ABSTRACT

It is now possible to routinely determine the age of 200–600-m.y.-old volcanic rocks interlayered with fossil-bearing deposits to uncertainties of less than 1 m.y. with uranium-lead zircon geochronology. This level of precision, coupled with the recognition that volcanic ash beds are much more common in fossiliferous rocks than previously realized, opens new opportunities for the study of evolutionary rates in deep time. It is now possible to constrain rates of evolutionary radiations, mass extinctions, and other evolutionary events as well as evaluate potentially diachronous biostratigraphic boundaries. For example, a combination of detailed biostratigraphic and chemostratigraphic data with new U-Pb zircon dates for the late Neoproterozoic and Early Cambrian has demonstrated that the soft-bodied Ediacaran fossils immediately underlie the Cambrian, that the base of the Cambrian is much younger than previously recognized, and that the Cambrian explosion lasted 10 m.y. or less. Other recent studies have shown the Middle and Late Cambrian each lasted only about 10 m.y., suggesting that the duration of the included trilobite zones was similar to those of Jurassic ammonites. Recent data from the Late Permian and earliest Triassic of south China now constrain the duration of the most profound mass extinction in the history of life to less than 1 m.y. Collaboration between paleontologists and geochronologists offers the prospect of accurately assessing the rates of evolutionary processes, from speciation to evolutionary radiations and mass extinctions, throughout the Phanerozoic.

“How fast, as a matter of fact, do animals evolve in nature? That is the fundamental observational problem that the geneticist asks the paleontologist” (Simpson, 1944).

INTRODUCTION

Answers to Simpson’s question about evolutionary rates have generally lacked precision, particularly for the pre-Cenozoic. Although many paleontological
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In Memoriam

Saul Aronow
Beaumont, Texas
May 15, 1998

Robert E. Barnett
Washington Court House, Ohio

Bruce B. Hanshaw
McLean, Virginia
July 18, 1998

Laurence B. James
Folsom, California
June 8, 1998

Louis Pavlides
College Park, Maryland
April 8, 1998

Grover Reinbold
Reno, Nevada
April 24, 1998

Mark Springett
Boulder, Colorado
July 16, 1998

Leonard R. Wilson
Norman, Oklahoma
July 15, 1998

Correction: July Science Article

The illustration in the center of the July 1998 issue (p. 16 and 17) is Figure 2 (not Figure 3) of the paper “Probing the Archean and Proterozoic Lithosphere of Western North America” by Deep Probe Working Group. The Figure 2 caption on p. 4 should be on p. 16, and the Figure 3 caption on p. 16 should be on p. 4. On p. 3, leftmost column, the fourth line under the head Seismic Observations: Three Province-Related Seismic Signatures should be: Cheyenne belt (Fig. 2; see p. 16–17), and the footnote at the bottom of the leftmost column on p. 4 should be: Figure 2 is on p. 16–17.

Evolutionary Rates continued from p. 1

issues have revolved around evolutionary rates, the inadequacies of the geologic time scale have generally precluded their resolution. Yet, accurate determination of rates is critical to answering important questions: How does the rate of speciation vary in different environments? How long do stable community assemblages persist? How much time is involved in evolutionary radiations or postextinction recoveries? How rapidly do species and communities respond to climatic and other environmental changes? And perhaps most significant, have these rates changed through the Phanerozoic? Without good data on the amount of time involved in these events, any determination of rate must be suspect.

Rates of some evolutionary and geological processes can be determined for the Cenozoic with some precision by means of a variety of techniques (e.g., climatic cyclicity, paleomagnetic reversals, Hilgen et al., 1997). However, farther back in the geologic record, the precision with which we can resolve events decreases, the accuracy of the geologic time scale degrades, and the reliability of information used to assess evolutionary rates falls dramatically. Consequently, much of our current knowledge of rates of change is based on interpolation of absolute time between a few well-constrained tie points used to construct relatively imprecise geologic time scales (e.g., Harland et al., 1990), often with the additional assumption that equal thicknesses of rock represent equal amounts of time.
of life, the end-Permian event (Fig. 1).

important episodes in geologic history, paleontology, and chemostratigraphy has revolutionized our knowledge of several scales envisioned by Simpson (1944).

The past 15 years have seen marked improvement in high-precision isotope dilution–thermal ionization mass spectrometry (IDTIMS) U-Pb dating of zircons (Krogh, 1982; Parrish and Krogh, 1987). This is largely the result of being able to analyze small amounts of zircon that may contain as little as 10–25 × 10⁻¹² g of radiogenic Pb. This capability is the result of low analytical blanks (0.5–2.0 × 10⁻¹² g of common Pb) and improvement in mass spectrometry, especially ion-counting techniques. Although these methods have revolutionized our understanding of how geological time is distributed in the rock record, only recently has the full potential of this technique begun to be realized. High precision for its own sake is often not an efficient strategy. We feel that the calibration of evolutionary rates is an example of a problem that requires the maximum resolving power of the U-Pb technique. For example, Tucker et al. (1990) showed through high-precision zircon geochronology that the mean duration of Ordovician graptolite zones is 1–2 m.y. and recognized that with this approach, evolutionary rates of Paleozoic fauna could be evaluated. Hughes (1995) used available U-Pb geochronology to constrain durations of Silurian graptolite zones; the range was 0.44–1.43 m.y.

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**Calibration of the Time Scale**

Geochronometric calibration of a relative, chronostratigraphic time scale is straightforward. Ideally, a volcanic rock is found very close to the point in a stratigraphic section chosen as the global stratotype for the boundary between two geologic intervals, and the volcanic rock contains a mineral, such as zircon or monazite, for which a precise crystallization age can be determined. Such ideal situa-
Evolutionary Rates continued from p. 3

Evolutionary Rates

...ations are uncommon, and so calibration requires dating rocks elsewhere in sections that can be correlated to the stratotype by means of bio-, chemo-, and magnetostratigraphy. The late Neoproterozoic-Cambrian boundary, for example, is defined as a point in rock in a section located in southeastern Newfoundland (Landing, 1992), but no volcanic rocks are present at or in close proximity to the boundary (Myrow and Hiscott, 1993; Landing, 1992). Consequently, the age of the boundary can be calibrated only through correlation with other sections that contain datable volcanic rocks in close proximity to the boundary.

It is a useful exercise to consult your favorite time scale to see how the age of a particular boundary was determined. The chronostratigraphic time scales that we all favor are synthesized geochronological resolution and the number of calibration studies has increased dramatically in the past ten years, existing time scales have been rendered inadequate, especially for the Paleozoic (Fig. 2).

Methods

Pb analyzed from zircon samples is a mixture of radiogenic and common Pb. Radiogenic Pb is produced by the decay of U in the zircon crystal. A small amount of common Pb is sometimes incorporated into the zircon when it crystalizes, and common Pb is added to the sample via sample processing (analytical blank). When calculating a date for a zircon, one must subtract the common Pb from the total Pb, and in doing so, one must assume a composition of both the blank and any indigenous common Pb. In general, the uncertainties associated with making blank and common Pb corrections can be minimized with large radiogenic Pb/common Pb ratios, which generally scale with sample size. Sources of systematic error may include error in spike calibration and uncertainty in the decay constants for uranium. These later uncertainties would apply to all analyses done in a particular lab; although they might affect absolute age determinations, the relative age differences between beds are not affected. Systematic errors can be a problem when comparing dates obtained by different methods.

Resolution of time with uncertainties of 1 m.y. or less in volcanic rocks provides a special set of problems. The most significant is the ability to distinguish small amounts of Pb loss and/or inheritance. It is common in airfall ash deposits to find zircon grains, probably incorporated into the eruption column, that are identical in morphology to the indigenous population, but which can be <1 to >10 m.y. older (Landing et al., 1998). This problem can be minimized by analyzing single grains of zircon. A zircon crystal’s size and its concentration of radiogenic Pb ultimately determine whether or not single-grain analysis is feasible. One seeks a high ratio of radiogenic to common Pb as possible for each analysis. In this way, the uncertainty on all three dates (206Pb/238U, 207Pb/235U, and 207Pb/206Pb) is low (0.1%–0.5%), and the difference between the 206Pb/238U and 207Pb/235U dates can be evaluated for inheritance of slightly older grains and/or Pb-loss. In the case of complex zircons, it is often necessary to relax precision requirements so as to be able to analyze a single grain or grain fragment. It is this trade-off that requires the super-high-resolution ion microprobe (SHRIMP) to rely on the 206Pb/238U date when determining the age of Paleozoic zircons (e.g., Claupe Long et al., 1995).

In the best-case scenario, a statistically significant cluster of concordant analyses is obtained for each sample, and weighted mean 206Pb/238U, 207Pb/235U and 207Pb/206Pb dates are calculated. More commonly, a suite of zircons is discordant and defines a linear array that intersects concordia. In these cases, uncertainty in the age of the zircons can be calculated for the intersection of the discordant array with the concordia curve (Ludwig, 1980), or, more often, the weighted mean of the 207Pb/206Pb dates can be used (e.g., Tucker et al., 1998; Bowring et al., 1993). When this approach is used, the minimum uncertainty in age is generally 1–2 m.y. There is no question that the best results are obtained from discordant zircons, and in older rocks they become increasingly difficult to find. Our technique could be termed the “brute force” approach. We typically attempt to analyze a minimum of 5–10 fractions of zircon for each ash bed to assess our reproducibility and to reduce errors in the age (this does not include the analyses that show evidence for inheritance, severe Pb loss, high common Pb, etc.). The test of our approach is to analyze multiple samples of the same horizon, as well as different beds in stratigraphic order (Grotzinger et al., 1995; Bowring et al., 1998).

RESOLVING THE CAMBRIAN RADIATION

The explosive diversification of higher marine invertebrates in the Early Cambrian is the single most dramatic event documented in the fossil record. Rocks that are late Neoproterozoic in age contain the soft-bodied remains of Edi-
Cambrian fossils and a small assemblage of skeletonized tubes, as well as recently discovered fossil embryos and sponge spicules (ca. 570 Ma; Xiao et al., 1998; Li et al., 1998). The first Cambrian shelly fossils occur in carbonates near the base of the Manykaian Stage, currently the basal stage of the Cambrian. Trace fossils, skeletal fossils, and spiny organic microfossils diversified rapidly during the ensuing Tommotian and Atdabanian stages, so that by the end of the Atdabanian, most durably skeletonized phyla and classes of marine invertebrates are recognized. Controversy continues over the rapidity of this radiation and the possibility that considerable diversity existed long before the base of the Cambrian, but has not been recognized in the fossil record because of small size or low preservation potential.

Since 1990, U-Pb geochronological studies have constrained the age of the late Neoproterozoic-Cambrian boundary, the duration of diverse Ediacaran fossils, the burst of innovations during the Tommotian-Atdabanian, the Lower-Middle Cambrian boundary, and the Cambrian-Ordovician boundary (Compston et al., 1992, 1995; Bowring et al., 1993; Isachsen et al., 1994; Grotzinger et al., 1995; Land- ing et al., 1997, 1998; Davidek et al., 1998). Figure 3 is a revised time scale for the Cambrian Period showing the control provided by U-Pb zircon ages on biostratigraphic boundaries.

Although volcanic rocks are uncommon interbedded with Ediacaran fossils, the fossils generally postdate Varanger-aged glaciogenic rocks (ca. 600 Ma) in eastern North America. In Newfoundland, Benus (1988) reported an age for volcanic rocks immediately overlying Ediacaran fossils at 565 ± 3 Ma. Compston et al. (1995) reported for volcanic rocks from the subsurface of Poland which are correlated with Ediacaran-bearing strata in Ukraine an age of 551 ± 4 Ma. Grotzinger et al. (1995) and Narbonne and Knoll (1994) have documented Ediacaran fossils including the new genus Swartpuntia immediately below the basal Cambrian in Namibia; this deposit is younger than 543.3 ± 1 Ma. Grotzinger et al. (1995) also showed that diverse small shelly fossils overlap with the Ediacaran fossils in Namibia. Although the Cambrian is often viewed as lacking Ediacaran fossils, several exceptions have appeared recently (Crimes et al., 1995; Conway Morris, 1993; Jensen et al., 1998). The lack of any obvious gap between the last Ediacaran fossils and the onset of Cambrian fossils leads to the simple conclusion that the Cambrian explosion is part of a continuous evolutionary radiation that started in the late Neoproterozoic (Grotzinger et al., 1995). The biostratigraphically defined boundary does not mark a sudden event or explosion in the diversification of life, but instead serves as an important reference point in an increasingly rich evolutionary record.

Carbon isotope stratigraphy is an essential tool for correlating latest Neoproterozoic rocks. Globally, many stratigraphic sections have yielded very similar fluctuations in carbon isotopes (Kaufman et al., 1997; Narbonne and Knoll, 1994). This pattern of isotopic variation provides an independent framework for correlation between sections and allows, in some cases, calibration of the isotopic shifts by dating volcanic layers. In Namibia, Grotzinger et al. (1995) showed that an isotopic interval known as the +2 plateau has a duration of about 5–6 m.y. and coincides with occurrence of the most diverse Ediacaran assemblages.

Temporal calibration of past global events, correlated using bio-, chemo-, and magnetostatigraphic data sets, is possible only with the precise absolute age control offered by U-Pb zircon dating of volcanics interlayered within sedimentary sequences. This temporal framework has important implications for our understanding of biological diversification and its possible links to contemporaneous tectonic, biogeochemical, and climatic changes. Exciting problems remain unresolved. What is the lower boundary of the Ediacaran faunas? Can we resolve time sufficiently during the late Neoproterozoic to identify distinct assemblages of fossils or migration between different biogeographic regions? Will additional data on the Manykaian Stage allow better temporal constraints on the gradual expansion of the small shelly fossils? Is the distribution of Ediacaran organisms diachronous?

**NEW RESULTS FOR THE MIDDLE CAMBRIAN-EARLY ORDOVICIAN**

Trilobites dominate Middle and Late Cambrian marine assemblages in both species diversity and numbers of specimens. Rapid speciation in trilobites has allowed biostatigraphers to divide the Middle Cambrian of Laurentia into six biostratigraphic zones, and the Upper Cambrian into seven (but see Geyer and Palmer, 1995). A detailed examination of the evolutionary patterns underlying trilobite history during this time reveals a more interesting pattern, however. In 1965 A. R. Palmer recognized a series of five larger biostatigraphic units, each beginning with a small number of trilobite families unrelated to those in underlying rocks. He traced the rapid diversification of these families across several biostatigraphic zones; the resulting diverse assemblage was finally eliminated by a mass extinction, and the cycle was repeated.

**Evolutionary Rates** continued on p. 6
Evolutionary Rates continued from p. 5

These extinction events cross a variety of facies and, significantly, are not associated with lithological changes (Palmer, 1965, 1979, 1984; Stitt, 1971, 1975; Thomas, 1995). These biomicrere events, as Palmer termed them, also affect brachiopods, conodonts, and other taxa. The causes of these events have been the subject of considerable debate; some authors have favored shelf-wide declines in water temperature (Stitt, 1971, 1975), perhaps associated with an incursion of anoxic water (Palmer, 1984). Others have favored a model tied to sea-level rise and a migration of deep-water taxa into near-shore environments (Westrop and Ludvigsen, 1987). Testing these alternative explanations and determining how quickly the extinctions and the subsequent adaptive radiations took place require tight constraints on time. The DNAG time scale, similar to other time scales of that vintage (Fig. 2), depicts a Middle Cambrian of 17 m.y. and a Late Cambrian of 18 m.y., yielding an average duration of a biostatigraphic zone of 2.8 m.y. and 2.6 m.y., respectively, with biomicrons averaging 7 m.y.

High-precision geochronology, while not yet to the level of the Cambrian radiations, has already changed this picture considerably. With the Ordovician boundary at about 490 Ma (Davidek et al., 1998) and the base of the Middle Cambrian at 509 Ma (Landing et al., 1998), the 13 trilobite zones of the Middle and Upper Cambrian now have an average duration of 3.5 m.y. and the biomicrons average 4 m.y. The trilobite zones are not of equal duration—those early and late in each biomicron are generally shorter (Shergold, 1995), but the length of these zones now approaches that of Jurassic ammonites, and the rates of specification, migration, and overturn are all very high. Improved geochronology may help resolve intercontinental problems (e.g., Geyer and Palmer, 1995) and, if the appropriate circumstances are identified, may be combined with biogeochemical information and phylogenetic analysis to determine rates of immigration at the base of biomicrons.

Rates of the End-Permian Mass Extinction

The Paleozoic ended at 251 Ma with the most severe mass extinction of the Phanerzoic. An estimated 85% of all marine species disappeared during the Late Permian, along with about 70% of land vertebrates and a significant number of plants and insects (Erwin, 1994; Retallick, 1995). The next largest mass extinction, at the close of the Ordovician, was only half as large. The end-Permian mass extinction eliminated the major marine communities of the Paleozoic, and in its aftermath an entirely new suite of communities developed which, in many ways, continue to dominate modern oceans. The causes of this extinction have long been enigmatic, in part because marine sections spanning the critical interval are relatively rare. Over the past decade, considerable advances have been made, and paleontologists, working together with geochemists and others, have established several important aspects of this extinction. Anoxia is present in both deep-ocean (Ishizaki, 1997) and shallow-ocean sections (Wignall et al., 1996) across the Permian-Triassic boundary, the latter during a time of marine transgression. Analyses of carbon isotope patterns across the boundary show multiple, brief, negative excursions (Holser and Schonlaub, 1991; Wignall et al., 1996), and are found in both marine and terrestrial sections, demonstrating that extinctions were essentially simultaneous in both realms. There is no evidence for glaciation near the boundary, but there is growing evidence for some degree of global warming in the early Triassic. Finally, the mass-extinction patterns are consistent with the effects of poisoning by massive amounts of CO₂ (Knoll et al., 1996).

How did these events interact to trigger this mass extinction? The age of the Permian-Triassic boundary at the classic Meishan section between Shanghai and Nanjing, China was determined to be ca. 251 Ma (Claupe-Long et al., 1991; Renne et al., 1995), but knowing the age of the boundary without additional age constraints provides no reliable estimates of the duration of the extinction. On the basis of rock thickness and the number of biostatigraphic zones, a variety of estimates have been offered for the duration of the Late Permian stages, ranging between 2 and 10 m.y.

Recently, in conjunction with Jin Yugen and his colleagues at the Nanjing Institute of Geology and Palaeontology, we have used the techniques described above to date a series of ash beds (Fig. 1) in south China that bracket the Permian-Triassic boundary and are well constrained biostatigraphically (Bowring et al., 1998). Because our results are tied to previous biostatigraphic and chemostatigraphic studies, they are of immediate significance beyond south China, and they provide the first constraints on the rapidity of the extinction and the association between the extinction and the related environmental changes. Furthermore, Bowring et al. (1998) showed that in the Meishan section, a sharp spike in δ¹³C_carb of ~6‰ occurred in less than 160 000 yr and perhaps as little as 10 000 yr (using the dates to calculate accumulation rates within this section). The latest Permian extinction occurred in less than 1 m.y. and could be coincident with the isotopic shift. At the moment, the geochronological resolution of the extinction pattern is more detailed than the palaeontological resolution. Further palaeontological studies employing the statistical methods could help to sort out the rapidity of the extinction and help to constrain possible mechanisms. Models for the extinction that involve changes related to aggregation of Pangea at that time (e.g., Faure et al., 1995) seem incompatible with the rapid pulse of extinction. The rapidity implies events at the 100 000 yr level, compatible with proposed oceanographic changes (e.g., Knoll et al., 1996) such as overturn or even bolide impact (Bowring et al., 1998). More work on the fine-scale texture of the extinction and associated geochemical changes is required to further constrain the mechanisms of extinction. Outstanding issues are whether the terrestrial extinction occurred at the same time as the marine, and whether the extinction was globally synchronous. With the ability to resolve time at the 200 000-300 000 yr level, this question is of extreme importance.

Following the biggest extinction in Earth history, life recovered dramatically, although in a fundamentally different world. The recovery period of the Early Triassic provides an opportunity to quantify rates of rapid diversification into a relatively barren ecosystem following the end-Permian extinction. A comparison of evolutionary rates and paleobiogeographic controls may be the best analog to the Cambrian radiation. Comparisons of this sort should help us to better understand the general processes involved in extinctions and recoveries throughout Earth history.

NEW DIRECTIONS FOR THE STUDY OF EVOLUTIONARY RATES

The integration of high-resolution U-Pb geochronology and detailed palaeontology offers a bright future to understanding rates of a variety of evolutionary processes. Thin layers of volcanic ash, interbedded with fossiliferous rocks, are more common than is often recognized, and correlations can be made to sections that lack volcanics by using biostatigraphy and chemostatigraphy. In addition, accumulation rates can be precisely evaluated when bracketed by abundant ashes, allowing much-improved resolution. Ideally, when volcanic rocks are regularly interspersed between fossil-bearing layers, reproducibility and precision can be evaluated by dating multiple ash beds within a single stratigraphic sequence.

This linkage between palaeontology and geochronology allows us to address several evolutionary questions, especially those that move beyond simple taxonomic approaches. In Precambrian rocks, there is potential for calibrating major branch points or nodes in the tree of life.
and comparing these estimates to those derived from analysis of molecular data through molecular clocks. The spectacular morphometric data on Cambrian and Ordovician trilobites produced by Foote (1993) is an excellent example for which high-resolution geochronology could document rates of morphological change from the Cambrian through the Ordovician radiation and extinction (rather than simply changes in the number of taxa). For this interval, the database is good enough that biogeographic effects could be examined as well. When coupled with high-resolution chronostratigraphy, the approach described in this paper will allow exploration of how subtle changes in climate or ocean chemistry are manifested in the evolutionary record.

Critical to understanding the diversification of life is an accurate chronology of life as preserved in the fossil record. Armed with an accurate chronology, we can begin to evaluate evolutionary rates by merging information on taxonomic, phylogenetic, and morphologic evolutionary patterns. Further, this approach offers the prospect of a more rigorous synthesis of data on molecular evolution and paleontology. When chronology is coupled with chronostratigraphic data, we can begin to understand the linkages between environmental change and evolution and to examine the distribution of time in the rock record with precision.

ACKNOWLEDGMENTS

Supported by the Exobiology Program of NASA, the Walcott Fund of the Smithsonian Institution, and the National Science Foundation (EAR 94-0618). High-precision U-Pb geochronology at MIT is possible because of the hard work of M. Martin, M. Schmitz, K. Davidek, D. Hawkins, and C. Isachsen. We thank Mark Martin and Liz Valiulis for producing the figures.

REFERENCES CITED


Evolutionary Rates continued from p. 7


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GSA Thanked for Book Donations

GSA Executive Director Donald M. Davidson, Jr., meets Colorado State University Dean of Libraries, Camilla Allre, at the Flood Recognition Event in the Morgan Library at Colorado State University. The flood disaster that occurred in Fort Collins, Colorado, on July 28, 1997, extensively damaged the library. In October 1997, GSA donated to the Morgan Library approximately 220 books and about 20 years’ worth of the journals Geology and the GSA Bulletin, valued at over $11,000.

NOTICE OF COUNCIL MEETING

Meetings of the GSA Council are open to Fellows, Members, and Associates of the Society, who may attend as observers, except during executive sessions. Only councilors, officers, and section representatives may speak to agenda items, except by invitation of the chair. Because of space and seating limitations, notification of attendance must be received by the Executive Director prior to the meeting. The next meeting of the Council will be Tuesday afternoon, October 27, 1998, at the Annual Meeting in Toronto, Canada.

BORED with your “old” planet? Go ahead, try one of ours!

Join the Planetary Geology Division of GSA, and join us in one or more of our Toronto Meeting Activities, which include:

- The Pre-meeting Educational Program “Exploring the Solar System in the Classroom: A Hands-on Approach” (Saturday, all day)
- The Pardee Keynote Symposium “Pathfinder and Global Surveyor, New Views of Mars” (Thursday Morning)
- A variety of Theme Sessions including “Assembling a new understanding of Mars”; “Impact and Volcanism: Sudbury and Beyond”; “Planetary Pot-Pourri”; and “Applied Geological Remote Sensing” (throughout the week)
- The Division Business meeting, including presentation of the G. K. Gilbert Award (Wednesday evening)

Remember to visit the Division’s booth in the Exhibit Hall, where nifty posters, T-shirts, membership forms, and other goodies will be available.

Sign Here, Please

Who: Author John McPhee, autographing his latest book
When: October 25 and 26
Where: 1998 GSA Annual Meeting in Toronto

Annals of the Former World will be on sale at the GSA Bookstore. Here’s your chance to get a copy of this newly published book, featuring several of your GSA colleagues.
NATIONAL ACADEMY OF SCIENCES COLLOQUIUM
"GEOLOGY, MINERALOGY AND HUMAN WELFARE"

NOVEMBER 8-9, 1998

The Arnold and Mabel Beckman Center, Irvine, California
Organized by Peter R. Buseck, Malcolm Ross, and Joseph V. Smith

Jillian F. Banfield, University of Wisconsin, Madison
"Biological impact on silicate mineral dissolution -
application of the lichen model to understanding mineral
weathering in soils."

Paul M. Bertsch, University of Georgia/SREL
"Advanced characterization of complex mineral
assemblages and of contaminant-mineral interactions:
Implications for contaminant transport and environmental
remediation."

Gordon E. Brown, Jr., Stanford University
"Mineral surface chemistry in environmental science."

Peter R. Buseck, Arizona State University
"Airborne minerals and related aerosol particles: Effects on
climate and the environment."

Rodney C. Ewing, University of Michigan
"Mineralogy: The design and selection of nuclear waste
forms for actinides."

Robert B. Finkelman, U.S. Geological Survey
"The health impacts of domestic coal use in China."

Miriam Kastner, Scripps Institution of Oceanography
"Oceanic minerals and rocks, their origin, occurrence, and
economic significance."

Keith A. Kvenvolden, U.S. Geological Survey
"Potential effects of gas hydrate on mankind."

Frederick A. Munpton, SUNY - College
"Natural Zeolites."

Robert P. Nolan, City University of New York
"Asbestos minerals in the mining and occupational
environment: Implications for fiber carcinogenesis."

"Negative pH, efflorescent mineralogy, extremely acidic
mine waters, and the challenge of environmental restoration
at the Iron Mountain superfund site, CA."

David R. Pevear, Exxon Production Research Co.
"The story of illite - How microscopic clay crystals constrain
the thermal history of giant sedimentary basins and help us
find oil."

F.D. Pooley, Cardiff University
"Characteristics of fibrous amphibole mineral dusts found in
the human lung and their biological potential to cause
disease."

Jeffery E. Post, Smithsonian Institution, National Museum
of Natural History
"Manganese oxides: Batteries and beyond."

Joseph M. Prospero, University of Miami RSMAS
"Transport of African mineral dust across North Atlantic:
Impact on the environment of the eastern United States."

John D. Sherman, UOP Research Center
"Synthetic zeolites and other microporous oxide molecular
sieves."

J.V. Smith, University of Chicago
"Geology, Mineralogy, and Human Welfare."

Garrison Sposito, University of California, Berkeley
"Surface geochemistry of the clay minerals."

Samuel J. Trina, Stanford University
"Geochemical controls on contaminant bioavailability in
soils, sediments and aquatic environments."

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Climate Change Workshop Results Begin To Appear

The August 1997 Washington Report presented a description of the series of regional workshops, conducted on behalf of the administration, designed to be the first step in conducting regional assessments of the impact of changing climate. What started out as a handful of workshops has now grown to 20, encompassing all U.S. states and territories. The last of the workshops will be held in September.

Results of the Western Arctic/Bering Sea-Alaska Workshop has been released as “Implications of Global Change in Alaska and the Bering Sea Region—Mackenzie River to Lena River.” The workshop was at the University of Alaska in Fairbanks in June 1997.

The Arctic, including Alaska, is one of the critical regions where climatic change is expected to be large and where the impacts (both positive and negative) on the environment and on socioeconomic activities could be pronounced. Consequently, the goals of the workshop were to educate the stakeholders (the individuals and groups who are directly affected) about the importance of the effects of climatic change on issues of particular concern to them; to refine the coarse impact assessments already compiled from previous workshops; to define a research agenda to further improve the impact assessments; and to develop support, with the help of the stakeholders, for mitigation and adaptation options. The workshop was attended by a diverse group of more than 100 participants representing academia, government agencies, private industry, nongovernmental organizations, Native organizations, and the general public.

Prior to the workshop, the organizers commissioned six position papers on the likely impacts of climate change on the ocean system, coastal zone, land ecosystem, nonrenewable resources, infrastructure, and social and cultural values. These papers provided a starting point for detailed breakout sessions on discussions and recommendations. A common thread of each paper was the climate warming observed over the land masses of the western Arctic during the past three decades, accompanied by decreases in snow cover and glacier area and volume, thawing of permafrost, and reductions in sea ice extent. Trans-boundary problems, such as connections to Russia and Canada, were also considered in detail.

The workshop proceedings present the results of the deliberations of the six working groups on the role of climate change in Alaska and the Bering Sea Region as a series of positive (+) and negative (-) impacts on human activities. Not surprisingly, the majority of the impacts are negative. The following are the results as presented in the proceedings:

I. Socioeconomic impacts that have occurred over the past decade:
- Major increases in catches of Alaskan salmon in recent years resulted from the increase of El Niño conditions since the mid-1970s (+).
- The same conditions have unfavorably affected Pacific Northwest and Canadian salmon stocks due to increased smolt predation and adverse streamflow (-). Accelerated permafrost thawing has led to costly increases in road damage and road maintenance (up to $3 million to replace 1 mile of road system) (-).
- Permafrost thawing has also caused major landscape changes, from forest to bogs, grasslands, and wetland ecosystems, affecting land use (-). Increased slope instability, landslides, and erosion have occurred in thawing permafrost terrain, threatening roads and bridges and causing local floods (-).
- But disappearance of permafrost also reduces construction problems; in some areas permafrost boundaries have moved north by 80 miles in the past century (+).
- The warmer climate has caused forest problems, such as increased fire frequency and insect outbreaks, that have reduced economic forest yields (-).
- A warmer climate has lengthened the growing season and growing degree days by 20% for agriculture and forestry, with the potential of producing higher yields (+).
- Boreal forests are expanding north at the rate of 60 miles for each 2°F temperature increase, thus increasing potential yields (+).
- With less sea ice in the Bering Sea, severe weather events such as storm surge frequency and severity have increased, as have coastal erosion and inundation and threats to structures (-).
- Subsistence lifestyles have been adversely affected; for example, changes in sea ice conditions make hunting on the ice more dangerous (-).
- The availability of marine mammals for subsistence is lower, due to changes in oceanographic and sea ice conditions (-).
- A warmer climate has also thawed traditional ice cells in several northern villages.
- Human health problems have increased, owing to new diseases moving north (-).
- The extended length of the summer season has been accompanied by an expansion of summer tourism (+).

II. Possible additional future consequences of climate change:
- Fisheries: Change in catches by location, volume, and species, and in markets (- and +).
- Seafood and Fish Industry (harvesters and processors):
  - Financial stress caused by the need for relocation (-).
  - Local loss of fishing industry jobs due to relocation of support services (-).
  - Eventual worldwide financial losses as global fisheries decline (-), perhaps benefiting Alaskan fisheries (+).
- Oil and Gas:
  - Cost of maintaining structures (pipelines, etc.) in thawing permafrost terrain (-).
  - Improved construction after the thawing of permafrost (+).
  - Economic benefits resulting from extended surface mining (+).
  - Improved offshore exploration and production, owing to less sea ice (+).
  - Increased threats from higher sea levels and erosion to coastal installations (-).
- Agriculture, Forestry, and Wildlife:
  - Higher yields in agriculture and forestry due to longer growing season (+).
  - Increased incidence of forest fires and losses to timber industry (-).
  - Increased insect outbreaks and infestations, leading to economic losses (-).
  - Losses or changes in wildlife and reindeer herding as ecosystems change (+ and -).
  - Losses or changes in fish and marine mammals with decline in sea ice extent (-).
- Effects on tourism: Longer season (+) but melting glaciers, smoke from forest fires (-).
Earth Science Week

The first Earth Science Week will be October 11–17, 1998. Earth Science Week, one of the American Geological Institute's 50th anniversary initiatives, offers the geoscience community new opportunities to demonstrate the importance of the earth sciences. AGI member societies and state geological surveys are planning Earth Science Week activities and events. "The goal for Earth Science Week," said AGI President Susan Landon, "is to have every geoscientist in the country do something in their community to promote the earth sciences."

Earth Science Week has enormous potential for increasing public awareness and understanding of the importance of the earth sciences in our lives. The celebration, which will be held annually during the second full week of October, will give geoscientists and organizations repeated opportunities:

- To give students new opportunities to discover the earth sciences
- To highlight the contributions that the earth sciences make to society
- To publicize the message that earth science is all around us
- To encourage stewardship of Earth, and
- To develop a mechanism for geoscientists to share their knowledge and enthusiasm about Earth and how it works.

AGI's role in sponsoring an annual Earth Science Week is to provide a clearinghouse for ideas, activities, and special events and to provide support materials that make it easy for geoscientists to participate. Information about Earth Science Week is available from the American Geological Institute and on the World Wide Web at www.earthsciweek.org.

The following statement about Earth Science Week, by Oregon Senator Ron Wyden, was entered into the Congressional Record in July. (Current GSA Congressional Science Fellow David Verardo is serving on Wyden's staff.)

Mr. President, in the nineteenth century, Meriwether Lewis and William Clark explored the western reaches of our expanding country. As they explored my home region of the Pacific Northwest, Lewis and Clark cataloged the mineral and natural resources of the land. In particular, they spoke of a mighty river known to the local inhabitants as Nch'i Wana, the Great River. We know it today as the Columbia River and its importance as a reliable source of water and power to the people of the Pacific Northwest is undeniable.

When twentieth century American explorers embarked on a similar journey to explore the Moon, one of their earliest actions was to bend down to the surface and pick up a rock. That simple movement framed an ancient reflex that underscores the basic imperative to explore our surroundings. Today, I want to recognize the important role played by the earth sciences in expanding our economy, supporting our national goals, and increasing our knowledge of the larger world.

Modern geophysical research reveals that ours is a dynamic planet. On the Earth's surface, great tectonic plates shift continental positions with terrific force. On the ocean's surface, microscopic plants and animals help regulate global atmospheric gases and serve as the foundation of our planet's food web. In the deep ocean abyss, mysterious and wondrous animal communities thrive in endless darkness by deriving life-sustaining nutrients from active volcanic vents.

Earth science is a global science that speaks a global language and unites people by promoting sustainable development. The study of earth science provides the skills necessary for locating and utilizing natural resources; understanding natural processes that often conflict with human designs; and comprehending our natural heritage through the unusual perspective of geologic time. The unique panorama of geologic time allows us to observe the full range of natural processes on Earth and aids in developing a comprehensive view of the natural world beyond a perspective limited only to that of human influence. In my home state of Oregon, we celebrate the land and respect the power of nature. We have learned to protect our citizens and expand our economy by working with nature and prudently mitigating natural hazards. In consideration of the importance of the earth sciences in the daily lives of all Americans, I submit, for the Record, the resolution issued by the Association of American State Geologists.

The resolution follows:

Whereas the earth sciences are fundamental to society; and
Whereas the earth sciences are integral to finding, developing, and conserving mineral, energy, and water resources needed for society; and
Whereas the earth sciences promote public safety by preparing for and mitigating natural hazards such as floods, landslides, earthquakes, volcanic eruptions, sinkholes, and coastal erosion; and
Whereas the earth sciences are crucial to environmental and ecological issues ranging from climate change and water and air quality to waste disposal; and
Whereas geological factors of resources, hazards, and environment are vital to land management and land use decisions at local, state, regional, national, and international levels; and
Whereas the earth sciences contribute critical information that enhances our understanding of Nature,

Therefore, be it resolved that the second full week of October henceforth be designated as Earth Science Week.
**The Sustainability Challenge I: Energy for the 21st Century**

A. R. (Pete) Palmer, Institute for Cambrian Studies

The earth science community holds several important keys to public understanding of the issue of sustainability. Humanity will face seriously negative consequences if the public, and our leaders, do not internalize the geoscience concepts that are fundamental to sustainability issues: that we live on “Spaceship Earth” and there is no place else to go; that we are parts of, not independent from, the global ecosystem; that the human context must be understood in the perspective of “deep time”; that some resources are finite and will become “addicted” globally to the material benefits procured directly and indirectly from oil, gas, and coal. Some voices point out that these are nonrenewable resources on human time scales and that demand during the next century will begin to exceed supply. Others say there is

Energy continued on p. 13
Energy continued from p. 12

no need to worry because technology will always supply a “fix” when it is needed. Meanwhile, it appears that the atmosphere is not handling very well the excess load of carbon generated by burning increasing quantities of fossil fuels. The build-up of CO₂ and its consequences are taking these predictions seriously. Roy Levitch, who represents Shell’s energy concerns in this area, will discuss Shell’s plans for development of sustainable energy. Walter Youngquist will examine the myths and realities of alternative energy sources. Our final speaker, Mike McCormack, a former U.S. Representative from Washington who was involved with energy issues in Congress, will review the political realities of shrinking fossil energy supplies. Discussion breaks are planned after each pair of speakers. These discussions will be moderated by Al Bartlett, emeritus professor of physics at the University of Colorado, who has lectured widely across the United States on issues of population growth and consumption. He will also briefly summarize the issues raised during the symposium.

At the GSA Annual Meeting in Toronto, come and join the discussion. Your grandchildren may appreciate your concern.
INTRODUCTION

During the early 1970s, staff and patrons at the McGill University Archives were abuzz about a huge new bequest: the papers of John William Dawson. Dawson had been called from the tiny maritime village of Pictou, Nova Scotia, in 1855 to serve as McGill’s principal. He presided over the university for nearly half a century.

Dawson was not only the major scientific player in 19th-century Canada, but he also commanded a leading position internationally. Dawson is one of those individuals whose diverse activities defy neat categorization. He was as much a paleontologist as a geologist, an administrator as well as an educator, and a popular writer on scientific and religious topics as well as the author of about 200 papers.

EARLY YEARS

John William Dawson, who always preferred to be addressed as “William,” was born October 13, 1820, in the seaside town of Pictou, Nova Scotia. He was the elder of two sons of Scottish immigrants. Dawson’s interest in natural history began early. Cephalopods were readily available in his coastal village.

For the first 30 years of his life, his parents were preoccupied with repaying debts incurred in maritime trade, a responsibility that they steadfastly discharged. Perhaps Dawson’s intense earnestness and self-reliance were honed in this environment. Frugality was as important as piety in the Dawson household, giving William an inescapable and omnipresent seriousness of purpose.

Whatever young William lacked in material wealth during his formative years was overshadowed by his parents’ deep affection and by the rich resources of Pictou. An academy in the town provided Dawson and other youths with a remarkable grounding in a range of subjects, especially in the natural sciences. Pictou Academy had been established in 1817 by the secessionist Presbyterian minister Thomas McCulloch as a school for training dissenting ministers and for teaching the liberal arts to youths of all religious persuasions. The academy housed an extensive collection of scientific apparatus, a small natural history museum, and a library with a remarkable assortment of treatises in natural philosophy and natural history.

Pictou was surrounded by sandstone and shale formations, which contained Carboniferous plant fossils. These provided fertile ground for Dawson’s first scientific explorations, and allowed him to put together a respectable collection of geological and paleontological specimens. At age 16, Dawson delivered a paper on “The Structure and History of the Earth” to the Pictou Literary and Scientific Society.

HIGHER EDUCATION

In 1840, at the age of 20, Dawson matriculated at the University of Edinburgh in Scotland. Edinburgh was one of the few universities in the English-speaking world that offered a systematic natural history curriculum. There, Dawson learned geology, physical geography, and mineralogy from Robert Jameson; botany from John Hutton Balfour; and chemistry from William Gregory. Although Dawson remained fiercely proud of his birthplace and sensitive to any charges of hailing from the “backwoods,” Nova Scotia must have seemed impoverished compared to the rich tapestry of life in Edinburgh.

Financial difficulties took him back to Pictou to help with the family bookselling business, but in 1841 he returned to Edinburgh to continue his studies and court his future wife, Margaret Ann Young Mercer, a distant cousin and daughter of a lace merchant. On the transatlantic voyage, Dawson met William Logan, who was about to become director of the Geological Survey of Canada. A few years later, Dawson guided Logan on a geological tour of the countryside, as he did Charles Lyell, showing both distinguished geologists the coalfields near Pictou, the cliffs of the Shubenacadie River, deposits at the Bay of Fundy, and the shores of the Minas Basin. Dawson maintained a cordial relationship with Logan, but he became the lifelong protegé, confidant, and disciple of Lyell. Lyell assisted in publishing Dawson’s work on the geology and paleontology of Nova Scotia, New Brunswick, and Prince Edward Island with the Geological Society of London.

More History

The GSA History of Geology Division will sponsor Symposium 14, Hutton, Lyell, Logan—and their Influence in North America, at the 1998 GSA Annual Meeting in Toronto. The symposium is scheduled for Monday afternoon, October 26. Susan Sheets-Pyenson was scheduled to speak in that session.
STARTING A CAREER

Upon his return to Nova Scotia in 1847, after the completion of a second academic session at the University of Edinburgh, Dawson sought to enlarge the sphere of his interests beyond the book-selling business. He was hired by the General Mining Association of London to conduct a geological survey of Cape Breton, and he investigated coal and other mineral deposits for the provincial government and for small mining companies.

Dawson also turned his talents to educational matters. He lectured on natural history to the Pictou Academy, the Halifax Mechanics’ Institute, and Dalhousie College. From 1850 to 1853, he traveled the length and breadth of Nova Scotia as its first superintendent of education.

His devotion to the task was so complete that he is credited with single-handedly reforming the public-education system of the province. At the same time, he managed to continue his scientific investigations on the side, leading to some of his most important paleontological discoveries. These include unearthing a fragment of a skeleton of the earliest North American Carboniferous reptile or batrachian (Dendrepeton acadianum), the oldest land snail (Pupa vetusta), and the oldest millipede (Xylobius sigillariæ), and to the first report of Devonian plants.

Dawson’s investigations into the geology and mineral deposits of Nova Scotia provided data for his magnum opus, Acadian Geology, in 1855 (2nd ed., 1868; 3rd ed., 1880; 4th ed., 1891). This work, the most complete treatment of the geology of the maritime provinces, was but slightly modified by the findings of the Geological Survey years later. Acadian Geology made Dawson’s reputation as a geologist of the first rank.

LATER GEOLOGIC STUDIES

Despite the extraordinary demands on Dawson’s time from his administrative responsibilities, his unceasing field work, first in Nova Scotia and later in Quebec, increased the number of post-Pliocene fossils known in Canada from about 30 to more than 200. He often suggested to his scientific adversaries that they leave their armchairs and cabinets and observe specimens in situ. He helped to perfect the examination of thin fossil slices using a microscope, a technique that allowed him to describe 125 new species of Paleozoic plants. His own collection of Canadian rocks and fossils formed the nucleus of the holdings of the Peter Redpath Museum, which in 1882 was donated to McGill in Dawson’s honor.

Dawson’s scientific reputation rests upon his work in paleobotany. He investigated Canadian formations stretching from the maritimes to the west (culminating in his Geological History of Plants, 1888), and he published several papers on the subject every year. Dawson has been called the grandfather of Paleozoic paleobotany in North America. His scientific legacy also includes pioneering work in Canadian geology, particularly for the eastern provinces and the St. Lawrence River valley.

CONTROVERSIES

Despite Dawson’s claim to follow “a quiet middle course” in his scientific work, he loved to plunge into the heat of scientific controversy. He attracted both vehement critics and adoring acolytes for his outspoken denunciation of Darwinian evolution. He had discovered and named the puzzling Eozoon canadense in 1864, a fragment that appeared to be a foraminifer. For the rest of his life, he argued that the specimen proved the presence of animal life in the Laurentian rocks. Controversy continued for decades, despite mounting evidence of inorganic composition for this pseudofossil.

His contributions to paleozoology also invited debate, as they treated a variety of organisms, ranging from the lowest forms of life to prehistoric man (in Fossil Men, 1880). Finally, his work on Devonian plants, featured in his controversial Bakerian lecture to the Royal Society of London in 1870, never won universal respect by his contemporaries. Three-quarters of a century later, discovery of plant remains in the Rhymie Chest of Scotland supported his great discovery.

REWARDS

Dawson accumulated many scientific honors and awards. He became a fellow of the Geological Society of London in 1854, and of the Royal Society of London in 1862. He successfully lobbied for the formation of a national scientific organization, thereby leading to the creation of the Royal Society of Canada in 1882, for which he served as the first president. He brought both the American and British Association for the Advancement of Science to meet in Montreal. His firm guidance was felt in the affairs of the Geological Survey of Canada and in those of myriad scientific societies, especially the Natural History Society of Montreal. He presided over the American Association for the Advancement of Science meeting at Montreal in 1882 and over the British association’s meeting in Birmingham, England, in 1886. He was knighted in 1884, becoming Sir William Dawson. In 1893, he became the fifth president of the Geological Society of America. His eldest son, George Mercer Dawson, became Canada’s leading field geologist and director of the Geological Survey of Canada; he also served as 12th president of the Geological Society of America.

FOR FURTHER READING

Kai S. Anderson has been chosen as the 13th GSA Congressional Science Fellow. He will work as a special legislative assistant on the staff of a committee or member of the U.S. Congress from September 1998 through August 1999.

Anderson was born and raised in rural northeast Oregon. He graduated valedictorian of La Grande High School and was named Oregon Elks Student of the Year in 1989. He then enrolled at Stanford University to pursue his interests in geoscience and public policy. In 1991, he received a Barry M. Goldwater Science and Mathematics Scholarship to pursue undergraduate research concerning siliceous sinter deposits of Yellowstone National Park. He spent a term at Stanford's Washington, D.C., campus, where he researched energy and environmental policy issues while interning at Conservation International. In 1993, he graduated Phi Beta Kappa with a Bachelor of Science degree in geology. His Ph.D. research, also at Stanford, focuses on the facies architecture of turbidite systems.

Anderson said that he views the GSA Congressional Science Fellowship as a tremendous honor. He expects that the fellowship will provide an opportunity to contribute to, and learn from, integrating science into the public policy-making process. He said that he hopes the fellowship experience will help him become a geoscientist who can help dispel some of the mystery that surrounds the science-policy nexus.

The Fellowship

The GSA Congressional Science Fellowship provides an unparalleled opportunity for a geoscientist to apply scientific and technical expertise to a wide range of policy issues as a staff member in a congressional or committee office. Funded by GSA and a grant from the U.S. Geological Survey, the fellowship demonstrates the value of science-government interaction and enhances involvement of the earth science community in the public policy arena. The program places highly qualified, accomplished scientists, engineers, and other professionals with the offices of individual members of Congress and committees for a one-year assignment. Fellows perform in much the same way as regular staff members; they have the opportunity to be involved in varied legislative, oversight, and investigative activities. They offer their special knowledge, skills, and competence for the opportunity to acquire experience and the chance to contribute to the formulation of public policy. In addition, the fellow reports periodically to the GSA membership and to the U.S. Geological Survey on geoscience issues facing the U.S. Congress, and the positive roles available for all earth scientists in policy formulation.

To prepare for their assignments, fellows attend a two-week orientation conducted by the American Association for the Advancement of Science. Fellowship requirements include exceptional competence in some area of the earth sciences, cognizance of a broad range of issues outside the fellow's particular area, and a strong interest in working on a range of public policy programs.

The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

CRITERIA

The program is open to highly qualified Ph.D. earth scientists. Candidates are expected to show exceptional competence in some area of the earth sciences, have a rather broad professional background, be cognizant of many matters outside their particular area, and have a strong interest and some experience in applying scientific knowledge toward the solution of societal problems.

AWARD

The 1999–2000 GSA Congressional Science Fellow will receive a one-year stipend of $42,000, or $56,000 for 16 months. The Fellow will also receive limited allowances for health insurance, relocation, and travel. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (The fellowship is available only to U.S. citizens, and employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact the AAAS, or the Geological Society of America.)

TO APPLY

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from:

Executive Director
Congressional Science Fellowship
Geological Society of America
P.O. Box 9140
Boulder, CO 80301

Deadline for receipt of all application materials is February 1, 1999.
Air Travel

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**FUNDING OPPORTUNITIES IN THE HYDROLOGIC SCIENCES THROUGH THE NATIONAL SCIENCE FOUNDATION**

Wednesday, October 28 from 3:00 to 5:00 p.m., Room 716B, Metro Toronto Convention Centre.

Presiding: L. Douglas James, Program Director, National Science Foundation (NSF), Hydrologic Sciences

Have a great hypothesis? Need funding? Unsure about funding mechanisms? If so, you need to attend this session. The session will begin with opening remarks by James on current funding opportunities in the hydrologic sciences, followed by an open question-answer-discussion period. If you’re nearing completion of your Ph.D., in a post doctorate position, struggling to achieve tenure, or just looking for new opportunities, then you need to take advantage of this chance to meet and question the program director of a major source of funding in the hydrologic sciences. Don’t be shy, come to learn or come prepared with specific questions, comments, and/or concerns about current and future research funding in our field.

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**Late-Breaking Research Sessions**

**Exciting new data or breakthroughs over the summer?**

Present your work at the GSA Annual Meeting this fall!

Special instructions for submitting an abstract for the Late-Breaking Research Sessions:

- An abstract on late-breaking research may be submitted electronically after September 1 until midnight, September 30, 1998.
- Abstracts may not be submitted on paper or by e-mail; they must be submitted using the Web form: http://www.geosociety.org/meetings/98.
- Space will be limited and selection will be based on scientific merit.
- The author must provide a brief explanation of why the abstract deserves consideration after the usual deadline for this meeting.
- The presentation will be poster mode only, and will be put with the appropriate discipline poster session. These posters will be announced as “Late-Breaking Research,” with booth number, at poster session entrances.
- Because of scheduling limitations, the policy is that only one volunteered paper may be presented in either oral or poster mode for the overall meeting. If you already had a volunteered abstract accepted, please do not submit another—even if the second one is “news.”

**Abstract Fee:** For this meeting, a nonrefundable abstract fee of $50 must accompany each Late-Breaking Research abstract submitted. Our Web-template form will ask for credit-card information. Our secure server system for transmission of your credit-card data will fully protect your confidential information.

**Schedule:** Abstracts will be reviewed by the Technical Program Chairs for 1998 and 1999. Electronic acceptance notices will be sent out the first week in October with the place and time of presentation. The date and time will depend on where your paper best fits scientifically. We will try to provide a time for your paper together with others of similar relevance.

**Publication:** These abstracts will be published on the Web along with the other annual meeting abstracts, and paper copies will be made available on site in Toronto. They will not be published in the Abstracts with Programs volume.
UNIVERSITY OF TORONTO

The University of Toronto is currently celebrating 150 years of teaching and research in geology. The Department was founded in 1853 - Canada's first - but teaching programs predate that event by several years. The University has been ranked in several recent surveys as Canada's pre-eminent research-intensive institution of higher learning, and the Department of Geology is recognized internationally for the breadth and strength of its faculty. Programs in geophysics and in geological engineering (the Lassonde Minerals Engineering Program) complement those in the Department of Geology.

MCMASTER UNIVERSITY

At McMaster University, our purpose is the discovery, communication, and preservation of knowledge. In our teaching, research, and scholarship, we are committed to creativity, innovation, and excellence. We value integrity, quality, and teamwork in everything we do. We inspire critical thinking, personal growth, and a passion for learning. We serve the social, cultural, and economic needs of our community and our society.

CANACCORD CAPITAL

Founded in 1950, Canaccord Capital is one of Canada's largest independent investment firms, recognized as a leader in equity financing for resource, technology, and special situation companies, both North American and internationally based. With principal offices in Toronto, Vancouver, and Calgary, and affiliated partners in the United States, Britain, and Bermuda, Canaccord Capital offers a full range of professional investment services including corporate finance, research, institutional equities, international trading, and private client services.

CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM (CIM)

The Canadian Institute of Mining, Metallurgy, and Petroleum (CIM) is the leading technical society of professionals in the Canadian minerals, metals, and energy industries. Founded in 1898, CIM has 12,000 members dedicated to the discovery, production, and economics of Canada's minerals, metals, materials, and energy industries. Along with 60 coast-to-coast branches and sections, CIM's Societies, Divisions and Committees arrange conferences, meetings and courses, liaise with government departments, commission special volumes and reports, and publish technical papers. CIM website: www.cim.org

THE GEOLOGICAL SURVEY OF CANADA

The Geological Survey of Canada (GSC) supplies the fundamental national geoscience knowledge base required to support effective mineral and hydrocarbon exploration and development across Canada; to provide the geological basis necessary to understand and address health, safety and environmental issues; and to advocate the interests of Canadian geoscience at the international level.

MINERALOGICAL ASSOCIATION OF CANADA

The Mineralogical Association of Canada was incorporated to promote and advance knowledge of mineralogy in its broadest sense. To this end, the Association publishes The Canadian Mineralogist and sponsors short courses devoted to specific aspects of mineralogy, petrology, geochemistry, mineral deposits, and crystallography. We invite you to visit our booth at GSA 1998.

ROYAL ONTARIO MUSEUM

Founded in 1914, the Royal Ontario Museum (ROM) has attained international recognition for its collections and the scope of its worldwide field activities. The ROM is Canada's largest museum, having over 40 galleries featuring artistic, archaeological, and scientific objects from around the world. Our new exhibit, “Monsters from the Deep Past,” featuring Burgess Shale and Ontario fossils, opens in time for your visit, October 21.

INTERNATIONAL GEOLOGICAL SURVEYS ATTEND 1998 GSA ANNUAL MEETING

The 1998 International Survey Program (ISP) Committee has invited national surveys worldwide to participate in the GSA Annual Meeting. Thirty delegates from 20 surveys will participate in various programs throughout the week.

International Survey Exhibits will focus on environmental developments in various countries. Sunday, 5:00 p.m. to 7:30 p.m.; Monday, Tuesday, and Wednesday, 9:00 a.m. to 5:30 p.m., MTCC Hall D, Booths 936 to 1144.

International Surveys Posters Symposium 30: Global Earth Science. Monday, 8:00 a.m. to 12:00 noon., MTCC Hall E. GSA extends a special welcome to delegates from the following international geological surveys and to all international registrants to the 1998 Annual Meeting in Toronto: Argentina, Australia, Austria, Bolivia, Brazil, Burkina Faso, Canada, Cote d'Ivoire, Ecuador, Finland, France, Ireland, Japan, Morocco, Norway, Peru, Slovak Republic, Ukraine.


For more information please contact Blyth Robertson, co-chair of the International Program Committee, (613) 996-6575 or e-mail bRobert@nrcan.gc.ca.

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**Overview of the 1998 GSA Annual Meeting Program**

**October 26–29, 1998** Metro Toronto Convention Centre

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**GSA TECHNICAL SESSIONS ON THE WEB — SEPT. 1**

The titles and authors database is now available on the Web. You can download sessions, events, exhibits, field trips, and courses together with a basic search and sorting software that will create your personal daily calendar. Web site: [http://www.geosociety.org/meetings/98](http://www.geosociety.org/meetings/98)

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**Technical Session Program Calendar — 1998**

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<td>8:00 a.m.</td>
<td>S08. Research Issues in Petroleum and Environmental Organic Geochemistry I — GS (Organic Geochemistry Division)</td>
<td>MTCC:801AB</td>
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<tr>
<td>2</td>
<td>1:30 p.m.</td>
<td>S05. The Voisey's Bay Ni-Cu-Co Deposit — SEG; 1998 Annual Meeting Committee</td>
<td>MTCC:718AB</td>
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<tr>
<td>3</td>
<td>1:30 p.m.</td>
<td>S08. Research Issues in Petroleum and Environmental Organic Geochemistry II — GS (Organic Geochemistry Division)</td>
<td>MTCC:801AB</td>
</tr>
<tr>
<td>4</td>
<td>1:30 p.m.</td>
<td>S15. IEE Annual Environmental Forum: The Sustainability Challenge: Energy for the 21st Century — IEE and GSA ad hoc Committee on Critical Issues</td>
<td>MTCC:715AB</td>
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### MONDAY, OCTOBER 26, 1998

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<td>5</td>
<td>8:00 a.m.</td>
<td>Archaeological Geology I</td>
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<td>6</td>
<td>8:00 a.m.</td>
<td>Economic Geology I</td>
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<td>7</td>
<td>10:00 a.m.</td>
<td>Geochemical Society: Ingerson Lecture</td>
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<tr>
<td>8</td>
<td>8:00 a.m.</td>
<td>Hydrogeology I: Water Quality, Isotopes, Remediation</td>
<td>MTCC:703</td>
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<td>9</td>
<td>10:00 a.m.</td>
<td>Igneous Petrology I</td>
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<tr>
<td>10</td>
<td>8:00 a.m.</td>
<td>Micropaleontology (Posters)</td>
<td>MTCC:Hall E</td>
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<td>11</td>
<td>8:00 a.m.</td>
<td>Paleontology (Posters)</td>
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<td>12</td>
<td>8:00 a.m.</td>
<td>Paleontology/Paleobotany I: Paleobiological Dynamics from the Terrestrial Realm</td>
<td>MTCC:801AB</td>
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<td>13</td>
<td>8:00 a.m.</td>
<td>Paleontology/Paleobotany II: Evolutionary Paleoecology from Biofacies to Stable Isotopes</td>
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<td>14</td>
<td>8:00 a.m.</td>
<td>Regional-Scale Faulting</td>
<td>MTCC:717AB</td>
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<td>15</td>
<td>8:00 a.m.</td>
<td>Volcanology</td>
<td>MTCC:709</td>
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<tr>
<td>16</td>
<td>8:00 a.m.</td>
<td>K01. Tectonic Evolution of Precambrian North America I — A Synthesis of Recent Results — LITHOPROBE; GSA Geology and Geodynamics Division; GSA Geophysics Division; 1998 Annual Meeting Committee</td>
<td>MTCC:718AB</td>
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<tr>
<td>17</td>
<td>8:00 a.m.</td>
<td>S02. Controls on Sedimentation and Stratigraphy in Major Coal Producing Basins of North America — GSA Coal Geology Division</td>
<td>MTCC:712</td>
</tr>
<tr>
<td>18</td>
<td>8:00 a.m.</td>
<td>S07. Military Applications of Engineering Geology — GSA Engineering Geology Division</td>
<td>MTCC:716A</td>
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<td>19</td>
<td>8:00 a.m.</td>
<td>S23. North American Ice Sheets during Marine Isotope Stages 3 to 1: Extent, Chronology, Data and Modelling — GSA Quaternary Geology and Geomorphology Division</td>
<td>MTCC:802AB</td>
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<tr>
<td>20</td>
<td>8:00 a.m.</td>
<td>S26. Paleocological and Geochemical Signature of Cretaceous Anoxic Events: A Memorial to William V. Sliter — CF and 1998 Annual Meeting Committee</td>
<td>MTCC:803AB</td>
</tr>
<tr>
<td>21</td>
<td>8:00 a.m.</td>
<td>S30. International Surveys (Posters) — International Subcommittee and 1998 Annual Meeting Committee</td>
<td>MTCC:Hall E</td>
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**KEY TO ORGANIZATIONS SPONSORING SESSIONS**

- AGI: American Geological Institute
- AGU: American Geophysical Union
- CF: Cushman Foundation
- CGU: Canadian Geophysical Union
- GIS: Geoscience Information Society
- GS: Geological Society
- GAC: Geological Association of Canada
- GSC: Geological Society of Canada
- IAGC: Institute for Environmental Education International Association of Geochemistry and Cosmochemistry
- IIGCP: International Geological Correlation Program
- IUGS: International Union of Geological Sciences
- IGCP: International Geoscience Program
- IAG: International Association of Geomorphology
- NAGT: National Association of Geoscience Teachers
- NRC: National Research Council
- NSF: National Science Foundation
- NS: National Academy of Sciences
- SEG: Society of Economic Geologists
- SEPM: Society of Sedimentary Geology
- SLMS: Society of Luminescence Microscopy and Spectroscopy
- SVP: Society of Vertebrate Paleontology
- USDOE: U.S. Department of Energy
- USGS: U.S. Geological Survey

GSA Today, September 1998
# | Time | Sponsor/Description                                                                                                                                                                                                 | Location    |
---|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
21 | 8:00 a.m. | T02. Natural Sources of Mercury and Arsenic: Significance in Regional Cycles and Environmental Assessments—IIE                                                                                                           | MTCC:716B   |
22 | 8:00 a.m. | T09. Luminescence in Geology: 10th Anniversary Meeting of Society of Luminescence Microscopy and Spectroscopy—SLMS                                                                                                       | MTCC:701A   |
23 | 8:00 a.m. | T11. Breaking Down Barriers: Communicating Relevant Geoscience Issues to the Public I (Posters)—GSA Education, Outreach and Policy Programs and IEE                                                                            | MTCC:Hall E |
24 | 8:00 a.m. | T20. Controls on the Style, Distribution, and Intensity of Deformation Around Faults and Folds—GSA Structural Geology and Tectonics Division                                                                              | MTCC:711    |
25 | 8:00 a.m. | T34. Terrestrial Records of Late-Glacial and Holocene Climate Change in the Americas                                                                                                                                   | MTCC:701B   |
26 | 10:00 a.m. | T44. Groundwater Sustainability—GSA Hydrogeology Division and IEE                                                                                                                                                    | MTCC:714AB  |
27 | 8:00 a.m. | T45. Capture Zones in Fractured Rock—GSA Hydrogeology Division and GSA Engineering Geology Division                                                                                                                    | MTCC:714AB  |
28 | 1:30 p.m. | Climates, Oceans and Lakes of the Quaternary                                                                                                                                                                           | MTCC:709    |
29 | 1:30 p.m. | Cordillera I: USA                                                                                                                                                                                                     | MTCC:707    |
30 | 1:30 p.m. | Economic Geology II                                                                                                                                                                                                   | MTCC:705    |
31 | 1:30 p.m. | Environmental and Engineering Geology                                                                                                                                                                                 | MTCC:703    |
32 | 1:30 p.m. | Geochemistry (Posters)                                                                                                                                                                                                | MTCC:Hall E |
33 | 1:30 p.m. | Geochemistry, Aqueous (Posters)                                                                                                                                                                                        | MTCC:Hall E |
34 | 1:30 p.m. | Geoscience Information Society (Posters)                                                                                                                                                                               | MTCC:Hall E |
35 | 1:30 p.m. | Igneous Petrology II                                                                                                                                                                                                   | MTCC:711    |
36 | 1:30 p.m. | Paleontology/Paleobotany III: Paleobiological Patterns: Phylogenetics and Morphological Constraints                                                                                                                     | MTCC:701B   |
37 | 1:30 p.m. | Precambrian Geology (Posters)                                                                                                                                                                                          | MTCC:Hall E |
38 | (See Monday a.m., p. 19) |                                                                                                                                                                                                                     |             |
39 | 1:30 p.m. | S09. Geochemical Indicators of Atmospheric Inputs into Terrestrial and Marine Environments—GS                                                                                                                                 | MTCC:701A   |
40 | 1:30 p.m. | S14. Hutton, Lyell, Logan — and Their Influence in North America—GSA History of Geology Division                                                                                                                       | MTCC:716A   |
41 | 1:30 p.m. | S18. Deformation Mechanisms and Microstructures—GSA Structural Geology and Tectonics Division                                                                                                                           | MTCC:717AB  |
42 | 1:30 p.m. | S28. Multimodal Heterogeneity in Clastic Aquifers: Quantifying Permeability and Lithofacies Distributions—GSA Hydrogeology Division and SEPM                                                                            | MTCC:714AB  |
43 | 1:30 p.m. | S29. Breaking Down Barriers: Communicating Relevant Geoscience Issues to the Public—GSA Education, Outreach and Policy Programs                                                                                         | MTCC:712    |
44 | 1:30 p.m. | T19. Geophysical Studies of the Crust and Lithosphere—GSA Geophysics Division; GSA Structural Geology and Tectonics Division                                                                                             | MTCC:803AB  |
45 | 1:30 p.m. | T24. Tectonic Evolution of Precambrian North America II (Posters)—LITHOPROBE; GSA Structural Geology and Tectonics Division; GSA Geophysics Division; 1998 Annual Meeting Committee | MTCC:Hall E |
46 | 1:30 p.m. | T33. Continental Glaciations: Continuing Debates I                                                                                                                                                                     | MTCC:802AB  |
47 | 1:30 p.m. | T34. Terrestrial Records of Late-Glacial and Holocene Climate Change in the Americas II                                                                                                                                | MTCC:716B   |
48 | 1:30 p.m. | T37. Paleontology Solves Geologic Problems—PS and SVP                                                                                                                                                                 | MTCC:801AB  |
49 | 1:30 p.m. | T49. Hydrogeologic Controls on Ecosystems—GSA Hydrogeology Division and IEE                                                                                                                                             | MTCC:715AB  |

**TUESDAY, OCTOBER 27, 1998**

50 | 8:00 a.m. | Archaeological Geology II                                                                                                                                                                                                  | MTCC:709    |
51 | 8:00 a.m. | Central/Southern Appalachians                                                                                                                                                                                              | MTCC:701B   |
52 | 8:00 a.m. | Economic Geology III                                                                                                                                                                                                        | MTCC:717AB  |
53 | 8:00 a.m. | Geochemistry, Aqueous I                                                                                                                                                                                                     | MTCC:803AB  |
54 | 8:00 a.m. | Geoscience Education (Posters)                                                                                                                                                                                              | MTCC:Hall E |
55 | 8:00 a.m. | Microstructures                                                                                                                                                                                                                 | MTCC:707    |
56 | 8:00 a.m. | Quaternary Geology and Geomorphology (Posters)                                                                                                                                                                               | MTCC:Hall E |
57 | 10:00 a.m. | SEG Distinguished Lecture                                                                                                                                                                                                   | MTCC:717AB  |
58 | 8:00 a.m. | Stratigraphic Correlation, Models, Cycles, and Architecture                                                                                                                                                                 | MTCC:705    |
59 | 8:00 a.m. | K03. Geology and Biology of Early Animal Evolution—PS                                                                                                                                                                         | MTCC:718AB  |
60 | 8:00 a.m. | S16. Research Opportunities in the Earth Sciences: A Ten-Year Vision—NRC; NSF                                                                                                                                                | MTCC:703    |
61 | 8:00 a.m. | S19. Accretionary Margins of North America—CF                                                                                                                                                                                | MTCC:716B   |
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<td>8:30 a.m.</td>
<td>S21. Experimental Petrology and Applications: A Tribute to 35 Years of Research in</td>
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<td>the Goldsmith-Newton Laboratory at the University of Chicago—MSA; GS</td>
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<td>63</td>
<td>8:00 a.m.</td>
<td>T06. Geomicrobiology I</td>
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<td>64</td>
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<td>T11. Breaking Down Barriers: Communicating Relevant Geoscience Issues to the Public</td>
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<td>II—GSA Education, Outreach and Policy Programs and IEE</td>
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<tr>
<td>65</td>
<td>8:00 a.m.</td>
<td>T24. Tectonic Evolution of Precambrian North America III—LITHOPROBE; GSA Structural</td>
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<td>Geology and Tectonics Division; GSA Geophysics Division; 1998 Annual Meeting Committee</td>
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<td>66</td>
<td>8:00 a.m.</td>
<td>T31. The Power of Paleolimnology: State of the Art and Future Directions (Posters)</td>
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<td>T33. Continental Glaciations: Continuing Debates II</td>
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<td>68</td>
<td>8:00 a.m.</td>
<td>T35. Holocene Climate Change on the Great Plains—GSA Quaternary Geology and</td>
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<td>Geomorphology Division; Terrain Sciences Division, GSC; Global Change and Climate</td>
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<td>69</td>
<td>8:00 a.m.</td>
<td>T41. Geological Evolution of Mexico: Its Relation to Conterminous North America</td>
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<td>T46. Solute Transport in Aquitards: Field Studies—GSA Hydrogeology Division</td>
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<td>Coal Geology (Posters)</td>
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<td>Cordillera II: Alaska/Canada and South America</td>
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<td>73</td>
<td>3:30 p.m.</td>
<td>Cretaceous and Tertiary Stratigraphy: Sequences, Volcanism, Paleomagnetism, and</td>
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<td>Impacts</td>
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<td>74</td>
<td>1:30 p.m.</td>
<td>Environmental and Engineering Geology (Posters)</td>
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<td>1:30 p.m.</td>
<td>Geochemistry I</td>
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<td>76</td>
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<td>Geochemistry, Aqueous II</td>
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<td>77</td>
<td>5:00 p.m.</td>
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<td>Impact and Volcanism: Sudbury and Beyond!</td>
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<td>80</td>
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<td>Northern Appalachians and Caledonides</td>
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<td>81</td>
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<td>Patterns and Processes of Siliciclastic Basin Fill</td>
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<td>S04. Accreting the Continent's Collections of Earth Science Information—GIS</td>
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<td>S10. Developing Sustainability Curricula: A Challenge for Earth Sciences Educators—</td>
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<td>S11. Student Research Symposium (Posters)—SGE</td>
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<td>S13. Conversations with the Earth: Philosophers and Geoscientists in Dialogue on the</td>
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<td>Role of the Earth Sciences in Society—IIE and International Association for Environmental Philosophy</td>
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<td>5:30 p.m.</td>
<td>S27. Understanding Ground Water in Arid and Semi-Arid Environments of North America and Australia—</td>
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<td></td>
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<td>GSA Hydrogeology Division; The University of Texas at Austin; Flinders University of South Australia; Centre for Groundwater Studies; Duke Engineering and Services; Sinclair Knight Merz</td>
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<td>89</td>
<td>1:30 p.m.</td>
<td>T06. Geomicrobiology II</td>
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<td>1:30 p.m.</td>
<td>T08. Continent Formation, Growth, and Recycling I</td>
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<td>91</td>
<td>1:30 p.m.</td>
<td>T15. Education About the Environment: What Works (Posters)—NAGT and IEE</td>
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<td>T17. Crustal Evolution and Historical Studies of American Geology—GSA History of Geology Division</td>
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<td>T22. What Are We Dating? Understanding the Crystallogenesis of U-Pb Geochronometers—</td>
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<td>GSA Structural Geology and Tectonics Division</td>
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<td>1:30 p.m.</td>
<td>T32. On the Nature and Origin of Stone Lines and Lithologic Discontinuities in</td>
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<td>Sediments and Soils—GSA Quaternary Geology and Geomorphology Division</td>
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<td>1:30 p.m.</td>
<td>T35. Holocene Climate Change on the Great Plains II—GSA Quaternary Geology and</td>
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<td>Geomorphology Division; Terrain Sciences Division, GSC; Global Change and Climate</td>
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<td>History Program, USGS</td>
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<td>8:00 a.m.</td>
<td>Archaeological Geology (Posters)</td>
<td>MTCC:Hall E</td>
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<td>97</td>
<td>8:00 a.m.</td>
<td>Climates and Oceans before the Quaternary</td>
<td>MTCC:703</td>
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<tr>
<td>98</td>
<td>8:00 a.m.</td>
<td>Geochemistry II</td>
<td>MTCC:705</td>
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<td>99</td>
<td>8:00 a.m.</td>
<td>Hydrogeology II: Hydraulic, Fracture Flow, Karst</td>
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<td>100</td>
<td>8:00 a.m.</td>
<td>Marine Geology (Posters)</td>
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<td>101</td>
<td>8:00 a.m.</td>
<td>Metamorphic Petrology I</td>
<td>MTCC:717AB</td>
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<td>102</td>
<td>8:00 a.m.</td>
<td>Paleontology/Paleobotany IV: Origin and Diversification of Early Life on Earth</td>
<td>MTCC:701A</td>
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<td>103</td>
<td>8:00 a.m.</td>
<td>Structural Geology and Tectonics (Posters)</td>
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<td>104</td>
<td>8:00 a.m.</td>
<td>K04. Deep Crustal Processes I—International Lithosphere Program; GSA Geophysics Division; GSA Structural Geology and Tectonics Division; Geological Association of Canada; Canadian Geophysical Union; International Association of Geomagnetism and Aeronomy; International Association of Seismology and Physics of the Earth's Interior; International Association of Volcanism and Chemistry of the Earth's Interior; American Geophysical Union</td>
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<td>105</td>
<td>8:00 a.m.</td>
<td>S06. The Lac de Gras Diamondiferous Kimberlite Field, Northwest Territories, Canada—SEG</td>
<td>MTCC:801AB</td>
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<td>107</td>
<td>8:00 a.m.</td>
<td>S17. Fault Reactivations, Neotectonics, and Seismicity in the Great Lakes Region I—GAC; GSA Structural Geology and Tectonics Division</td>
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<td>108</td>
<td>8:00 a.m.</td>
<td>S25. Response to Holocene Climate Change on the Great Plains—GSA Quaternary Geology and Geomorphology Division; Terrain Sciences Division, GSC; Global Change and Climate History Program, USGS</td>
<td>MTCC:802AB</td>
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<td>109</td>
<td>8:00 a.m.</td>
<td>T05. Landslides and Engineering Geology—GSA Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division</td>
<td>MTCC:709</td>
</tr>
<tr>
<td>110</td>
<td>8:00 a.m.</td>
<td>T07. Sources, Transport, Fate and Toxicology of Trace Elements in the Environment—IAGC, in memory of Helen L. Cannon</td>
<td>MTCC:701B</td>
</tr>
<tr>
<td>111</td>
<td>10:00 a.m.</td>
<td>T10. Field Camp Pedagogies: Adjusting to Modern Equipment and the Modern Student</td>
<td>MTCC:712</td>
</tr>
<tr>
<td>112</td>
<td>8:00 a.m.</td>
<td>T29. Tonalites, Trondhjemites, and Granodiorites and Related Rocks: Ancient Examples and Modern Analogues</td>
<td>MTCC:714AB</td>
</tr>
<tr>
<td>113</td>
<td>8:00 a.m.</td>
<td>T30. Environments and Timing of the Last Interglaciation: Vegetation, Paleohydrology, and Climate—GSA Quaternary Geology and Geomorphology Division</td>
<td>MTCC:707</td>
</tr>
<tr>
<td>114</td>
<td>8:00 a.m.</td>
<td>T31. The Power of Paleolimnology: State of the Art and Future Directions</td>
<td>MTCC:716A</td>
</tr>
<tr>
<td>115</td>
<td>8:00 a.m.</td>
<td>T39. Paleontological Databases and Taxonomic Decisions—PS</td>
<td>MTCC:715AB</td>
</tr>
<tr>
<td>116</td>
<td>8:00 a.m.</td>
<td>T42. Onshore-Offshore Correlation of Cenozoic Strata, Western Margin of North Atlantic (Posters)</td>
<td>MTCC:Hall E</td>
</tr>
<tr>
<td>117</td>
<td>1:30 p.m.</td>
<td>Asian Tectonics</td>
<td>MTCC:703</td>
</tr>
<tr>
<td>118</td>
<td>1:30 p.m.</td>
<td>Epstein Colloquium I</td>
<td>MTCC:701B</td>
</tr>
<tr>
<td>119</td>
<td>1:30 p.m.</td>
<td>Geology Education</td>
<td>MTCC:709</td>
</tr>
<tr>
<td>120</td>
<td>1:30 p.m.</td>
<td>Hydrogeology (Posters)</td>
<td>MTCC:Hall E</td>
</tr>
<tr>
<td>121</td>
<td>1:30 p.m.</td>
<td>Metamorphic Petrology II</td>
<td>MTCC:712</td>
</tr>
<tr>
<td>122</td>
<td>3:30 p.m.</td>
<td>Mineralogy/Crystallography</td>
<td>MTCC:712</td>
</tr>
<tr>
<td>123</td>
<td>1:30 p.m.</td>
<td>Paleocenography/Paleoclimatology (Posters)</td>
<td>MTCC:Hall E</td>
</tr>
<tr>
<td>124</td>
<td>1:30 p.m.</td>
<td>Paleontology/Paleobotany V: Phanerozoic Diversification, Dispersal, and Extinction Patterns</td>
<td>MTCC:701A</td>
</tr>
<tr>
<td>125</td>
<td>1:30 p.m.</td>
<td>Planetary (Posters)</td>
<td>MTCC:Hall E</td>
</tr>
<tr>
<td>126</td>
<td>1:30 p.m.</td>
<td>Precambrian Oil, Sedimentation, Zircon Chronology, and Mafic Magmatism</td>
<td>MTCC:711</td>
</tr>
<tr>
<td>127</td>
<td>1:30 p.m.</td>
<td>Quaternary Geology and Geomorphology I: Fluvial and Hillslope Geomorphology: Channel Erosion, Sediment Transport, and Paleoenvironmental Studies</td>
<td>MTCC:803AB</td>
</tr>
<tr>
<td>128</td>
<td>1:30 p.m.</td>
<td>S17. Fault Reactivations, Neotectonics, and Seismicity in the Great Lakes Region II—GAC; GSA Structural Geology and Tectonics Division</td>
<td>MTCC:716B</td>
</tr>
<tr>
<td>129</td>
<td>1:30 p.m.</td>
<td>S20. Role of Partial Melting During Evolution of Convergent Orogenic Belts—GSA Structural Geology and Tectonics Division</td>
<td>MTCC:714AB</td>
</tr>
<tr>
<td>130</td>
<td>1:30 p.m.</td>
<td>S24. Application of Cosmogenic Nuclides in Surficial Processes and Global Change Studies—GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division</td>
<td>MTCC:802AB</td>
</tr>
<tr>
<td>131</td>
<td>1:30 p.m.</td>
<td>T01. Gold Deposits Associated with Alkaline Rocks—SEG</td>
<td>MTCC:801AB</td>
</tr>
<tr>
<td>132</td>
<td>1:30 p.m.</td>
<td>T06. Geomicrobiology III</td>
<td>MTCC:707</td>
</tr>
<tr>
<td>133</td>
<td>1:30 p.m.</td>
<td>T12. Teaching Hydrogeology to Undergraduate and Graduate Students—GSA Hydrogeology Division; NAGT; GSA Education, Outreach, and Policy Programs</td>
<td>MTCC:716A</td>
</tr>
</tbody>
</table>
134 1:30 p.m. T31. The Power of Paleolimnology: State of the Art and Future Directions II MTCC:715AB
135 1:30 p.m. T38. The End-Permian Mass Extinction: Paleozoic Nemesis MTCC:718AB
136 1:30 p.m. T53. Origin and Transport of Non-Hydrocarbon Gases in Sedimentary Basins MTCC:717AB

THURSDAY, OCTOBER 29, 1998

137 8:00 a.m. Carbonates: Paleoenvironmental Records MTCC:705
138 8:00 a.m. Epstein Colloquium II MTCC:801AB
139 8:00 a.m. Experimental Petrology MTCC:707
140 8:00 a.m. Geophysics: GPR, GPS, Earthquakes, Paleomagnetism, and Tectonics (Posters) MTCC:Hall E
141 8:00 a.m. Hydrogeology III: Karst, Nitrates, Tracers, Aquifers MTCC:715AB
142 8:00 a.m. Mesoscopic Studies of Joints and Faults MTCC:716A
143 8:00 a.m. Paleontology/Paleobotany VI: Evolutionary Paleobiology from Micro- to Macroevolution MTCC:714AB
144 8:00 a.m. Quaternary Geology and Geomorphology II: Tectonic Geomorphology and Soil Geomorphology/Weathering MTCC:716B
145 8:00 a.m. Sedimentary Geology: Stratigraphy, Carbonate and Clastic Deposition, and Diagenesis (Posters) MTCC:Hall E
146 8:00 a.m. K02. Pathfinder and Global Surveyor: New Views of Mars—GSA Planetary Geology Division MTCC:718AB
147 8:00 a.m. S03. Environmental Quality vs. Economic Development: The Role of Coal in Developing Nations—GSA International Division; GSA Coal Division; USGS; GSC; IEE MTCC:703
148 8:00 a.m. S22. Locating Old Mantle Plumes—GSA Geophysics Division; Geophysics Division, GAC; GSA International Division MTCC:701A
149 10:00 a.m. T08. Continental Formation, Growth, and Recycling II MTCC:803AB
150 8:00 a.m. T13. Creating Learning Environments with the Internet and Multimedia I—NAGT and AGI MTCC:711
151 8:00 a.m. T14. Teaching Through Inquiry in the Geosciences I—NAGT and GSA Geoscience Education Division MTCC:712
152 8:00 a.m. T23. Deep Crustal Processes I (Posters)—International Lithosphere Program; GSA Geophysics Division; GSA Structural Geology and Tectonics Division; GAC; CGU; International Association of Geomagnetism and Aeronomy; International Association of Seismology and Physics of the Earth's Interior; AGU MTCC:Hall E
153 8:00 a.m. T25. NAFTA: North American Floating Terrane Accretion—IGCP 376 MTCC:709
154 8:00 a.m. T26. Role of Partial Melting During Evolution of Convergent Orogenic Belts (Posters) MTCC:Hall E
155 8:00 a.m. T27. Applied Geological Remote Sensing—IUGS MTCC:803AB
156 8:00 a.m. T36. Surficial Processes and Landscape Dynamics Within Arid and Desert Environments—U.S. Army Research Office; Desert Research Institute MTCC:701B
157 8:00 a.m. T48. Radionuclide Transport Experiments at Underground Research Laboratories—USDOE/Yucca Mountain Project MTCC:802AB
158 8:00 a.m. T50. From Continental Shelf to Abyssal Plain—Links Between Sediment Transport and Morphology MTCC:717AB
159 1:30 p.m. Coal Geology MTCC:712
160 1:30 p.m. Economic Geology (Posters) MTCC:Hall E
161 1:30 p.m. Experimental Petrology (Posters) MTCC:Hall E
162 1:30 p.m. Geochemistry, Aqueous: Paleo and Processes MTCC:715AB
163 1:30 p.m. Igneous Petrology (Posters) MTCC:Hall E
164 1:30 p.m. Metamorphic Petrology (Posters) MTCC:Hall E
165 1:30 p.m. Mineralogy/Crystallography (Posters) MTCC:Hall E
166 1:30 p.m. Paleontology/Paleobotany VII: Preservation Anomalies and Refinements to the Record: Taphonomy to Trace Fossils MTCC:701A
167 1:30 p.m. Quaternary Geology and Geomorphology III: Quaternary Glacial Events and Palaeoclimate MTCC:705
168 1:30 p.m. Volcanology (Posters) MTCC:Hall E
169 1:30 p.m. T13. Creating Learning Environments with the Internet and Multimedia II—NAGT and AGI MTCC:707
170 1:30 p.m. T14. Teaching Through Inquiry in the Geosciences II—NAGT and GSA Geoscience Education Division MTCC:711

KEY TO ORGANIZATIONS SPONSORING SESSIONS

AGI American Geological Institute
AGU American Geophysical Union
CF Cushman Foundation
CGU Canadian Geophysical Union
GIS Geoscience Information Society
GAC Geological Association of Canada
GSC Geological Society of Canada
IEC Institute for Environmental Education
IAGC International Association of Geochemistry and Cosmochemistry
IGCP International Geological Correlation Program
IUGS International Union of Geological Sciences
NAGT National Association of Geoscience Teachers
NRC National Research Council
NSF National Science Foundation
PS Paleontological Society
SEG Society of Economic Geologists
SEPM Society of Sedimentary Geology
SGE Sigma Gamma Epilon
SLMS Society of Luminescence Microscopy and Spectroscopy
SVP Society of Vertebrate Paleontology
USDOE U.S. Department of Energy
USGS U.S. Geological Survey
GSASponsored Short Courses

Registration information and course descriptions were published in the June issue of GSA Today. For additional information, contact Edna Collins, GSA headquarters, ecollis@geosociety.org, or see GSA’s Web site, www.geosociety.org. Fees are given in U.S. dollars.

PREREGRISTRATION DEADLINE: SEPTEMBER 18

1. ANALYSIS OF VEINS IN LOW-TEMPERATURE ENVIRONMENTS—INTRODUCTION FOR STRUCTURAL GEOLOGISTS
Saturday, October 24 and Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by GSA Structural Geology and Tectonics Division. FACULTY: David V. Wittscho, John W. Morse, and Wil Lamb, Dept. of Geology and Geophysics, Texas A&M University, College Station, and Zachary D. Sharp, Dept. of Earth and Planetary Sciences, University of New Mexico. Limit: 40. Fee: $290, students $270; includes course manual and lunch both days. CEUs: 1.6.

2. DEFORMATION MECHANICS AND MICROSTRUCTURES
Saturday, October 24, 8:00 a.m. to 5:00 p.m., and Sunday, October 25, 8:00 a.m. to 12:00 noon. University of Toronto. Cosponsored by GSA Structural Geology and Tectonics Division. FACULTY: Janellמינים, Dept. of Geological Sciences, Brown University; Christian Teysier, Dept. of Geology, University of Minnesota; Holger Stunitz, Geology and Paleontology Institute of Basel University, Switzerland. Limit: 30. Fee: $250, students $230; includes course manual, slide set, and lunch on Saturday. CEUs: 1.6.

3. PHASE I ENVIRONMENTAL SITE ASSESSMENTS
Saturday, October 24 and Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by GSA Engineering Geology Division. FACULTY: Raymond C. Kimbrough, Tom Joiner & Associates, Inc., Tuscaloosa, Alabama. Limit: 30. Fee: $225; includes course manual and lunch both days. CEUs: 1.6. Optional exam fee: $90. Optional NREP Study Guide is available for $50.

4. THREE-DIMENSIONAL SEISMIC INTERPRETATION: A PRIMER FOR GEOLOGISTS
Saturday, October 24 and Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. FACULTY: Bruce S. Hart, New Mexico Bureau of Mines and Mineral Resources, Socorro. Limit: 40. Fee: $240, students $220; includes course manual and lunch both days. CEUs: 1.6.

5. ANALYTICAL METHODS AND APPLICATIONS IN PROVENANCE STUDIES OF LITHIC ARTIFACTS
Sunday, October 25, 8:00 a.m. to 5:00 p.m. University of Toronto. Cosponsored by GSA Archaeological Geology Division. FACULTY: Patrick J. Julig, Dept. of Sociology and Anthropology, Laurentian University, Sudbury, Ontario; Darrel G. F. Long, Dept. of Earth Sciences, Laurentian University, Sudbury, Ontario; R. G. V. Hancock, SLOWPOKE reactor facility, Dept. of Chemical Engineering and Applied Chemistry, University of Toronto. Limit: 30. Fee: $220, students $200; includes course manual and lunch both days. CEUs: 0.8.

6. APPLICATIONS OF ENVIRONMENTAL ISOTOPES IN GROUNDWATER STUDIES
Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by GSA Hydrogeology Division. FACULTY: Ramon Aravena, Dept. of Earth Sciences, University of Waterloo, Ontario; Ian D. Clark, Dept. of Geology, University of Ottawa. Limit: 50. Fee: $190, students $170; includes course manual and lunch. CEUs: 0.8.

7. BUCK ROGERS, FIELD GEOLOGIST: 21ST CENTURY ELECTRONIC WIZARDRY FOR MAPPING AND FIELD DATA COLLECTION
Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. FACULTY: John H. Kramer, Condor Earth Technologies, Inc., Sonora, California; Todd T. Fitzgibbon, U.S. Geological Survey, Menlo Park, California. Limit: 35. Fee: $240, students $220; includes course manual and lunch. CEUs: 0.8.

8. DESIGN AND CREATION OF STATE-OF-THE-ART, INTERACTIVE, MULTIMEDIA CD-ROMS FOR USE IN TEACHING GEOLOGY
Sunday, October 25, 8:00 a.m. to 5:00 p.m. University of Toronto. FACULTY: Parvinder S. Sethi, Dept. of Geology, Radford University, Radford, Virginia. Limit: 25. Fee: $230, students $210; includes course manual and lunch. CEUs: 0.8.

9. DETECTING ENVIRONMENTAL EFFECTS USING BENTHIC FORAMINIFERA AND THECAMOEBOIDS
Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by Cushman Foundation. FACULTY: David B. Scott; and Eduard G. Reinhardt, Dept. of Earth Sciences, Dalhousie University, Halifax, Nova Scotia; Francine M. G. McCarthy, Dept. of Earth Sciences, Brock University, St. Catharines, Ontario; R. Timothy Patterson, Dept. of Earth Sciences, Carleton University, Ottawa, Ontario. Limit: 30. Fee: $230, students $210; includes course manual and lunch. CEUs: 0.8.

10. GEOTECHNICAL AND ENVIRONMENTAL APPLICATIONS OF TIME DOMAIN REFLECTOMETRY
Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by GSA Engineering Geology Division. FACULTY: Kevin M. O’Connor, President, GeoTDR, Inc., Apple Valley, Minnesota; Charles H. Dowding, Dept. of Civil Engineering, Northwestern University. Limit: 50. Fee: $190, students $170; includes course manual and lunch. CEUs: 0.8.

11. TEACHING PRACTICAL HYDROGEOLOGY: HOW TO MAKE DO WITH SCANT “REAL WORLD” DATA
Sunday, October 25, 8:00 a.m. to 5:00 p.m. Metro Toronto Convention Centre. Cosponsored by GSA Hydrogeology Division. FACULTY: Donald J. Siegel, Dept. of Earth Sciences, Syracuse University. Limit: 50. Fee: $170, students $150; includes course manual and lunch. CEUs: 0.8.
You are invited to participate in the 1999 Denver Annual GSA meeting where the new programming initiatives will be inaugurated (see GSA Today, October, 1997, p. 19–20 or GSA’s Web site: www.geosociety.org). As GSA enters the next millennium, we ask your help in increasing the vitality and quality of the Annual Meeting through these programming changes. The 1999 Annual Meeting program structure offers new opportunities for effective and dynamic programming, and increases programming flexibility by allowing a mixture of invited and volunteered papers and different session formats. Because the changes to program and procedures are major, we ask that you carefully read the descriptions of the various programming options and procedures before submitting a proposal.

Starting in 1999, the program will consist of Pardee Keynote Symposia, Topical Sessions, Oral and Poster General Sessions, and Hot Topic Sessions at lunch. The current all-invited symposia and all-volunteered theme sessions have been merged to form Topical Sessions that allow a mixture of invited and volunteered abstracts. General sessions with all-volunteered papers remain the same. Lunch time forums on Hot Topics will be continued with more discussion and audience participation. A brief description of Pardee Keynote Symposia and Topical Sessions and instructions for submitting proposals follow. More specific guidelines are available from the GSA Meetings Department, cgriswol@geosociety.org, or on the Web, www.geosociety.org/meetings/99.

PARDEE KEYNOTE SYMPOSIA
These sessions are special events that are of broad interest to the geoscience community. Topics appropriate for these scientific Keynote Symposia are those on the leading edge in a scientific discipline or area of public policy, which address broad fundamental problems, are interdisciplinary, or focus on global problems. The primary criterion for selection is excellence. Selection is on a competitive basis with only four to eight half-day, non-concurrent sessions being offered (one per half day; minimum of one per day). All speakers will be invited. We are striving for a good mix of Pardee Keynote Symposia for each annual meeting that will be of interest to the GSA and Associated Society membership. Funding up to $2000 per Pardee Keynote Symposium is available to help the conveners bring in the very best speakers. Session scheduling commitment will be made to conveners by April 30, 1999.

These sessions are made possible by the generous support of the Joseph T. Pardee Bequest Fund.

Proposal. Proposals must justify why the session should have a “Keynote” stature, have a well-formed plan, discuss the format of the session, and include a tentative list of appropriate, effective speakers. Individuals, GSA Divisions, and Associated Societies may submit proposals.

Deadline. January 6, 1999, mid-night MST, firm deadline. Sorry! No proposals will be accepted after that date. Web submission is required!

Review. After January 6, these proposals will be reviewed by a seven-member panel of Joint Technical Program Committee (JTPC) representatives who broadly cover the major geoscience disciplines. Affiliations with a Division, Associated Society, or other group will not be a factor considered during the review process. Proposals
Denver Program continued from p. 25
not chosen as Pardee Keynote Symposia
will automatically be considered for Topi-
cal Sessions unless the convener indicates
otherwise.

Scheduling. Conveners may indicate
preferred times for the proposed symposia;
however, only one per half day with a mini-
umum of one per day, including Thursday,
will be allowed. In scheduling the Pardee
Keynote Symposia, we will consider what is
best for the entire program and which order
will provide the most effective meeting.
We will consider preferences based on other
programmatic issues. In submitting a Pardee
Keynote proposal, the convener (and any
affiliated group) agrees that any half day,
Monday through Thursday, is acceptable.
If a specific time slot is desired, please submit
a proposal for a Topical Session instead.

TOPOCAL SESSIONS

These sessions are topically focused
with a mix of invited and volunteered
papers. The sessions are designed to pro-
mote the exchange of timely or state-of
the-art information with respect to a cen-
tral topic, and to allow scheduling of
interdisciplinary talks that bear on a spe-
cific topic. Organizers (advocates) may
invite specific papers to ensure a successful
and excellent session. A maximum of four
invited speakers is automatically allowed,
but an advocate may request more invita-
tions with a justification for the larger
number. Volunteered abstracts will be
automatically solicited in GSA Today for all
approved Topical Sessions. Any individual
or group may propose and organize one or
more Topical Sessions.

Proposals. Proposals must include
(1) brief description of the session for pub-
lication (limited to 50 words); (2) rationale
for the session, the number of proposed
invited speakers (names of prospective
invited speakers may be included), and a
justification for the number of invited
speakers if more than four are proposed;
(3) program format or relationship to
other potential sessions (see below). Three
scientific discipline categories should be
selected; the JTPC representatives for these
categories will serve as reviewers of the
proposals. The first category
selected by the advocate will determine
which JTPC representative is responsible
for the program and which category should
be checked on the abstract form. Sponsor-
ship by an organization is not necessary.

Deadline. January 6, 1999, mid-
night MST; firm deadline. Sorry! NO
proposals will be accepted after that
date. Web submission is required.

Review. These proposals will be
reviewed by the Technical Program Chairs
(TPC). Proposals with more than four
invited speakers will be reviewed by two
JTPC representatives; the 1999 Technical
Program Chair and the Annual Program
Committee will make the final decision.

It is essential that proposals be submitted
by January 6, 1999.

Organization. After acceptance,
the advocates will formally invite speakers
who will ensure a dynamic session, and
are encouraged to solicit additional vol-
unteered contributions. In addition, the
“Call for Papers” in GSA Today and other
GSA mailings will request volunteered
abstracts for both the Topical and General
Sessions. Final scheduling of abstracts is
the responsibility of the advocate and
appropriate JTPC representative.

Please note: Because of the review
process, proposals for Pardee Keynote
Symposia and Topical Sessions must be
made using the 1999 submittal form!

Electronic submission is necessary.
The form will be available on the Web by
November 1, 1998, at www.geosociety.org/
meetings/98. Questions? Contact us by
phone, (303) 447-2020, ext. 133, or
e-mail, meetings@geosociety.org.

SESSION FORMAT

Flexible and creative programming is
couraged for both the Pardee Keynote
Symposia and Topical Sessions. A Topical
Poster and/or Oral Session related to a
Keynote Symposium or a combination of a
Topical Oral followed by Poster Session is
couraged. Such combinations should be
outlined in the proposals. In general, each
session should have a different primary
advocate or convener.

Organizers are encouraged to have
one or more of the invited speakers pre-
sent an overview of the topic at the begin-
ing of the session that would be of inter-
est and understandable to fellow scientists
who are not in the specialty field but nev-
evertheless are interested in the topic. This
type of overview presentation will be so
designed in the program and should be
given by well-regarded, effective speakers.

Different or new formats are allowed,
but they must be stated in the proposal
along with the technical support needs.
Formats that promote discussion are
encouraged. See specific guidelines for
more information.

We strongly encourage you to partici-
pate in the 1999 Denver GSA Annual
Meeting! The new program structure is
more flexible and designed to encourage
excellence in programming. Special Topi-
cal Session organizers now have the ability
to ensure a successful, excellent program,
and everyone may contribute papers to
sessions with invited speakers. The new
Pardee Keynote Symposia expand the
opportunity for high-profile sessions on
significant scientific developments that
impact our science. Help us make the GSA
Annual Meeting an increasingly dynamic
and stimulating meeting that appeals to
a wide audience. For more information,
contact the GSA Meetings Department,
cgriswol@geosociety.org or www.
geosociety.org/meetings/99.
Preliminary Announcement and Call for Papers

SOUTH-CENTRAL SECTION, GSA
33rd Annual Meeting

Lubbock, Texas
March 15–16, 1999

The Department of Geosciences of Texas Tech University in conjunction with the Departments of Economics and Geography, Civil Engineering, and Plant and Soil Science will host the 1999 annual meeting of the South-Central Section of the Geological Society of America. The meeting will be held from Sunday evening, March 14, through Tuesday, March 16, at the Holiday Inn Civic Center in Lubbock, Texas. Both premeeting and postmeeting field trips are scheduled.

LOCATION

Lubbock is on the Southern High Plains, the largest plateau in North America. It is the hub of a diverse agricultural industry, and therefore is the focus of research relating to environment, water supply and quality, climate effects, and waste disposal. It lies at the intersection of Interstate 27 and U.S. highways 62, 82, and 84. Inexpensive air connections can be made via Southwest, American, Continental, and Delta.

Lubbock is also the location of the world-class Lubbock Lake Site, a Texas State Park and museum that preserves a 12,000-year record of habitation, the longest continuous record known in North America. Other locations of interest to visitors include the Museum of Texas Science and the Ranching Heritage Center. Lubbock is also home to three award-winning wineries that are open for touring and wine tasting.

CALL FOR PAPERS

Papers are invited for presentation in oral sessions, symposia, and poster sessions. Oral presentations will be 15 to 20 minutes in length. Poster sessions will be set up for four hours, and authors will be available for two hours. Volunteered abstracts not included in symposia will be scheduled for regular technical sessions. Anyone wishing to organize a symposium should contact James Barrick at Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-1053.

Abstracts for all sessions must be submitted camera-ready on official 1999 GSA abstract forms. These forms are available from the Abstracts Coordinator, GSA, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 161, or nrcarson@geosociety.org.

Send an original and five copies of the abstract (for both volunteered and invited papers) to James Barrick, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053.

Indicate on the abstract your preference for a poster or oral session and the symposium (if any) appropriate to your research. GSA rules prohibit individuals from presenting more than one volunteered abstract, although they can be co-authors on additional volunteered abstracts. Abstracts submitted for symposia are not affected by this limitation.

Attendees are encouraged to order an abstract booklet either with their annual dues or by contacting GSA Publication Sales (1-800-472-1988 or www.geosociety.org). There will be a limited number of abstract booklets available for purchase on site.

SYMPOSIA

1. Paleontology and Stratigraphy of Cretaceous and Tertiary Strata in West Texas and Northern Mexico. (Sponsored by South-Central Section, Paleontological Society.) Thomas M. Lehman, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3148, fax 806-742-0100, tiehman@ttu.edu; Francisco J. Vega, Instituto de Geología, Ciudad Universitaria, 04510 Mexico, phone 52-5-622-4320, fax 52-5-622-4289, vegver@servidor.unam.mx.

2. Proterozoic and Early Paleozoic Magmatism and Tectonics in Southern Laurentia. Melanie Barnes, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-204, fax 806-742-0100, 19mel@ttu.edu; Elizabeth Y. Anthony, Dept. of Geological Sciences, University of Texas El Paso, (915) 747-5483, fax 915-747-5073, anthony@geo.utep.edu.


4. Environmental Applications of Geology in the Southern High Plains. Ken Rainwater, Dept. of Civil Engineering, Texas Tech University, Lub-}

South-Central continued on p. 28
Preliminary Announcement and Call for Papers

NORTHEASTERN SECTION, GSA
34th Annual Meeting

Providence, Rhode Island
March 22-24, 1999


Meeting in conjunction with the GSA Northeastern Section will be the Eastern Section of SEPM, the Northeastern Section of the Paleontological Society, the Eastern and New England Sections of the National Association of Geoscience Teachers, the Association for Women Geoscientists, and the Council on Undergraduate Research Geology Division. The meeting will be held at the Westin Hotel, Providence, Rhode Island.

CALL FOR PAPERS

Papers are solicited from students and professionals to be included in: general oral and poster sessions; theme sessions, which are composed of volunteered papers focusing on specific topics; and symposia, which consist mostly of invited papers. Volunteer presentations that are consistent with one of the symposia are also solicited. If you wish to present a paper at a symposium, contact the convenor of the symposium.

ABSTRACTS

Abstracts must be submitted camera-ready on the official 1999 GSA section meeting abstract form in accordance with instructions on that form, which is available on the official 1999 GSA section meeting abstract form in accordance with instructions on that form, which is available at any SEPM regional office, or from the conveners directly. For general information, contact Technical Program Co-chair David E. Fastovsky, 315 Green Hall, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2185, defastov@uri.acr.uri.edu.


2. Saving the Beach: Successes and Problems. (Sponsored by Eastern Section SEPM.) Jon Boothroyd, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2191, boothroyd@uri.acr.uri.edu; William Cleary, University of North Carolina—Wilmington, (910) 256-3721, ext. 251, clearyw@uncw.edu.


Send one original plus five copies of all abstracts to be considered to: Anne I. Veeger, Technical Program Co-chairperson, Dept. of Geology, University of Rhode Island, 8 Ranger Rd., Suite 2, Kingston, RI 02881, (401) 874-2187, veeger@uri.acr.uri.edu. An individual may present only one volunteered paper; however, a person may also be co-author on papers presented by others. Individuals invited for symposia may present additional papers.

Abstracts due: December 8, 1998

SYMPOSIA

Prospective authors should contact the conveners directly. For general information, contact Technical Program Co-chairperson, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2187, veeger@uri.acr.uri.edu. An individual may present only one volunteered paper; however, a person may also be co-author on papers presented by others. Individuals invited for symposia may present additional papers.

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FIELD TRIPS

The field trip coordinator is C. C. (Tex) Reeves, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3115, fax 806-742-0100.

1. Stratigraphy of the Caprock Escarpment. Thomas Lehman, Department of Geosciences, Texas Tech University, Lubbock, (806) 742-3148, fax 806-742-0100, tlehman@ttu.edu.

2. Quaternary Stratigraphy of the Southern High Plains. Vance Holliday, Dept. of Geography, University of Wisconsin, Madison, WI 53706, (608) 262-6300, holliday@geography.wisc.edu.

3. Nuclear Waste Storage at the WIPP Site, New Mexico. C. C. Reeves, Dept. of Geosciences, Texas Tech University, Lubbock, (806) 742-3115, fax 806-742-0100; Judy Reeves, Compliance Services Group, (806) 748-0040.

4. Geology of Palo Duro Canyon. Gerald Schultz, West Texas A&M University, Canyon, TX 79016, (806) 651-2580, fax 806-651-2928, gschultz@faculty.wtamu.edu.

5. Triassic Vertebrates of West Texas. Sankar Chatterjee, Dept. of Geosciences, Texas Tech University, Lubbock, (806) 742-3108, fax (806) 742-0100, gssan@ttu.edu.

PROJECTION EQUIPMENT

Please bring your own loaded carousel trays. There will be two projectors for each oral session; overhead projectors will be available. Specifics of the poster session will be published in the final announcement.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be available in the Holiday Inn Civic Center. Space rental is $125, which will include one complimentary registration. Exhibitors are encouraged to set up Sunday afternoon for registration and the welcoming party. For more information, please contact Susan Tomlinson, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3200, fax 806-742-0100, gislt@ttu.edu.

BUSINESS MEETINGS AND SOCIAL EVENTS

The welcoming party, in the exhibit hall, will begin at 7 p.m. on Sunday, March 14. On-site registration will be available, and those who have preregistered may pick up their name badges and tickets for the banquet and purchase abstract booklets.

The Meeting Banquet, in the Holiday Inn atrium at 7 p.m. on Monday, March 15, will be followed by a special lecture presentation. Banquet tickets should be purchased in advance; only a limited number of tickets will be available during on-site registration.

A luncheon meeting of Department Heads and Chairs will be held at noon on Monday, March 15.
TRAVEL ASSISTANCE GRANTS

To be eligible for travel assistance grants, the abstract must list only authors who give papers (oral or poster) clearly as a student paper. Awards will be based on quality of research and effectiveness of presentation.

Awards will be presented for the Best Oral Student Paper and Best Student Poster at the South-Central GSA meeting. Applications for travel assistance may be obtained from James E. Barrick, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3106, fax 806-742-0100, ghjeb@ttu.edu. Applications must be received by December 18, 1998.

REGISTRATION

Preregistration deadline: February 5, 1999. The registration form will appear in the December 1998 issue of GSA Today. Please take advantage of the lower registration fees and register by February 5. All field trip participants must register for the meeting.

Members pay less! Join GSA now or at the meeting. Contact Membership Services for further information.

HOUSING

A block of rooms is reserved at the Holiday Inn Lubbock Civic Center, 801 Avenue Q, Lubbock, TX 79401, (806) 763-1200, fax 806-763-2656. This hotel is located in the Civic Center district and is within walking distance of a short drive of several restaurants and clubs. The hotel offers shuttle service to and from Lubbock International Airport. The Texas Tech campus is a 5-minute drive from the hotel. Campus can also be reached via the city bus service.

OTHER INFORMATION

It is our goal that this program be accessible to all persons. If you have special dietary or physical needs, please state them on the registration form.

More detailed information will appear in the December 1998 GSA Today. If you have questions about the meeting, contact the general chairperson, Calvin Barnes, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3106, fax 806-742-0100, gical@ttu.edu.
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Division.) Donald I. Siegel, Dept. of Earth Sciences, 204 Heroy Laboratory, Syracuse University, Syracuse, NY 13244, (315) 443-3607, disiegel@mailbox.syr.edu.


10. Geoarchaeology in the Northeast. Barbara Calogero, 148 Lawler Rd., West Hartford, CT 06117, (860) 233-3417, logero5307@aol.com; Duncan Ritchie, Public Archaeology Laboratory, Pawtucket, Rhode Island, (401) 728-8780.

11. Actualism in Paleontology: Using Physiology of Modern Organisms as Analogies for Paleontological Interpretation. (Sponsored by the Paleontological Society.) Paul Strother, Weston Observatory, Boston College, 381 Concord Rd., Weston, MA 02193, strother@bc.edu; Cynthia Fisher, West Chester (Pennsylvania) University, (610) 436-2203, cfisher@wcupa.edu.

12. Teaching with Fossils. (Sponsored by the Paleontological Society.) (POSTER ONLY.) Paul Strother, Weston Observatory, Boston College, 381 Concord Rd., Weston, MA 02193, strother@bc.edu; Steven Good, West Chester (Pennsylvania) University, (610) 436-2203, sgood@wcupa.edu.


14. Science Standards Tailgate Party: An Open Forum for the Display and Trade of Standards-Based Lessons, Web Addresses, Geologic Materials, Contacts, Ideas, and Other Geoscience Resources. (POSTER ONLY.) Rachel Burks, Dept. of Physics, Towson State University, Towson, MD 21204, (410) 830-3005, rburks@towson.edu.


16. Undergraduate Research. (Sponsored by the Council on Undergraduate Research Geology Division.) (POSTER ONLY.) Larry Malinconico, Dept. of Geology, Lafayette College, Easton, PA 18042, (610) 250-5193, malincol@lafayette.edu.

SHORT COURSES

Water Waves and Coastal Processes. Cy Galvin, P.O. Box 623, Springfield, VA 22150, (703) 569-9187, galvincoastal@juno.com.

Practical Hydrogeology: How to Make Do with Scant "Real World" Data. Donald I. Siegel, Dept. of Earth Science, 307 Heroy Geology Laboratory, Syracuse University, Syracuse, NY 13244-1070, (315) 443-3607, disiegel@mailbox.syr.edu.

WORKSHOP

Roy Sheldon Mentor Program in Applied Geology. Sunday, March 21. For graduate and advanced undergraduate students, a workshop on professional opportunities and challenges in the applied geosciences.

STUDENT AWARDS AND TRAVEL ASSISTANCE

The GSA Northeastern Section will give awards for the best oral paper and best poster session presented by students. A faculty mentor may be a junior author, but a major part of the paper or poster session must represent work by the student author. Designate papers submitted for this award at the bottom of the abstract form.

The Northeastern Section will award travel grants to students who present papers (oral or poster) of which she or he is author or co-author and the presenter at the meeting. The section will also award student research grants to undergraduates in 1999. Applications for travel assistance and guidelines for student research proposals are available from Kenneth N. Weaver, Secretary-Treasurer, Northeastern Section, GSA, c/o Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21211-5210, (410) 554-5532, fax 410-554-5502.

EXHIBITS

Booth and table exhibit space will be available in a large convention hall at the Westin Hotel in the same room as the poster sessions. Reduced rates are available for educational or not-for-profit groups. For further information and space reservation, contact Chris Galagan, Exhibits Coordinator, Applied Science Associates, 70 Dean Knauss Dr., Narragansett, RI 02882, (401) 789-6224, chris@apppsi.com.

SPECIAL EVENTS

The Welcoming Reception, Sunday evening, March 21.

Map Blast ’99, the Sequel, Monday evening, March 22, a special, informal session for display and discussion of newly published, unpublished, or in-progress geologic maps of any sort. Maps should have a title and a stand-alone explanation. This is not a poster session; abstracts are not required, and none will be published. Authors must be present.

Contact Jon Boothroyd, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2191, fax 401-874-2190, boothryd@uriacc.uri.edu.

Breakfasts, Luncheon Meetings, Receptions, and Business Meetings. SEPM Eastern Section; Association for Women Geoscientists; GSA Northeastern Section Education Committee and National Association of Geoscience Teachers, Eastern and New England Sections; Paleontological Society, Northeastern Section; and GSA Northeastern Section Management Board.

The GSA Northeastern Section banquet, Tuesday, March 23.

ACCOMMODATIONS

A large block of rooms has been reserved for meeting participants at the Westin Hotel (1-800-WESTIN-1) or (401) 598-8000, site of the meeting. To ensure guaranteed room rates, be sure to state your GSA connection when making reservations. Attendees should make their reservations before February 16, 1999.

CHILD CARE

Child-care arrangements will be coordinated by Lesley Fastovsky, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 295-1173, fax 401-874-2190, defastov@uriacc.uri.edu.

REGISTRATION

Registration will be handled by GSA headquarters. To obtain low registration fees and to assist in planning by the local committee, please preregister, using the registration form in the December 1998 issue of GSA Today.

Members pay less! Join GSA now or at the meeting. Contact Membership Services for further information.


DETAILED INFORMATION

The GSA Northeastern Section is committed to making every event at the 1999 meeting accessible to all people interested in attending. Indicate special requirements, such as an interpreter or wheelchair accessibility, on the meeting registration form, or contact O. Don Hermes (address below).

Complete information on registration, accommodations, and activities will appear in the December 1998 issue of GSA Today, and as part of the Abstracts with Programs for 1999 mailed in March 1999. For additional information or suggestions, contact the general chairs, O. Don Hermes, (401) 874-2192, dhermes@uriacc.uri.edu, or Jon C. Boothroyd, (401) 874-2191, boothryd@uriacc.uri.edu, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, fax 401-874-2190.
Preliminary Announcement and Call for Papers

**SOUTHEASTERN SECTION, GSA**

**48th Annual Meeting**

**Athens, Georgia • March 25-26, 1999**

The 1999 meeting of the Southeastern Section of the Geological Society of America in Athens, Georgia, will be hosted by the University of Georgia Department of Geology. Find us at: http://www.gly.uga.edu.

**CALL FOR PAPERS**

Papers are invited for presentation in oral technical sessions and poster sessions. Although papers dealing with all aspects of the southeastern or Appalachian regions of the United States are especially encouraged, papers dealing with other regions are also welcome. Abstracts not accepted for symposia (invited) or theme (volunteered) sessions will be considered for regular technical sessions.

**REGISTRATION**

Preregistration deadline: February 19, 1999

Please preregister to qualify for lower registration fees and to assist the local committee in planning. On-site registration at a higher fee, will also be available. Students and precollege teachers can register at a reduced rate during the preregistration period. Preregistration by mail will be handled by GSA headquarters. Preregistration forms will be in the December 1998 issue of GSA Today. Members pay less! Join GSA now or at the meeting. Contact Membership Services for further information.

**ABSTRACTS**

Abstract deadline: December 14, 1998

Abstracts for all sessions must be submitted camera-ready on official 1999 GSA abstract forms, available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 161, ncarlson@geosociety.org. An original and five copies of all abstracts (volunteered and invited) should be sent to Mike Roden, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2416, mroden@gly.uga.edu. We encourage participants in symposia and theme sessions to send an extra copy to the convenor of the session. Abstracts will be reviewed for information content, format, and originality. GSA rules prohibit individuals from presenting more than one volunteered abstract. Abstracts submitted for symposia are not affected by this limitation.

**FIELD TRIPS**

Contact the field trip leaders listed below for details about specific field trips. For general questions concerning field trips, contact Ev Garrison, (706) 542-1097, egarrison@uga.cc.uga.edu, or Sue Goldstein, (706) 542-2397, sgoldst@gly.uga.edu, both at Dept. of Geology, University of Georgia, Athens, GA 30602.

**FIELD TRIPS (TENTATIVE)**

1. Coastal Plain Paleocene-Eocene Stratigraphy and Paleontology of Southeastern and South-Central Georgia. (Sponsored by the Southeastern Section of SEPM.) John R. Anderson, Georgia Perimeter (formerly Dekalb) College, 2101 Womack Rd., Dunwoody Campus, Dunwoody, GA 30338, (770) 551-3121, janderso@gpc.peachnet.edu.

2. Dahleona Gold Belt as Exemplified by the Findley Mine, Dahleona, Georgia. Jerry German, Georgia Dept. of Transportation, Office of Materials and Research, 15 Kennedy Dr., Forest Park, GA 30297, (404) 363-7500.

3. Geology and Geomorphology of Stone Mountain, Georgia. (Sponsored by NAGT.) James A. Whitney, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2027, jwhitney@arches.uga.edu; John Dennison, University of North Carolina; Pamela Gore, Georgia Perimeter College, pgore@gpc.peachnet.edu.

4. Geotraverse across the Western Part of the Southern Appalachian Blue Ridge to Western Inner Piedmont, Northeast Georgia and South Carolina. Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-2238, bobmap@utk.edu.

5. Graves Mountain Georgia: Mineralogy, Economic Geology, and Environmental Problems. Dave Wrenner, Doug Crowe, and Paul Schroeder, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2652, dwenner@arches.uga.edu; Todd Rasmussen, University of Georgia, (706) 542-4300, trasmuss@smokey.forestry.uga.edu.

6. Elberon Granite: Geology and Processing. Sam Swanson and R. D. Dallmeyer, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2415 swanson@arches.uga.edu; dalmeyer@arches.uga.edu.

7. Ordovician of Northwest Georgia. (Sponsored by the Palaeontological Society.) Anthony J. Martin, Emory University, Geosciences Program, Atlanta, GA 30322.


9. Coastal Geology and Paleontology: Sapelo Island. (Sponsored by the Palaeontological Society.) Susan T. Goldstein, Dept. of Geology, University of Georgia, Athens, GA 30603, (706) 542-2397, sgoldst@gly.uga.edu.

**SYMPOSIA**

Contact the conveners for further information on the symposia listed below. If you have suggestions for additional symposia, contact Sally Walker, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2396, swalker@gly.uga.edu.

1. Relevance of Environmental Ethics to the Geosciences: The Case of Coastal and Marine Environments. Dorinda G. Dallmeyer, Dean Rusk Center, University of Georgia, Athens, GA 30602, (706) 542-5141, dorindad@arches.uga.edu.

2. Precambrian Rocks in the Southern Appalachians: Nature, Age, Distribution, and Tectonic Significance. Calvin F. Miller, Dept. of Geology, Vanderbilt University, Nashville, TN 37235, (615) 322-2323, millerdf@ctrvax.vanderbilt.edu; Paul Fullagar, University of North Carolina, (919) 966-4516, pfullag@pop unc.edu.

3. Ultramafic Rocks and Eclogites in the Southern Appalachian Orogen: Petrology and Tectonic Significance. Loren A. Raymond, Dept. of Geology, Appalachian State University, Boone, NC 28608, (704) 262-3049, raymondLA@conrad.appstat.edu; Rich Warner, Clemson University, (864) 656-5023, rich.warner@ces.clemson.edu.

4. Tectonic History and Deformation Processes in the Southern Appalachians. Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-2238, bobmap@utk.edu; Jim Wright, Rice University, (713) 285-5130, jwright@wlnet.rice.edu; Sandra Wyld, University of Georgia, (706) 542-9908, swyl@gly.uga.edu.

5. New Developments in Carolina Terrane Geology: Igneous, Metamorphic, and Tectonic. Mark Colberg, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2394, fax 706-542-2425, mrc@gly.uga.edu; Alberto Patino-Douce, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2394, klingon@3rdrock.gly.uga.edu.

6. Environmental Research and Remediation at the Savannah River DOE Site. Christopher Romanek, SREL, Drawer E, Aiken, SC 29802, (803) 725-5883, romanek@srel.gov.

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7. Memorial Symposium in Honor of Robert Frye. Stephen Henderson, Dept. of Geology, Emory University—Oxford College, Oxford, GA 30267, (770) 784-8345, shender@emory.edu; Anthony J. Martin, Emory University, (404) 727-6476, paleoman@earthlink.emory.edu.


10. John Dennison Retirement Celebration Symposium. Richard Diecchio, Dept. of Geography & Earth Systems Science, Mail Stop IE2, George Mason University, Fairfax, VA 22030-4444, (703) 993-1218, rdiecki@gmu.edu; Lisa Pratt, Indiana University, (812) 855-5581, pratl@indiana.edu.

THEME SESSIONS

If you are interested in convening an additional theme session, contact Sally Walker, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2396, swalker@uga.edu.

1. Geomorphic and Other Terrestrial Records of Quaternary Climate Change in the Southeast. David Leigh, Dept. of Geography, University of Georgia, Athens, GA 30602, (706) 542-2396, dieleigh@arches.uga.edu; Andrew Ivester, Dept. of Geography, University of Georgia, Athens, GA 30602, (706) 542-2856, ivester@athens.net.


4. From Microbes to Flowers: The Geologic Record of Photosynthesis. Julie Bartley, Geology Department, State University of West Georgia, Carrollton, GA 30118, (770) 830-2315, jabartley@westga.edu.

5. Paleoecologic Puzzles in Biostratigraphy and Stratigraphy. Jack Hall, Dept. of Earth Sciences, University of North Carolina, Wilmington, NC 28403-3490, (910) 962-3488, hallj@email.uncc.edu; Carl Stock, University of Alabama, Tuscaloosa, (205) 348-1883, cstock@rgs.geo.ua.edu.

6. Tectonic History and Deformation Processes in the Southern Appalachianians. Robert D. Hatcher, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (615) 974-2238, bobmap@utk.edu; Jim Wright, Dept. of Geology and Geophysics, Rice University, Houston, TX 77005, (713) 285-5130, jwright@owlnet.rice.edu; Sandra Wyld, University of Georgia, (706) 542-9908, sswyld@uga.edu.

7. Geology, Mineralogy, Genesis, and Industrial Use of Kaolin Deposits from the Southeastern United States. Jessica Elzea, Thiele Kaolin Company, P.O. Box 1056, Sandersville, GA 31082, (912) 552-3951, jessica.elzea@thielekaolin.com.

8. Undergraduate Research. (POSTER ONLY.) (Sponsored by the Council for Undergraduate Research.) Joel B. Thompson, Marine Sciences, Eckerd College, 4200 54th Ave. S., St. Petersburg, FL 33711, (813) 684-8991, thomspbj@eckerd.edu.

9. Advances in Archaeological Geology. Kent Schneider, USDA-Forest Service, 1720 Peachtree Rd. NW, Atlanta, GA 30367, (404) 347-7250, schneider_kent/r8@fs.fed.us.

10. Standard-Based K–12 Geoscience Education in the Southeast. (Sponsored by NAGT and GSA-ED.) Don Byerly, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 967-5007, dbberyly@utk.edu.

11. Approaching Questions of Origins in Earth Science Education—Creative Solutions to Evolving Controversies. (Sponsored by NAGT, Palaeontological Society, and GSA Geoscience Education Division.) Jon Bryan, Earth Sciences, Okaloosa-Walton Community College, 100 College Blvd., Niceville, FL 32578-1294, (850) 729-5426, bryanj@gwcc.net; Michael Gibson, University of Tennessee at Martin, (901) 587-7435, mgibson@utm.edu.

12. Environmental Geochemistry and Health. June Mirecki, Dept. of Geology, 58 Corning St., College of Charleston, Charleston, SC 29424, (843) 953-8278, mireckij@cofc.edu; Mike Higgins, Roswell, Georgia.

13. Coastal Plain Geology of the Southeastern United States. (Sponsored by the Southeastern Section of SEPM.) John T. Hayes, Dept. of Geography and the Earth System Sciences, George Mason University, Fairfax, VA 22030-4444, jthaynes@umd5.umd.edu.

POSTER SESSIONS

Four half-day poster sessions are planned for the meeting. Please indicate your preference for a poster session on the GSA abstract form.

STUDENT RESEARCH PROGRAMS

The Council for Undergraduate Research will sponsor a student poster research session (theme session 8 above) to showcase senior theses and other undergraduate research projects. First authors must be undergraduate students and responsible for the bulk of the research, preparation of posters, and presentation of results. For more information, contact Joel B. Thompson.

K–16 TEACHERS

Two half-day theme sessions (10 and 11) are planned for K–12 and college-level introductory geoscience teachers. Session 10 will focus on standards in earth science education and include a keynote speaker followed by a panel discussion in addition to volunteered papers and posters. See session 10 above for contact information. Session 11 will explore approaches to teaching the evolution of life in earth science education. Contact Michael Gibson, Dept. of Geology, Geography, and Physics, University of Tennessee, Martin, TN 38238-5039, (901) 587-7435, mgibson@utm.edu.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be in the Classic Center, adjacent to the technical sessions. Booth space is limited, so plan to reserve early. Exhibits will be open all day Thursday and Friday morning. For space reservation or further information contact Barbara Ruff or Vicki Mullis, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2652, bruff@uga.edu or vickim@gly.uga.edu.

STUDENT TRAVEL GRANTS

Limited funds for travel expenses of students presenting papers at the meeting are available from the GSA Southeastern Section. Students must be members of GSA to apply. For information, contact Harold Stowell, Dept. of Geology, University of Alabama, Tuscaloosa, AL 35487-0338, (205) 348-5098, hstowell@rgs.geo.ua.edu.

All information and necessary forms are on the World Wide Web at http://www.geo.ua.edu/segasa/segasa/html.

Travel grant requests must be postmarked no later than March 1, 1999.

ACCOMMODATIONS

Blocks of rooms have been reserved for attendees at Holiday Inn, (706) 549-4433 ($84 per night for a standard room, $99 for a deluxe room) and Holiday Inn Express, (706) 546-8122 ($74 per night for 1–2 guests; $79 per night for 3–4 guests). Rates do not include 7% sales tax.

WELCOME PARTY AND GUEST ACTIVITIES

The welcome party Wednesday evening will be in the Classic Center. All party attendees must be registered; on-site registration will be available in the Classic Center prior to the party.

Several guest activities are planned during the meeting. An Athens city bus tour will be held Thursday morning, March 25, and lunch and a visit to the State Botanical Garden in the afternoon.

A bus tour of historic Madison, Georgia, will be available on Friday, March 26.
GSA Awards Research Grants

Leah Carter, GSA Grants Administrator

The GSA Committee on Research Grants met in Boulder, Colorado, on April 17-18, 1998, and awarded $309,315 to 187 graduate student applicants, and $20,000 for the Gladys W. Cole and W. Storrs Cole Awards to two postdoctoral applicants. Committee members for 1998 are James N. Connelly (Chair), Duncan M. FitzGerald, Paul M. Myrow, Thomas L. Patton, Allen F. Glazner, Brian G. Katz, Jim E. O’Connor, and Thomas O. Wright (National Science Foundation conference).

COLE AWARDS FOR POSTDOCTORAL RESEARCH

Steven L. Forman, University of Illinois—Chicago, was awarded the Gladys W. Cole Memorial Research Award for 1998 to support his project, “Holocene Eolian Activity on the Eastern Snake River Plain, Idaho.” This award is restricted to support for the investigation of the geomorphology of semi-arid and arid terrains in the United States and Mexico.

The W. Storrs Cole Memorial Research Award, which is restricted to support research in invertebrate micropaleontology, was presented this year to Susan T. Goldstein, University of Georgia, for her project “Phylogeny and Reproductive Pattern in the Foraminiferida.”

Eligibility for both Cole awards is restricted to GSA Members and Fellows between 30 and 65 years of age.

STUDENT AWARDS

This year, proposals were received from 443 students of which 187 (37%) were awarded grants. Of these recipients, 93 are master’s candidates, and 94 are doctoral candidates. Proposal requests totaled $833,886 for an average of $1,882. The average award was $1,654.

Fourteen alternate candidates were selected by the committee in the event that some of the grantees return all or part of their grant funds because they have changed their research project or have received funds from another source.

The committee’s budget included $130,000 from the Penrose Endowment and the Pardee Memorial, $100,000 from the National Science Foundation, $6,000 from the Second Century Fund (donations by Unocal and the Lipman Research Fund), $8,050 from the Harold T. Stearns Award Fund, the Geophysics Division, the Sedimentary Geology Division, and the Structural Geology and Tectonics Division; and $4,902 funds returned too late in 1997 and early 1998 to be re-awarded. The budget also included $65,662 from the GSA Foundation, which included $24,739 from the Research Fund (including $2,000 from Mobil Oil), $24,728 from GEOSTAR and unrestricted funds, and $10,215 from various restricted special funds and the Engineering Geology and Hydrogeology Divisions.

The recipients of student research grants awarded by GSA divisions and sections will be announced in the October issue of GSA Today.

OUTSTANDING MENTION

The Committee on Research Grants specially recognized 25 of the proposals as being of exceptionally high merit in conception and presentation:

Rebecca K. R. Ambers, University of Oregon, “Reservoir-Bottom Sediments: A Record of Land Use in a Watershed.”

Dyke Andreaeen, University of California, Santa Cruz, “Pliocene Changes in the Thermohaline Circulation in Relation to Heat Input into the South Atlantic Ocean.”


Julie E. Fiddell, University of South Carolina, Columbia, “Holocene Climate Variability and the History of ENSO.”

Amy M. Gaffney, University of Washington, “Petrology and Geochemistry of Xenoliths in Mauna Loa Tholeiite: Implications for Hawaiian Magmatism.”

Forest James Gahn, University of Cincinnati, “Evolutionary Paleoecology, Taphonomy and Systematics of Early Mississippian (Kinderhookian) Crinoids from the Wasonville Formation of Southeast Iowa.”

Philip M. Gottshall, University of Cincinnati, “Comparative Geographic and Environmental Dynamics of Gastropods and Bivalves During the Ordovician Radiation.”

Todd Halihan, University of Texas, Austin, “The Physical Origins and Properties of Fracture Skins in Quartzite.”

Angela M. Hessler, Stanford University, “Chemical Weathering under Archean Conditions: Thermodynamic, Geochemical, and Mineralogical Analysis of the 3.2 Ga Moodies Group, South Africa.”


Jonathan L. Jones, Ball State University, “Direct Relationships between Metamorphic Phase Transitions and Earthquake Faulting from Detailed Structural Observations of Fault and Fracture Systems in Western Norway.”

Paul Kapp, University of California, Los Angeles, “Detachment Faulting and Blueschist Exhumation, Central Tibet.”

Daniel John Koning, University of New Mexico, Albuquerque, “Application of Cosmogenic Cl-36 Dating to Paleoseismic Studies of the Alamogordo Fault, Southern New Mexico.”

Andrew C. Kurtz, Cornell University, “Quantifying Mineral Aerosols as a Source Term in the Marine Silica Budget.”


Jeffrey David Manuszak, Purdue University, “Development of a Sedimentological and Structural Model for Collisional Basins: A Case Study of the Nutzotin Basin, Alaska.”

Heather A. Moffat, University of Rochester, “Comparative Taphonomy of Meter-Scale Cycles: Ordovician and Jurassic Examples.”

Salma Monani, University of Wisconsin, Madison, “Oxygen Isotopes from Tertiary Granites, Scotland: Evidence of Crust/Mantle Interaction during the Opening of the Atlantic.”

Patricio I. Moreno, University of Maine, “High-Resolution Pollen and Charcoal Records from Lago Condorito (41° 30’S), Southern Chile.”

Georgios P. Tsoflas, University of Texas, Austin, “Use of Ground Penetrating Radar for the Characterization of Fracture and Rock Matrix Hydraulic Properties in Geologic Formations.”


Michael Wara, University of California, Santa Cruz, “Boron Isotopes in Foraminiferal Calcite: Testing a Paleo-pH Proxy.”

Mark Webster, University of California, Riverside, “Evolutionary Trends in Morphological Variability in Late Cambrian Trilobites across the Pterocephaliid Biomere Boundary: Resolving Controls on Major Evolutionary Faunal Turnovers.”


Research Grants continued on p. 34
Susan Logan Brown Zenker, University of North Carolina, Chapel Hill, “Neodymium Isotopes in Late Cretaceous and Cenozoic Fish Teeth.”

**STUDENT RECIPIENTS OF SPECIAL AWARDS IN 1998**

**Gretchen L. Blechschmidt Research Award.** This award supports research for women interested in achieving a Ph.D. in the geological sciences and a career in academic research. This year’s recipient is Heather A. Moffat, University of Rochester, for her project “Comparative Taphonomy of Meter-Scale Cycles: Ordovician and Jurassic Examples.”

**John T. Dillon Alaska Research Award.** John T. Dillon was noted for his radiometric dating work in the Brooks Range, the results of which have had a major impact on the geological understanding of this mountain range. The recipient of this award is Jeffrey D. Manuszak, Purdue University, for “Development of a Sedimentologic and Structural Model for Collisional Basins: A Case Study of the Nutzotin Basin, Alaska.”

**Robert K. Fahnestock Award.** This award honors the memory of Ken Fahnestock, who was a member of the Committee on Research Grants. It is awarded to the applicant with the best proposal in sediment transport or related aspects of fluvial geomorphology. The 1998 recipient is Suzanne Florence Leclair, Bingerville, University of Oklahoma, “Characterization/Evaluation of High Molecular Weight Hydrocarbons (>C40) in Crude Oils from Variations in Petroleum Genesis.”

**Lipman Research Award.** The Lipman Research Fund is supported by gifts from the Howard and Jean Lipman Foundation to promote and support student research grants in volcanology and petrology. Peter W. Lipman, president of the Lipman Foundation, was the recipient of a GSA research grant in 1965. The 1998 Lipman Award recipient is Jennifer M. Wenner, Boston University, for “The Role of High-Silica Granites in the Sierra Nevada Batholith as End Members in a Mixing Process that Generates Average Continental Crust.”

**Bruce L. “Biff” Reed Scholarship Award.** The Bruce L. “Biff” Reed Scholarship Award was established in Reed’s memory to provide grants to graduate students pursuing studies in the tectonic and magmatic evolution of Alaska, primarily, and also can fund other geologic work in Alaska. This year’s recipient is Matthew A. Pachell, Utah State University, for “Glacial Tectonism of Pleistocene Sediments, Flat Cape, Southwestern Alaska.”

**Alexander Sisson Research Award.** Family members of Alexander Sisson established a fund in his memory to promote and support research for students pursuing studies in Alaska and the Caribbean. The recipient of the award this year is Rachel Susan Hannah, Michigan State University, for “Ash Flow Tuffs of El Valle Central, Costa Rica.”

**Harold T. Stearns Fellowship Award.** Stearns established the Harold T. Stearns Fellowship Award in 1973 for student research on aspects of the geology of the Pacific Islands and the circum-Pacific region. The 1998 recipients are: Julie E. Friddell, University of South Carolina, Columbia, for “Holocene Climate Variability and the History of ENSO,” and Amy M. Gaffney, University of Washington, for “Petrology and Geochemistry of Xenoliths in Mauna Loa Tholeiite: Implications for Hawaiian Magmatism.”

**Industrial Donations and Awards.** Industrial donations this year amounted to $7,000 ($2,000 from Mobil Oil Corporation and $5,000 from Unocal Corporation). The 1998 recipients are: Eiisa T. Bergslien, University of Buffalo, for “Experimental Investigation of Two-Phase Flow in Rough-Walled Fractures”; Amy E. Clifton, Rutgers University, for “Temporal Evolution and Scaling Relationships of Fracture Populations in Oblique Rift Zones”; Todd Halihan, University of Texas, Austin, “Physical Origins and Properties of Fracture Skins in Quartzite”; Michael H. Peck, University of Oklahoma, “Characterization/Evaluation of High Molecular Weight Hydrocarbons (>C40) in Crude Oils from Various Depositional Environments Worldwide”; M. Bruce Rohrbaugh, Jr., University of Tennessee, “Characterization of Joint Patterns using Circular Scanlines.”

**OTHER SUCCESSFUL APPLICANTS** Other applicants recommended for funding are the following:

- Helen Alseben
- Robert Andress
- Chris Andronicos
- Christopher David Augustine
- Yarrow L. Oxford
- Victoria A. Baeder
- Claire L. Beaney
- Andrey Bekker
- Tara Lynn Benda
- Deborah Bergfield
- Adam Edward Bielecki
- Gerald O. Black IV
- Sarah L. Brown
- Matthew E. Brueseke
- Andrew M. Bush
- Ilya Val Byuniech
- Lucia Capra
- Robert P. Casavant
- Andrea D. Cicero
- Casey D. Clapsaddle
- Arlene D. Collins
- John Comstock
- Badescu Adrian
- Luke Copland
- Robert D. Crangle, Jr.
- Betsy Lynn Cunningham
- Kristina A. Curry
- Brian J. Darby
- Kathleen A. DeGraaff
- Carol Merritt Dehler
- John DeLaChapelle
- Nicole M. DeNovo
- Stephen Quinn Dornbos
- Andrea L. Dutton
- Timothy Karl Ehrlich
- Jennifer M. Eick
- Julie Anne Ezdale
- Peter John Evans
- Brian Exton
- Laura Faulkenberry
- Tammy C. Fawcett
- Hilary Fletcher
- David A. Fowle
- Duane G. Froese
- Robert R. Gaines
- Stanley J. Galicky
- Juan Carlos Garcia y Barragan
- Adrian E. Goettemoeller
- D. A. Grau
- Jessica Graybill
- Sean Andre Guidy
- Diana P. Hallman
- K. Jill Hammond
- Wayne G. Henderson
- Casey D. Clapsaddle
- James P. Hagan
- Jason Andrew Hooten
- Richard G. Hoy
- Trent D. Hubbard
- Brian Butler Hunt
- Emily P. Hunt
- Sonja Ingram
- Alexander Irondi
- Vladimir Isplatov
- Glenn S. Jaacks
- Thomas C.
- Johanna Kemy
- Brennan T. Jordan
- Thomas J. Kalakay
- Dale A. Kerner
- Eric Killemen
- Matthew E. Kirby
- Dirk Kirste
- Andre Klein
- John M. Kollmeier
- Thomas R. Kulp
- Julie V. LaBranche
- Melissa Lafreniere
- Christopher K. Lajewski
- Michael T. Landrum
- Ovidiu R. Lazar
- Cosmos Lettsch
- David William
- Leverington
- Charles R. Lindsay
- Aimee Lyn MacEachern
- Thomas Edward Macrini
- Kevin Mahan
- Jeffrey Mariga
- Jason Mayfield
- Brannon Wade
- McDonald
- Cathleen E. McGinnis
- Angela A. McLain
- Sunil Mehta
- Brian Menounos
- David Mitchell
- Jessica D. Moore
- German Mora
- Jeffrey S. Munroe
- Remo Nardin
- Guadalupe Velazquez
- Olivan
- Colin Ozanne
- Mutiu Ozogun
- Michael B. Parsons
- Sandra Passchier
- William H. Pock
- Lesley A. Perg
- Heather Lynne Petcovic
- Michael S. Petronis
- Molly Marie Pohl
- Matthew Jude Pranter
- Jessica L. Purley
- Steven I. Quane
- Jason A. Rech
- Tammy Rittenour
- Delores M. Robinson
- Michelle A. Roth
- Jason Charles Ruf
- Jennifer Claire Russel
- Seth J. Sadowfsky
- Hilary Sanders
- Juan C. Bermudez
- Santa
- Andrew T. Scott
- Kurt A. Shokemaker
- Mark Skidmore
- Garret L. Slaughenhoup
- Joshua B. Smith
- Jeanine M. St. Clair
- James St. John
- Stephanie B. Stack
- Joshua Sternberg
- Margaret Streepy
- Matthew L. Stutz
- Aviva Joy Sussman
- David W. Szymanski
- Neil John Tabor
- Leland Taylor
- Stephen Thompson
- Douglas K. Tinkham
- Vaughn Charles Turekian
- Matthew M. Ullman
- Chad Underwood
- G. Hampton Uzelle IV
- Rosario Vasquez-Scherhorn
- John A. Vines
- David Welch
- Amy Thomson Wetly
- Joshua Craig Whipple
- Brian Willhite
- Scott J. Willkins
- Nathan D. Williams
- Shawn Patrick Willis
- Grace Sherwood Winer
- Paul Adam Wisniewski
- Elizabeth Marie Witton
- Virginia Wong
- Brian R. Zurbuchen
Clinton Nominates Groat
To Head USGS

GSA Fellow and Councillor Charles G. Groat has been nominated by President Clinton to head the U.S. Geological Survey.

Groat, 58, has been active for more than 25 years in geological studies, energy and minerals resource management, groundwater occurrence and protection, geomorphic processes and landform evolution in desert areas, and coastal studies. Currently, Groat is Associate Vice President for Research and Sponsored Projects at the University of Texas, El Paso. Previously, he has served as Director of the Center for Environmental Resource Management at the university (1995–1998), Executive Director at the Center for Coastal, Energy, and Environmental Resources at Louisiana State University (1991–1995), Executive Director of the American Geological Institute (1990–1992), and Director and State Geologist for the Louisiana Geological Survey (1978–1990).

Groat received an A.B. in geology from the University of Rochester in 1962, his M.S. from the University of Massachusetts in 1967, and his Ph.D. in 1970 from the University of Texas at Austin. Groat’s nomination goes to the Senate Energy and Natural Resources Committee for a hearing and vote, and then to the Senate for confirmation.
CALL FOR FIELD TRIP PROPOSALS

We are interested in proposals for single-day and multi-day field trips beginning or ending in Denver, and dealing with all aspects of the geosciences. Please contact the Field Trip Co-Chairs:

Alan Lester
Department of Geological Sciences
University of Colorado
Campus Box 399
Boulder, CO 80309-0399
(303) 492-6172
fax 303-492-2606
alan.lester@colorado.edu

Bruce Trudgill
Department of Geological Sciences
University of Colorado
Campus Box 399
Boulder, CO 80309-0399
(303) 492-2126
fax 303-492-2606
bruce@lolita.colorado.edu

CALL FOR SHORT COURSE PROPOSALS

Due December 1, 1998

The GSA Committee on Continuing Education invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines. Courses may be conducted in conjunction with all GSA annual or section meetings. We are particularly interested in receiving proposals for the 1999 Denver Annual Meeting or the 2000 Reno Annual Meeting.

Proposals must be received by December 1, 1998. Selection of courses for 1999 will be made by February 1, 1999. For those planning ahead, we will also consider courses for 2000 at that time.

For proposal guidelines or information, contact:
Edna Collis, Continuing Education Coordinator, GSA headquarters, 1-800-472-1988, ext. 134, eccollis@geosociety.org

GSA SECTION MEETINGS — 1999

SOUTH-CENTRAL SECTION

NORTHEASTERN SECTION

SOUTHEASTERN SECTION

ROCKY MOUNTAIN SECTION

NORTH-CENTRAL SECTION

CORDILLERAN SECTION

FUTURE GSA MEETINGS

2000  Reno, Nevada  November 13–16
2001  Boston, Massachusetts  November 5–8
2002  Denver, Colorado  October 28–31
2003  Seattle, Washington  November 2–5
POSTDOCTORAL POSITION IN SILICON STABLE ISOTOPE BIOGEOCHEMISTRY UNIVERSITY OF CALIFORNIA SANTA BARBARA

We seek someone to help us understand why Si dissolved in the oceans is enriched in Si-30 relative to the Si in igneous and metamorphic rocks; a question that is fundamental to progress in quantifying the biogeochemical cycle of Si. The position entails analysis of isotope fractionations occurring during the processes (weathering, clay and phytolith formation, etc.) that transform Si in rocks into dissolved Si that washes into the ocean. The work involves application of a technical breakthrough in measuring isotopes in dissolved and particulate Si (Anal. Chem. 68, 3746-3750, 1996). We seek an individual with background in geochemistry, soils or clay mineralogy, preferably with experience with stable isotopes, and an interdisciplinary interest. Send resume, including the names of 3 references, to Oliver Chadwick, Geography Dept., University of California, Santa Barbara, CA 93106. E-mail queries about the position can be sent to Chadwick (oa@geo.ucsb.edu). The principal on the project, Min DeNiro (deniro@magic.geol.ucsb.edu) or Mark Brzezinski (brzezinski@lifesci.lscf.ucsb.edu). Position open until filled. Preliminary interviews will be conducted with qualified individuals at the Geological Society of America Meeting in Toronto in October, 1999 or by phone for those not attending GSA. Initial appointment is for 24 hours of arrival at GSA Today office.

POMONA COLLEGE

SEDIMENTOLOGIST / GEOMORPHOLOGIST

The Department of Geology at Pomona College invites applications for a tenure-track position in sedimentology and geomorphology. Responsibilities include teaching undergraduate courses in physical geography, historical geology, geomorphology and sedimentology. Opportunities to teach in subjects such as paleontology and/or geochemistry may occur on a less regular basis. The successful candidate must have a commitment to teaching undergraduate (the foremost consideration in the evaluation of an applicant for employment), and to conducting an active research program with field and laboratory components which allows undergraduate participation. Our geology program has strong connections with analytical facilities, and college participation in the operation and development of the department is expected. Applicants should send a current resume, a statement of teaching philosophy, a statement of research plans, reprints and three letters of recommendation by November 16, 1998 to: Dr. Linda A. Reinem, Search Coordinator, Department of Geology, Pomona College, Claremont, CA 91711. Address questions of interesseven@pomona.edu.

The Pomona College and The Claremont Colleges, is among the nation’s most selective undergraduate institutions with an ethnically diverse student body. Pomona College is an affirmative action, equal opportunity employer and especially invites applications from women and minorities.

SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE

The Department of Geology invites applications for a tenure-track position in paleobiology at the assistant professor level, starting August 16, 1999. Applicants must hold a Ph.D. and should have published work in the area of Crustal Seismology. Of particular interest are individuals who have demonstrated teaching ability and the existence of, or potential for, developing, an externally funded research program of high quality. Areas of research emphasis may include but are not limited to paleobiology, biostatigraphy, and global change. Teaching duties will include invertebrate paleontology and paleoecology, introductory undergraduate geology courses, and upper level and graduate courses in the emphasis area. Applicants should submit a curriculum vitae, a statement of teaching and research interests, and the names of at least three referees. Send applications by October 1, 1999, or until the position is filled. Information about the Department and its programs can be found at: http://www.science.siu.edu/geology/index.html. Southern Illinois University is an Equal-Opportunity, Affirmative-Action Employer.
STRUCTURAL GEOLOGY — PETROLEUM GEOLOGY
WEST VIRGINIA UNIVERSITY

The Department of Geology & Geography invites applications for a tenure-track faculty position in structural geology. The appointment will be at the level of beginning assistant professor, effective January or August 1999, and the Ph.D. degree is required at the time of appointment. We are seeking an individual who is adept in both quantitative and field approaches to geological research and teaching. This individual will be expected to collaborate with others in the department and to establish linkages with the petroleum industry. The successful candidate will have demonstrated research capability in structural geology and petroleum geology, and he or she should be able to effectively teach undergraduate and graduate courses in these fields and supervise M.S. and Ph.D. students. The candidate should be able to teach a large section of introductory geology and to participate in the team-teaching of our capstone field camp. In addition, the candidate must attract external research funding. Additional information is available online at http://www.geo.wvu.edu.

To apply, please send a letter of application and submit a curriculum vitae including a list of publications, grants, a statement of teaching and research interests, transcripts from graduate schools, and contact information for five references to: Richard L. Semken, Search Committee Chair, Department of Geology & Geography, Box 6300, West Virginia University, Morgantown, WV 26506. Review of applications will begin on September 1 and will continue until the position is filled. West Virginia University is an Equal Opportunity/Affirmative Action employer.

ENVIRONMENTAL CONSULTANT
CANADIAN NATIONAL

In order to ensure compliance with CN’s Real Estate sales/lease transactions and to minimize financial and legal risks to the corporation, you will be responsible for initiating, guiding, prioritizing, and managing to completion all environmental transactions and claims. You will be expected to ensure that assessments are conducted in accordance with internal, corporate and industry applicable standards, policies, and processes. You will also be called upon to provide clear and effective guidance and advice regarding environmental matters to Management as well as to recommend improvements or develop strategies for quality and cost improvement. Finally, you will oversee consultants responsible for conducting site assessments in order to ensure high quality and cost-effectiveness of services provided.

You have successfully completed an undergraduate degree in Environmental or related sciences, and have a minimum of ten years related experience. You possess in-depth knowledge of environmental laws and regulations. You have demonstrated excellent skills in consulting, strategic thinking, project management, and teamwork. You have the ability to analyze complex data, recommend course of action, implement solutions, and monitor results. Please forward your resume and a cover page indicating your interest no later than August 4, 1998, to the Human Resource Department, Canadian National, 935 de La Gauchetière Street West, 8th Floor, Montreal, Quebec, H3B 2M9. Fax 514-399-8335. Internet: joanis@cn.ca. We are looking for a consultant that would work on-site in Toronto.

We thank all applicants for their interest in this position; however, only those selected for an interview will be contacted.

MINERALOGY—PETROLOGY
DENISON UNIVERSITY

The Department of Geology and Geography invites applications for a tenure-track appointment at the Assistant Professor level, to begin in the Fall semester of 1999; a Ph.D. is required. Primary teaching responsibilities include teaching, petrology, and introductory physical geology. Other subjects which would complement our program include economic geology and stratigraphy. The department stresses a balance of classroom, field, and laboratory experiences for our majors, and we seek a colleague who will contribute to and collaborate with us on all these components. We are especially interested in a person who will bring a strong field component of research. Applicants should include a vita, a statement of your research and teaching philosophy, a list of publications and grants, and letters of recommendation. The screening committee will begin reviewing applications on December 1, 1998 and continue until the position is filled. UIC is an affirmative action/equal opportunity employer.

SEDIMENTOLOGIST
UNIVERSITY OF ILLINOIS, CHICAGO

The Department of Earth and Environmental Sciences, University of Chicago, invites applications for a tenure-track position at the rank of assistant professor in geology. Applications are invited from sedimentologists for an Assistant Professor, tenure-track appointment, starting Fall, 1999. We are interested in candidates who will develop a strong research program. The appointee will be expected to demonstrate excellence in both teaching and research, develop a vigorous externally funded research program, and advise graduate students. A Ph.D. is required. Applicants should send a resume, statements outlining research and teaching interests, and names of at least four references to: Steven L. Forman, Sedimentology Search Chair, University of Illinois at Chicago, Department of Earth and Environmental Sciences, 845 W. Taylor Street, M/C 185, Chicago, IL 60607-7059. For more information about the Department see our web page: www.uic.edu/depts/geom/. For fullest consideration, submit by October 15, 1998 or until the position is filled. UIC is an affirmative action/equal opportunity employer.

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interests, curriculum vitae, and the names of three referees should send a statement of research and teaching experience, and applications of cosmogenic isotopes to surficial processes. The successful candidate will be expected to develop a strong research program and to teach at the undergraduate and graduate levels. Applicants should send a statement of research and teaching interests, curriculum vitae, and the names of three referees to: Geochemistry Search Committee, Department of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge, MA 02138. Applications should be received by September 15, 1998. Harvard University is an Affirmative Action / Equal Opportunity Employer. We particularly encourage applications from women and minorities. Information: Marilyn Ashley, Geosynclinal Office, (709) 739-3517, fax 709-739-3537, frontiers@nfsympatcc.ca, www.frontier-regions.nsf.net.

November
November 10–15, 2nd International Conference on the Geology of Cuba, the Gulf of Mexico and Northwestern Caribbean, Pinar del Rio, Cuba. Information: Jorge Corbiella-Regura, University of Pinar del Rio, Marti 270, Pinar del Rio 20100, Cuba, fax 53-82-5479 or 53-82-5813, jcorbiella@upr.edu.cu.


December

Send notices of meetings of general interest, in format above, to Editor, GSA Today, P.O. Box 9140, Boulder, CO 80301, E-mail: editing@geosociety.org.

Send curriculum vitae, list of publications, description of teaching and research interests and objectives, and the names, address (including street address), e-mail address and fax/phone numbers of at least three references to: Search Committee, Department of Earth Sciences, Dartmouth College, 6105 Fairchild, Hanover, NH 03755. E-mail: earth.sciences@dartmouth.edu; web pages: http://www.dartmouth.edu/~earthsci.

Applications will be accepted until October 15, 1998. The appointment will be effective July 1, 1999. Dartmouth College is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

LOW-TEMPERATURE GEOCHEMISTRY HARBARD UNIVERSITY DEPARTMENT OF EARTH & PLANETARY SCIENCES The Department of Earth and Planetary Sciences at Harvard University seeks to fill a faculty position in the general area of low-temperature geochemistry. The appointment will be made at the assistant or untenured associated professor level. Candidates from all fields of low-temperature geochemistry are encouraged to apply: areas of interest include, but are not limited to, biogeochemistry, geochronology (particularly of surficial and sedimentary processes), continental weathering and continent-ocean exchanges, and applications of cosmogenic isotopes to surficial processes. The successful candidate will be expected to develop a strong research program and to teach at the undergraduate and graduate levels. Applicants should send a statement of research and teaching interests, curriculum vitae, and the names of three referees to: Geochemistry Search Committee, Department of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge, MA 02138. Applications should be received by September 15, 1998. Harvard University is an Affirmative Action / Equal Opportunity Employer. We particularly encourage applications from women and minorities. For more information about the department, you may visit our web site at: www.eps.harvard.edu.

ASSISTANT PROFESSOR OF STRUCTURAL GEOLOGY / ACTIVE TECTONICS Responsibilities will include advising M.S. and undergraduate research, academic-year teaching of the sophomore-level core introductory field geology course, structural geology and other courses of the candidate’s choosing. To approach structural problems using both field and analytical methods and to bridge current departmental interests in crustal studies/petrology and surface processes. Ph.D. required. Specific expertise could include, quantitative analysis, geophysics and geochronology. Individual dedicated to integrating high quality research and teaching at the undergraduate and Master’s levels. Apply by December 15, 1998 with CV and names of 3 references to: Chair, Search Committee, Department of Geology, University of Vermont, Burlington, VT 05405.

HYDROGEOLOGIST The Maryland Geological Survey, an agency of the Maryland Department of Natural Resources, invites applications for a full-time, benefited position in its Hydrogeology and Hydrology Program. The purpose of the position is to support hydrogeologic studies in coastal plain settings. Responsibilities will include water-level monitoring, water-quality sampling, aquifer characterization, ground-water flow and solute-transport modeling, and report preparation. The position requires a Master’s degree in Hydrogeology or a related field with graduate-level courses in hydrogeology, computer applications, and aqueous chemistry. Experience in ground-water modeling using MODFLOW, MODPATH, and STRATA is desired. Depending on qualifications, the starting salary range is $26,282 to $30,257 with promotional opportunities. Send resume, transcripts, and references to: Personnel Office (Code 002), Maryland Geological Survey, 2300 St. Paul Street, Baltimore, Maryland 21218. Maryland Geological Survey is an EEO/A/A employer.

Opportunities for Students Traveling Fellowship: Interdisciplinary Research Training Group (RTG) in ecology, geology, archeology, geography, and soils. Limited funding available for graduate students to come to Minnesota for up to 3 months to enhance training in “Paleorecords of Global Change.” Application deadline is October 7, 1998 for travel during 1999. Students applying for this award should contact the U-M faculty with whom they wish to work well in advance of the application date. For application, contact Sue Julson, RTG, University of Minnesota, Ecology, Evolution, and Behavior, 1987 Upper Buford Circle, St. Paul, MN 55108. Phone (612) 624-4238; fax 624-6277; e-mail: julson001@tc.umn.edu; web: http://krc.geo.umn.edu/RTG/ An Equal Opportunity Educator and Employer.
Military Geology in War and Peace

In warfare, military geologists pursue five main categories of work: tactical and strategic terrain analysis, fortifications and tunneling, resource acquisition, defense installations, and field construction and logistics. In peace, they train for wartime operations and may be involved in peace-keeping and nation-building exercises. The classic dilemma for military geology has been whether support can best be provided by civilian technical-matter experts or by uniformed soldiers who routinely work with the combat units. In addition to the introductory paper this volume includes 24 papers, covering selected aspects of the history of military geology from the early 19th century through the recent Persian Gulf war, military education and operations, terrain analysis, engineering geology in the military, use of military geology in diplomacy and peace keeping, and the future of military geology.

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