municipal Solid Waste Landfills

GSA Hydrogeology Division; Geochemical Society. Geoff Thyne and Richard Statom, Colorado School of Mines, Golden, Colo.

Hydrogeology; Geochemistry, Aqueous; Geochemistry, Organic

Groundwater pollution from landfill leachate is a serious hazard for all populated areas. This session focuses on research associated with predicting leachate composition and pollutant transport, natural attenuation of pollutants, and other related topics. ORAL

T67 Watershed Processes Within Tropical Montane Catchments

Russell S. Harmon, U.S. Army Research Office, Durham, N.C.; Ellen Wohl, Colorado State University, Fort Collins, Colo.

Hydrogeology; Quaternary Geology/Geomorphology; Environmental Geoscience

The session focus is watershed processes operating at different spatio-temporal scales within mountainous catchments in seasonal and/or humid tropics. Processes of interest include rainfall-runoff, soil and infiltration capacity variability, weathering, flow regime, sediment transport, water chemistry, and aquatic-riparian habitats and communities. ORAL

T68 Yucca Mountain Update: Recent Advances from Scientific Investigations of the Unsaturated Zone

U.S. Department of Energy—Yucca Mountain Project. Robert Levich, U.S. Department of Energy, Las Vegas, Nev.; Ronald Linden, Golder Assoc. Inc, Las Vegas, Nev.

Hydrogeology; Public Policy; Environmental Geoscience

Recent advances in moisture monitoring, seepage testing, geochemical and isotopic studies of minerals and pore fluids, thermally driven coupled processes, radionuclide transport phenomena, flow field calculations, and performance assessment of Yucca Mountain. ORAL

T69 Phosphates: Geochemical, Geobiological, and Materials Importance

Mineralogical Society of America; Geochemical Society. John Rakovan, Miami University, Oxford, Ohio; Matthew J. Kohn, University of South Carolina, Columbia, S.C.

Mineralogy/Crystallography, Geochemistry, Other

This session will focus on the chemistry, chronology, biology, mineralogy, and materials applications of phosphates as a follow-up to the MSA short course on phosphates held the preceding weekend. Contributions in any field of phosphate research are encouraged. ORAL

T70 Antarctica During the Neogene

Allan C. Ashworth, North Dakota State University, Fargo, N.Dak.

Paleoclimatology/Paleoceanography; Paleontology/Paleobotany; Stratigraphy

The controversial Neogene history of Antarctica and its ice sheets is examined in light of several new studies of terrestrial and marine deposits from different parts of the continent and the Southern Ocean. ORAL

T71 Feedback in Earth Systems—Determining System Response to Perturbation Through Observations and Modeling

J. Alcock, Penn State, Abington College, Abington, Penn.; Lee Kump, Penn State University, University Park, Penn.

Paleoclimatology/Paleoceanography; Planetary Geology; Environmental Geoscience

Feedback has the potential to damp or enhance perturbations to systems at or near steady state. Recognition and study of feed-

back in earth systems, therefore, is an important tool for understanding a wide variety of past and future events such as global climate change, mass extinction, geochemical cycling, and catastrophic slope failure. ORAL and POSTER

T72 Geologic Records of Paleoelevation

Henry Fricke, Colorado College, Colorado Springs, Colo.

Paleoclimatology/Paleoceanography; Tectonics; Hydrogeology

By bringing together researchers from a wide range of disciplines, this session on paleoelevation will focus on recent advances in method development, possible reasons for disagreement between methods, and the presentation of regional case studies. ORAL

T73 Global Biogeochemical Change During PETM Events

Gerald R. Dickens, Rice University, Houston, Tex.; Lisa C. Sloan, University of California, Santa Cruz, Calif.

Paleoclimatology/Paleoceanography; Paleontology/Paleobotany; Stratigraphy

Assessing complex links between biology, geology, chemistry, and climate during extreme changes in earth system processes. ORAL and POSTER

T74 Isotopic and Elemental Tracers of Late Quaternary Climate Change

Geochemical Society. Donna Surge and German Mora, Iowa State University, Ames, Iowa.

Paleoclimatology/Paleoceanography; Geochemistry, Other; Quaternary Geology/Geomorphology

A growing number of isotopic and elemental approaches integrate climate with biological and geochemical processes. This session will bring together geologists, geochemists, oceanographers, limnologists, atmospheric and soil scientists, climatologists, and paleoecologists to explore new ways to examine late Quaternary paleoclimate records. ORAL and POSTER

T75 Paleosols and Phanerozoic Climate: Geochemistry to Trace Fossils

Nathan D. Sheldon, University of Oregon, Eugene, Ore.; Neil Tabor, University of California, Davis, Calif.

Paleoclimatology/Paleoceanography; Geochemistry, Other; Sediments, Clastic

Recent years have seen an increasing number of paleoenvironmental reconstructions based on terrestrial records. New approaches range from isotropy to ichnology. This session will bring together these varied and multidisciplinary approaches to the reconstruction of Phanerozoic ecosystems, climate, and climate change from paleosols. ORAL

T76 Three Billion Years of Reef Systems

Paleontological Society. George D. Stanley, University of Montana, Missoula, Mont.

Paleontology/Paleobotany; Sediments, Carbonates; Stratigraphy

Reefs are enduring marine ecosystems. Their biotic and geologic history has been affected by changes in the atmosphere, nutrients, seawater chemistry, sedimentation, and the evolution of new biotic groups. This session explores interdisciplinary approaches to better understand the history and sedimentology of reefs. ORAL

T77 Advances in the Fossil Record of Insects and Terrestrial Arthropods

Paleontological Society. Robert E. Nelson, Colby College, Waterville, Maine.

Paleontology/Paleobotany; Stratigraphy

A session devoted to new discoveries in paleo-entomology (in the broad sense), from the Paleozoic to the Quaternary. ORAL and POSTER

T78 Developing Perspectives on the Ecological Context of Biological Evolution Across the Neoproterozoic-Cambrian Transition

Paleontological Society. Loren E. Babcock, Ohio State University, Columbus, Ohio.

Paleontology/Paleobotany; Precambrian Geology; Stratigraphy

The Neoproterozoic-Cambrian interval was a time of significant reorganization in biological systems. This session addresses important recent developments and unresolved questions concerning the ecological context within which early organisms radiated through the Neoproterozoic-Cambrian transition. ORAL

T79 Evolutionary Paleobiology and Paleoecology of the Bivalvia

Paleontological Society. Peter D. Roopnarine and Carol M. Tang, California Academy of Sciences, San Francisco, Calif.

Paleontology/Paleobotany; Paleoclimatology/Paleoceanography

Recently, there has been a rapid expansion of our knowledge of the Bivalvia and the techniques used to study this important fossil group. This session will include recent work in the evolutionary history and paleoecology of bivalves, including contributions from paleontology, phylogenetic systematics, ecology, biogeochemistry, and molecular biology. ORAL

T80 New Frontiers in the Fossil Record of Insects and Terrestrial Arthropods

Robert Nelson, Colby College, Waterville, Maine.

Paleontology/Paleobotany; Stratigraphy

A session to bring together those working on, and those interested in, the fossil record of arthropods, the dominant animal phylum on dry land. ORAL and POSTER

T81 Paleobiogeography: Integrating Plate Tectonics and Evolution

Paleontological Society. Bruce S. Lieberman, University of Kansas, Lawrence, Kans.

Paleontology/Paleobotany; Tectonics

The goal of this session is to bring together researchers in several areas exploring the relationship between plate tectonics and evolution. ORAL

T82 Paleontology in National Parks: Sharing the Fossil Record with Managers and the Public

National Park Service. H. Gregory McDonald, National Park Service, Denver, Colo.; Ted Fremd.

Paleontology/Paleobotany; Geoscience Information/Communication; Geoscience Education

The session will provide a forum for both park and other paleontologists to present their research on fossils in parks and how this research can benefit both managers and the public's understanding of the importance of these resources in parks. ORAL and POSTER

T83 Phenotypic Variation: Discriminating Between Evolution and Environment

Paleontological Society. Steven J. Hageman, Appalachian State University, Boone, N.C.; Peter Kaplan, University of Michigan, Ann Arbor, Mich.

Paleontology/Paleobotany

The ability to document changes in phenotype through time and space is one of the unique contributions that paleontology provides to evolutionary biology. The challenge of interpreting causal factors of phenotypic variation within and among fossil species can be addressed by morphometric analyses. ORAL

T84 Seafood Through Time: The Ecologic Context of the History of Life: In Honor of Richard K. Bambach

Paleontological Society. Andrew M. Bush, Harvard University, Cambridge, Mass.; Roderic Brame, Wright State University, Dayton, Ohio.

Paleontology/Paleobotany; Paleoclimatology/Paleoceanography; Stratigraphy

Richard Bambach has long emphasized the importance of paleoecology to macroevolution, mass extinction, diversity dynamics, and more. In his honor, this symposium will highlight ecologic controls on life's history and current methods in paleoecology. ORAL

T85 Microprobe Monazite Geochronology: New Developments and Applications

Mineralogical Society of America. Robert J. Tracy, Virginia Tech, Blacksburg, Va.; Michael L. Williams, University of Massachusetts, Amherst, Mass.

Petrology, Metamorphic; Tectonics; Geochemistry, Other

This session is aimed at bringing together a group of speakers to present the latest ideas on microprobe monazite geochronology, including development of analytical techniques and application to problems of timing in orogenic terranes. ORAL and POSTER

T86 Chesapeake Bay Impact Structure: Geology, Geophysics, and Geohydrology of America's Largest Crater

GSA Planetary Geology Division. C. Wylie Poag, U.S. Geological Survey, Woods Hole, Mass.; Gregory S. Gohn, U.S. Geological Survey, Reston, Va.

Planetary Geology; Marine/Coastal Science; Stratigraphy

Seismic reflection profiles and coreholes reveal the structure, morphology, stratigraphy, depositional history, and geohydrological properties of this late Eocene submarine crater. This session will synthesize 16 years of study and will evaluate the impact in the context of terrestrial impact models. ORAL

T87 Drilling into Impact Structures: Petrology, Geochemistry, and Geophysics

GSA Planetary Geology Division; Geological Society of South Africa; European Science Foundation IMPACT Program. Christian Koeberl, University of Vienna, Vienna, Austria; Wolf Uwe Reimold, University of the Witwatersrand, Johannesburg, South Africa.

Planetary Geology; Petrology, Metamorphic; Geochemistry, Other

This session allows presentation of some of the first results from the current Chicxulub deep drilling project. In addition, presentation of results from other completed crater drillings and future studies are encouraged. ORAL and POSTER

T88 Early Mars

GSA Planetary Geology Division. Herbert Frey, NASA Goddard Space Flight Center, Greenbelt, Md.

Planetary Geology; Tectonics; Volcanology

The major crustal features of Mars (crustal dichotomy, Tharsis, Hellas, and Utopia) formed early in its history. All exerted significant influence on the subsequent evolution of Mars. This session will look at the Noachian period and observational constraints that help us understand what happened when during that time. ORAL and POSTER

T89 Impact Stratigraphy

GSA Planetary Geology Division; GSA Sedimentary Geology Division. David T. King, Auburn University, Auburn, Ala.; Michael Robert Rampino, New York University, New York, N.Y.

Planetary Geology; Stratigraphy

This session deals with recent advances in understanding of the nature and stratigraphic distribution of impact-crater ejecta, both distal and proximal, of various ages and from various target materials. Papers will cover ejecta deposits in various environments of deposition, their preservation potential, correlation, and criteria for recognition. ORAL and POSTER

T90 Terrestrial Approaches to Extraterrestrial Problems and Vice Versa

GSA Planetary Geology Division. Louise M. Prockter, Applied Physics Lab, Laurel, Md.; Tracy K.P. Gregg, University at Buffalo, State University of New York, Buffalo, N.Y.

Planetary Geology; Structural Geology; Volcanology

This session aims to bring planetary scientists and their terrestrial counterparts together—literally—in a session of paired presentations on a particular planetary process or geological feature. Choose your partner and join us. ORAL

T91 A-Type Plutons and Convergent Margins: Orogenic Links to Anorogenic Magmatism?

International Geologic Correlation Program Project 426: Granite Systems and Proterozoic Lithospheric Processes. W.R. Van Schmus, University of Kansas, Lawrence, Kans.; O. Tapani Rämö, University of Helsinki, Helsinki, Finland; Jorge S. Bettencourt, Universidade de São Paulo, São Paulo, Brazil.

Precambrian Geology; Petrology, Igneous; Tectonics

Papers are requested which address the origin of Mesoproterozoic anorogenic magma systems with particular emphasis on papers which link them to convergent margin tectonic activity in Laurentia or other global analogues. ORAL and POSTER

Travertine deposits at Mammoth, Yellowstone National Park, Wyoming. Photo by Martin Miller.

T92 Effective Communication and/or Partnership Among Geoscientists, the Public, and Policy Makers: Case Studies

National Association of Geoscience Teachers; GSA Geology and Public Policy Committee, Critical Issues Caucus. Paul H. Reitan, SUNY at Buffalo, Buffalo, N.Y.; Christine Turner, U.S. Geological Survey, Denver, Colo.

Public Policy; Geoscience Education; Geoscience Information/Communication

Societies benefit by incorporating geological understanding into public affairs (e.g., education, land use, water, hazard mitigation). We can learn how to facilitate this engagement by knowing what has worked and why, or what hasn't worked and why. Let's learn from case studies—local schools and communities to regional and national policy. ORAL

T93 Hydrogeology in Developing Countries: Opportunities and Challenges

GSA Hydrogeology Division. Stephen E. Silliman, University of Notre Dame, Notre Dame, Ind.; Michael D. Guebert, Taylor University, Upland, Ind.

Hydrogeology; Environmental Geoscience; Public Policy

Hydrogeologists face opportunity and challenge in developing countries. Papers are sought on water in developing countries (e.g., characterizing water resources, challenges faced in development projects, and case studies). Research and applied examples are encouraged, as are studies ranging from local to regional projects. ORAL

T94 Injecting Geoscience Into Public Policy: Strategies That Work

David Wunsch, New Hampshire Geological Survey, Concord, N.H.; David Applegate, American Geological Institute, Alexandria, Va.

Public Policy

Earth scientists need to be involved in policy decisions that affect society. This session will highlight success stories and outline strategies for integrating geoscience into public policy at the local, state, and federal levels. ORAL

T95 Whetting the Appetite of Politicians: Water Issues in the American West

Association of Earth Science Editors; GSA Geology and Public Policy Committee. Richard W. Jones, Wyoming State Geological Survey, Laramie, Wyo.; Monica G. Easton, Ontario Geological Survey, Sudbury, Ontario, Canada.

Public Policy; Hydrogeology; Geoscience Information/Communication

With submissions from scientists, engineers, planners, and other professionals, this session will explore different viewpoints with respect to water resource problems to illustrate how cooperation in communication can result in sound policies and strategies for the use of scarce water resources in the western United States. ORAL and POSTER

T96 Workforce and Education: Exploring the Industry-Academia Connection Toward Developing a Capable and Sufficient Science and Technology Labor Pool

GSA Geology and Public Policy Committee; GSA Professional Development Committee. Marilyn J. Suiter and Richard M. Taber, National Science Foundation, Arlington, Va.

Public Policy; Geoscience Education

This session is on information on the current status of enrollment, degrees, and employment trends in science and technology, with focus on the geosciences. Examples of exemplary training methods and of successful collaborations that lead to workforce-ready graduates and information on nontraditional employment sectors for graduates are also invited. ORAL

T97 Geoecology—The Emergence of an Old Concept to Solve Problems in the 21st Century

GSA Quaternary Geology and Geomorphology Division. Alan Gallegos, USDA Forest Service, Clovis, Calif.; Hugh D. Safford, USDA Forest Service, Vallejo, Calif.

Quaternary Geology/Geomorphology; Environmental Geoscience

This session will include presentations of the history, broad scope, and application of geoecology in today's world. Many scientists are practicing geoecology and should be recognized as geoecologists. ORAL

T98 Geological and Ecological Responses to Landscape Disturbances

GSA Quaternary Geology and Geomorphology Division. Frederick J. Swanson, USDA Forest Service, Corvallis, Ore.; Jon J. Major, U.S. Geological Survey, Vancouver, Wash.

Quaternary Geology/Geomorphology; Environmental Geoscience; Sediments, Clastic

Cedar Mesa Sandstone, Canyonlands National Park, Utah. Photo by Martin Miller.

This volunteer poster session aims to explore studies of coupled geologic and ecologic responses to landscape disturbances by processes such as volcanic activity, land use, wildfire, and hurricanes. POSTER

T99 Geology, Biogeochemistry, and Ecology: A New Synthesis for Arid Landscape Processes

GSA Quaternary Geology and Geomorphology Division; GSA Geobiology and Geomicrobiology Division. Marith Cady Reheis, U.S. Geological Survey, Denver, Colo.; Robert L. Sanford, Denver University, Denver, Colo.

Quaternary Geology/Geomorphology; Geomicrobiology; Geochemistry, Other

Cooperative studies in biogeochemistry, earth surface processes, and ecology are yielding exciting advances in our understanding of how geologic substrates and processes control and interact with vegetation distributions, plant invasions, and soil geochemistry. This topical session will showcase some of these advances and stimulate collaboration. ORAL and POSTER

T100 Geomorphic Impacts of Wildfire

GSA Quaternary Geology and Geomorphology Division; GSA Engineering Geology Division. Susan H. Cannon, Golden, Colo.; Deborah Martin, U.S.

Geological Survey, Boulder, Colo.; Charles Luce, USDA Forest Service, Boise, Idaho.

Quaternary Geology/Geomorphology; Engineering Geology; Hydrogeology

The occurrence of catastrophic wildfires throughout the world and the encroachment of development into fire-prone ecosystems have resulted in the need for a better understanding of how fire changes the hydrological and depositional responses of watersheds. ORAL and POSTER

T101 Interdisciplinary Approaches to Understanding Soil and Vadose Zone Hydrology of Saprolite: Integration of Hydrogeology, Sedimentology, Geomorphology, Pedology, and Biology

GSA Hydrogeology Division; GSA Sedimentary Geology Division; SEPM—Society for Sedimentary Geology; GSA Quaternary Geology and Geomorphology Division. Steven G. Driese and Larry D. McKay, University of Tennessee, Knoxville, Tenn.

Hydrogeology; Quaternary Geology/Geomorphology; Sediments, Clastic

Integration of hydrology, sedimentology, geomorphology, pedology, and biology toward understanding the origin and development of porosity in saprolite and its influence on soil and vadose zone hydrology and chemistry. ORAL

T102 Post-Laramide Uplift and Erosion of the Rocky Mountains and Colorado Plateau

GSA Sedimentary Geology Division. Joel L. Pederson, Utah State University, Logan, Utah; Frank J. Pazzaglia, Lehigh University, Bethlehem, Penn.

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

Session highlights new ideas on the timing, mechanisms, and degree of middle-late Cenozoic uplift and erosion in this classic region. A broad spectrum of submittals is encouraged, including geophysics, thermochronology, geodynamics, and surface processes, as well as both regional and local, field, and modeling research. ORAL and POSTER

T103 Quaternary Sciences from Land to Sea: In Honor of John T. Andrews

GSA Quaternary Geology and Geomorphology Division. Peter U. Clark, Oregon State University, Corvallis, Ore.; Gifford H. Miller, University of Colorado, Boulder, Colo.

Quaternary Geology/Geomorphology; Paleoclimatology/Paleoceanography

John T. Andrews has had a tremendous impact on the Quaternary sciences. The purpose of this session is to honor Andrews' career through papers that reflect his many scientific contributions in ice sheet, solid earth, and ocean interactions. ORAL and POSTER

T104 Quaternary Stratigraphy and the Glacial Environment: In Honor of Ernest H. Muller

GSA Quaternary Geology and Geomorphology Division. P. Jay Fleisher, State University College, Oneonta, N.Y.; David A. Franzi, Plattsburgh State University of New York, Plattsburgh, N.Y.

Quaternary Geology/Geomorphology

Contemporary glacial stratigraphy continues to be advanced by Ernest H. Muller's legacy of thought-provoking research. This session honors Ernie's exceptional contributions to Quaternary geology. Abstracts on subjects related to Quaternary stratigraphy and the glacial environment are welcome. ORAL

T105 Response of Dryland Geomorphic Systems to Climate Change and Variability

GSA Quaternary Geology and Geomorphology Division. Nicholas Lancaster, Desert Research Institute, Reno, Nev.

Quaternary Geology/Geomorphology; Hydrogeology

A multidisciplinary examination of the causes and effects of short-term climatic change and variability on geomorphic processes and landscapes in drylands. ORAL and POSTER

T106 Remotely Sensed Data for Geologic and Environmental Studies

GSA Geophysics Division. Wendy M. Calvin, University of Nevada, Reno, Nev.; Trude V.V. King, U.S. Geological Survey, Denver, Colo.

Environmental Geoscience; Remote Sensing/Geographic Info System

The session examines the application of remotely sensed data for geologic and environmental studies. Emphasis will be placed on integrating remotely sensed data with other geo-scientific data. Applications include geologic and mineral mapping, environmental site characterization, vegetation stress, forest fire management, and land use issues. ORAL and POSTER

T107 New Perspectives on Chert, Its Origin, Diagenesis, and Economic Significance

James P. Rogers, consultant, Aurora, Colo.; Mark W. Longman, Lakewood, Colo.

Sediments, Carbonates; Sediments, Clastic; Geomicrobiology

Session will include papers on current studies of the origin, alteration and significance of chert, some quite revolutionary. Chert is an old subject, sometimes maligned by sages and ages. Come and learn of new ways to look at this old "mystery" rock. ORAL

T108 The Green River Formation Revisited: Crucible for New Concepts and Advances in Paleoclimatology, Tectonics, Chronostratigraphy, Sequence Stratigraphy, Isotope Geochemistry, and Paleontology

International Association of Limnogeologists. H. Paul Buchheim, Loma Linda University, Loma Linda, Calif.; Alan R. Carroll, University of Wisconsin, Madison, Wis.; Arvid Aase, Fossil Butte National Monument, Kemmerer, Wyo.

Sediments, Carbonates; Paleontology/Paleobotany; Paleoclimatology/Paleoceanography

The Green River Formation continues to provide new insights into the interaction of paleoclimatic, tectonic, sedimentologic, geochemical, and paleontologic processes. This session will explore this record and its significance to ancient lacustrine processes. ORAL and POSTER

T109 Deltas—Old and New

GSA Sedimentary Geology Division. Janok P. Bhattacharya, University of Texas at Dallas, Richardson, Tex.; Liviu Giosan, Woods Hole Oceanographic Institution, Woods Hole, Mass.

Sediments, Clastic; Marine/Coastal Science; Environmental Geoscience

Study advances in modern and ancient deltas warrant a new look at old paradigms and provide an unparalleled opportunity to set new goals. The session will focus on integration of multidisciplinary information from oceanic and terrestrial realms and will discuss novel ideas based on high-resolution geophysics, field observations, and modeling. ORAL

T110 Tectonics, Climate Change, and the Late Cenozoic Evolution of the Rocky Mountains, Colorado Plateau, and Western Great Plains

GSA Sedimentary Geology Division. Margaret E. McMillan, University of Wyoming, Laramie, Wyo.; Catherine Riihimaki, University of California, Santa Cruz, Calif.

Stratigraphy; Tectonics; Quaternary Geology/Geomorphology

Interpretations of the Cenozoic tectonic and climate history of the greater Rocky Mountains hinge on assumptions about landscape development. We encourage presentation of new ideas and the reevaluation of old concepts that arise from the regional integration of geophysics, geomorphology, geochronology, sedimentology, and stratigraphy. ORAL

T111 Detrital Thermochronology—Dating of Exhumation and Landscape Evolution in Mountain Belts

GSA Structural Geology and Tectonics Division. Matthias Bernet, Yale University, New Haven, Conn.; Cornelia Spiegel, Universität Tübingen, Tübingen, Germany.

Tectonics; Sediments, Clastic; Quaternary Geology/Geomorphology

This session will present the latest state-of-the-art developments in detrital thermochronology and of U-Pb, Ar-Ar, and fission-track to (U-Th)/He dating techniques. Problems addressed in this session range from tectonic and erosional exhumation of active and ancient mountain belts, over sediment provenance analysis, to landscape evolution. ORAL and POSTER

T112 EarthScope Town Hall Meeting

GSA Structural Geology and Tectonics Division; GSA Geophysics Division; Mineralogical Society of America; Geochemical Society. Basil Tikoff, University of Wisconsin, Madison, Wis.; Tracy Rushmer, University of Vermont, Burlington, Vt.

Tectonics; Geophysics/Tectonophysics/Seismology; Volcanology

This session will provide critical EarthScope information to the geologic community and present the wide range of possibilities for integrated science. It will highlight aspects of geoscience directly relevant to the EarthScope initiative. ORAL and POSTER

T113 Extensional Tectonics in the Southern Basins and Ranges, United States, and in Western Turkey

GSA Structural Geology and Tectonics Division. Ibrahim Çemen, Oklahoma State University, Stillwater, Okla.; John Bartley, University of Utah, Salt Lake City, Utah.

Tectonics; Structural Geology; Geophysics/Tectonophysics/Seismology

Different research groups have been studying extensional structures, related basin formation, volcanism, and metamorphism in the southern Basins and Ranges of the United States and western Turkey, two of the best examples of continental extension. This session will provide a formal discussion on problems related to extensional tectonics in the two regions. ORAL and POSTER

T114 Forward Modeling in Tectonics and Structural Geology

GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division. Bruno C. Vendeville, University of Texas, Austin, Tex.; Martha O. Withjack, Rutgers University, Piscataway, N.J.

Structural Geology; Tectonics; Stratigraphy

This session focuses on physical and numerical tectonic modeling at various scales (lithosphere, sedimentary cover) and settings (shortening, extension, strike-slip, gravity tectonics, pluton emplacement, etc.), and on modeling the influence of tectonics onto sediment deposition. ORAL and POSTER

T115 Geometry, Kinematics, and Vorticity of High-Strain Zones

GSA Structural Geology and Tectonics Division. Christopher M. Bailey, College of William & Mary, Williamsburg, Va.; Dazhi Jiang, University of Maryland, College Park, Md.; Andy Bobyarchick, University of North Carolina, Charlotte, N.C.

Structural Geology; Tectonics

This session is aimed at discussing recent work on the geometry, kinematics, and vorticity of deformation in high-strain zones as well as linking both modeling and field studies related to this topic. ORAL

T116 Kinematics of the Himalayan-Tibetan Orogen—Comparing the Present with the Past

GSA Structural Geology and Tectonics Division. Michael Murphy, Houston, Tex.

Tectonics

To what extent and over what time scales may intracontinental deformation be described as steady state? This session will address this question by comparing short- and long-term kinematic data from the Himalayan-Tibetan orogen. ORAL and POSTER

T117 Lithospheric Structure and Evolution of Rocky Mountain Region, from Deep Mantle to Mountain Tops

GSA Structural Geology and Tectonics Division. Karl E. Karlstrom, University of New Mexico, Albuquerque, N.Mex.; Michael L. Williams, University of Massachusetts, Amherst, Mass.

Tectonics; Geophysics/Tectonophysics/Seismology

The Rocky Mountain region provides a template for understanding lithospheric evolution. The themes of this session will be possible secular changes in lithospheric processes, how continents become stabilized and destabilized, and the geodynamics of intracontinental regions. ORAL

T118 New Constraints on Mesoproterozoic–Early Neoproterozoic Supercontinent Assembly and Dispersal

GSA Structural Geology and Tectonics Division. Richard E. Hanson, Texas Christian University, Fort Worth, Tex.; Samuel Bowring, Massachusetts Institute of Technology, Cambridge, Mass.

Tectonics; Precambrian Geology

This multidisciplinary session will examine new constraints and controversial models bearing on the configuration and evolution of the Rodinia supercontinent, which dominated global interactive systems in the latter part of the Precambrian and was the precursor to both Gondwana and Pangea. ORAL

T119 Nonconventional Fold-Thrust Belts: Assessing the Spectrum of Variation in a Structural Style

GSA Structural Geology and Tectonics Division; Ocean Energy, Inc. Oscar E. Gilbert, Ocean Energy Inc., Houston, Tex.; Dietrich Roeder, Murnau Geodynamics Inc., Denver, Colo.

Structural Geology; Tectonics; Geophysics/Tectonophysics/Seismology

"Typical" fold-thrust belts are only part of a continuum of possible thrust styles. Most fold-thrust belts—including the Makran, Niger delta, Caspian, and central Asian ranges—exhibit significantly different substyles. This session addresses the variability among fold-thrust belts, including new rules and paradigms for exploration. ORAL and POSTER

T120 Structure and Tectonics of the Midcontinent, North America

GSA Structural Geology and Tectonics Division. Gregory C. Ohlmacher and Pieter Berendsen, University of Kansas, Lawrence, Kans.

Structural Geology; Tectonics; Engineering Geology

Surficial fractures and folds in Phanerozoic rocks of the Midcontinent provide insight into the behavior and tectonics of basement faults in stable continental regions. This session will focus on the kinematics and mechanics of surface structures, their relationships to basement faults, reactivation of basement faults, and earthquake hazards. ORAL

T121 Tackling Transpression and Transtension in Orogenesis. Tools of Structural Geology from Microfabric to Tectonic Reconstruction

GSA Structural Geology and Tectonics Division. M.A. Edwards, Institut für Geologie, Freiberg, Germany; Nicholas W. Hayman, University of Washington, Seattle, Wash.; John Dewey, University of California, Davis, Calif.

Structural Geology; Tectonics

We consider good and bad tools in orogen restoration to constrain tectonic transport and the degree of transpression and transtension. Which fabrics are formed where and when (e.g., in middle crust, during collapse)? Are kinematic indicators from complex (e.g., triclinic) shear zone misleading? Experimental, natural, and theoretical examples welcomed. ORAL and POSTER

T122 Tectonic Evolution of the Middle East and Adjacent Regions: The Confluence of the Alpine and Himalayan Orogenic Systems and a Window into Processes of Continental Dynamics

GSA Structural Geology and Tectonics Division. Bernard Guest, University of California, Los Angeles, Calif.; Jahan Ramezani, Massachusetts Institute of Technology.

Tectonics; Neotectonics/Paleoseismology; Geophysics/Tectonophysics/Seismology

A forum to facilitate discussion regarding: The tectonic evolution of the Middle East and adjacent regions, the confluence of the Alpine and Himalayan orogenic systems, and the processes of continental dynamics. ORAL and POSTER

T123 Tectonic Modeling Applied to the Characterization and Evaluation of Yucca Mountain as a National Nuclear Waste Repository Site: Concepts, Methods, and Hazard Analyses at Local and Regional Scales

Dennis O'Leary, U.S. Geological Survey, Denver, Colo.

Tectonics; Neotectonics/Paleoseismology; Volcanology

This session examines the applicability of tectonic models to the characterization of Yucca Mountain to the explanation of its structural history and to hazard analysis. Which models best explain local and regional deformation? Is there an optimal model for Yucca Mountain? Which criteria determine validity and utility of tectonic models? ORAL

T124 Thermal and Mechanical Significance of Gneiss Domes in the Evolution of Orogens

GSA Structural Geology and Tectonics Division; Mineralogical Society of America. Donna L. Whitney, University of Minnesota, Twin Cities, Minneapolis, Minn.; Christian Teyssier, University of Minnesota, Minneapolis, Minn.; Kip V. Hodges, Massachusetts Institute of Technology, Cambridge, Mass.

Tectonics; Petrology, Metamorphic; Structural Geology

Domes of high-grade metamorphic and plutonic rocks commonly occur in orogenic cores. This session discusses the origin of domes cored by migmatites and granites and their significance in the thermal and mechanical evolution of orogens. ORAL and POSTER

T125 Thrust Belt Curvature: Integrating Paleomagnetic and Structural Analyses

GSA Structural Geology and Tectonics Division. Aviva J. Sussman, University of Arizona, Tucson, Ariz.; Arlo B. Weil, University of Michigan, Ann Arbor, Mich.

Tectonics; Structural Geology; Geophysics/Tectonophysics/Seismology

Understanding the three-dimensional evolution, mechanics, and kinematics of curved fold-thrust belts requires the integration of classic structural analyses and paleomagnetic studies. Abstracts are welcomed from investigators whose research bridges both methods. ORAL and POSTER

T126 Reconstructing the Cambrian World: Temporal and Spatial Changes in Physical and Biotic Environments

Paleontological Society. Ed Landing, New York State Museum, Albany, New York; Gerd Geyer, Universität Würzburg, D-97070 Würzburg, Germany.

Paleontology/Paleobotany; Geochemistry, Organic

Dramatic biotic and physical developments can be related to a precise geochronology to demonstrate unexpected rates of change through the Cambrian. The Cambrian radiation was associated with continental fragmentation, high biotic provincialism, and increasing rates of turnover as ecosystems became more complex. ORAL

T127 The Role of the Earth Sciences in Fostering Global Equity and Stability

GSA International Division; U.S. National Committee for the Geological Sciences; U.S. National Committee for Geodesy and Geophysics. Eldridge M. Moores, University of California, Davis, Calif.; W.G. Ernst, Stanford University, Stanford, Calif.; Grant H. Heiken, Los Alamos, N.Mex.; Susan M. Landon, Golden, Colo.; P. Patrick Leahy, U.S. Geological Survey, Reston, Va.

Environmental Geoscience; Public Policy; Economic Geology

This session will bring together a broad spectrum of earth scientists, policy makers, and ethicists to discuss the role of the earth sciences in achieving a global sustainable society, global equity, and stability. ORAL

Teacher Field Trip Planned for K–16 Education Program

Join us in Denver for exciting and informative workshops for K–12 educators, junior college instructors, college professors, preservice instructors, and graduate students. A full slate of workshops and activities are scheduled for Saturday and Sunday. Topics include the use of new technology, plate tectonics, pedagogy, and a teacher field trip. Check the June issue of *GSA Today* for complete workshop listings, dates, and times. Preregistration is recommended to assure your spot in these popular sessions.

Graduate-level recertification credits from the Colorado School of Mines will be offered for workshop participation and all technical sessions, based on contact hours and written summaries of activities. Details will be available on-site at the workshops. Contact Glenda Robinson, Subaru Distinguished Earth Science Teacher, for more information at grobinson@geosociety.org.

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 $15 for all students and $25 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, so 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.

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
Geoscience Education
Geomicrobiology
Geophysics/Tectonophysics/Seismology
Geoscience Information/Communication
History of Geology
Hydrogeology
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 Info 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 your abstract into your preferred mode. However, they will override your original 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. Projection equipment consists of one laptop with PowerPoint installed, two 35 mm projectors, one overhead projector, and two screens. Requests for other equipment will be addressed on a case-by-case basis.

Poster Mode. Each poster session presenter is provided with two horizontal, freestanding display boards approximately 8' wide by 4' high. Precise measurements will appear in the Speaker Guide, which will be posted on the GSA Web site in September. The speaker must be at the poster booth 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 your abstract to 2,000 characters or fewer. The online abstract system will reject abstracts that exceed this limit.

You can include a table or an image with your abstract, but understand that the image and table might reduce the number of words allowed in your abstract. Taken together, the text and images 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.)

Leave a blank line between paragraphs or they will run together when displayed. (You can do this while typing text you want to paste onto the online form, before copying the text, or after pasting it on the form.)

ABSTRACTS FEE

Once the abstract is in place, a window to submit payment will appear. The nonrefundable submission fee is $15 for all students; $25 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 MID-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. The JTPC technical program chairs were approved by the GSA Council.

FIELD TRIPS

Come experience the Rockies—whether by hiking the crags or pouring over borehole images at the actual well site—during one of the many field trips planned for the Denver 2002 Annual Meeting. Choose from a full array of trips to view the geology of the southern Rocky Mountains ranging from multiday excursions delving into the Proterozoic evolution of central Colorado to single-day visits to view the processes currently modifying the Rocky Mountain landscape.

Most trips will start and end in Denver. Air travel plans that include a Saturday night stay over can substantially offset field trip costs. Please note: The weather in late October may be a factor in trips in the Rocky Mountains. The following list is tentative and subject to change. Further details will be given when registration for the meeting begins in June. For more information, contact the trip leader or the 2002 field trip co-chairs: Eric Erslev, Dept. of Earth Resources, Colorado State University, Fort Collins, CO 80523-1482, (970) 491-6375, fax 970-491-6307, erslev@cnr. colostate.edu, and Jerry Magloughlin, Dept. of Earth Resources, Colorado State University, Fort Collins, CO 80523-1482, (970) 491-1812, fax 970-491-6307, jerrym@cnr.colostate.edu.

Premeeting

Paleontology and Geology of the Green River Formation, Colorado, Utah, and Wyoming

Tues.–Fri., Oct. 22–25. Cosponsored by *GSA Sedimentary Geology Division*. Arvid K. Aase, Fossil Butte National Monument, PO Box 592, Kemmerer, WY 83101, (307) 877-4455, fax 307-877-4457, arvid_aase@nps.gov; Alan Carroll; H. Paul Buchheim. Max.: 42. Cost: $315. *Begins and ends in Salt Lake City, Utah.*

Middle and Late Jurassic Dinosaur Fossil-Bearing Horizons: Depositional Settings and Implications for Dinosaur Paleoecology, Northeastern Bighorn Basin, Wyoming

Wed.–Sat., Oct. 23–26. Erik P. Kvale, Dept. of Geological Sciences and Indiana Geological Survey, Indiana University, 611 N. Walnut Grove, Bloomington, IN 47405, (812) 855-1324, fax 812-855-7899, kvalee@indiana.edu; Debra Mickelson; Steve T. Hasiotis; Gary D. Johnson. Max.: 36. Cost: $590.

Cleanup at Summitville—The Superfund Mine Site That Changed Colorado

Thurs.–Sat., Oct. 24–26. Cosponsored by *GSA Hydrogeology Division*. D. Kirk Nordstrom, U.S. Geological Survey, 3215 Marine St., Suite E-127, Boulder, CO 80303-1066, (303) 541-3037, fax 303-447-2505, dkn@usgs.gov; Geoff Plumlee. Max.: 22. Cost: $280.

High Plains to Rio Grande Rift: Late Cenozoic Evolution of Central Colorado

Thurs.–Sat., Oct. 24–26. Cosponsored by *GSA Sedimentary Geology Division*. Eric Leonard, Dept. of Geology, Colorado College, Colorado Springs, CO 80903, (719) 389-6621, fax 719-389-6910, eleonard@coloradocollege.edu; Mary Hubbard; Emmett Evanoff; Shari Kelley; Christine Siddoway. Max.: 30. Cost: $225

Key Rocks and Seminal Thinkers: Classic Rocky Mountain Localities That Influenced Tectonic Thought

Thurs.–Sat., Oct. 24–26. Cosponsored by *GSA History of Geology Division*. A.M. Celâl Şengör, İTÜ Maden Fakültesi, Jeoloji Bölümü, Ayazaga, Istanbul 80626, Turkey, sengor@itu.edu.tr; Tim Lawton. Max.: 44. Cost: $220. *Begins in Salt Lake City, Utah, and ends in Denver.*

Active Incision-Driven Evaporite Tectonism, Glenwood Springs, Colorado

Fri. and Sat., Oct. 25–26. Bob Kirkham, Colorado Geological Survey, 5253 County Road, 1 South, Alamosa, CO 81101, (719) 587-0139, fax 719-587-2187, rmk@amigo.net; Bruce Bryant; Mark Hudson. Max.: 22. Cost: $160.

Formation, Reactivation, and Evolution of Proterozoic Shear Zones in the Colorado Rocky Mountains: From Continental Assembly to Intracontinental Orogeny

Fri. and Sat., Oct. 25–26. Colin A. Shaw, Dept. of Earth and Environmental Sciences, New Mexico Institute of Mining and Technology, Socorro, NM 87801, (505) 835-5657, fax 505-835-6436, colins@nmt.edu; Karl E. Karlstrom. Max.: 36. Cost: $185.

Neotectonics of the Rio Grande Rift in Colorado

Fri. and Sat., Oct. 25–26. Cosponsored by *GSA Quaternary Geology and Geomorphology Division and GSA Structural Geology and Tectonics Division*. Jim McCalpin, GEO-HAZ Consortium, PO Box 837, Crestone, CO 81131, (719) 256-5227, fax 719-256-5228, mccalpin@geohaz.com; Alan Nelson; Dean Ostenaa; Andrew Valdez. Max.: 45. Cost: $160.

Structure and Stratigraphy of the Southern Colorado Front Range–Cañon City Syncline, Colorado

Fri. and Sat., Oct. 25–26. Cosponsored by *GSA Sedimentary Geology Division*. Paul R. Krutak; P. Krutak Geoservices International, PO Box 369, 2118 Main Street, Rye, Colorado 81069-0369, phone and fax (719) 489-2282, pkrutakgeos@hotmail.com. Max.: 36. Cost: $160.

Borehole Image Logging in Geology and Hydrogeology

Sat., Oct. 26. Cosponsored by *GSA Hydrogeology Division*. John H. Williams, U.S. Geological Survey, 425 Jordan Road, Troy, NY 12180-8349, (518) 285-5670, fax 518-285-5601, jhwillia@usgs.gov; Roger Morin; Fred Paillet; John Stowell. Max.: 24. Cost: $95.

Debris Flows Along the I-70 Corridor, Floyd Hill to the Eisenhower Tunnel

Sat., Oct. 26. Jeff Coe, U.S. Geological Survey, Denver Federal Center, MS 966, Box 25046, Denver, CO 80225, (303) 273-8606, fax 303-273-8600, jcoe@usgs.gov; Jonathan Godt. Max.: 24. Cost: $85.

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

Sat., Oct. 26. Peter Birkeland, Dept. of Geological Sciences, University of Colorado, Boulder, CO 80309 (retired), birkelap@stripe.colorado.edu; Ralph Shroba; Ven Barclay; Parker Calkin; Edwin Larson; Mary McMillan. Max.: 20. Cost: $35. *Begins and ends in Boulder.*

Environmental and Engineering Geology of the I-70 Corridor Denver–Eisenhower Tunnel

Sat., Oct. 26. Cosponsored by *GSA Engineering Geology Division*. Ed Nuhfer, Dept. of Geology, Geography, and Environmental Science, University of Colorado at Denver, Campus Box 137, PO Box 173364, Denver, CO 80217-3364, (303) 556-4915, fax 303-556-6197, enuhfer@carbon.cudenver.edu; William Savage. Max.: 36. Cost: $65.

Geoarchaeology of South Park: A Prairie Ecosystem in the Rocky Mountains

Sat., Oct. 26. Cosponsored by *GSA Archaeological Geology Division.* Steve Holen, Curator of Archaeology, Denver Museum of Nature and Science, 2001 Colorado Blvd., Denver, CO 80205, (303) 370-8261, sholen@dmns.org; Tom Lincoln. Max.: 30. Cost: $70.

Geologic Reconnaissance of the Denver Front Range and Dinosaur Ridge

Sat., Oct. 26. Cosponsored by *GSA Geoscience Education Division.* Norb Cygan, Friends of Dinosaur Ridge, 16831 W. Alameda Parkway, Morrison, CO 80456, (303) 697-3466, fax 303-697-8911, NECYGAN@aol.com; Betty Rall; Duff Kerr; Pete Modreski; Susan Landon. Max.: 45. Cost: $70.

Laramide Structure and Synorogenic Sedimentation of the Colorado Front Range

Sat., Oct. 26. Cosponsored by *GSA Sedimentary Geology Division*. Edward J. (Ned) Sterne, Savant Resources, 730 17th Street, Suite 410, Denver, CO 80202, (303) 592-1905, ext. 103, fax 303-592-1909, nedsterne@savantresources.com; Robert G. (Bob) Raynolds; Christine Smith Siddoway. Max.: 36. Cost: $65.

Modern-Day Consequences of Historic Coal Mining in the Foothills and Boulder and Weld Counties, Colorado

Sat., Oct. 26. Cosponsored by *GSA Coal Geology Division.* 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; Celia Greenman, Nicole Koenig. Max.: 24. Cost: $80.

Tepee Buttes: Fossilized Methane-Seep Ecosystems

Sat., Oct. 26. Cosponsored by *GSA Geobiology and Geomicrobiology Division.* Russell S. Shapiro, Dept. of Geoscience, University of Nevada, Las Vegas, 4505 Maryland Parkway, Las Vegas, NV 89154-4010, (702) 895-1239, fax 702-895-4064, rshapiro@nevada.edu; Henry Fricke. Max.: 20. Cost: $105.

Half Day—During the Meeting

Tour of U.S. Geological Survey Mapping and Geologic Facilities, Denver Federal Center

Tues., Oct. 29, 12:30–5 p.m. Peter J. Modreski, U.S. Geological Survey, MS 915, Box 25046, Denver Federal Center, Denver, CO 80225-0046, (303) 236-5639, fax 303-236-5348, pmodreski@usgs.gov; Joseph J. Kerski. Max.: 24. Cost: $25.

Postmeeting

Permian-Triassic Depositional Systems, Paleogeography, Paleoclimate, and Hydrocarbon Resources in Canyonlands and Monument Valley, Utah

Thurs.–Mon., Oct. 31–Nov. 4. Cosponsored by *GSA Sedimentary Geology Division.* Jacqueline E. Huntoon, Dept. of Geological Engineering and Sciences, Michigan Technological University, Houghton, Michigan 49931, (906) 487-2412, fax 906-487-3371, jeh@mtu.edu; Russell F. Dubiel; John D. Stanesco; Debra Mickelson. Max.: 20. Cost: $695.

Approaches to Characterizing Complex Geology for Watershed Investigations in Fractured Crystalline Bedrock: The Idealized and the Reality

Thurs., Oct. 31. Jonathan Saul Caine, U.S. Geological Survey, PO Box 25046, MS 973, Denver, CO 80225-0046, (303) 236-1822, fax 303-236-3200, jscaine@usgs.gov; Clifford Bossong; Geoffrey Thyne. Max.: 30. Cost: $85.

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

Thurs., Oct. 31. 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, dmageol@msn.com; David C. Noe. Max.: 90. Cost: $65.

Field Trip to Glenwood Caverns–Fairy Cave, Glenwood Springs, Colorado: An Introduction to CO_2 and H_2S Speleogenesis

Thurs., Oct. 31. Cosponsored by *GSA Hydrogeology Division.* Fred G. Luiszer, Dept. of Geological Sciences, University of Colorado, Campus Box 399, Boulder, CO 80309-0399, (303) 492-5251, fax 303-492-2606, luiszer@spot.colorado.edu; Harvey DuChene. Max.: 45. Cost: $85.

Structural Geometry and Thermal History of Pseudotachylyte from the Homestake Shear Zone, Sawatch Range, Colorado

Thurs., Oct. 31. Cosponsored by *GSA Structural Geology and Tectonics Division.* Joseph L. Allen, Dept. of Physical Sciences, Concord College, Athens, WV 24712-1000, (304) 384-5238, fax 304-384-6225, allenj@concord.edu; Kieran D. O'Hara; David P. Moecher. Max.: 33. Cost: $75.

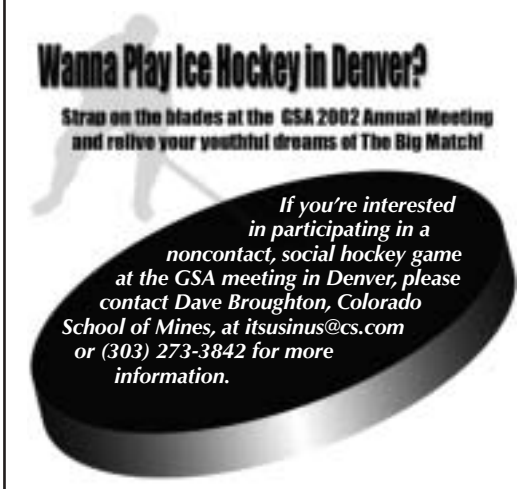
SEG Field Trips

Cripple Creek Gold Mining District

Fri., Oct. 25. Sponsored by *Society of Economic Geologists.* David Vardiman, AngloGold (Colorado) Corporation, PO Box 191, 100 N. 3rd Street, Victor, CO 80860, (719) 689-4019, fax 719-689-3254, dvardiman@anglogoldNA.com. Max.: 25. Cost: TBD.

Field Workshop: Interpretation of Leached Cappings and Evaluation of Copper Deposits for Solvent Extraction and Electrowinning Copper Production

Thurs.–Sat., Oct. 31–Nov. 2. Sponsored by *Society of Economic Geologists.* Richard L. Nielsen, Geocon, Inc., 13741 Braun Drive, Golden, CO 80401, (303) 279-3118, ringeocon@aol.com; John E. Dreier, 13790 Braun Road, Golden, CO 80401, (303) 278-0828, fax 303-278-0838, jedreier@worldnet.att.net. Max.: 20. Cost: $390 SEG members; $490 nonmembers; $195 SEG student members. *Begins and ends in Phoenix, Arizona.*



This hockey game will have an East vs. West "competitive" format and provide lots of fun and exercise. If we can generate enough interest, we will work out a suitable schedule and venue.

SHORT COURSES

GSA-Sponsored Short Courses

Preregistration deadline: September 20

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

Anisotropy of Magnetic Susceptibility and Applications to Granitic Rocks

Fri. and Sat., Oct. 25–26. Cosponsored by *GSA Structural Geology and Tectonics Division*. Eric C. Ferré, University of Wisconsin; Mike Jackson, University of Minnesota. Fee: $320; students $300. CEU: 1.6.

Managing Environmental Projects

Fri. and Sat., Oct. 25–26. Cosponsored by *GSA Engineering Geology Division*. Raymond C. Kimbrough, Tom Joiner & Associates, Inc., Tuscaloosa, Ala. Fee: $300; students $280. CEU: 1.6.

Abrupt Climate Changes

Sat., Oct. 26. Cosponsored by *GSA Quaternary Geology and Geomorphology Division*. Wallace S. Broecker, Lamont-Doherty Earth Observatory, Columbia University. Fee: $240; students $220. CEU: 0.8.

Estimating Rates of Groundwater Recharge

Sat., Oct. 26. Cosponsored by *GSA Hydrogeology Division*. Richard W. Healy, U.S. Geological Survey, Denver; Bridget R. Scanlon, Bureau of Economic Geology, University of Texas, Austin. Fee: $275; students $255. CEU: 0.8.

Laser Ablation ICP-MS: Fundamentals and Applications to Environmental and Biological Samples

Sat., Oct. 26. Cosponsored by *GSA Archaeological Geology Division*. Alan E. Koenig, Ian Ridley, U.S. Geological Survey, Denver. Fee: $275; students $255. CEU: 0.8.

Practical Methods in Applied Contaminant Geochemistry: From Characterization to Remediation

Sat., Oct. 26. Cosponsored by *GSA Hydrogeology Division*. Donald I. Siegel, Syracuse University. Fee: $250; students $230. CEU: 0.8.

Other Courses, Workshops, and Forums

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

Sequence Stratigraphy for Graduate Students

Fri. and Sat., Oct. 25–26. Free short course for graduate students. Cosponsored by *British Petroleum (BP)* and *ExxonMobil*. Instructors: Art Donovan (BP); Morgan Sullivan (ExxonMobil); Kirt Campion (ExxonMobil). Information: Morgan Sullivan, morgan.d.sullivan@exxonmobil.com.

Phosphates: Geochemical, Geobiological, and Materials Importance

Fri.–Sun., Oct. 25–27. Holiday Inn, Golden, Colo. Sponsored by *Mineralogical Society of America*. Organizers: John M. Hughes; Matthew Kohn; John Rakovan. Information: MSA Business Office, 1015 18th St. NW, Suite 601,Washington, D.C. 20036-5212, (202) 775-4344, fax 202-775-0018, business@minsocam.org, www.minsocam.org.

The Fossil Record of Predation

Sat., Oct. 26. Sponsored by the *Paleontological Society*. Information: Michal Kowalewski, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, 4044 Derring Hall, Blacksburg, VA 24061, (540) 231-6521, fax 540-231-3386, michalk@vt.edu.

Technical Writing for Results

Sat., Oct. 26. Sponsored by *National Ground Water Association*. Information: NGWA, 601 Dempsey Road, Westerville, OH 43081, (800) 551-7379, fax 614-898-7786, www.ngwa.org.

Job Hunting and Career Development Workshop

Sun., Oct. 27, 1–3 p.m. Sponsored by *Association for Women Geoscientists*. Information: Pranoti M. Asher, Dept. of Geology and Geography, Herty Building, Room 1100, Georgia Southern University, Statesboro, GA 30460-8149, (912) 681-0338, fax 912-681-0668, pasher@gasou.edu.

Digital Forum

Tues., Oct. 29. Sponsored by *Geoscience Information Society*. Information: Adonna Fleming, James A. Michener Library, University of Northern Colorado, Greeley, CO 80639, (970) 351-1530, fax 970-351-2963, acflemi@unco.edu.

IEE Workshop:

Rational Science for Rational Policy: Geology in Service of Society Through Communications with Government and Media

Mon., Oct. 28. Sponsored by *Institute for Earth Science and the Environment (IEE)*. Instructors: Lee C. Gerhard, Kansas Geological Survey, University of Kansas, Lawrence, KS 66047-3726, (785) 864-3965, lgerhard@kgs.ukans.edu; Victor J. Yannacone, (516) 758-9468, v.yannacone@abanet.org. More information will appear in the June issue of *GSA Today*.

International Ground-Water Modeling Center
Colorado School of Mines
Golden, Colorado, 80401-1887, USA
Telephone: (303) 273-3103 / Fax: (303) 384-2037
Email: igwmc@mines.edu

igwmc

International Ground-Water Modeling Center

2002 Short Course Schedule

Plan to Learn More Modeling Skills During Your GSA Trip

PRACTICAL SIMULATION OF VARIABLE-DENSITY FLOW, SOLUTE TRANSPORT, AND SEAWATER INTRUSION

October 21 - 25, 2002
Instructors : Dr. Clifford I. Voss and Dr. Craig T. Simmons

The aim of this course is to familiarize attendees with:1) the basics of solute transport processes for both constant and variable-density flow, 2) numerical aspects of simulating constant and variable-density flow with solute transport, 3) setting up, running, post-processing and evaluating flow and transport models, and 4) practical aspects of transport modeling and case studies. Attendees will learn to run a variable-density flow and solute transport simulator (U.S. Geological Survey's SUTRA code) using a graphical interface.

MODFLOW: INTRODUCTION TO NUMERICAL MODELING

October 23 - 26, 2002
Instructor : Eileen Poeter

This course is designed for the hydrogeologist and environmental engineer familiar with ground-water flow concepts, but who have limited or no experience with ground-water flow modeling. Basic modeling concepts: conceptual model development, definition of boundary and initial conditions, parameter specification, finite-differencing, gridding, time stepping, and solution control using MODFLOW-2000 and UCODE. Basic modules of MODFLOW are explained and concepts are reinforced with hands-on exercises. Calibration is presented via the public domain universal inversion code, UCODE.

UCODE: UNIVERSAL INVERSION CODE FOR AUTOMATED CALIBRATION

October 25 - 26, 2002
Instructor : Eileen Poeter

If you have a working knowledge of ground-water flow modeling and some knowledge of basic statistics, you will benefit the most from this short course. This course introduces to ground-water professionals to inverse modeling concepts and their use via UCODE, relying heavily on hands-on exercises for automatic calibration of ground-water models to promote understanding of UCODE and avoid "black-boxing."

FOR INFORMATION CALL (303) 273-3103
FOR REGISTRATION CALL (303) 273-3321
VISIT http://www.mines.edu/research/igwmc/short-course/

KARST HYDROLOGY JUNE 17-22, 2002

This is the 23rd 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 and Nicholas C. Crawford

Offered by the
Center for Cave and Karst Studies
Applied Science and Technology
Program of Distinction
Western Kentucky University

Additional Courses Offered:

Karst Geomorphology . . . . . June 9–15
Exploration of Mammoth Cave . . . June 9–15
Management of Aquifers . . . . . June 10–12
(San Antonio, TX)
Speleology . . . . . June 16–22
Cave Survey/Cartography . . . . . June 16–22

For more information, contact:
Center for Cave and Karst Studies
phone 270-745-3252
caveandkarst@wku.edu

About the Author

A GSA member, the author found fame when she took advantage of the GSA Bookstore's Members' Corner Book Display. Her book gained national exposure at GSA meetings held around the country. The author now splits her time between Menlo Park, California, and West Bay, Grand Cayman.

For information on the Members' Corner, contact Ann Crawford, 1-800-472-1988, ext. 1053, acrawford@geosociety.org. Books must be of direct relevance to the earth sciences. Selection of materials will be at the discretion of the GSA director of publications.

ANNOUNCEMENTS

MEETINGS CALENDAR

2002

September 9–11	Natural and Cultural Landscapes: The Geological Foundation, Dublin, Ireland. Information: landscapes@ria.ie, the Royal Irish Academy, the Geological Survey of Ireland, the Geological Survey of Northern Ireland.
September 23–25	Tectonics of Eastern Turkey and Northern Arabian Plate, Erzurum, Eastern Turkey. Information: Niyazi Turkelli, Bogazici University, turkelli@boun.edu.tr, 90-216-308-2711, fax 90-216-332-2681; or Muawia Barazangi, Cornell University, barazangi@geology.geo.cornell.edu. *(Registration and abstract submission deadline: June 1, 2002.)*
October 11–13	Binghamton International Geomorphology Symposium 2002—Dams and Geomorphology, Bloomsburg, Pennsylvania, USA. Information: Patricia J. Beyer, Dept. of Geography & Geosciences, Bloomsburg University, 400 E. Second Street, Bloomsburg, PA 17815, (570) 389-4108, pbeyer@bloomu.edu, http://planetx.bloomu.edu/~geog/binghamton2002.
October 21–24	The Annual Conference on Contaminated Soils, Sediments and Water, Amherst, Massachusetts, USA. Information: Denise Leonard, (413) 545-1239, info@UMassSoils.com.

2003

January 6–10	10th International Symposium on Deep Seismic Profiling of Continents and their Margins, Taupo, New Zealand. Information: F. Davey, Institute of Geological & Nuclear Sciences, New Zealand, +64-4-570-1444, fax:+64-4-570-4600, seismix2003@gns.cri.nz, www.gns.cri.nz/news/conferences/seismix2003/.
January 20–23	International Conference on Soil and Groundwater Contamination and Cleanup in Arid Countries, Muscat, Sultanate of Oman. Information: Anvar Kacimov, Department of Soil & Water Sciences, SQU, PO Box 34 Al-Khod 123, Sultanate of Oman, (968) 515-223, fax 968-513-418, anvar@squ.edu.om, www.squ.edu.om.
August 10–14	Geoscied IV: Earth Science for the Global Community, Calgary, Alberta, Canada. Information: www.geoscied.org.
August 24–27	International Symposium on Hydrometallurgy in Honor of Professor Ian Ritchie, Vancouver, British Columbia, Canada. Information: The Minerals, Metals and Materials Society, (724) 776-9000, or Courtney Young, cyoung@mtech.edu, (406) 496-4158, fax 406-496-4133, Department of Metallurgical Engineering, Montana Tech, Butte, MT 59701, http://cms.tms.org. *(Abstracts deadline: October 1, 2002.)*

Volunteer Geologists Needed for Philmont Scout Ranch

Geology volunteers spend one or two weeks in the backcountry at the famous Philmont Scout Ranch south of Cimarron, New Mexico. Stay at an old mining camp in the southern Sangre de Cristo Mountains and talk about geology to the backpackers. Spouses welcome (sorry, no children). Contact Ed Warner at (720) 904-0560 or ewarn@ix.netcom.com.

In Memoriam

Robert B. Forbes
Kingston, Washington
December 1, 2001

Frank D. Gorham Jr.
Albuquerque, New Mexico
September 11, 2001

Ronald W. Stanton
Reston, Virginia

Daniel S. Turner
Littleton, Colorado
December 21, 2001

DeWitt C. Van Siclen
Houston, Texas
September 25, 2001

David J. Varnes
Lakewood, Colorado
February 3, 2001

Please contact the GSA Foundation for information on contributing to the Memorial Fund.

GeoVentures

GeoTrips

Iceland: Fire and Ice

August 1–15, 2002

Scientific leader: Haraldur Sigurdsson, Graduate School of Oceanography, University of Rhode Island. **Guest Lecturer:** Haukur Johannesson, Natural History Institute, Reykjavík, Iceland.

Description: This trip will reveal many unaltered and fresh geologic features that can be seen nowhere else on land. Expect to acquire an expanded understanding of volcanoes, hotspots, and rifts. View steep-walled and flat-topped hyaloclastite ridges derived from subglacial eruption, young hyaloclastite islands produced by submarine eruptions, great explosion craters, tephra cones, calderas, blocky obsidian flows, waterfalls descending into the rift valley and, of course, extraordinary glacial panoramas.

Fees and Payment: $3,400 for GSA members; $3,500 for nonmembers. A $400 deposit is due with your reservation and is refundable (less $100) through May 15. Fee is based on double occupancy. The single supplement, based on availability, is an additional $486. Total balance is due May 15. Min.: 20; max.: 40. Included: Classroom programs and materials; field trip transportation, lodging, all meals, guidebook and map. Not included: Airfare to and from Reykjavík, alcoholic beverages, and other expenses not specifically included.

Iceland: A Student Only–Oriented GeoTrip

August 1–15, 2002

Scientific leader: James Reynolds, Brevard College, Brevard, North Carolina.

Description: Designed for students *only*, this trip will visit classical geological localities of Iceland on a low-frills budget. Participants will camp and prepare meals in a group kitchen tent. Eighty kilometers of hikes will take us through spectacular volcanic and glacial scenery. The trip begins in Baltimore and will fly to Reykjavík to make a 12-day loop around the country.

Fees and Payment: $2,700 for GSA student members; $2,800 for nonmembers. A $200 deposit is due with your reservation and is refundable (less $100) through May 15. Total balance is due May 15. Min: 20; max: 35. Included: Roundtrip airfare to Reykjavík from Baltimore (currently the gateway city), classroom programs and materials, field trip transportation, lodging, all meals, guidebook and map. Not included: Airfare to and from Baltimore, camping equipment (tent and sleeping bag), alcoholic beverages, and other expenses not specifically included.

REGISTER TODAY!

Send a deposit to hold your reservation; please pay by check or credit card. You will receive further information and a confirmation of your registration within two weeks after your reservation is received.

Name

Institution/Employer

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Workshop on the Tectonics of Eastern Turkey and Northern Arabian Plate Erzurum (Eastern Turkey) September 23–25, 2002

In order to better understand the mechanism for continent-continent collision we are convening a focused international workshop that would allow earth scientists with a wide variety of expertise to address some of the key geodynamic questions concerning the collision of the Arabian and Eurasian plates. Continent-continent collision processes play a critical role in the development and growth of the continents and interdisciplinary collaboration is needed to elucidate the processes involved in the evolution of the Anatolian Plateau in Eastern Turkey. In particular, results will be reported on the structure of the crust, lithosphere, and upper mantle based on the two-year PASSCAL Eastern Turkey Seismic Experiment (ETSE). ETSE is a joint collaborative effort of scientists from Bogazici (Istanbul) and Cornell Universities.

Scientific results will be presented by several invited speakers as well as by contributed oral and poster papers. Enough time will also be spent in a workshop format discussion.

The registration and abstract submission deadline is June 1, 2002.

Requests for information should be directed to:

Prof. Niyazi Turkelli (Bogazici University)
e-mail: turkelli@boun.edu.tr
fax: (90) (216) 332-268
tel: (90) (216) 308-2711 (office)
(90) (532) 440-8185 (cell)

or you may contact
Prof. Muawia Barazangi at Cornell University
barazangi@geology.cornell.edu

PENROSE CONFERENCE SCHEDULED

Precambrian High-Pressure–High-Temperature Metamorphism: A Key to Understanding the Lower Crust and Reconstruction of Precambrian Plate Tectonics

September 23–29, 2002
Hengshan-Wutaishan and Beijing, China

Conveners:

M. Brown, *Department of Geology, University of Maryland, College Park, MD 20742, USA, (301) 405-4080, fax 301-314-7970, mbrown@geol.umd.edu*

A. Kröner, *Institut für Geowissenschaften, Universität Mainz, D-55099 Mainz, Germany, kroener@mail.uni-mainz.de*

P.J. O'Brien, *Universität Potsdam, Institut für Geowissenschaften, Postfach 60 15 53, 14415 Potsdam, Germany, obrien@geo.uni-potsdam.de*

C.W. Passchier*, Institut für Geowissenschaften, Universität Mainz, D-55099 Mainz, Germany, cpasschi@mail.uni-mainz.de*

Li Jianghai, *Department of Geology, Peking University, Beijing 100871, People's Republic of China, jhli@geoms.geo.pku.edu.cn*

Zhai Mingguo, *Department of Geology & Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, People's Republic of China, mgzhai@mail.igcas.ac.cn*

The major goal of this conference is to discuss new approaches to Precambrian plate tectonics in light of recent discoveries of high-pressure–high-temperature metamorphism in Proterozoic rocks from the Canadian Shield, the North China Craton, Tanzania, southern India, Brazil, Siberia, and the Baltic Shield. These rocks record evidence of metamorphic pressures of 1.7–1.0 GPa with characteristic near-isothermal decompression pressure-temperature paths. The metamorphic and structural evolution of these rocks, their tectonic setting, and the mechanism of their exhumation are topics of international interest. Furthermore, the preservation of lower crustal sections composed of high-grade gneisses and time-equivalent upper crustal sections exposing greenstone belts makes it possible to study the relationships between them in the same crustal section, potentially to advance our understanding of continental crust formation and evolution. One area where such examples are exposed is the Hengshan-Wutaishan area of Northern China. The first part of this conference will be devoted to a field trip to the Hengshan-Wutaishan area that will provide a template within which to focus on the evidence for plate tectonics in the Precambrian during the discussions in Beijing.

Outcrop, Heng Mountains. Photo courtesy of A. Kröner.

The Heng Mountains in northern Shanxi Province, about 250 km west-southwest of Beijing, form part of the North China Craton and consist of ductilely deformed Late Archean to early Paleoproterozoic (ca. 2700–2100 Ma) orthogneisses and minor paragneisses intruded by numerous mafic dykes of gabbroic composition. The strongly deformed and boudinaged mafic rocks, which commonly preserve primary igneous textures, underwent high-pressure granulite metamorphism (Grt-Cpx-Pl-Qtz-Rt) at 850–900 °C and about 14 kbar, suggesting that the entire Hengshan metamorphic assemblage experienced high-pressure conditions equivalent to crustal depths of about 50 km. The Hengshan metamorphic assemblage is adjacent to the low-grade Late Archean Wutai greenstone belt that consists of ca. 2.5 Ga bimodal volcanic rocks and metasediments of arc affinity associated with coeval granitoids. The Hengshan metamorphic assemblage may be the lower, plutonic part of a Late Archean to Early Paleoproterozoic magmatic arc, the upper volcanic part of which is represented by the adjacent Wutai greenstone belt. Virtually all the magmatic events recorded in the Hengshan metamorphic assemblage also are identified in the Wutai greenstone belt.

The general themes of the conference are: (1) Precambrian high-pressure–high-temperature eclogite- and granulite-facies rocks and their evolution, and tectonic implications for plate tectonic processes; and (2) the structural relationship between high-grade lower crustal domains and low-grade upper crustal domains, including the geometry and evolution of major ductile shear zones and thrust belts. Key speakers from the fields of metamorphic petrology, tectonics, and geodynamic modeling will address these themes in an interdisciplinary manner. Other contributions will address specific regional examples, where many of the details of the field relationships provide primary information and important constraints. All participants are encouraged to bring poster presentations, from which additional oral presentations will be selected. It is anticipated that about a third of the time in Beijing will be devoted to oral presentations, about a third of the time to discussion, and about a third of the time to viewing the posters.

The conference is limited to 80 participants. We encourage interested graduate students to apply. The registration fee, which will cover lodging, meals, field trips, and all other conference costs except personal incidentals, is likely to be US$400 (US$300 for students). Participants will be responsible for their own travel to and from Beijing.

Application Deadline:
June 1, 2002

Geologists and petrologists with an interest in Precambrian high-grade gneiss terrains and greenstone belts are encouraged to apply. Potential participants should send a letter of application to Alfred Kröner or Mingguo Zhai (addresses above), including a brief statement of interests, the relevance of the applicant's recent work to the themes of the meeting, the subject of any proposed presentation (verbal or poster), and contact information (particularly e-mail address for the period June–September 2002). We expect to attract a diverse group of field geologists, metamorphic petrologists, tectonicians, and modelers. Invitations will be e-mailed to participants by mid-June 2002.

Cosponsors: National Science Foundation of China, Beijing, China; Chinese Academy of Sciences, Beijing, China; and Peking University, Beijing, China.

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Positions Open

ENVIRONMENTAL STUDIES, PRESCOTT COLLEGE

The Environmental Studies Program of Prescott College seeks applicants for a one-year, non–tenure track position teaching a variety of earth science courses at the undergraduate level. Prescott College is a liberal arts college that emphasizes high-quality experiential education. Instructors are encouraged to develop field-oriented courses and employ innovative teaching methods that stimulate enthusiasm for earth science among a non-specialist student population. The term of appointment begins in August 2002 and concludes in May 2003. The successful applicant will teach six courses, including Introduction to Earth Science, Geomorphology, Geologic Evolution of the Southwest (a course in Historical Geology), Environmental Geology, and two other courses to be negotiated with the department chair. The ability to teach Oceanography and Introductory Physics courses is considered an advantage. Submit: Resume/vitae, cover letter, a statement of educational philosophy, unofficial transcripts, the names and contact information for three professional references, and the Prescott College Application (www.prescott.edu/hr) to Human Resources, Prescott College, 220 Grove Ave., Prescott, AZ 86301. EOE.

ASSISTANT PROGRAM DIRECTOR
JOINT OCEANOGRAPHIC INSTITUTIONS, INC. (JOI)

Seeking candidates for position of Assistant Program Director to help run the Ocean Drilling Program (ODP) and U.S. Science Support Program (USSSP), and to participate on a JOI team that will respond to National Science Foundation (NSF) program management solicitations associated with the incipient Integrated Ocean Drilling Program (IODP, see www.iodp.org).

Duties include assisting the Program Directors of USSSP and ODP in planning, coordinating, and managing program activities; preparing reports and publications; implementing new/revised policies; developing technical, fiscal, and administrative approaches to improve management of the programs; interacting with subcontractors; representing JOI within the scientific community; providing expert scientific and technical knowledge; and fostering communication/team work among program participants.

Incumbent will also assist in the preparation of JOI's response to anticipated NSF solicitations that seek U.S. management entity to: (1) provide a riserless drilling vessel to the international IODP, which is slated to begin October 1, 2003; and (2) administer a USSSP-successor program to support the participation of U.S. scientists in the IODP.

Applicants must possess a Ph.D. or equivalent experience in geosciences or oceanography. Three or more years of research, administration, and/or managerial experience are desirable, as is familiarity with the ODP and USSSP. The position requires excellent coordination and communication skills and requires travel. Salary is commensurate with experience. Generous benefits package.

Submit a curriculum vitae and contact information for three references to Director, Contracts & Administration, JOI, 1755 Massachusetts Ave. NW, Suite 700, Washington D.C. 20036-2102. Additional information is available at www.joiscience.org. Review of applications will begin May 1, 2002, and continue until position is filled. EOE/ MF/DV.

LEAVITT FELLOWSHIP IN GEOSCIENCES AT MIT

The William Z. Leavitt Career Development Postdoctoral Fellowship Fund was established to provide a postdoctoral fellowship for the most talented young scientists in geosciences. Individuals holding the Ph.D. degree in any area of geoscience will be eligible to receive support from the fund. The one-year fellowship is extendible for a second year. The intent of this fellowship is to provide a young scientist of outstanding ability with the opportunity to work in an independent and creative mode on projects of their choosing in a collaborative and supportive environment. MIT is committed to diversity and particularly encourages applications from qualified women and minorities.

Please forward a resume and brief statement of research interests to the attention of Professor Ronald G. Prinn, Head, Department of Earth, Atmospheric and Planetary Sciences, ATTN: Leavitt Fellowship, Massachusetts Institute of Technology, 54-918, 77 Massachusetts Avenue, Cambridge MA 02139-4307.

MIT is an Equal Opportunity/Affirmative Action Employer MIT is a non-smoking environment.

EXECUTIVE DIRECTOR—CUAHSI

The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI), a 50-member university consortium, seeks an Executive Director, who shall serve as its chief operating officer. CUAHSI is in its first year of its existence, and it has a planning grant from the National Science Foundation to develop a science plan that would serve as the basis for programs of infrastructure for the facilitation of research and education across the broad spectrum of hydrologic sciences. The CUAHSI Board of Directors has established several committees that are actively developing material to include in the science plan. The Executive Director will be expected to take the lead in finalizing the plan and bringing it to reality through development of funding proposals to NSF and through negotiating cooperative agreements with Federal Agencies and other complementary entities. The Executive Director also will be responsible for the development of a professional support staff that will be located in Washington, D.C.

The CUAHSI Program. CUAHSI has been working with the hydrologic community and related scientists to explore what missing components of infrastructure could be made available through focused, science-driven programs to facilitate research and education in the hydrologic sciences. To date, five component programs have been identified and standing committees established to address each. These are: (1) measurement technology, (2) information systems, (3) hydrologic observatories, (4) education and outreach, and (5) research applications. A standing committee on hydrologic science also has been established to elucidate the science issues that will serve as the drivers for the operational program elements. For additional information about CUAHSI, please see our Web site, www.cuahsi.org.

Qualifications. The Executive Director of CUAHSI must be a recognized scientist with administrative capability. A Ph.D. and a proven record of research and of supervision of complex research projects of medium to large size in the hydrologic sciences are required. Salary will be commensurate with qualifications and experience. Appointment will be for an initial period of two years, but could evolve into a career opportunity. However, university faculty members are encouraged to consider this position for temporary assignment in the Washington, D.C., area. The position of Executive Director will be filled at the earliest possible convenience of the chosen candidate. The Search Committee will begin evaluating applications on 3 May 2002. Applicants should send their curriculum vitae and the names and addresses of three references to: Prof. Stephen J. Burges, Chair, CUAHSI Search Committee, Box 352700, University of Washington, Seattle, WA 98195-2700.

CUAHSI is an equal opportunity employer.

TENURE-TRACK POSITION
IN ENVIRONMENTAL CHEMISTRY
ARKANSAS STATE UNIVERSITY

The Department of Chemistry and Physics at Arkansas State University invites applications for a tenure-track position in Chemistry at the rank of Assistant or Associate Professor to begin August 2002. The position requires an earned doctoral degree in any sub-discipline of chemistry and relevant research or experience with chemistry of the environment. We seek enthusiastic candidates with a commitment to quality instruction, active research involving graduate and undergraduate students, and who will contribute significantly to a multidisciplinary environmental sciences Ph.D. program. Further information about the program can be found at http://www.cas.astate.edu/evs.

Dr. Robyn Hannigan, the Chair of the Search Committee, will accept your letter of application, curriculum vitae, a statement on research goals related to environmental science, and contact information for at least three references. Send application materials to Department of Chemistry and Physics, PO Box 419, Arkansas State University, State University, AR 72467. Review of applications will begin immediately and continue until the position is filled. http://chemistryandphysics.astate.edu/envchem.htm. AA/EOE.

INSTRUCTOR (M.S. LEVEL) IN GEOLOGY
UNIVERSITY OF SOUTHERN INDIANA

The Department of Geology at the University of Southern Indiana invites applications for a full-time position at the Geology Instructor level, beginning August 2002 and renewable on a yearly basis. The Department seeks a creative and energetic geologist in any area of geology. The successful applicant will teach and develop introductory laboratory sessions (including field experiences) at the undergraduate level, conduct an evening lecture in Physical Geology, and will maintain and enhance the department's growing equipment and teaching collections. A master's degree in geology is required. The University is committed to excellence in teaching, scholarship and professional activity, and service to the University and community. Minorities and women are encouraged to apply. Please submit a letter of application, and include a brief statement of teaching experience and scholarly interests, a resume, and name/address and phone/e-mail of three references for review beginning April 10, 2002, to: Dr. Paul K. Doss, Chair, Department of Geology and Physics, University of Southern Indiana, 8600 University Blvd., Evansville, IN 47712. Additional information may be obtained from http://www.usi.edu/science/geology/index.asp.

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VISITING ASSISTANT PROFESSOR
DENISON UNIVERSITY

The Department of Geology and Geography invites applications for a one-year sabbatical-replacement position to begin in the fall semester of 2002. A Ph.D. in geology is desired but qualified ABD candidates will be considered. Teaching responsibilities include introductory physical geology, environmental geology, and possibly a more advanced course in one's area of specialization. Denison is a selective liberal arts college strongly committed to and supportive of excellence in teaching and active faculty research that involves undergraduate students. Our department stresses a balance of classroom, field, and laboratory experiences for our students, and we seek a colleague who will contribute to and collaborate with us on all these components of undergraduate geoscience education. For information about our program, visit http://www.denison.edu/geology/.

Candidates should submit a letter of application, including a discussion of their approach to teaching in a liberal arts setting, along with a curriculum vitae, academic transcripts, and the names, addresses, e-mail addresses, and phone numbers of three references to: Tod Frolking, Chair, Department of Geology and Geography, Denison University, Granville, OH 43023. E-mail: Frolking@denison.edu. Review of applications begins 20 March 2002 and will continue until the position is filled.

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U.S. GEOLOGICAL SURVEY
WESTERN REGION
COASTAL AND MARINE GEOLOGY TEAM
CHIEF SCIENTIST

The U.S. Geological Survey (USGS) invites applications for a full-time permanent position located in Santa Cruz, California. The successful candidate will serve a time-limited (maximum 5 years) rotational management assignment as Chief Scientist of its Coastal and Marine Geology Team in the Western Region (http://walrus.wr.usgs.gov/). Following the rotational assignment the incumbent will be reassigned to management or research position at an equivalent grade. Starting salary is $98,303 to $127,798 commensurate with experience.

The USGS seeks an established scientist of national reputation with demonstrated ability to develop, lead, and administrate a coastal and marine research center. The Coastal and Marine Geology Team conducts a spectrum research to develop scientific understanding of coastal and marine geologic systems of interest to the nation as they affect the health, safety and welfare of the public. The Team consists of 120 to 150 researchers and science support staff located in Santa Cruz and Menlo Park, California.

Ph.D. or equivalent experience is required. Candidates need a strong background in coastal and marine geologic research, including demonstrated research achievements. Candidates also need the ability to lead, develop, and manage an internationally recognized coastal and marine science center.

For detailed vacancy announcement, including specific qualification requirements and application procedures for

(continued on p. 46)

Canada Research Chair

University of Saskatchewan
Environmental Earth Sciences - Synchrotron Radiation

An outstanding individual is required to establish research excellence in the application of synchrotron radiation in the area of environmental earth sciences at the University of Saskatchewan. He/she will have access to the new Canadian Light Source (CLS), a 3rd generation synchrotron facility scheduled to begin operation in early 2004. The CLS is located on the University of Saskatchewan campus a short walk from the Department of Geological Sciences. A technical description of the facility and beamlines under construction can be found at www.cls.usask.ca/research/beamline.shtml

The University invites applications from outstanding individuals to be nominated for either a Tier One or Tier Two Canada Research Chair (www.chairs.gc.ca). The successful candidate will also hold a tenurable faculty appointment in the Department of Geological Sciences. The Department has 15 full-time faculty, including two endowed research chairs in geochemistry. The analytical infrastructure in the Department is one of the finest in North America, with MC-ICP-MS, laser ablation quadrupole ICP-MS, TIMS, IRMS, electron microprobe, SEM, XRD, and trace-metal clean room (www.usask.ca/geology/).

The University of Saskatchewan is a publicly funded institution, established in 1907. It has over 19,000 degree students, 4,500 employees, an operating budget of approximately $200 million and receives research funds in excess of $100 million. It offers a full range of programs, both academic and professional, in thirteen colleges, including a full range of health sciences. The City of Saskatoon, with a population of about 210,000, offers an abundance of parks, recreational and cultural facilities on the banks of the South Saskatchewan River and is in close proximity to pristine lakes, forests, and a national park.

This position has been cleared for advertising at the two-tiered level. Applications are invited from qualified individuals regardless of their immigration status in Canada. The University of Saskatchewan is committed to Employment Equity. Members of designated groups (women, Aboriginal people, people with disabilities, and visible minorities) are encouraged to self-identify on their applications.

We will begin reviewing applications on March 31, 2002 and continue until a suitable candidate is found.

For additional information, please contact:

Dr. Jim Basinger, Head
Department of Geological Sciences
University of Saskatchewan
114 Science Place, Rm 114 Geology
SASKATOON SK S7N 5E2 CANADA
Ph: (306) 966-5684, Fax: (306) 966-8593
Email: jim.basinger@usask.ca

(continued from p. 44)

Chief Scientist, Coastal and Marine Geology Team go to:
Refer to Vacancy Announcement USGS–W-02-077 at: http://www.usajobs.opm.gov/wfjic/jobs/IB2382.HTM
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Deadline for applications: May 6, 2002. The USGS is an Equal Opportunity Employer.

POSTDOCTORAL POSITION IN SAR REMOTE SENSING IDAHO STATE UNIVERSITY

The Department of Geosciences at Idaho State University (http://www.isu.edu/geology/) seeks outstanding candidates for a NASA-funded Postdoctoral Research Associate. The Postdoctoral Associate will conduct research in synthetic aperture radar remote sensing, for application to volcanology, crustal dynamics, and geomorphology. The project will combine SAR and InSAR techniques with ground-based geoscience studies to evaluate interrelated regional processes, at a variety of temporal and spatial scales, in Idaho and the Intermountain West.

Applicants must have a Ph.D. in geology or a closely related field, experience in SAR remote sensing, and the ability to perform effective research in a team. Good oral and communication skills, strong computer skills, and a willingness to teach a remote sensing course are essential. The anticipated duration of the position is 3 years, depending upon funding and performance. To apply, send a vita, a cover letter outlining research interests and experience, and the names of three references to: Department of Geosciences, Postdoctoral Associate Search, Campus Box 8072, Idaho State University, Pocatello, Idaho, 83209-8072. E-mail contact: glennanc@isu.edu. Review of applications will begin April 15, 2002, and continue until the position is filled. Idaho State University is an equal opportunity employer.

GEOBIOLOGY FACULTY POSITION, MIT

The Department of Earth, Atmospheric, and Planetary Sciences at MIT invites qualified candidates to apply for a new faculty position in Geobiology. We particularly encourage creative and dynamic early career scientists to apply at the Assistant Professor level. However, appointment at a higher rank may be considered for an exceptional candidate. We are particularly interested in individuals who study the microbiological mediation of processes at the interfaces between the solid and fluid earth, ecosystem-climate interactions, the molecular biology of geologically significant microbes and the co-evolution of life and earth's surface environment. The Department of Earth, Atmospheric, and Planetary Sciences at MIT has a very broad program in all aspects of earth sciences including geology, geophysics, geochemistry, planetary science and ocean-atmosphere dynamics. We seek candidates with broad interests and the capacity to inspire and engage in multidisciplinary research. Interest and commitment to teaching at the undergraduate and graduate are essential at MIT.

Interested scientists should send a curriculum vitae, a one page description of research plans, and arrange for three letters of professional reference to: Prof. Ronald G. Prinn, Department Head, Attention Geobiology Search, Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Bldg. 54-918, 77 Massachusetts Avenue, Cambridge, MA 02139-4307. E-mail: rgp@mit.edu; fax: (617) 253-8298. MIT is an Equal Opportunity/ Affirmative Action Employer.

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Opportunities for Students

Research and Teaching Assistantships Available for Fall Semester 2002 at Temple University: Research and Teaching Assistantships are available for the fall term (September 2002) in our Masters Program in Geology at Temple University. The 2-year Masters Program offers advanced courses and thesis research opportunities in environmental geology, hydrogeology, geochemistry, environmental geophysics, cyclic stratigraphy, soil science/paleosols, K/T boundary studies, and materials science. Financial support for every student includes stipend, book allowance and full tuition for 2 years. Research Assistantships and/or summer support are available for studies in karst hydrology and volcanology monitoring. Graduates of our program have an excellent record of employment and acceptance into doctoral programs. For information and applications please write, call or e-mail Edwin J. Anderson, Department of Geology, Temple University, Philadelphia, PA 19122 (tel. (215) 204-8249, fax (215) 204-3496, e-mail andy@astro.temple.edu). Applications will be accepted until these positions are filled. Please visit our Web site at http://www.temple.edu/geology for additional information.

Graduate Research Assistantships in Geology and Remote Sensing. The Department of Geosciences at Idaho State University (http://www.isu.edu/geology/) invites potential M.S. students to apply for graduate research assistantships in the area of geology and remote sensing. Assistantships may also be available to geoscience students who apply for the Ph.D. program in Engineering and Applied Science. Students will conduct research in synthetic aperture radar remote sensing, for application to volcanology, crustal dynamics, and/or geomorphology. The project will combine SAR and InSAR techniques with ground-based geoscience studies to evaluate interrelated regional processes, at a variety of temporal and spatial scales, in Idaho and the Intermountain West. Students will work with faculty, post-doctoral researchers, and other students with interdisciplinary interests.

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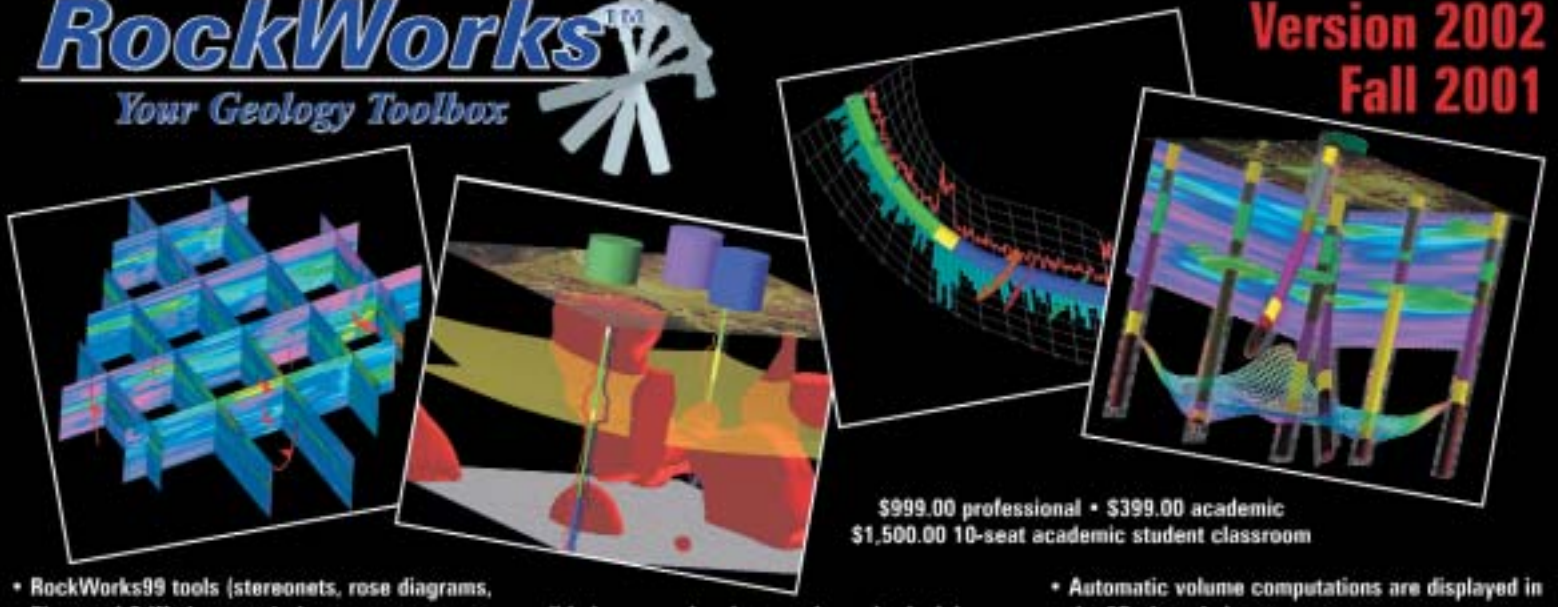

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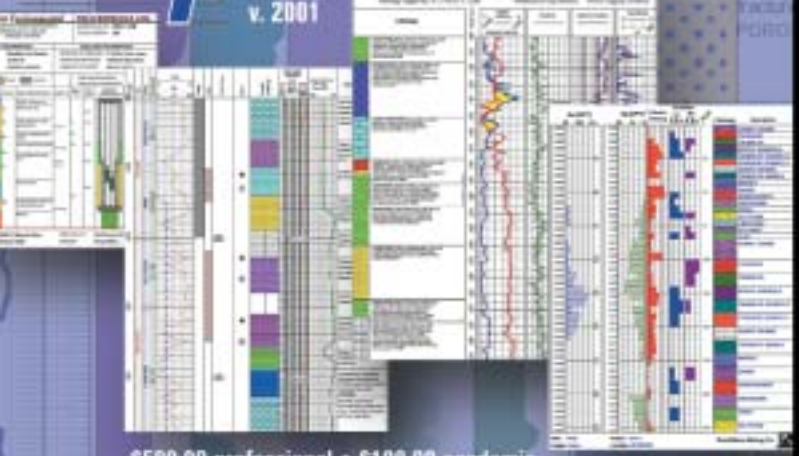

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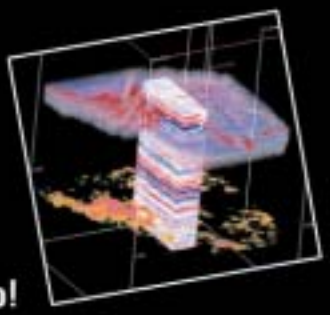
- Easy to use Horizon and Fault interpretation tools
- Volume Flattening and Horizon Sculpting provide valuable Stratigraphic analysis



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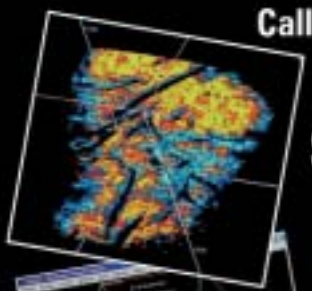

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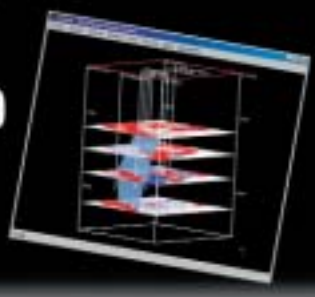

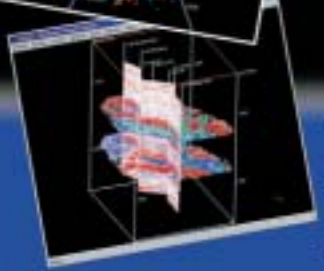

- Multiple Volume loading provides a means for 4D Seismic and AVO analysis
- 8 ways to view your seismic including transparency and "Quickview" capabilities
- Generate prospects within hours of receiving your 3D Seismic Volume

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