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Dynamics of Plate Boundary Fault Systems from Basin and Range Geodetic Network (BARGEN) and Geologic Data

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ABSTRACT

Continuously recorded Global Positioning System (GPS) data from the northern Basin and Range suggest that contemporary deformation is quite slow and broadly distributed, rather than being concentrated in the relatively narrow zones of historical earthquakes. Surprisingly, however, in north-central Nevada, the data indicate rapid, range-normal crustal shortening at a rate of 2–3 mm/yr in an area where the geology indicates crustal extension via Holocene normal faulting. A possible explanation for the conflicting geodetic and geologic data is that the region of shortening represents the contractile side of a slowly east-propagating deformation pulse generated by the 1915 Pleasant Valley and 1954 Dixie Valley and Fairview Peak earthquakes. Such pulses, which are transient effects not recorded by faulting, are predicted by a broad class of physical models, but have only been observed within a few years after very large earthquakes, when the signal is much larger than the long-term deformation rate. The Basin and Range, and similar areas with a combination of low long-term deformation rates and large earthquakes, may therefore have the best potential by combining modern geologic and geodetic data to elucidate fault system behavior, in particular how transient effects from an earthquake on one fault may influence patterns of stress and seismic strain release on others. These types of data are essential in developing realistic models of seismic hazard, and in linking short-time scale observations with longer term geologic processes.

INTRODUCTION

The relative motion of rock masses is the prime observable for competing theories of earth deformation, at time scales ranging from a fraction of a second (e.g., seismic waves) to hundreds of millions of years (breakup and aggregation of supercontinents). Traditionally, the study of

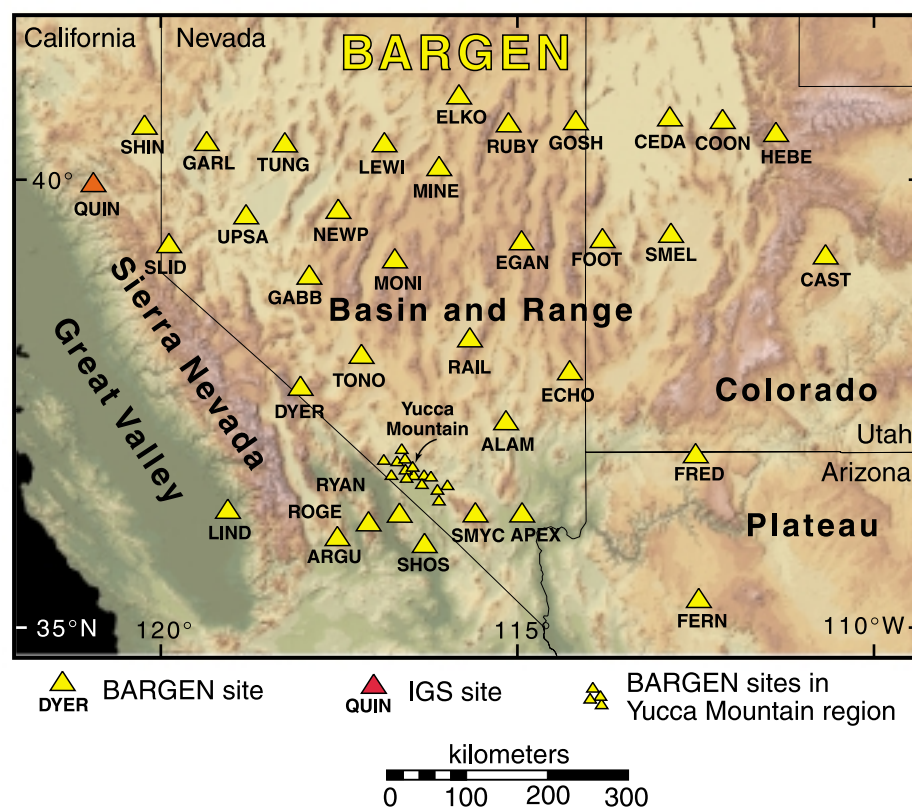


Figure 1. Relief map of Great Basin region showing locations of BARGEN (Basin and Range Geodetic Network) continuous GPS sites. IGS—International GPS Services.

these kinematic phenomena have been segregated by frequency band or time scale, each requiring different approaches, such as seismology, geodesy, structural geology, and isotope geochemistry. Major progress is likely to transcend temporal and disciplinary boundaries, challenging us to bridge them with coordinated, broadband research.

In this paper, we describe a prototype of such an effort focused on the northern Basin and Range province of western North America. The area lies between the Sierra Nevada–Great Valley block to the east and the Colorado Plateau to the west, and is characterized by north-trending mountain ranges and basins of curiously uniform size and spacing (Fig. 1). Ranges rise ~1500 m above adjacent basins, and

are spaced about 30 km apart. This part of the Basin and Range reaches a maximum width of 750 km at latitude 40°N, and includes some 20–25 basin-range pairs. The ranges began forming between 10 and 15 Ma as the Sierra Nevada–Great Valley block moved westward relative to the interior, first at rates near 20 mm/yr almost due west (Wernicke and Snow, 1998), then slowing to the current overall rate near 12 mm/yr northwest (Hearn and Humphreys, 1998; Bennett et al., 1999; Thatcher et al., 1999; Dixon et al., 2000). Total displacement of the block since 16 Ma is ~250 km (Wernicke and Snow, 1998). Most of the ranges are delimited on one side by a major normal fault with significant

GSA TODAY (ISSN 1052-5173) is published monthly by The Geological Society of America, Inc., with offices at 3300 Penrose Place, Boulder, Colorado. Mailing address: P.O. Box 9140, Boulder, CO 80301-9140, U.S.A. Periodicals postage paid at Boulder, Colorado, and at additional mailing offices. Postmaster: Send address changes to *GSA Today*, Member Service Center, P.O. Box 9140, Boulder, CO 80301-9140.

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Printed in U.S.A. using pure soy inks.



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Quaternary slip (Dohrenwend et al., 1996).

The uniformity in size and spacing of the ranges implies relatively uniform crustal strain, which is distortion, expressed as the amount of tectonic displacement per unit distance in a particular direction, designated as strains (str), microstrains (μ str, 10^{-6} str) or nanostrains (nstr, 10^{-9} str). For example, 1 nstr represents the elongation of a 1-m-long rod by 1 nm, or a 1000-km-long rod by 1 mm. Between repeated earthquakes, elastic strain buildup in the upper part of the crust increases the load or stress on faults (interseismic strain accumulation) until an earthquake occurs, when the stress drops and the elastic strain is released by fault

slip (coseismic strain release). At latitude 40°N (Fig. 2A) in the Basin and Range, in contrast to the apparent uniformity of crustal strain, coseismic strain release over the last few hundred years has been strongly concentrated in the Intermountain seismic belt on the east side of the province (Wasatch fault zone), the central Nevada seismic belt near the west side of the province (Fairview Peak, Dixie Valley, and Pleasant Valley fault zones), and on faults along the western margin (Honey Lake fault zone and related faults; Fig. 2A). The most recent strong ($M > 6.5$) earthquakes along the 40°N transect occurred in 1915 on the Pleasant Valley fault (Wallace, 1977) and in 1954 on the Dixie Valley, Fairview Peak, and related faults (Caskey et al., 1996; Fig. 2A). Along the

Science, Stewardship, and Service: Bringing It All Together, Part II

Last month, we began drawing to a close our discussion of GSA's values of science, stewardship, and service. We looked at the GSA Foundation as the vehicle through which we're able to manifest these values as a Society. This month, I'd like to share with you some of GSA's top funding priorities for 2001 given to the GSA Foundation.

The Priority-Setting Process

Last May, the Programmatic Overview Committee (POC) met to consider many funding possibilities identified by staff in nine business plans. Members of GSA's Executive Council, a past president, and the president of the GSA Foundation Board are voting members of the POC, with key staff providing support. This group reviewed the funding proposals and ranked them—high, medium, and low—with a collective eye toward GSA's mission and the needs and wants of members.

The GSA Foundation Board endorsed the resulting list. Work then began to develop budgets and fund-raising plans to make these programs a reality.

Science at the Forefront

Student research grants continue to be GSA's top funding priority. In partnership with the National Science Foundation (NSF), we hope to continue to expand this program and increase the total dollars awarded to young geoscientists.

GSA Field Forums will continue to provide opportunities for growth for professional members. Initiated two years ago, these forums are an extension of GSA's Penrose Conferences, with an emphasis on field study.

The impact of geoscience on public policy continues to be a priority through the Congressional Science Fellowship program. Jointly funded by GSA and the U.S. Geological Survey, this program will continue to carry the voice of geoscience to Capitol Hill.

Opportunities for Students

One of GSA's most popular programs, Institute for Earth Science and the Environment, or IEE, National Park Internships, will be expanded to include participation by other geoscience organizations. Under a new name, GeoCorps America™, this outreach program will

*Methods and means
cannot be separated
from the ultimate aim.*

—Emma Goldman

reflect the combined strength of the entire geoscience community, and will be administered by GSA. Watch for details in upcoming issues of *GSA Today*.

IEE student mentoring programs, funded through Foundation gifts from Roy Shlemon and the estate of John F. Mann, will continue. These programs help young geoscientists make the transition from student to professional.

The new Geoscience Journalism Internship program will begin in 2001. This program recognizes the need to encourage development of the next generation of science writers who will communicate geoscience and its value to the general public. Watch for details in *GSA Today* in 2001.

Additional Priorities

GSA will move quickly into electronic publishing in 2001 with funding from GSA's own budget for strategic initiatives and from key partnerships and alliances. The Foundation will help support major technical development projects under this initiative.

The Foundation was instrumental in obtaining sponsorship for GSA's Distinguished Earth Science Educator in Residence program. Funded through August 2001 by Subaru of America, this program allows for much-needed teacher input into GSA's K-16 education activities, development of Web-based resources for K-12 teachers, and evaluation of an advanced placement exam in geology. The Foundation will continue to provide ongoing support as this program evolves.

The GSA-GSA Foundation partnership makes it possible for all of us to demonstrate our commitment to science, stewardship, and service in ways that have an impact far beyond our personal circle of influence. I encourage you to do so using the GSA Foundation reply envelope found between pages 8 and 9 in this issue.



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Wasatch fault zone, the most recent strain release via earthquakes occurred on fault segments near latitude 40°N ~1500 yr B.P. (Machette et al., 1992). Outside of these areas, fewer than half of the range-bound faults have Holocene slip, and many of them may not have significant Late Pleistocene (<130 000 yr B.P.) slip (Wallace, 1987; Dohrenwend et al., 1996).

The contrast in behavior at different time scales raises the question of whether the accumulation of extensional strain in the province is spatially uniform or is mostly or completely concentrated within the seismically active belts. At one extreme, strain accumulation on all faults in the system occurs simultaneously and at a very low rate, and hence contemporary deformation measurements using GPS

would be of little use in distinguishing which fault is most likely to fail next. At another extreme, strain accumulation on a given fault in the system would occur rapidly over a short period of time, separated by a long interval where it occurs on other faults. In this case, high contemporary strain rates in any given area would indicate seismic hazard, and the pattern of strain accumulation in time and space would be relatively complex.

Here, we summarize aspects of recent geological and geodetic investigations across the province bearing on the question of continuous versus discrete strain accumulation and release on intraplate fault systems, and on the general potential of such broadband studies of earth deformation for advancing tectonic research.

BASIN AND RANGE GEODETIC NETWORK (BARGEN)

To investigate the active tectonics of the province, we established a 50-station network of continuously operating GPS stations across the northern and central Basin and Range, known as the Basin and Range Geodetic Network, or BARGEN (Fig. 1; see http://cfa-www.harvard.edu/space_geodesy/BARGEN [September 2000]). In order to develop tectonically meaningful data in a short period of recording (a few years), the effects of local ground movement contaminating the signal (Wyatt, 1982) had to be minimized, and thus each BARGEN site includes a high-stability geodetic monument (Lang-

Fault Systems *continued on p. 4*

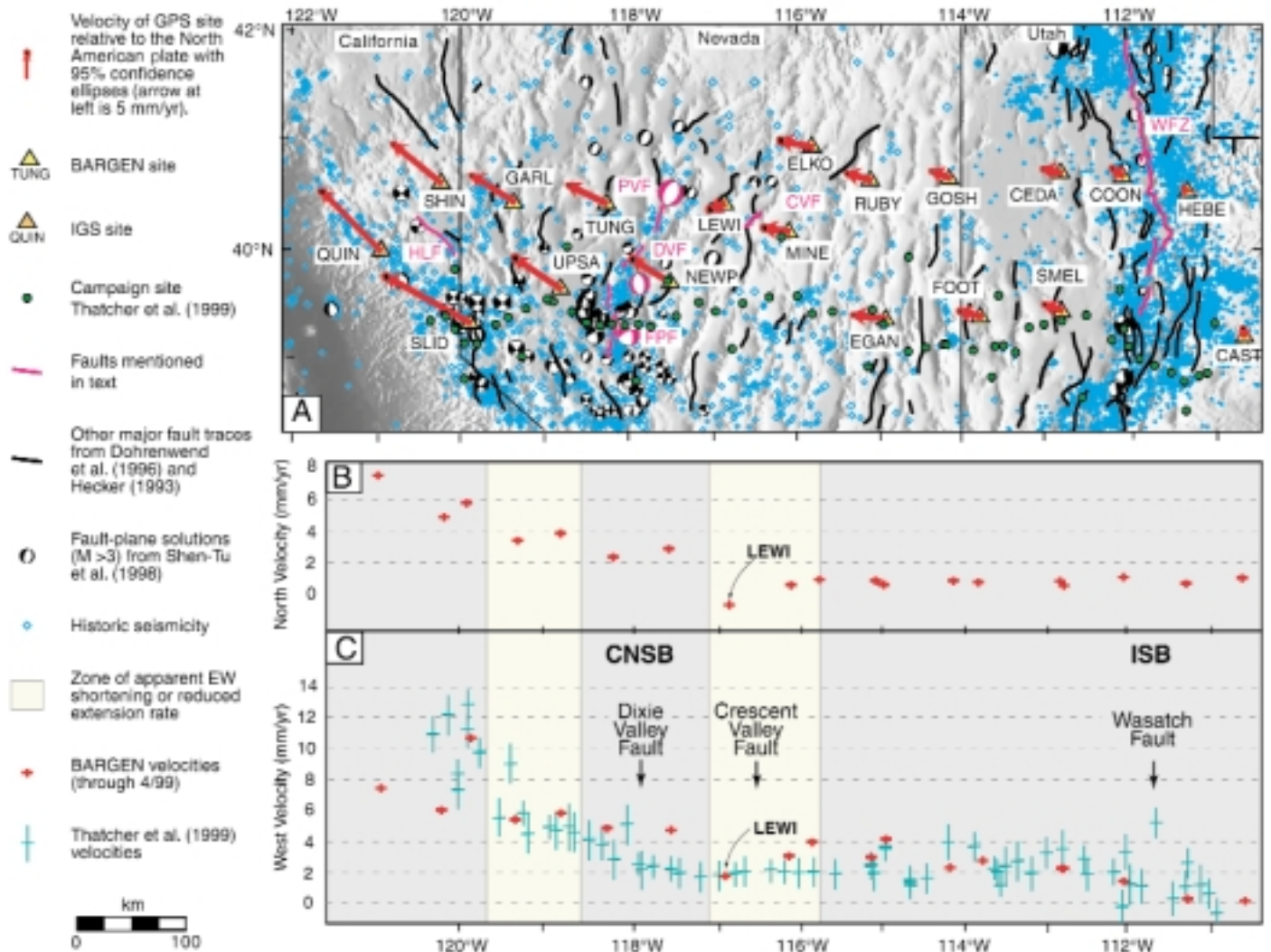


Figure 2. A: Shaded relief map of a transect across northern Great Basin showing seismicity, traces of selected fault zones, and GPS velocity vectors (with 95% confidence ellipses) from continuous sites from 1996 to 1999 (Bennett et al., 1999). Historic seismicity from Council of the National Seismic System. Historic earthquakes in central Nevada seismic belt (CNSB): DVF—Dixie Valley (1954); FPF—Fairview Peak (1954); PVF—Pleasant Valley (1915). Faults (in pink): CVF—Crescent Valley fault; DVF—Dixie Valley fault; FPF—Fairview Peak fault; HLF—Honey Lake fault; PVF—Pleasant Valley fault; WFZ—Wasatch fault zone. IGS—International GPS service. ISB—Intermountain seismic belt. B: North components of velocity as a function of longitude, with 1 σ error bars. C: West components of velocity as a function of longitude, from BARGEN continuous GPS data (red, from Bennett et al., 1999; periodically updated velocity solutions available at http://cfa-www.harvard.edu/space_geodesy/WUSC [September 2000]) and campaign GPS data (green, from Thatcher et al., 1999).

Fault Systems *continued from p. 3*

bein et al., 1995; Fig. 3). BARGEN GPS data are downloaded daily via telemetered relays and processed (see Bennett et al., 1998, 1999, and http://cfa-www.harvard.edu/space_geodesy/BARGEN [September 2000] for details). The ultimate result of processing data over a particular time interval is a geodetic solution, which includes the north, east, and vertical components of position and velocity. The solution may be presented as a table of velocity components, maps of horizontal velocity vectors (velocity fields as in Fig. 2A), plots of velocity components with respect to site position, the slopes of which are velocity gradients (as in Figs. 2B and 2C), and plots of the position of individual components versus time (time series as in Fig. 4). Velocity gradients, or velocity change per unit distance in a given direction, are also strain rates, reported below in units of nanostrains per year (nstr/yr), which is equivalent to 3×10^{-17} strains per second.

Prior to space-based techniques such as GPS, geodetic surveys required line-of-sight laser interferometer measurements, from mountain peak to mountain peak, through the optically noisy lower troposphere.



Figure 3. Photograph of Wyatt-design BARGEN monument and GPS antenna at site FRED. Monuments are constructed with one vertical borehole and three slanted boreholes plunging 55° with azimuths of 0°, 120°, and 240°, to a depth of 10 m.

This generally required transport of heavy equipment by aircraft for each survey, and flights along baselines to correct for atmospheric conditions. Repeated over a span of 10–20 years, these expensive and laborious surveys were able to provide strain rate measurements accurate to as little as ± 10 –20 nstr/yr, but each measurement represented only an average or bulk strain rate of many sites, over areas at most a few tens of kilometers wide, without spatial

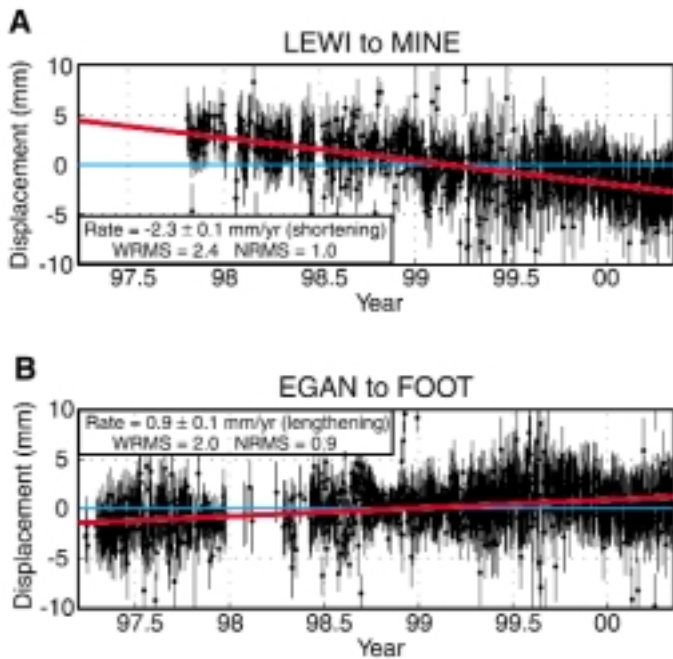


Figure 4. Time series of west positions between selected sites in BARGEN network. Negative slope indicates contraction, positive slope indicates extension. WRMS is the weighted root-mean-square and NRMS is the normalized root-mean-square of the linear regression (shown in red).

referencing to other networks or sites (e.g., Savage et al., 1995). Using these networks, inferred velocities were accurate to within 1–2 mm/yr, with gradual improvement only possible after decades of repeated surveys. As illustrated below, GPS geodetic solutions using continuously acquired data yield directly the velocity of each site in a global reference frame (i.e., velocity fields), accurate to within as little as ± 0.2 – 0.5 mm/yr, and large-scale strain rates to within ± 2 nstr/yr, in just a few years of monitoring. The method is comparatively inexpensive because sites need not be on mountain peaks, require little visitation once installed, and yield results in years rather than decades. Obviously, this new capability opens a vast horizon for observing fault systems, especially at scales larger than a few tens of kilometers and strain rates of 10 nstr/yr or less, as required for study of most intraplate fault systems and strain transients.

The velocity field, relative to the North American plate, of the first 18 BARGEN sites installed (in 1996 and 1997), shows monotonically increasing west to northwest velocity, from near 0 mm/yr on the east side of the province up to 12 mm/yr on the west, becoming more northerly from east to west (Fig. 2A; see http://cfa-www.harvard.edu/space_geodesy/BARGEN [September 2000] for a data table). The west components of motion increase monotonically westward, indicating broadly distributed extensional strain at a rate of ~ 10 nstr/yr. By comparison, rates adjacent to the San Andreas fault system are as much as 200–300 nstr/yr (e.g., Bennett et al., 1999), or 20–30 times Basin and Range rates. The north components of velocity are near zero across the eastern half of the province, but from central Nevada to the Sierra Nevada increase rapidly westward to values near 7 mm/yr.

One site in the network (LEWI, Fig. 2A), however, lies well off these trends in both north and west components, raising the question of relatively large systematic error in continuous GPS velocities, at least for certain sites. Further, the initial results of three campaign-mode GPS surveys (in 1992, 1996, and 1998) near latitude 40°N , which involved a larger number of stations (Figs. 2A and 2C) but very sparse temporal sampling, were interpreted to indicate high strain rates along the seismically active margins of the province, and low strain rates in the relatively aseismic interior (Thatcher et al., 1999). This contrast in tectonic

interpretations is illustrated by comparison of the west components of velocity for the two network solutions (Fig. 2C).

Thus, evaluating error sources in both continuous and campaign modes of surveying is crucial to resolving the apparent difference. For our ~ 2.5 yr solution, formal errors (1σ) in site velocity (either between sites or relative to a North American reference frame) are in the 0.1–0.2 mm/yr range (Davis et al., 1999). The formal errors, which account for uncertainties in phase measurement, timing (clock error), satellite position, atmospheric distortion, and other effects, may underestimate the true uncertainty or accuracy of the solution, which could arise from factors such as monument instability. The formal errors are reasonable estimates, however, because the scatter of the west velocities about a regression line is only about 0.5 mm/yr. If the actual errors were significantly higher, then the scatter of the data would be significantly greater than this value (Davis et al., 1999). This value is therefore an upper bound, because a significant component of the scatter may of course be due to real variations from linearity in the deformation field, rather than error. For the 11 sites in the eastern part of the network where north velocities are near zero, the scatter about a line of zero slope is only ~ 0.3 mm/yr (Fig. 2B; Davis et al., 1999). Assuming a model of no differential north-south motion for the eastern part of the network (a reasonable inference based on the geology), this value is near the formal error in velocity. In sum, we estimate our velocity error at 0.5 mm/yr based on 2.0–2.5 years of data, noting there is a reasonable possibility that errors may be as low as 0.1–0.2 mm/yr (Davis et al., 1999). In contrast, a campaign-mode effort in the same region, measuring six years of deformation, only resolves the

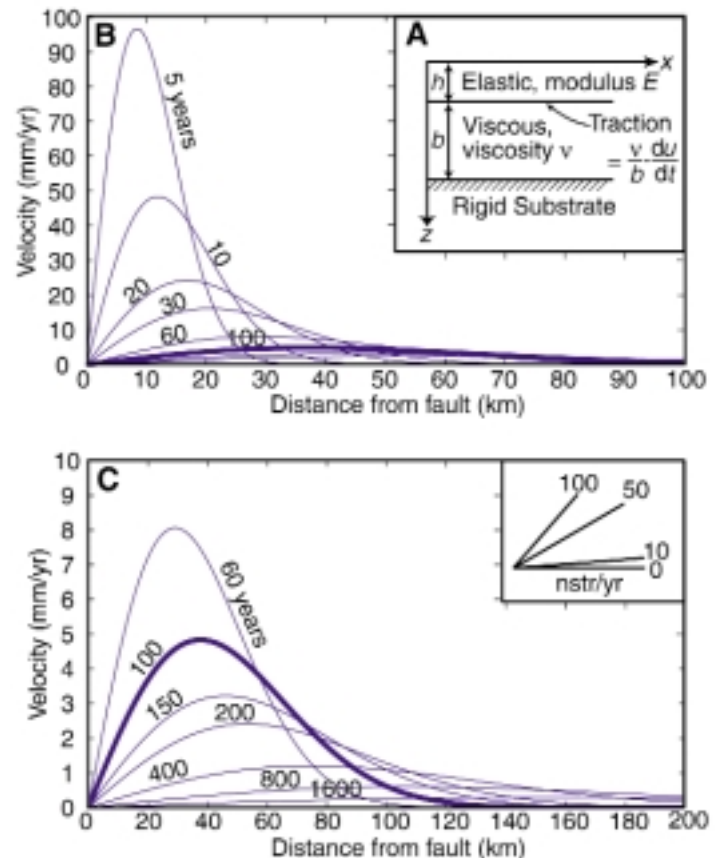


Figure 5. A: Diagram showing model for horizontal surface motion of transient waves after an earthquake in a brittle layer overlying a viscous layer on a rigid substrate (after Foulger et al., 1992). B and C: Evolution of horizontal velocity field normal to fault trace following a normal fault earthquake, with $U_0 = 2$ m, Young's modulus $E = 0.5 \times 10^{11}$ Pa, viscosity $v = 5 \times 10^{19}$ Pa-s, and layer thicknesses b and h 15 km each, as may be appropriate for the Basin and Range. Plots show two separate time and length scales for same model.

velocity of any particular site or group of sites to within 1–2 mm/yr (Fig. 2C).

INTERPRETING THE ANOMALOUS MOTION OF SITE LEWI

The velocity of site LEWI is 2–3 mm/yr below the west velocities of its two neighboring sites MINE and TUNG (Fig. 2A), defining a region of crust that is shortening at a rate of about 2.0 mm/yr, or 25 nstr/yr for this 80-km-long baseline. This value is at least four times our estimate of error in velocity. But is it accurate, and is there a reasonable explanation for it?

A time series of the relative position of LEWI and MINE has a well-defined negative slope, indicating east-west shortening (Fig. 4A), in contrast with other time series in the network that have positive slopes, indicating east-west elongation (e.g., EGAN relative to FOOT, Fig. 4B). Spectral analysis of LEWI's position did not reveal any characteristics, such as overall scatter, low-frequency noise or annual fluctuations, that are greater than those for other sites in the network (Davis et al., 1999), and so the only basis for questioning its accuracy is the fact that its velocity is anomalous. The overall north-west convergence direction between LEWI and MINE (obtained by subtracting their respective horizontal velocity vectors) is normal to the trace of the Crescent Valley fault (Fig. 2A), an archetypal range-bounding normal fault with Holocene scarp heights as high as 5 m (A. Friedrich and J. Lee, oral commun., 2000). At 2 mm/yr, the shortening could not continue for more than a few thousand years without contractional strain release (thrust faulting), suggesting the shortening is a transient state of strain, where the crust in the Crescent Valley area is still in a state of deviatoric tension, but with the magnitude of differential stress decreasing with time as a transient pulse or wave of contraction counteracts the regional stress field. Thus at present, despite the ominous appearance of the fault, the seismic hazard would appear to be decreasing with time.

A simple explanation for such a transient phenomenon is the response of viscous layers in the deep crust and upper mantle to an earthquake or earthquakes. In such a model, the sudden release of elastic strain energy in the upper, brittle portion of the crust perturbs or excites the deep crust and upper mantle stress field. Although these layers are elastic on a short time scale, they may also behave viscously at longer time scales, in response to the stresses imposed by faulting. Such viscoelastic behavior is short-lived (decades to centuries) and may be opposite in sign to regional strain accumulation patterns, depending on time, position, and the mechanical properties of the crust. In the case of a normal fault earthquake, upper crustal blocks on either side of the fault snap back (shorten) in response to coseis-

mic extension, much like the breaking of a stretched rubber band. The brittle crust thereby imposes a shearing traction on the viscous substrate, which decreases away from the fault. The shearing traction, at first concentrated near the fault, spreads outward as the substrate slowly responds to relieve stress. Thus after the earthquake, the region affected by coseismic shortening slowly extends, and the region just outside of it begins to shorten. Although such a strain pattern has not previously been observed adjacent to a large normal-fault earthquake, it was observed in GPS surveys between 1987 and 1992 across the Northern Volcanic Zone in Iceland, which experienced a rapid episode of dike injection in 1975 (Foulger et al., 1992, 1996).

The system may be understood quantitatively, to first order, by a physical model where an instantaneous displacement is applied to an elastic layer overlying a viscous layer (Fig. 5A; Bott and Dean, 1973). The elastic layer shortens during an earthquake, imparting a top-outward horizontal traction on the viscous substrate, such that the traction and horizontal displacement u decays according to the diffusion equation, or

$$\frac{\partial u}{\partial t} = \kappa \frac{\partial^2 u}{\partial x^2},$$

where x is the horizontal distance, t is time, and κ is the diffusivity. The horizontal surface velocity is simply the time derivative of the error-function solution to the diffusion equation, or

$$\frac{\partial u}{\partial t} = \frac{U_0}{t\sqrt{\pi}} \frac{x}{2\sqrt{\kappa t}} e^{-x^2/4\kappa t},$$

where U_0 is 1/2 the total horizontal dilation during the earthquake, and $\kappa = Ebh/v$ (Foulger et al., 1992; parameters defined in Fig. 5A). The model predicts rapid (relative to interseismic values) postseismic extension adjacent to the fault (the positive velocity versus distance slopes, Figs. 5B and 5C), and shortening in a band outward of it (the negative slopes). In this particular model (which is by no means unique), the velocity outward from the fault zone at $x = 60$ km is 3–4 mm/yr 100 years after the earthquake (heavy curve in Fig. 5C), in good agreement with relative eastward velocity of LEWI with respect to MINE and TUNG. To the west of the central Nevada seismic belt, we note that although a region of rapid shortening is not apparent, west velocities decrease slightly between sites TUNG and GARL, contrary to the regional, comparatively rapid, velocity gradients west of the central Nevada seismic belt observed in both campaign and BARGEN data.

The model in Figure 5 may provide a reasonable first-order estimate of these effects, but it ignores many potentially important considerations, such as truly viscoelastic behavior of the substrate (in

this model, it is purely viscous), and three-dimensional effects such as right-lateral shear and the finite length of fault segments. Nonetheless, it seems clear that if viscoelastic phenomena are indeed an important component of the geodetic signal, they may also provide an explanation for many of the smaller local anomalies in velocity, such as higher local strain rates along the Wasatch fault zone (e.g., baseline HEBE-COON) and in the Reno-Tahoe area (e.g., baseline UPSA-SLID).

Strain accumulation may therefore be relatively homogeneous across the region, with higher rates in seismogenic zones due to viscoelastic effects, rather than higher strain accumulation rates. We note that the long-term slip rates on Basin and Range faults (of order 30–300 k.y.) do not appear to be in excess of 0.5 mm/yr (17 nstr/yr on a 30 km baseline), even within the active seismic zones (e.g., Zreda and Noller, 1998; de Polo, 1998; Machette et al., 1992; Caskey et al., 1996; Friedrich et al., 2000), which is about an order of magnitude less than would be required if all the strain accumulation in the province were focused within one or two seismic belts at those time scales (say, 5 mm/yr on a 50 km baseline, or 100 nstr/yr). So it is possible, if not probable, that the geodetic signal, like the pattern of ranges and basins, speaks to relatively homogeneous strain accumulation across the province (linear velocity versus distance plots), perturbed by comparatively large viscoelastic effects of the most recent earthquakes.

CONCLUSIONS

These results, while preliminary, nonetheless demonstrate the power of combining modern geodetic and geologic data, especially in areas where transient signals are easily distinguishable from interseismic strain accumulation. In areas where strain accumulation is rapid (100s of nstr/yr), as along the San Andreas fault or in the Ventura or Los Angeles basin areas, postseismic transient strain rates are (1) of the same order or smaller than strain accumulation rates, (2) occupy a large fraction of the total interseismic period, and (3) are strongly overprinted by strain accumulation signatures of major plate boundary faults (e.g., Hager et al., 1999). However, in areas such as the Basin and Range, transient strain rates may be much easier to characterize because they are of the same magnitude as in rapidly straining areas (i.e., earthquakes in the Basin and Range are about the same size as those in the Los Angeles basin), but are an order of magnitude larger than the average strain accumulation rate, persist for only a small fraction of the interseismic cycle, and are relatively uncontaminated by strain accumulation signals from neighboring faults. A combination of paleoseismology, continuous GPS, and viscoelastic modeling in the Basin and Range may therefore offer the best potential to advance our understanding of the dynamics of fault systems, in ways that would be

difficult or impossible in areas that are the traditional focus of geodetic studies, where biases from neighboring fault zones and large corrections for interseismic strain rates obscure patterns of fault interaction.

ACKNOWLEDGMENTS

BARGEN research is conducted under the auspices of the National Science Foundation's Continental Dynamics Program, the U.S. Department of Energy's Yucca Mountain Project, and NASA's Solid Earth and Hazards Program, with design and maintenance assistance from the University Navstar Consortium (UNAVCO) Facility in Boulder, Colorado, the University of Nevada, Reno, and the University of Utah. We thank Gene Humphreys, Wayne Thatcher, and Karl Karlstrom for many useful suggestions on the manuscript.

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Manuscript received July 4, 2000; accepted September 6, 2000. ■



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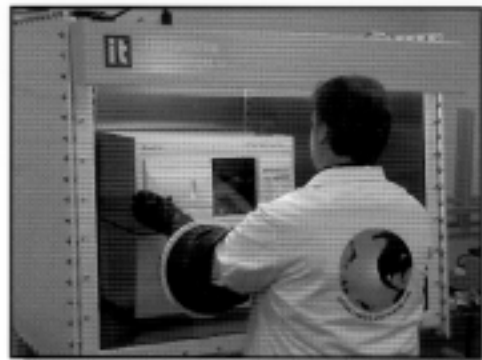
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ROCKY MOUNTAIN (53rd) and SOUTH-CENTRAL (35th) SECTIONS, GSA, Joint Annual Meeting

Albuquerque, New Mexico, Sheraton Old Town Hotel,
April 29–May 2, 2001

The Rocky Mountain and South-Central Sections of GSA will meet jointly in Albuquerque, New Mexico, in 2001. The meeting is sponsored by the Department of Earth and Planetary Sciences, University of New Mexico, and the Department of Geology, Sul Ross State University.

ENVIRONMENT

With scenery that is a veritable textbook of geology, New Mexico has from early days attracted pioneer earth scientists like Jules Marcou, J.S. Newberry, F.V. Hayden, Benjamin Silliman Jr., J.W. Powell, G.K. Gilbert, Clarence Dutton, Waldemar Lindgren, N.L. Darton, Kirk Bryan, C.V. Theis, C.E. Jacob, and E.H. Colbert. Pre-Columbian Native Americans digging for turquoise and Spanish conquistadors seeking the gold of Cibola were forerunners of geologists who made New Mexico a leading producer of oil and gas, coal, uranium, copper, molybdenum, gold, silver, and potash. The Albuquerque area lies near the intersection of five major geologic provinces. To the west and northwest is the Colorado Plateau and San Juan Basin region. To the north and northwest are Precambrian-cored foreland uplifts of the Nacimiento and southern Sangre de Cristo and Taos Ranges. Features related to the Cenozoic Rio Grande Rift continue southward from south-central Colorado through central New Mexico and merge with the Basin and Range province of southern New Mexico. To the east of the Sandia Mountains and behind Albuquerque lies the Great Plains province.

CALL FOR PAPERS

Papers are invited for technical sessions, symposia, theme sessions, and poster presentations. The technical sessions will provide 15 minutes for presentation and five minutes for discussion. Symposia conveners may assign more time to invited key speakers. Two 35-mm carousel projectors (please bring your own trays), two screens, and an overhead projector will be provided for each oral session. Computer projection equipment may be made available if sufficient notice is provided. Papers of regional interest to earth and environmental scientists in the Rocky Mountain and South-Central areas as well as those of general interest will be considered for the program.

Poster presentations are encouraged and will allow at least three hours of display time. Authors must be present for at least two hours.

ABSTRACTS

Abstracts Deadline:
January 24, 2001

Abstracts for all sessions must be submitted online at the GSA Web site. Please see the article on GSA's new electronic abstract submittal system on page 11. If you cannot submit your abstract electronically, contact Nancy Carlson, (303) 447-2020, ext 161, ncarlson@geosociety.org.

FIELD TRIPS

Premeeting field trips will be offered. Unless otherwise noted, all field trips begin and end in Albuquerque. For details about particular field trips, contact the field trip leaders listed below or Karl E. Karlstrom, Field Trips Coordinator, (505) 277-4346, kek1@unm.edu. We hope there will be a strong linkage between symposia and related field trips.

Premeeting

1. Volcanology and Hydrothermal Systems of Valles Caldera and the Jemez Mountains. Fraser Goff, fraser@lanl.gov, Los Alamos National Laboratory. (One day, April 29.)
2. Cenozoic Stratigraphy and Neogene Tectonic Evolution of the Middle Rio Grande Rift. Sean Connell, connell@gis.nmt.edu, and David W. Love, dave@gis.nmt.edu, New Mexico Bureau of Mines and Mineral Resources; and Spencer G. Lucas, New Mexico Museum of Natural History. (Three days, April 27–29.)
3. Proterozoic Ductile Thrust Belt in the Manzano Mountains. Karl E. Karlstrom, (505) 277-4346, kek1@unm.edu, University of New Mexico. (One day, April 29.)
4. NAGT Field Trip: Learning Geology in the Field—Old Mountain Belts to Young Volcanoes near Albuquerque. Gary Smith, gsmith@unm.edu, Aurora Pun, apun@unm.edu, and Alex Castrounis, indy500@unm.edu, University of New Mexico; and Kent C. Nielsen

knielsen@utdallas.edu, University of Texas—Dallas. (One day, April 28, open only to K–12 teachers.)

5. Tent Rocks. Gary Smith, gsmith@unm.edu, University of New Mexico. (One day, April 29.)

SYMPOSIA

The following symposia are planned for the Albuquerque meeting.

1. Validating Models of Subsurface Flow and Transport. Daniel B. Stephens, Daniel B. Stephens and Associates, Inc., (505) 889-7752, danstephens@dbstephens.com.
2. Ouachita-Marathon Tectonics: Current Research and Speculations—A Tribute to George Viele. William A. Thomas, University of Kentucky, (606) 257-6222, geowat@pop.uky.edu, and Kent C. Nielsen, University of Texas—Dallas, (972) 883-6837, knielsen@utdallas.edu.
3. Geologic Framework of the Middle Rio Grande Basin. Jim Cole, U.S. Geological Survey, (303) 236-1417, jimcole@usgs.gov, Paul Bauer, bauer@nmt.edu, and Sean Connell, connell@gis.nmt.edu, New Mexico Bureau of Mines and Mineral Resources.
4. Hydrogeology of the Middle Rio Grande Basin. James R. Bartolino, U.S. Geological Survey, (505) 830-7936, jrbartol@usgs.gov.
5. Proterozoic Tectonics of the Southwestern U.S. Karl E. Karlstrom, University of New Mexico, (505) 277-4346, kek1@unm.edu, and Mike Williams, University of Massachusetts, mlw@geo.umass.edu.
6. Geophysics of the Rio Grande Rift and Southern Rocky Mountains. G. Randy Keller, University of Texas—El Paso, keller@geo.utep.edu, and W. Scott Baldrige, Los Alamos National Laboratory, (505) 667-4338, sbaldrige@lanl.gov.
7. NAGT Session I: Geoscience Education and Research in American Indian and Hispanic Communities. Steve Semken, Dine College, ssemken@shiprock.ncc.cc.nm.us.
8. NAGT Session II: Development and Use of Web-based Resources for College Instruction. Kent C. Nielsen, (972) 883-6837, knielsen@utdallas.edu, and Rebekah K. Nix, University of Texas—Dallas.
9. Timing of Ancestral Rocky Mountain Orogeny. Spencer G. Lucas, New Mexico Museum of Natural History, (505) 841-2873, slucas@nmmnh.state.nm.us, and Steve Cather, New Mexico Bureau of Mines and Mineral Resources, steve@gis.nmt.edu.

THEME SESSIONS

1. Undergraduate Research Poster Session. Sponsored by the Geology Division of the Council on Undergraduate Research, this session will showcase senior theses and other undergraduate research projects. A student must be listed as the lead author and be the major preparer of the poster. For further information, contact Jeff Connelly, University of Arkansas at Little Rock, (501) 569-3543, jbconnelly@ualr.edu, or Kim Hannula, Fort Lewis College, (970) 247-7278, hannula_k@fortlewis.edu.
2. Climate Change, Hydrology and Water Allocation in the Western U.S. Michael E. Campana, University of New Mexico, (505) 277-3269, aquadoc@unm.edu.
3. Forest Fire Impacts on Hydrochemistry and Hydrology. Patrick Longmire, (505) 665-1264, plongmire@lanl.gov, and Bruce Gallaher, (505) 667-3040, gallaher@lanl.gov, Los Alamos National Laboratory.

NEW: PARTNERING SHORT COURSE PROGRAM

GSA is pleased to introduce the new Partnering Short Course Program at this section meeting. This program offers short courses specifically designed to appeal to the members of both GSA and the Partnering Associated Society. The first short course offered in the program is brought to you by GSA and SEPM (Society for Sedimentary Geology).

GSA and SEPM Partnering Short Course: Paleosols for Sedimentologists. Sunday, April 29, 8 a.m.-5 p.m., Sheraton Old Town Hotel, Albuquerque. Greg H. Mack, Dept. of Geological Sciences, New Mexico State University; Ph.D., Indiana University. Greg Mack specializes in interpretation of the influence of tectonism and paleoclimate on depositional environments of Phanerozoic siliciclastic sediment. His research involves the use of

paleosols to interpret Permian, Cretaceous, and late Tertiary paleoclimate. The potential of paleosols to aid in solving a variety of problems related to earth history has started to be realized during the past two decades. Reconstruction of ancient climate, stream behavior within sedimentary basins, semiquantitative determination of subsidence and sediment accumulation rates, and delineation of terrestrial paleoecosystems are examples of research areas significantly advanced by the study of paleosols. Despite this increased interest, many sedimentary geologists are not thoroughly conversant in paleosol recognition and applications as an interpretative tool. This course focuses on the fundamental aspects of paleosol description, recognition, and interpretation, concentrating on (1) field and petrographic features indicative of paleosol development, (2) key terminology applicable to paleosols, and (3) interpretative uses of paleosols for reconstructing basin histories and paleoclimates. Limit: 30. Fee: \$99; includes course manual and refreshments. CEUs: 0.8.

STUDENT SUPPORT

The GSA Rocky Mountain and South-Central sections have travel grants available for GSA Student Associates who are presenting oral or poster papers as authors or coauthors. Students must be currently enrolled to be eligible. Rocky Mountain Section students should contact Kenneth E. Kolm, Colorado School of Mines, kkolm@mines.edu, (303) 273-3932. South-Central Section students will find application instructions on the South-Central Section pages of the GSA Web site, www.geosociety.org.

Each section will give awards for the best oral and poster student papers at the meeting. Awards will be based on the quality of both the research and presentation. To be eligible, a student must be the lead author and presenter of the work. The abstract must be clearly identified as a

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EXHIBITS

Exhibits representing education, research, and industry will be displayed at the meeting site. For further information, contact: John W. Geissman, jgeiss@unm.edu, (505) 277-3433.

ADDITIONAL INFORMATION

Information concerning registration, accommodations, and activities will appear in the February 2001 issue of *GSA Today* and on the GSA Web site, www.geosociety.org. Requests for additional information or suggestions should be addressed to the General Chair, John W. Geissman, jgeiss@unm.edu, (505) 277-3433.

GSA is committed to making all events at the 2001 meeting accessible to all people interested in attending. You can indicate special requirements (wheel chair accessibility, etc.) on the registration form. ■

New Abstracts System Try It, You'll Like It!

GSA is now using a new abstracts management system that can be accessed from our Web site at www.geosociety.org. You can also get to the system from your section's page on our Web site. Use the "Abstracts" link.

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After submitting your abstract, please feel free to contact GSA's Abstracts Program Coordinator Nancy Carlson at ncarlson@geosociety.org with any comments or questions you have about the new system.

GSA's Electronic Publications: Take a Look

Mary Lou Zoback, GSA President

Yes, please take a look at the GSA publications available free online until the end of the year! As most graduate students have discovered, PDF versions of both *GSA Bulletin* and *Geology* have been freely available on our Web site, www.geosociety.org, for all of 2000. Current subscribers to either or both journals should have been receiving monthly e-mails with a linkable table of contents for each month's issue.

These downloadable files served as an introduction to more complete digital versions of the journals that will be offered to GSA members in 2001. The new online journals will consist of full-text html files for viewing on the screen; PDF files for printing paper copies of articles that look identical to the printed pages; SGML coding that will allow full-text searching and the creation of an archival journal database; linking from GeoRef to GSA journals, and reference linking to the CrossRef database. Plus, all subscribers will enjoy instant access to the journals (particularly valuable for overseas subscribers who often wait weeks for the paper journals).

Value-added features in the future

The changes for 2001 represent the first step in our transition to online journals; many other societies have already begun this transition. While traditional paper journals will remain with us for some time, moving into the online medium will enable us to continue to add enhancements for the reader as our journals evolve. Some enhancements include:

- Interactive data plots. Imagine clicking

on a geochemical plot, bringing up the spreadsheet that created it, and being able to add your own data to see how it compares with those in the paper or to recalculate theoretical curves for different input values.

- Multiple plot or map layers. A single figure could consist of multiple registered layers so you could superimpose layers of interest. For example, Quaternary faults could be shown on the gravity data, without the full geologic map.
- Hot links to digital versions of articles in *GSA Bulletin* and *Geology* back to 1972. We are in the process of electronically capturing these articles to make them available with a click of a mouse. This might prevent some reinventing of the wheel, which tends to happen when we overlook articles more than 5–10 years old.
- Customized e-mail messages to notify you of articles on topics of interest to you.
- Links galore: You'll be able to link to each reference in an article and you'll be able to link to any articles that reference the paper you are currently viewing.

Pricing in 2001

All professional societies rely heavily on income from their publications and are treading cautiously into this transition period to online publications. The model for the future remains unclear—will libraries become the primary provider with single institutional online subscriptions, eliminating the need for personal subscriptions for many members? Or will libraries decide that their role as archivists

Online Options

Electronic publications can offer more than online versions of paper journals.

Let's face it—most of us still print out the things we want to read. Online versions can make research more convenient with direct links to references and access to archives from any Internet connection—a real plus when traveling. They also can offer authors opportunities to present information and figures in new ways, such as in video clips and interactive data plots.

In the coming months, *GSA Today* will feature information on how to get the most out of online publications—both as readers and as contributors. Stay tuned!

is no longer necessary since professional societies are providing the electronic archive and either cancel their subscriptions or purchase limited site licenses? In either scenario, we need to continue to provide access to publications for all members, including those who are either self-employed or working for small companies without large research libraries.

In 2001, we are offering online journal subscriptions only to individual members. On your 2001 dues statement, you have three options: online only, online plus paper, or paper only. It might seem that the online-only option should be significantly less expensive than the paper options. However, keep in mind that much of the cost of our journals is in manuscript processing, editing, and production. Also, since GSA becomes the archivist (or must contract for archiving services) for the online journals, we are incurring additional costs.

Let us hear from you

I suspect many of you are like me—I am being buried by paper that is often stacked into many high piles around my office. The monthly e-mail table of contents allows me to easily peruse, at my desktop, any article of interest in a current issue. Electronic indexing will give me quick access to a past article I recalled seeing.

Please take a look at our current online journals (recognizing their limitations compared to what will be offered in 2001). If you are not currently a subscriber, this is a great opportunity to get reacquainted with both *GSA Bulletin* and *Geology*. I know you will be impressed with the scientific breadth in both journals as well as the coverage in new and emerging areas of earth sciences. Finally, let us hear your comments and your suggestions for features you'd like to see as our journals evolve in the new millennium. ■

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Boston 2001: A Geo-Odyssey

Rob Young and David Bush, Technical Program Co-Chairs

Boston is the proud host of A Geo-Odyssey, GSA's Annual Meeting and Exposition in November 2001. Help us make this an exciting and successful meeting by submitting proposals for topical sessions and Pardee Symposia. Deadline for proposals: January 8, 2001.

The hub of New England, Boston showcases a varied geology that should appeal to all. Highlights include the crystalline rocks of the northern Appalachians, Pleistocene and coastal sediments and geomorphology, hydrological and environmental reclamation sites such as nearby Woburn of *A Civil Action* fame, and downtown Boston's current ambitious highway engineering wonder, the Big Dig.

As a center of history, Boston is truly unrivaled. Relive colonial and revolutionary Boston with a stroll along the Freedom Trail from the Boston Common to Old North Church. Not to be missed is the Faneuil Hall and Quincy Market area, as much a mecca for shoppers today as it was in the 1700s. A short excursion west of Boston takes you to the Concord and Lexington revolutionary battlefields and to the homes of Concord's 19th century literary greats. To the south is Plymouth, with its replicas of the pilgrim village, their ship the *Mayflower*, and of course, one very famous rock.

Boston is also a modern, vibrant city with a world-class symphony and a vast selection of museums, theaters, shopping, and fine dining. While seafood is the specialty and purists can still find the traditional baked beans and cod, Boston abounds in excellent restaurants that serve every imaginable cuisine.

The meeting's theme, A Geo-Odyssey (borrowed from the science fiction classics of Arthur Clarke and Stanley Kubrick), is an appropriate one for the start of the 21st century. The dictionary defines odyssey as "a long wandering or voyage, usually marked by many changes in fortune; an intellectual quest." New England, a place where the past is an intimate part of the present, is also where Louis Agassiz, Dana and the Hitchcocks, and many others brought important early changes and ideas to geology. In keeping with our theme, we'll continue that intellectual quest with technical sessions that deal with the cutting edge of our science at the beginning of a new century. We'll also cast an eye to the past and recall what has brought us to our present spot on the path, so that we may go forward with confidence.

We welcome proposals for Pardee Keynote Symposia and topical sessions. They must be sent electronically on or before January 8, 2001. The link can be

found at www.geosociety.org.

Most session rooms in Boston will allow for combined oral and poster presentations so these different presentation methods may be combined into one session if desired.

Program Opportunities

The Annual Meeting program's mixture of invited and volunteered papers and varying session formats allows for an effective, dynamic, and flexible lineup. Joint Technical Program Committee (JTPC) representatives play a large role in program decisions. Descriptions of the various program options and guidelines are available at www.geosociety.org. Since modifications are made from year to year, please read the guidelines carefully before submitting a proposal. Two types of sessions can be proposed:

Pardee Keynote Symposia, made possible by a grant from the Joseph T. Pardee Memorial Fund. Topics appropriate for these keynote symposia should be of broad interest to the geoscience community, be on the leading edge in a scientific discipline or area of public policy, address broad fundamental problems, be interdisciplinary, or focus on global problems. Selection is on a competitive basis; the primary criterion is excellence. Four to eight half-day, nonconcurrent (one per half day; minimum of one per day) sessions will be offered. All speakers will be invited.

Topical Sessions promote the exchange of timely or state-of-the-art information with respect to a central topic and allow scheduling of interdisciplinary talks on a specific topic. Organizers (advocates) may invite specific papers to ensure a successful and excellent session and are encouraged to solicit volunteered contributions. A maximum of four invited speakers may be allowed, although advocates may request more invitations if they can justify the larger number. Sessions must include volunteered abstracts, which are solicited in *GSA Today* for all approved topical sessions. Advocates may request considerations such as a special format. All requests are reviewed by the JTPC for approval. To be part of the technical program, all sessions must receive a minimum of 12 abstracts. Advocates are encouraged to submit proposals as poster sessions to accommodate the growth of the technical program and the limitations of meeting space.

Oral and Poster General Sessions

Consisting entirely of volunteered papers, these sessions are an important component of the meeting. The number of abstracts received determines the number of general sessions in each discipline. The

goal of the Technical Program Committee (TPC) and the JTPC representatives is to provide presenters the best possible opportunity for communicating new scientific information rather than to dictate what can or will be presented. (The rejection rate for recent GSA Annual Meetings has been less than 5%.) Expanded poster sessions allow presentation of more papers. An effort will be made to avoid scheduling poster sessions concurrently with oral sessions in the same discipline to allow for well-attended, dynamic sessions.

Hot Topics Spice up the Lunch Hour

Lunchtime forums featuring one Hot Topic per day are held Monday through Thursday. These hour-long sessions differ from technical sessions in that they focus on discussion and audience participation. A debate format is recommended, and panels are discouraged. Each session must have a moderator, and titles should be catchy and provocative. If you are interested in organizing one of these sessions or in being a Hot Topics Chair, contact Technical Program Chair Rob Young.

Join Us in Boston

We're counting on you to help make the 2001 GSA Annual Meeting in Boston a dynamic and stimulating conference, with first-rate reports on issues that affect our science, research that sheds new light on topics of interest, and scientific developments from every discipline. We look forward to working with you. If you have any questions or concerns regarding these program initiatives, please call or e-mail one of us:

Rob Van der Voo, Annual Program Chair (2000-2001), (734) 764-8322; voo@umich.edu.

Rob Young, Technical Program Co-Chair, (828) 227-3822; ryoung@wcu.edu.

David Bush, Technical Program Co-Chair, (770) 836-4597; dbush@westga.edu. ■

2001 Schedule

- | | |
|---------|---|
| Jan. 8 | Proposals due. <i>Firm deadline; electronic submissions required.</i> |
| April | Electronic abstracts form available at www.geosociety.org for active submissions. |
| July 17 | Paper-copy originals due at GSA. <i>Firm deadline.</i> No paper abstracts accepted after this date— <i>no exceptions.</i> |
| July 24 | <i>Electronic abstracts deadline.</i> Electronic copies accepted until midnight (MST). |
| Aug. 17 | Program schedule finalized. |
| Sept. 4 | Accepted abstracts appear at www.geosociety.org . |



Great Cascadia Earthquake Tricentennial

Conveners: **John J. Clague**, Department of Earth Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, jclague@sfu.ca

Brian F. Atwater, U.S. Geological Survey, Department of Geological Sciences AJ-20, University of Washington, Seattle, WA 98195, atwater@u.washington.edu

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Ivan Wong, URS Greiner Woodward Clyde, 500 12th Street, Suite 200, Oakland, CA 94607, Ivan_Wong@urscorp.com

The year 2000 marks the tricentennial of the last great (magnitude 8 or larger) earthquake at the Cascadia subduction zone, which is located along the Pacific coast of North America from British Columbia to northern California. Coastal and offshore work has confirmed that many great plate-boundary earthquakes have struck this region in the Holocene, and geodetic studies have shown that the subduction zone is accumulating strain that will be released in a future earthquake.

To commemorate the tricentennial, almost 100 geologists, geophysicists, engineers, and public officials gathered in Seaside, Oregon, in the first week of June 2000 to critically review current knowledge about great Cascadia earthquakes, clarify the hazards posed by these earthquakes, discuss appropriate strategies for reducing earthquake losses, and identify priority research directions. Further understanding of the great earthquake potential of the Cascadia subduction zone is required for seismic hazard characterization, engineering design, emergency planning and response, and other mitigation efforts in a region with a population of nearly 10 million people. Seaside was an appropriate place to hold the conference because much of the community, including the conference hotel, lies within the inundation zone of the tsunami of the 1700 earthquake!

The conference consisted of three days of indoor sessions, a field trip, and a public forum on Cascadia earthquakes and tsunamis. Sessions on the first day dealt with earthquake hazards and their mitigation. These initial sessions provided focus for subsequent sessions on regional earthquake histories, tectonics, and present-day seismicity and strain accumulation. Evidence for past Cascadia earthquakes was examined and discussed during a canoe

trip along the Niawiakum River in southwestern Washington and at a nearby park where lake, tidal marsh, and deep-sea cores collected during previous paleoseismological investigations were displayed. The public forum, held on the first evening of the conference, attracted more than 200 people, including two state senators, and allowed conference participants to hear concerns of local residents. The forum and the conference as a whole were covered extensively in local newspapers.

A huge amount of progress has been made in understanding the behavior of the Cascadia subduction zone over the past two decades. Fifteen years ago, scientists were debating whether great earthquakes occur at the subduction zone. Today, few scientists doubt that great earthquakes occur in this region; rather, the discussion has shifted to questions such as the magnitude of the earthquakes and attendant tsunamis, the location and width of the seismogenic zone, and the involvement of crustal structures in plate-boundary rupture. These issues were topics of discussion and debate at the conference. Consensus was achieved on several important issues; major points of consensus are summarized below.

- Damage, injuries, and loss of life from the next great earthquake at the Cascadia subduction zone will be great and widespread, and will impact the national economies of Canada and the United States for years or decades. Increased research, information exchange, public education, mitigation, and planning are needed to reduce risk. Damage from historical earthquakes and results of predictive damage and loss studies suggest that disastrous future losses will occur in the Pacific

Northwest from a great Cascadia earthquake. Mitigation efforts in other seismically active regions and cost-benefit studies indicate that mitigation can effectively reduce these losses and help with recovery. Accurate data acquired through geological and geophysical research, followed by information and technology transfer to key decision makers, will reduce risk to citizens of the coastal Pacific Northwest.

- The Cascadia subduction zone produces great earthquakes, the most recent of which occurred in 1700 and was of moment magnitude (M_w) 9. Geologic evidence from a large number of coastal and offshore sites from northern California to southern Vancouver Island and historical records from Japan show that most or all of the 1100 km length of the subduction zone ruptured about 300 years ago. Japanese accounts of a correlative tsunami suggest that this rupture occurred in a single earthquake, possibly of M_w 9, on January 26, 1700. The sizes of earlier Cascadia earthquakes are unknown. It is possible that some of them ruptured adjacent segments of the subduction zone over periods ranging from hours to years, as has happened historically in Japan and Colombia.
- Great Cascadia earthquakes generate tsunamis, the most recent of which was probably at least 10 m high on the Pacific coast of Washington, Oregon, and northern California, and up to 5 m high in Japan. These tsunamis threaten coastal communities all around the Pacific Ocean but would have their greatest impact on the U.S. and Canadian west coasts, which would be struck 15–40 minutes after the earthquake. Deposits of past great Cascadia tsunamis have been identified at numerous coastal sites in California, Oregon, Washington, and British Columbia. The distribution of the deposits and computer-based simulations of tsunamis indicate that many coastal communities in the region are partially to largely within the inundation zone of past Cascadia tsunamis. These communities are threatened by future tsunamis from great Cascadia earthquakes. Tsunami arrival times depend largely on the location of the rupture zone, specifically its distance from the coast.
- Strong ground shaking from a M_w 9 plate-boundary earthquake will last three minutes or more and will be dominated by long-period ground motions. Damaging ground shaking will probably occur as far inland as Vancouver, Portland, and Seattle. The large cities of Cascadia are 100–150 km from the

nearest point on the inferred plate-boundary rupture zone. Although ground shaking at these locations will be less than that of a nearby large ($M_w \geq 7$) crustal earthquake, the shaking will last much longer and the long-period waves could damage many tall or long engineered structures. Shaking will be strongest along the Pacific coast, resulting in significant damage to coastal communities.

- The mean recurrence interval for great plate-boundary earthquakes in Cascadia is 500–600 years, but some of the past earthquakes had intervals less than the time that has elapsed since the 1700 earthquake. Intervals between successive great earthquakes range from a few centuries to about one thousand years. The number of well measured recurrence intervals is small—rarely more than five. The data show that great earthquakes have occurred at irregular intervals, but they do not show whether the earthquakes cluster or are randomly distributed in time. Because the recurrence pattern is poorly known, probabilities that the next earthquake will occur within particular intervals have broad ranges.
- The Cascadia plate boundary is currently locked, and the locked zone is offshore and widest off northwest Washington. The maximum area of seismogenic rupture is 1100 km long and 50–150 km wide. The location and size of the seismogenic portion of the plate boundary are critical for determining earthquake magnitude, tsunami size, and the strength of ground shaking. The landward limit of the “locked” portion of the plate boundary, where no slip occurs between the Juan de Fuca and North American plates during periods between earthquakes, has been delineated from geodetic measurements of the deformation of the land surface. However, few or no data constrain the seaward limit of the locked zone. In addition, the transition zone, which separates the locked zone from the zone of continuous sliding to the east, is also poorly constrained. Earthquake rupture may extend an unknown distance from the locked zone into the transition zone.
- Movement on some crustal faults near the coast may accompany plate-boundary earthquakes and increase the size of the tsunami and the intensity of local ground shaking. Detailed mapping along the coast of Cascadia on the adjacent continental shelf has revealed the presence of numerous folds and faults that were active during the Quaternary and perhaps remain active today. The question of whether some crustal faults slip during plate-boundary earthquakes, and thus are independent seismic sources, was debated at the conference. Movement on crustal faults does not explain the coastal coseismic subsidence evidence in some areas, which can only be interpreted as resulting from plate-boundary rupture. The evidence, however, does not disprove that some faults ruptured before, during, or immediately after great earthquakes. This issue is important for seismic risk assessment because moderate or large earthquakes might occur on crustal faults close to urban areas, and displacements of the seafloor along such faults could trigger tsunamis with very large waves.

Additional Reading

Atwater, B.F., and Hemphill-Haley, E., 1997, Recurrence intervals for great earthquakes of the past 3500 years at northeastern Willapa Bay, Washington: U.S. Geological Survey Professional Paper 1576, 108 p.

Clague, J.J., 1997, Evidence for large earthquakes at the Cascadia subduction zone: *Reviews of Geophysics*, v. 35, p. 439–460.

Flück, P., Hyndman, R.D., and Wang, K., 1997, Three-dimensional dislocation model for great earthquakes of the Cascadia subduction zone: *Journal of Geophysical Research*, v. 102, p. 20,539–20,550.

Hyndman, R.D., and Wang, K., 1995, The rupture zone of Cascadia great earthquakes from current deformation and the

thermal regime: *Journal of Geophysical Research*, v. 100, p. 22,133–22,154.

McNeill, L.C., Goldfinger, C., Yeats, R.S., and Kulm, L.D., 1998, The effects of upper plate deformation on records of prehistoric Cascadia subduction zone earthquakes, *in* Stewart, I., and Vita-Finzi, C., eds., *Coastal tectonics: Geological Society of London Special Publication 146*, p. 321–342.

Myers, E., Baptista, A.M., and Priest, G.R., 1999, Finite element modeling of potential Cascadia subduction zone tsunamis: *Science of Tsunami Hazards*, v. 17, p. 3–18.

Wang, Y., and Clark, J.L., 1999, Earthquake damage in Oregon, preliminary estimates of future earthquake losses: *Oregon Department of Geology and Mineral Industries Special Paper 29*, 59 p. ■

Conference Participants

Kenneth R. Aalto	Lisa McNeill
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Jim Ament	Meghan Miller
Brian F. Atwater	Ray Miller
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Walter Barnhardt	Alan R. Nelson
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Marcos Cisternas	George Plafker
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Mark Darienzo	Tim Richter
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Mark Hemphill-Haley	C.R.H. Thoms
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Ian Hutchinson	Martitia P. Tuttle
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Ike Jensen	Timothy J. Walsh
Joel E. Johnson	Kelin Wang
Robert Kayen	Yumei Wang
Harvey Kelsey	Zhenming Wang
Steven Kramer	Ray Wells
Roland LaForge	William S.D. Wilcock
Robert Losey	Donald S. Windeler Jr.
Ian Madin	Robert Witter
Ravindra K. Mahajan	Ivan Wong
Brian G. McAdoo	Robert Yeats
Pat McCrory	Robert Youngs
David McDaniel	

2001 GSA Annual Meeting Field Trips

An exciting and diverse range of field trips awaits you at the 2001 meeting in Boston. The northern Appalachians provide a spectacular laboratory for the study of ancient tectonic processes, and several field trips will focus on various aspects of Appalachian orogenesis. Other trips will focus on the dynamic New England coastline and recent attempts to decipher the complex history of Quaternary sea-level change. Finally, the urban setting of the greater Boston area will give participants glimpses into the numerous challenges associated with groundwater contamination and engineering geology. Trip destinations will range from the immediate Boston area to the rugged coast of Maine, from the White Mountains of New Hampshire to the Berkshires of western Massachusetts and many points in between. Take full advantage of the diverse offering of trips, including both single and multi-day trips and half-day trips that will depart from the Hynes Convention Center.

The following list is tentative and subject to change. Proposals for trips are still coming in, and final selections have not yet been made. Further details will be given in the April 2001 issue of *GSA Today*. For additional information, contact the 2001 Field Trip Co-chairs: Dave West, Dept. of Geology, Earlham College, Richmond, IN 47374, (765) 983-1231, fax 765-983-1497, westd@earlham.edu, and Dick Bailey, Dept. of Geology, Northeastern University, Boston, MA 02115, (617) 373-3181, fax 617-373-4378, r.bailey@nunet.neu.edu. The deadline for field trip proposals is December 1, 2000.

Cobblestones, Puddingstone, and More—Boston's Use of Stone as an Essential Urban Element. Dorothy Richter and Gene Simmons.

Engineering Geology of the Big Dig Project (Central Artery Project). Dan Bobrow and Charles Daugherty.

Geochronology and Geochemistry of the Shelburne Falls Arc and the Taconian Orogeny in Western New England. Paul Karabinos and J. Christopher Hepburn.

Geology of East Point, Nahant, Massachusetts. Martin E. Ross and Richard H. Bailey.

Geological, Geochemical, and Environmental Aspects of Metamorphosed Black Shales in Maine. Charles V. Guidotti and Mark Van Baalen.

Geology, Groundwater Contamination, and Groundwater Remediation at the Massachusetts Military Reservation, Cape Cod. Rudolph Hon, Francis Fedele, Martin Acker, and Peter Dillon.

Geology and Water Supply Development at the Massachusetts Military Reservation, Cape Cod. Peter Dillon, Rudolph Hon, Boyd Allen, Francis Fedele, and Kent Gonser.

Metamorphism of a Fold-Thrust Belt in the Hinterland of the Alleghanian Orogen in Southern New England. Robert P. Wintsch, Michael J. Kunk, and John N. Aleinikoff.

The MetroWest Water Supply Tunnel Project. Mario Carnevale and Jutta Hager.

Middle Paleozoic Magmatism and Tectonics in the New England Avalon Zone. O. Don Hermes, Margaret Thompson, Anton Maria, and Nasir Hamidzada.

The Notches: Bedrock and Surficial Geology of New Hampshire's White Mountains. Timothy T. Allen, John W. Creasy, P. Thompson Davis, J. Dykstra Eusden, Brian K. Fowler, and Woodrow B. Thompson.

Quaternary Environments and History of Boston Harbor, Massachusetts. Patrick Colgan and Peter Rosen.

Quaternary Sea-level Change and Coastal Evolution in Eastern Maine. Joe Kelley, Dan Belknap, Duncan Fitzgerald, and Jon Boothroyd.

Petrology and Field Relations at Pine Hill, Medford, Massachusetts. Martin E. Ross.

Rare Element Granitic Pegmatites of Northern New England. Carl Francis and Michael Wise.

Recent Developments in the Study of the Neoproterozoic Boston Bay Group. Richard H. Bailey, Margaret D. Thompson, and Benjamin H. Bland.

Walking Tour of Urban Geology of Downtown Boston. James W. Skehan.



Great Basin and Sierra Nevada: GSA Field Guide 2

Edited by **David R. Lageson, Stephen G. Peters, and Mary M. Lahren**

This second volume of the GSA Field Guide Series is a comprehensive compilation of new and exciting research on this amazingly diverse region, with well-crafted guides to field localities of special interest. Full-color plates in some chapters make this guide an especially appealing and useful volume. The volume gives complete coverage of field trips held in conjunction with the 2000 GSA Annual Meeting in Reno.

Chapters cover the active tectonics of Lake Tahoe and the historical surface faulting and paleoseismicity of the central Nevada seismic belt, the Neoproterozoic glacial record of Death Valley, Mesozoic plutonism in the Sierra Nevada, Paleozoic subduction, Ordovician stratigraphy, and much more. The geology of the Nevada Test Site and of the nuclear-waste repository at Yucca Mountain also is discussed. Also included is an invited field guide from the 1999 GSA Cordilleran Section meeting that covers the wines and geology of Napa Valley, California.

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434 pages
softcover
FLD002
ISBN 0-8137-0002-7

\$44.00, member price
\$55.00, nonmember price

The Geological Society of America

GSA Grants Support Student Research

Leah J. Carter, Research Grants and Awards Administrator

Grants for Graduate Students

The general research grants program provides partial support of master's and doctoral thesis research in earth science for graduate students at universities in the United States, Canada, Mexico, and Central America. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program. **APPLICANTS MUST BE GSA MEMBERS.**

Funding for this program is provided by a number of sources, including GSA's Penrose and Pardee endowments, the National Science Foundation, industry, individual GSA members through the Geostar and Research Grant funds, and numerous dedicated research funds that have been endowed at the GSA Foundation by members and families.

Applications must be on current GSA forms available in geology departments in the United States and Canada, or from the Research Grants Administrator, GSA, P.O. Box 9140, Boulder, CO 80301-9140, lcarter@geosociety.org. Application forms, appraisals, and information are available on GSA's Web page, www.geosociety.org. Evaluations from two faculty members are required on GSA appraisal forms. Application and appraisal forms may be downloaded from the Web, but must be mailed to GSA. Forms will not be accepted by e-mail or facsimile. The deadline is February 1 each year for grants awarded in April. Of the 600 proposals received in 2000, 245 were funded. More than \$400,000 was awarded.

Specialized Grants

The Committee on Research Grants selects recipients of special, named awards from applicants to the general research grants program. The same application forms are used, and must also be post-marked by February 1. It is not necessary for applicants to indicate that they wish to be considered for a specialized grant. The committee considers all qualified applicants when selecting recipients for special awards.

The Gretchen L. Blechschmidt Award supports research by women who are interested in achieving a Ph.D. in the geological sciences and a career in academic research, especially in the fields of biostratigraphy and/or paleoceanography, and who have an interest in sequence stratigraphy analysis, particularly in conjunction with research into deep-sea sedimentology.

The aim of the John T. Dillon Alaska Research Award is to support research that addresses earth science problems particular to Alaska, especially field-based studies dealing with structural and tectonic development, and those that include some

aspect of geochronology (either paleontologic or radiometric) to provide new age control for significant rock units in Alaska.

The Robert K. Fahnestock Memorial Award is made annually to the applicant with the best application in the field of sediment transport or related aspects of fluvial geomorphology.

The Lipman Research Award promotes and supports graduate research in volcanology and petrology.

The Bruce L. "Biff" Reed Award is for graduate students pursuing studies in the tectonic and magmatic evolution of Alaska and also can fund other geologic research.

The Alexander Sisson Award supports research for students pursuing studies in Alaska and the Caribbean.

The Harold T. Stearns Fellowship Award is given annually in support of research on one or more aspects of the geology of Pacific islands and of the circum-Pacific region.

The John Montagne Fund is awarded annually in support of research in the Quaternary and geomorphology field.

Division Grants

Nine of the 12 GSA divisions award grants for outstanding student research within the respective division's field of interest. The Committee on Research Grants will select candidates from the general research grant applicants for awards by

the Geophysics (Allan V. Cox Award), Hydrogeology, Sedimentary Geology, and Structural Geology and Tectonics Divisions.

The Archaeological Geology Division awards the Claude C. Albritton, Jr., Scholarships for graduate students in the earth sciences and archaeology. Guidelines are available from the division secretary.

The Coal Geology Division awards the A.L. Medlin Scholarship Award and a Field Research Award to students who submit the best proposals of research projects in the field of coal geology. Guidelines are available from the division secretary.

The Planetary Geology Division offers two S.E. Dwornik Student Paper Awards in the field of planetary geology annually. Contact the division secretary for information.

The Quaternary Geology and Geomorphology Division awards the J. Hoover Mackin and Arthur D. Howard Research Grants to support graduate student research on Quaternary geology or geomorphology. Applications are available from the division secretary, Alan R. Nelson, U.S. Geological Survey, Box 25046, MS 966, Federal Center, Denver, CO 80225. The deadline for applications is February 1 for grants awarded in April.

The Engineering Geology Division offers the Roy J. Shlemon Scholarship Awards. Contact Robert A. Larson, 6416 Woodley Avenue #5, Van Nuys, CA 91406 for more information.

The Geoscience Education, History of Geology, and International Divisions do not currently award grants for student research.

GSA Grants *continued on p. 18*



GSA Student Associate Member TRAVEL GRANTS

The GSA Foundation has awarded \$4,500 grants to each of the six GSA sections. The money, when combined with equal funds from the sections, is used to assist GSA undergraduate Student Associates, as well as graduate Student Members, traveling to GSA meetings. For information and deadlines, contact your section secretary.



Cordilleran—Bruce Blackerby,
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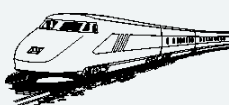
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South-Central—Rena Bonem,
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Southeastern—Harold Stowell,
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2001-2002 Congressional Science Fellowship

The American Geological Institute is offering a Congressional Science Fellowship for the geosciences. The successful candidate will spend 12-16 months (starting September 2001) in Washington working as a staff member for a member of Congress or congressional committee. The fellowship is a unique opportunity to gain first-hand experience with the legislative process and contribute to the effective and timely use of geoscientific knowledge on environmental, resource, natural hazards, and science policy issues.

Minimum requirements are a master's degree with at least three years of post-degree work experience or a Ph.D. at the time of appointment. The fellowship carries a stipend of up to \$42,000. Funding for the fellowship is provided by the AGI Foundation. All application materials must be postmarked by Feb. 1, 2001.

For details on how to apply, visit the AGI web site
www.agiweb.org/gapac/csf.html

GSA Grants *continued from p. 17*

Section Grants for Undergraduate and Graduate Students

Recipients for graduate research grants from the South-Central Section are selected from applicants to the GSA general research grants program. The Committee on Research Grants recommends applicants to the management board of the section, and this board makes the final selection. Eligibility is restricted to graduate students attending a college or university within the geographic area of the section.

The South-Central Section also awards grants to undergraduate students. Application forms are available from the section secretary. The deadline for spring applications is March 15, 2001.

The North-Central Section awards grants to undergraduate students within the geographic boundary of the section. For information on 2001 deadlines, contact the section secretary.

The Southeastern Section awards grants for both undergraduate and graduate student members of GSA who are enrolled in institutions within the geographical boundaries of the section. Application forms and deadline information can be obtained from the section secretary.

The Northeastern Section offers research grants for undergraduate students who are enrolled at institutions within the section and are Student Associates of GSA. Contact the section secretary, Kenneth N. Weaver, Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21218-5210, for application forms. Applications must be postmarked by February 12 for grants awarded in April.

The Rocky Mountain and Cordilleran Sections do not currently offer research grants. ■



The North American mining industry is undergoing significant change. Mergers, acquisitions, consolidations, politics and attitudes toward mining are impacting where the new mines of tomorrow will be located. NWMA's 106th Annual Meeting promises to provide the understanding needed to take advantage of new approaches and future business opportunities, and to obtain in-depth information on the latest and most relevant geological, operational, environmental, financial and regulatory practices for the mining industry.

Winds of Change

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- **26 Technical Sessions** focusing on Mineral Deposits, Business and Finance, Operations, Public Affairs, the Environment and Geology and Exploration.
- **250 industry suppliers' exhibits** will show you hundreds of ways you can reduce costs and increase productivity and efficiency.
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Engaging “My Neighbor” in the Issue of Sustainability

Part XI: An Earth Science Perspective on the Cultural Context of Sustainability

George W. Fisher, Johns Hopkins University, Baltimore, MD 21218

Most of the essays in this series have highlighted the earth science dimensions of sustainability. Last month's essay, however, noted that our ability to live sustainably will depend upon the aggregate effects of individual choices about how to live, and so suggested the need to expand the scope of our discussion (Zen, 2000). The importance of choice means that the shape of a sustainable society will be determined not just by our scientific understanding of how Earth works, but also by our values—our sense, individually and communally, of what is right and what is wrong.

One way to approach the question of values is to characterize the shift to a sustainable way of living as a necessary step in our cultural, moral, or spiritual evolution (Fisher, 2000a, p. 111). For humans, cultural evolution has replaced biological evolution as the primary way of responding to environmental challenges because it is so much faster than biological evolution and because we are often tempted to believe that we can manage cultural evolution (Stebbins, 1982; Ayala, 1998; Siageldin, 2000). Although the two kinds of evolution depend upon different mechanisms, there are illuminating parallels between them. Both require mechanisms for preserving current ways of living and transmitting them to the next generation. In biological evolution, these functions are provided by the system of genetic instructions; in cultural evolution, by the system of cultural mores. Both kinds of evolution require ways of inducing variation in the way we live. Biological variation is produced by mutation, and cultural variation by social innovation, often by groups on the margins of society. And, to be successful, both kinds of evolution require ways of retaining changes that are beneficial and rejecting those that are harmful. Biological retention results from a more effective phenotype, cultural retention from more effective social systems. Successful phenotypes and social institutions both diffuse through the population as the result of personal decisions, spreading slowly at first and eventually dominating the population.

Seen in this way, human values lie at the very heart of cultural or moral evolution. They constitute the fundamental fabric of social and religious institutions that

tend to preserve current ways of living. Religious institutions, especially, can stabilize value systems for thousands of years. The ten commandments are one example. But value systems can and do change. Attitudes toward slavery, human sexuality, and the use of military force have changed dramatically in this country within the last two centuries. Values change by a complex process that depends upon individual decisions about what is right and what is wrong. But individual decisions are not made in a vacuum. They are influenced by the value systems prevalent in the community within which deciding individuals live. And yet communal value systems really have no existence apart from the evolving personal and institutional consensus of the men and women who constitute the community.

Individual decisions are related to community values in a way reminiscent of the link between individual species and the global ecological system. No advanced species can exist alone. All depend upon the ecological system to supply needed nutrients and energy and to dispose of waste products. And yet the global ecological system has no existence apart from the species that constitute the system. Like the ecological system, the cultural system is hierarchical, operating simultaneously at the level of the family, the local community, the national community, and the global human community. As in ecological systems, local influences tend to be felt most intensely. But the effects of communities at higher social levels are important also, especially over longer time periods. As global communications become more rapid, global cultural systems seem likely to become more influential.

This image of ourselves as embedded in a complex, interactive, hierarchical system with both ecological and cultural dimensions provides both a rich ground for scientific debate (Sober and Wilson, 1998) and a wealth of insight into the probable complexity of value systems and cultural institutions. For example, it suggests the vital importance of cultural diversity as a source of social innovation. And it suggests that we need to be suspicious of values proposed as absolute. What seems good from the perspective of one cultural group (or species) may seem harmful from the perspective of another.

It also suggests that good is to be found in a judicious balance between the welfare of individual groups (or species) and the welfare of the global cultural (or ecological) system, rather than the dominance of one over another. This sense of balance suggests that nature is more attuned to complex, both/and solutions than to the either/or positions that so often emerge from philosophical discourse. It suggests, for example, that the debate between those arguing for an anthropocentric view of environmental ethics and those favoring an extreme ecocentric view may be resolved by adopting strategies that benefit humans *and* the ecological system rather than those that benefit either at the expense of the other.

For the earth science community, this image provides a familiar starting point for discussion with social scientists, ethicists, and theologians about the issue of sustainability, and suggests how a deep understanding of earth science may contribute to understanding the cultural questions implicit in sustainability as well as the ecological questions. For all of us, this image suggests that the sense of humility, awe, and wonder that emerges from both the scientific and religious views of nature (Fisher, 2000a, 2000b; DeWitt in Hope and Young, 1995) provides an appropriate place to ground our reflections on sustainable living.

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- Note: This series of essays, with some enhancements for teachers, is now available through a link on GSA's Web site, www.geosociety.org. From either Public Interest or the “Related Links” area of Geoscience Initiatives, click “Sustainability” then “Toward a Stewardship of the Global Commons.”

POSITION ANNOUNCEMENTS *(from Employers using GSA's Employment Service at the 2000 Annual Meeting)*

VALDOSTA STATE UNIVERSITY

Valdosta State University invites applications for three tenure-track Assistant Professorships. We offer a Bachelor of Science degree with a major in Environmental Geography. Many of our students participate in undergraduate research and/or internships with NASA, Moody AFB, or regional development agencies. Faculty and students conduct research at nearby Lake Louise Field Station. We seek individuals with a commitment to quality undergraduate teaching, potential to contribute to program development, and ability to develop active research programs involving undergraduates. Teaching responsibilities include introductory geography courses in landforms and in weather and climate and/or introductory geology courses, as well as upper-level field-based undergraduate courses in at least one of the following areas: biogeography, geomorphology, hydrology, meteorology and climatology, pedology, sedimentology, or environmental geology. Expertise in GIS is an asset. Ph.D.s are preferred, but ABDs will be considered. Valdosta State University is an Equal Opportunity/Affirmative Action Employer. Salary is commensurate with experience. Starting August 1, 2001. Details at <http://www.valdosta.edu/phy/>. Submit application, vita, evidence of excellence in teaching, and three letters of recommendation by November 30, 2000, to Dr. Dennis Marks, Head, Department of Physics, Astronomy, and Geosciences, Valdosta State University, Valdosta, GA 31698.

GEORGIA STATE UNIVERSITY DEPARTMENT OF GEOLOGY TENURE-TRACK FACULTY POSITION IN SEDIMENTOLOGY-STRATIGRAPHY

The Department of Geology at Georgia State University seeks to fill a tenure-track faculty position at the rank of

assistant professor in the area of Sedimentology-Stratigraphy beginning August 15, 2001. Georgia State's Geology Department (see www.gsu.edu/geology), located in downtown Atlanta, has eight tenure-track and tenured faculty, approximately 50 undergraduate majors, and 15 resident graduate students. The successful candidate will teach an upper division undergraduate course in sedimentology-stratigraphy, introductory courses, and a course in his/her research specialty. The area of research is open within the broad area of sedimentology and stratigraphy. We expect the successful candidate to be an excellent instructor, to develop a productive externally funded research program, and to direct graduate research. A Ph.D. degree is required. Postdoctoral experience and prior college-level instructional experience are desirable. To ensure full consideration, please send your curriculum vitae (resume), statement of teaching and research interests, and the names and contact information of four references to: Prof. W. Crawford Elliott, Chair of the Search Committee, Department of Geology, Georgia State University, Atlanta, GA 30303. Initial consideration of applications will begin on December 15, 2000, and applications will continue to be accepted until the position is filled. GSU, a unit of the University System of Georgia, is an equal opportunity employer. Applications from underrepresented groups are particularly welcomed.

DEPARTMENT OF GEOGRAPHY-GEOLOGY AT ILLINOIS STATE UNIVERSITY IN NORMAL/BLOOMINGTON ANNOUNCES FACULTY VACANCIES IN MINERALOGY/PETROLOGY AND GROUNDWATER GEOLOGY

The Department of Geography-Geology at Illinois State University invites applications for two tenure-track positions: Mineralogy/Petrology and Groundwater Geology.

The preferred starting date for each position is August 16, 2001. The positions will be at the Assistant Professor level, ABD is required, Ph.D. preferred. The successful candidates must be authorized to work in the United States at the time of appointment. Each must show promise in research, be committed to excellence in teaching, and have a good rapport with students.

Applicants for the Mineralogy/Petrology position must be field oriented and be able to teach general education courses and advanced undergraduate courses in Mineralogy, Igneous and Metamorphic Petrology, Optical Mineralogy, and possibly Field Camp. Supervision of undergraduate student research is required.

Applicants for the Groundwater Geology position must be able to teach general education courses, advanced undergraduate courses, and graduate courses in Groundwater Modeling, Contaminant Transport, Aquifer Systems, and possibly Exploration Geophysics. Supervision of thesis research in our Geohydrology M.S. program is required.

To assure full consideration, applicants must submit a curriculum vitae; official transcripts of all college work; a statement of teaching and research interests; and the names, addresses, telephone numbers, and e-mail addresses of three references by January 15, 2001, to: Dr. David Malone, Department of Geography-Geology, Illinois State University, Campus Box 4400, Normal, IL 61790-4400. Telephone: (309) 438-2692; Fax: (309) 438-5310; e-mail: dmalon@ilstu.edu. For more information about Illinois State University, contact our web page at <http://www.ilstu.edu>. Illinois State University is an Affirmative Action, Equal Opportunity Employer encouraging diversity.

Call for Applications!

Looking to expand your professional horizons?

Believe in serving society through science?

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Put your expertise and experience to work helping shape science and technology policy on Capitol Hill. Work directly with national and international leaders.

The Congressional Science Fellow will be selected from top competitors early in 2001. Successful candidates are GSA members who possess either a Ph.D. in the earth sciences or a related field, or a master's degree in the earth sciences or a related field with at least five years of professional experience. If you possess this professional background, have experience in applying scientific knowledge to societal challenges, and share a passion for helping shape the future of the geoscience profession, GSA invites your application. The fellowship is open to U.S. citizens or permanent residents of the U.S. The deadline to apply is February 2, 2001.

To learn more about the Fellow experience, contact David Verardo, 1997-1998 GSA Congressional Science Fellow, at (703) 625-6105 or dverardo@geosociety.org.

For application information, check our Web site at www.geosociety.org/science/csf/scifello.htm or contact Karlon Blythe, Program Officer, GSA Headquarters, (303) 447-2020, ext. 136, or kblythe@geosociety.org.

GSA Announces

New Membership Category

The Affiliate category is for those who wish to join GSA but do not qualify for any of the existing membership categories. Affiliates can be elementary through high-school students, amateur rockhounds, or anyone who does not have the education or experience required for a GSA Student or Professional membership. Affiliates enjoy most of the benefits of membership. An application form is available at the GSA Web site or from the Member Service Center. Gift certificates are also available.

Visit www.geosociety.org or contact member@geosociety.org, 1-888-443-4472, or (303) 447-2020, ext. 774.

The Biggs Award

Congratulations to the 2000 Biggs Award recipient, **Carol de Wet**, Associate Professor in the Department of Geosciences at Franklin & Marshall College.

The Biggs Award encourages and rewards excellence in teaching among college-level professors of earth science who are in the early stages of their careers. The award is made possible as a result of support from the Donald and Carolyn Biggs Fund, the GSA Geoscience Education Division, and GSA's Science, Education, and Outreach Programs.

Earth science instructors and faculty members from any academic institution engaged in undergraduate education, who have been teaching full time for 10 years or fewer, are eligible. (Part-time teaching is not counted in the 10-years-or-fewer requirement.)

For more information, contact Leah Carter at lcarter@geosociety.org, or (303) 447-2020, ext. 137.

for Excellence in Earth Science Teaching

Proposal Deadline: January 8, 2001

When you get home from Reno, it's time to start thinking about the 2001 GSA Annual Meeting and Exposition in Boston! You are invited to submit proposals for topical sessions and Pardee Keynote Symposia for this important earth science summit. Get the word out on important research and information, reach thousands of your fellow earth scientists, and help make this the earth science meeting of the year. Proposals are due by January 8, 2001, and must be submitted electronically at www.geosociety.org. See page 13 for more information.

GSA Offers Awards in Geomorphology and Micropaleontology

Two of GSA's most prestigious awards supporting research are made possible by the generosity of the late W. Storrs Cole. Qualified GSA Members and Fellows are urged to apply.

The Gladys W. Cole Memorial Research Award provides support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. GSA Members and Fellows between the ages of 30 and 65 who have published one or more significant papers on geomorphology are eligible for the award. While the funds may not be used for work that is already finished, recipients of previous awards may reapply if they need additional support to complete their work. The 2001 award is for \$11,500.

The W. Storrs Cole Memorial Research Award supports research in invertebrate micropaleontology. This award carries a stipend of \$9,500 in 2001 and will go to a GSA Member or Fellow between the ages of 30 and 65 who has published one or more significant papers on micropaleontology.

For application forms or for more information, contact Leah Carter, Research Grants Administrator, GSA, P.O. Box 9140, Boulder, CO 80301-9140, lcarter@geosociety.org. Application forms are also available at www.geosociety.org.

Applications must be mailed and must be postmarked on or before February 1, 2001. Applications sent by facsimile or e-mail will not be accepted. The Committee on Research Grants will report its actions to each applicant in April 2001.

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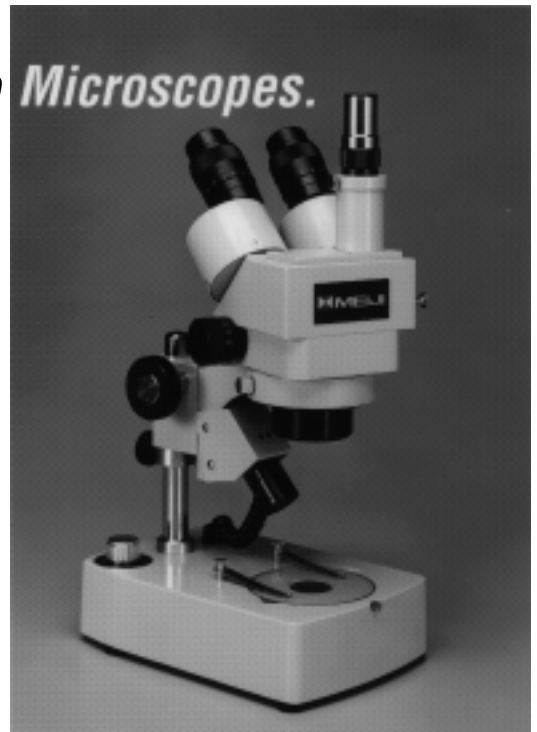


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Geologic Atlas of China: An Application of the Tectonic Facies Concept to the Geology of China

Kenneth J. Hsü and Chen Haihong, assisted by Sun Shu, Wang Qingchen, and Li Jiliang, Elsevier, New York, 1999, 262 p., 11 color plates, \$251.50.

China is a collage of oceanic and continental fragments of varying sizes, and was thought to have been assembled either by accretion of relatively rigid continental blocks dispersed from southern continents such as Gondwana, or by the development of vast southward-growing accretionary complexes that were hundreds of kilometers to more than a thousand kilometers wide. In this book, Ken Hsü and his Chinese collaborators present an alternative model that Phanerozoic China was constructed mainly by collapse of complexly distributed back-arc basins behind a few long-lived frontal arcs fringing Gondwana, Cathaysia, and Laurentia. Hsü envisions three basic tectonic elements in a collapsed back-arc system: a rhaetide, expressed by rigid-basement nappes; a celtide, consisting of melange and mobilized basement nappes below the rhaelite; and an alemanide, exhibiting thin-skinned deformation underneath the celtide. His supposition is systematically shown via a tectonic facies map of China and a detailed description of individual tectonic units. The geologic discussion is intermingled with a narrative account of Hsü's research in China since 1977 and his evolving thoughts on Chinese geology. This book represents a conceptual breakthrough in understanding the complex geologic history of China, and Hsü's archipelago model will be tested for many years to come. Unfortunately, Hsü's brilliant idea is overshadowed by his highly uneven writing. Those who are not

familiar with Chinese geography will find the book difficult to follow, because numerous mountains and places mentioned in the text are not shown on the map. It is also difficult for a reader to appreciate the context of Hsü's passion in condemning the establishment of Chinese geologic thinking in the book's introduction, as most Chinese geologic literature is unknown to people outside China. A few minor errors occur in the text such as referring to the Cenozoic left-slip Altyn Tagh fault as a right-slip structure. References on geologic observations are quite out of date and some are missing from the reference list. The most critical problem of the tectonic facies map of China is its neglect of the effect of Mesozoic and Cenozoic intracontinental deformation on redistributing older tectonic elements. Despite these problems, the lasting contribution of the tectonic facies map of China lies in its power in demanding more and thorough geologic observations in vast Asia, which perhaps possesses the best record of continental-growth history on Earth. Those who are seriously interested in the geologic history of Asia should definitely read this long book with patience. You may be enlightened.

An Yin
University of California
Los Angeles, CA 90095-156702

Needed: Officer and Councilor Nominations

The GSA Committee on Nominations requests your help in compiling a list of GSA members qualified for service as officers and councilors of the Society. The committee requests that each nomination be accompanied by basic data and a description of the qualifications of the individual for the position recommended (vice president, treasurer, councilor). Nominations are due by February 1, 2001.

Please send nominations and back-up material to Administrative Services Dept., GSA, P.O. Box 9140, Boulder, CO 80301-9140.

Reminder:

Call for Nominations

Last month, we put out the call for nominations for the following medals and awards for 2001. Don't miss this chance to recognize your deserving colleagues for their contributions to the geosciences and to GSA. Make a note of the deadlines for nominations and send them in!

For details on the awards and nomination procedures, see the October 2000 issue of *GSA Today*, go to our Web site at www.geosociety.org, or call GSA at (303) 447-2020, ext. 137. Materials and supporting information for any of the nominations may be sent to Administrative Services Dept., GSA, P.O. Box 9140, Boulder, CO 80301-9140.

National Awards

Nominations for the William T. Pecora Award, the National Medal of Science, the Vannevar Bush Award, and the Alan T. Waterman Award are due April 30, 2001. Nominations for these awards should be sent to GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301-9140.

Penrose Medal
Deadline: February 1, 2001

Day Medal
Deadline: February 1, 2001

Honorary Fellows
Deadline: February 1, 2001

Young Scientist Award
(Donath Medal)
Deadline: February 1, 2001

GSA Public Service Award
Deadline: February 1, 2001

Distinguished Service Award
Deadline: March 1, 2001

John C. Frye Environmental
Geology Award
Deadline: March 31, 2001

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Positions Open

MICHIGAN STATE UNIVERSITY ASSISTANT PROFESSOR

Tenure system, academic year, starting August 16, 2001, for a broadly trained PHYSICAL GEOGRAPHER who will complement existing departmental strengths in climatology, geomorphology, people-environment, and techniques.

Research interests and applications in one or more of the following are desired: environmental risk assessment, hydrology, environmental change and modeling, paleoenvironments, and hazards. Interest in linking physical processes and human activity in urban and/or rural environments a plus. Ability to generate extramural funding required. The successful candidate will teach undergraduate and graduate courses in their specialty. In addition an interest and ability to teach undergraduate courses on North America or Europe and general education is highly desirable. Applicants must have a Ph.D. in geography or closely related field at the time of appointment.

Salary will be competitive and commensurate with qualifications and experience. Please send curriculum vitae, pertinent publications, and a letter of application discussing research and teaching interests to: Joe Darden, Search Committee Chairperson, Department of Geography, 314 Natural Science Building, Michigan State University, East Lansing, MI 48824; 517/355-1628; e-mail: jtdarden@msu.edu (confirm with mailed original). Please arrange for three letters of recommendation to be sent. Review of applications begins January 2001 and continues until the position is filled.

Michigan State University is an affirmative action/equal opportunity employer. Minority and women candidates are encouraged to apply. Handicapped persons have the right to request and receive reasonable accommodation.

UNIVERSITY OF TORONTO AT SCARBOROUGH PHYSICAL SCIENCES DIVISION, ENVIRONMENTAL SCIENCE

Applications are invited for a tenure-track faculty position in Environmental Science at the University of Toronto at Scarborough, Division of Physical Sciences. The appointment, at the Assistant Professor level, would be effective starting July 1, 2001, or as soon as possible thereafter. A completed Ph.D. is expected. The successful candidate will have teaching and research interests in Soil Science, with ancillary teaching and research interests in one or more of the following: geomorphology, soil chemistry, soil or sediment contamination/remediation, soil mineralogy.

Candidates should send their curriculum vitae, statements of teaching specializations and research interests, and arrange to have letters from three referees forwarded before December 31, 2000 to: Professor James Thompson, Chair, Division of Physical Sciences, University of Toronto at Scarborough, Scarborough, ON M1C 1A4, Canada.

Phone: 416-287-7197. Fax 416-287-7204. E-mail: jthompson@scar.utoronto.ca.

In accordance with its Employment Equity Policy, the University of Toronto encourages applications from qualified women and men, members of visible minorities, aboriginal peoples and persons with disabilities.

VIRGINIA TECH GEOBIOLOGY

The Department of Geological Sciences at Virginia Polytechnic Institute and State University invites applications for a tenure-track Assistant Professor in geobiology. Applicants must hold a Ph.D. degree in geosciences or biosciences. Preference will be given to candidates with a strong background in paleontology (including micropaleontology), excellent quantitative skills, and a broad interdisciplinary training. The applicant should have a strong commitment to undergraduate and graduate education.

Interested applicants should send a letter of interest, curriculum vitae, copies of transcripts, names and contact information of three references, statement of anticipated research and teaching interests along with a short essay explaining where the applicant would like to see him/herself within the geosciences in the future. Applicants should send their application package to Professor Fred Read, Geobiology Search Committee, Department of Geological Sciences, Virginia Tech, Blacksburg, VA 24061; phone: 540-231-6984; fax: 540-231-3386; e-mail: wilcar@vt.edu. For detailed information about the position and Department, see <http://www.geol.vt.edu>. Review of applications will begin January 8, 2001 and continue until the position is filled.

The College of Arts and Sciences is deeply committed to recruiting, selecting, promoting, and retaining women, persons of color, and persons with disabilities. We strongly value diversity in the college community, and seek to assure equality in education and employment. Individuals with disabilities desiring accommodations in the application process should notify Carolyn Williams at the above address, TTY: 1-800-828-1120 by the application deadline.

GRAND VALLEY STATE UNIVERSITY DEPARTMENT OF GEOLOGY

Earth Science Educator: Responsibilities include teaching introductory geology courses, shared responsibility for earth science education courses and teaching general education theme courses in geology. Additionally the individual will develop courses, act as a liaison between the department and the School of Education and the K-12 community, offer courses for in-service teachers, develop the use of computers in education, and carry out regular faculty duties such as advising, committee work, etc. Faculty are encouraged to do cooperative research with undergraduates. A Ph.D. in Geoscience is required along with expressed interest in teaching introductory courses and working in developing the department's earth science and group science majors. Additional expertise or experience in an area that increases the breadth of our department also is desirable (see Web site <http://www.gvsu.edu/acad/geology/>). Send a letter of application, a vita, a succinct statement of teaching philosophy, and the names, addresses, phone numbers, and e-mail addresses of three references to: William J. Neal, Chair, Department of Geology, Grand Valley State University, Allendale, MI 49401. (616-895-3381) (nealw@gvsu.edu). Applications must be postmarked by December 1, 2000.

GVSU is an Affirmative Action/ADA and Equal Opportunity Employer.

CRUSTAL GEOPHYSICS UNIVERSITY OF NEVADA, LAS VEGAS

The Department of Geoscience at UNLV invites applications for a tenure-track position in crustal geophysics. Appointment will be at the assistant professor level to begin August 2001. A Ph.D. in Geophysics or a related field with emphasis in geophysics is required. We seek candidates with research specialization in seismology, geodesy, paleomagnetism, including magnetostratigraphy, with applications in lithospheric dynamics, tectonics, or neotectonics. Development of a rigorous externally funded research program and supervision of graduate students at both the master's and doctoral levels is expected. The successful candidate will teach an introductory level geoscience course, upper level applied geophysics, and graduate courses in the area of specialization.

Opportunities exist for collaboration with existing research groups in crustal processes, surficial processes, and hydrogeology. Active research programs include volcanology, igneous petrology, neotectonics, structural geology, China and Cordilleran tectonics, sedimentary geology, contaminant transport, ore genesis, and 40Ar/39Ar geochronology. Environmental geoscience in the depart-

ment has been strengthened recently through the addition of faculty with expertise in surface hydrologic processes, GIS, numerical modeling, and soil science.

Salary will be commensurate with qualifications and experience. Position is contingent upon funding. Candidates should submit a letter of application outlining teaching and research interests, a curriculum vitae, unofficial academic transcripts, and contact information for three professional references to Rodney V. Metcalf, Geophysics Search Chair, Department of Geoscience, University of Nevada, Las Vegas, Box 454010, Las Vegas, NV 89154-4010; phone: 702-895-3262, e-mail: metcalf@nevada.edu. Review of applications will begin January 8, 2001, and continue until appointment is made. For more information, see the UNLV World Wide Web site at <http://www.unlv.edu>. UNLV is an Equal Opportunity/Affirmative Action employer. Persons are selected on the basis of ability without regard to race, color, sex, age, national origin, sexual orientation, religion, disability, or veteran status.

UNIVERSITY OF PUGET SOUND ASSISTANT PROFESSOR OF GEOLOGY

Full-time, tenure-line position; begins fall term 2001. Teach undergraduate courses in mineralogy, igneous and metamorphic petrology, and intro course in physical geology, environmental science, or oceanography. Teach one interdisciplinary science in context course (team-taught with humanities or social sciences faculty) each year. Develop successful research program involving undergraduates. Write/submit external grant proposals. Ph.D. in Geology (ABD considered) with specialization in any area of igneous and metamorphic petrology/geochemistry. Experience in two or more of the following areas strongly preferred: x-ray diffractometry, x-ray spectrometry, scanning electron microscopy (including x-ray microanalysis), and computer applications in geology. Demonstrated excellence in teaching at undergraduate level; strong commitment to developing a quality undergraduate centered research program in areas of specialization; and ability to cross disciplinary boundaries in teaching/research. Send statement of teaching and research interests, curriculum vitae, and three reference letters by January 5, 2001, to: Geology Search, University of Puget Sound, P.O. Box 7297, Tacoma, WA 98406.

POSTDOCTORAL RESEARCH SCIENTIST IN HYDROGEOLOGY LAMONT-DOHERTY EARTH OBSERVATORY

Lamont-Doherty Earth Observatory of Columbia University, New York, seeks a candidate for a Postdoctoral Research Scientist position in Hydrogeology for an investigation of liquid carbon dioxide injected into fractured rocks. The project is multifaceted including field observations of hydrology using isotope tracers; pressure pulse/steady-state permeability tests; and numerical modeling for circulation of deep ground waters. The successful candidate should possess skills in numerical modeling of deep ground waters and understanding of tracer chemistry and chemical reactions of carbon dioxide with aquifer rocks, and is expected to participate in field operations. Ph.D. degree in earth sciences or engineering is required. Starting annual salary is \$43,000. Applicant screening will begin December 31, 2000.

Candidates are requested to send a vita, including e-mail address and the names and addresses of three references, to Dr. Taro Takahashi, Associate Director, Lamont-Doherty Earth Observatory, Route 9W, Palisades, NY 10964, taka@ldeo.columbia.edu.

Columbia University is an equal opportunity/affirmative action employer. Minorities and women are encouraged to apply.

UNIVERSITY OF FLORIDA GEOLOGICAL SCIENCES

The Department of Geological Sciences invites applications for a tenure-track assistant professor position to begin with the 2000-2001 academic year in the general area of low-temperature geochemistry. Preference will be given to individuals who will develop a vigorous, innovative research program focusing on organic, aqueous and/or sedimentary systems from a geochemical perspective. Possible specialties include biogeochemistry, organic geochemistry, geochronology, environmental geochemistry and other areas that complement existing departmental strengths (see Web.geology.ufl.edu for information on the Department and its programs). The successful candidate will also be committed to excellence in undergraduate and graduate education. A letter of interest, including a statement of research and teaching goals, a curriculum vitae, and the names and addresses of three referees should be sent to: Dr. Jonathan B. Martin (jmartin@geology.ufl.edu), University of Florida, Department of Geological Sciences, 241 Williamson Hall, Box 112120, Gainesville, FL 32611-2120.

Classifieds continued on p. 24

Classifieds *continued from p. 23*

Ph. (352) 392-2231, fax (352)-392-9294. Candidates are urged to apply before 15 December 2000, and no applications can be accepted after 15 January 2001.

The University of Florida is an equal opportunity employer; qualified women and minorities are especially encouraged to apply.

ASSISTANT PROFESSOR DEPARTMENT OF GEOLOGY BALL STATE UNIVERSITY, MUNCIE, INDIANA

Tenure-track position (igneous-metamorphic petrology and structural geology) available August 17, 2001. Responsibilities: teaching the above courses along with a course in general education, such as physical/environmental geology, and a graduate level seminar related to the candidate's specialty; developing a program of research; advising student research at graduate and undergraduate levels. Area of research is open but should enhance the department's offerings and research strengths. Minimum qualifications: doctoral degree; ABD will be considered if all requirements are met by August 1, 2001; some college teaching and/or professional experience; appropriate background to teach the courses mentioned. Preferred qualifications: doctorate in geology; demonstrated teaching abilities and effective interaction with other faculty and students on individual projects and research; records supporting quality of teaching, research, and/or professional performance; interest in participating in the summer five-week field course; knowledge in geoscience education methods; appropriate area of research as previously mentioned. Send statement of teaching and research interests, including how research might be developed to include students, especially undergraduates; vita; names, postal addresses, and e-mail addresses for at least three references; and transcript of highest degree earned to: Chairperson of Search Committee, Department of Geology, Ball State University, Muncie, IN 47306. Review of applications will begin November 27, 2000, and will continue until the position is filled. (www.bsu.edu/geology). Visit with the Department Chairperson, Dr. Al Samuelson, at GSA in Reno in November.

Ball State University is an equal opportunity, affirmative action employer and is strongly and actively committed to diversity within its community.

LOWELL CHAIR IN ECONOMIC GEOLOGY UNIVERSITY OF ARIZONA

The Department of Geosciences invites applications for the J. David Lowell Chair in Economic Geology, a tenure-eligible faculty position to be filled in 2001. We seek applicants interested in carrying out innovative teaching and research in the area of economic geology, including applied issues directly related to the discovery, development, and production of mineral deposits. We are looking for individuals who approach broad-based applied issues from a geological perspective and who can combine academic and industrial interests. A requirement of the position is to develop and coordinate innovative graduate professional training programs related to mineral exploration and production. Excellence in basic or applied research related to mineral deposits is also expected. The level of appointment will be commensurate with qualifications. A Ph.D. or equivalent degree is required.

The Department of Geosciences is committed to sustained excellence in research and innovative teaching in economic geology both at the undergraduate and graduate levels. The selection process will begin December 15, 2000, and will continue until the position is filled. Interested applicants should submit a curriculum vitae, a statement of research, a statement of teaching interests (specifically addressing opportunities in professional education), and a list of at least three references (with addresses, e-mail, phone, and fax numbers) to: Chairman, Lowell Search Committee, Department of Geosciences, The University of Arizona, Gould-Simpson Building, 1040 E. Fourth Street, Tucson, AZ 85721 (520-621-6024, 520-621-2672 [fax], chair@geo.arizona.edu).

Please reference job number 19393.

The University of Arizona is an EEO/AA Employer - M/W/D/V.

STRUCTURAL GEOLOGY AND TECTONICS UNIVERSITY OF ARIZONA

The Department of Geosciences at the University of Arizona invites applicants for a tenure-track/tenured position in the field of structural geology and tectonics. The position is expected to be filled at the assistant professor level, but qualified applicants at other levels are invited to apply, with the final position title based on the qualifications of the selected candidate. We seek applicants interested in carrying out innovative teaching and research on the processes and products of deformation in Earth's crust. We are especially interested in individuals who employ multidisciplinary approaches to tackle tectonic problems. A Ph.D. or equivalent

degree in Geosciences is required. The Department of Geosciences is committed to sustained excellence in tectonics research, to innovation in the geosciences curriculum both at the undergraduate and graduate levels, and to leadership in graduate student training. The selection process will begin January 15, 2001, and will continue until the position is filled. Information about the Department of Geosciences is available at <http://www.geo.arizona.edu>. Interested applicants should submit a curriculum vitae, a statement of research and teaching interests, and a list of at least three references (with addresses, e-mail, phone, and fax numbers) to: Peter G. DeCelles, Chair, Structure Search Committee, Department of Geosciences, The University of Arizona, Tucson, AZ 85721 (520-621-4910, 520-621-2672 [fax], chair@geo.arizona.edu). Please reference number 19383. The University of Arizona is an EEO/AA Employer - M/W/D/V.

EARTH STRUCTURE AND DYNAMICS FACULTY POSITION RICE UNIVERSITY DEPARTMENT OF GEOLOGY AND GEOPHYSICS

The Rice Geology and Geophysics Department is expanding in faculty, staff, and facilities. We are seeking to fill several tenure-track positions in Earth Structure and Dynamics, the first of which is available starting July 1, 2001. We are interested in hiring an earthquake/global seismologist, a mineral physicist, and/or a high temperature geochemist/petrologist. Applications at all levels will be considered; those received by December 10, 2000, are assured of receiving fullest attention.

Please send a resume and names of four or more references to: Chair, Search Committee, Geology and Geophysics Department, MS-126, Rice University, P.O. Box 1892, Houston, TX 77251-1892.

Information about the department can be found at <http://terra.rice.edu>. Rice is an equal opportunity affirmative action employer.

EARTH SYSTEMS SCIENCE FACULTY POSITION RICE UNIVERSITY DEPARTMENT OF GEOLOGY AND GEOPHYSICS

The Rice Geology and Geophysics Department is expanding in faculty, staff, and facilities. We wish to fill several tenure track positions in Earth Systems Science, the first of which is available starting July 1, 2001. We are particularly interested in hiring a low-temperature geochemist and a quantitative geomorphologist whose research emphasizes use of remote sensing data. Applications at all levels will be considered; those received by December 10, 2000, are assured of receiving fullest attention.

Please send a resume and names of four or more references to: Chair, Search Committee, Geology and Geophysics Department, MS-126, Rice University, P.O. Box 1892, Houston, TX 77251-1892.

Information about the department can be found at <http://terra.rice.edu>. Rice is an equal opportunity affirmative action employer.

TENURE TRACK FACULTY POSITION RESERVOIR GEOSCIENCES DEPARTMENT OF GEOLOGICAL SCIENCES, UNIVERSITY OF COLORADO AT BOULDER

The Department of Geological Sciences at the University of Colorado at Boulder invites applications for a tenure-track faculty position in reservoir geosciences, with consideration to those applying at the assistant or associate professor level. Candidates with research interests in any area of reservoir sedimentology, reservoir geophysics, and petrophysics will be considered. This applied position focuses on the integration and analysis of reservoir databases, and/or modeling efforts. This includes, but is not limited to: reservoir and outcrop sedimentology, numerical modeling/simulation, use of statistics in reservoir modeling, interpretation of 3D and 4D seismic reflection data, reservoir monitoring, borehole geophysics, and petrophysical interpretation. Additional information about the position and the local research environment can be obtained at: www.colorado.edu/GeolSci.

Applications will be reviewed beginning January 8, 2001, and will be considered until the position is filled.

The University of Colorado at Boulder is committed to diversity and quality in education and employment.

GEOLOGY AND GEOLOGICAL ENGINEERING COLORADO SCHOOL OF MINES TENURE-TRACK FACULTY POSITION

The Department of Geology and Geological Engineering at the Colorado School of Mines seeks applications for a tenure-track position in geological engineering to begin August 2001. The program includes an ABET accredited BS degree and graduate degrees at the ME, MS, and Ph.D. levels. The position will be filled at the assistant or associate professor level depending upon qualifications and experience. A Ph.D. in geological engineering or a related discipline is required and registration as a professional engineer

or the qualifications to become registered is strongly desired. The preferred area of expertise is engineering geology and geotechnics. The candidate will be expected to teach an undergraduate course in engineering geomorphology and undergraduate and graduate courses in geological engineering. Research interests should complement current strengths in the geological engineering program. The candidate will be expected to develop a strong, externally funded research program directed toward geological aspects of civil, environmental or mining engineering activities, supervise graduate thesis projects, and publish the results.

Candidates should submit a resume, a statement of teaching and research accomplishments and goals, and thenames, addresses, e-mail addresses, and phone numbers of five individuals from whom letters of reference may be solicited to: Colorado School of Mines, Human Resources Office, Search #00-051190, 1500 Illinois Street, Golden, CO 80401. Fax: 303-384-2025. Review of applications will begin in November 2000 and continue until the position is filled. CSM is an EEO/AA employer. Women and minorities are encouraged to apply. More information on the program is included on the department Web site at <http://www.mines.edu/Academic/geology/>.

ILLINOIS STATE GEOLOGICAL SURVEY SENIOR MANAGER, COAL SECTION HEAD

Direct research and service activities of the Coal Section and coordinate activities of the Energy Resources and Utilization Laboratory which includes the Coal, Oil and Gas, and Energy and Environmental Engineering Sections. Duties include managing personnel; reviewing reports and manuscripts; writing reports; developing plans for new projects; writing, helping to write, and reviewing proposals; representing the Survey to outside organizations, and conducting own research activities. Requires broad experience in coal geology, including resource assessments, mining, coal quality, and (preferably) coal-bed methane. Should have some knowledge of coal preparation/cleaning/use, coal combustion processes and byproducts, and environmental issues related to coal use. Some experience in oil and gas production and resource development. Basic understanding of the economics of energy resource development. Demonstrated scientific and management skills to direct research and service activities. Experience in the application of computer technology to geologic problems. Ability to attract funding from government and industry. Strong communication skills including writing and public speaking. Knowledge and creativity to help formulate, in collaboration with peers and the Group Head, original, solution-oriented research and service programs in coal resources, the engineering of coal utilization, oil and gas resources, and energy resource economics that address current and future needs of Illinois citizens, industry, and government. Master's degree in geology or related field with 17 years experience, or Ph.D. with 14 years experience, and managerial experience and supervisory/leadership training equivalent to UI Master Supervision Certificate are minimum requirements. Ph.D. as above and national reputation as a scientist are preferred requirements. Salary range: \$60,000-\$70,000. Closing date: 12/15/00. For more info visit www.igs.uiuc.edu. For application form, contact walston@igs.uiuc.edu or 217-244-2401, Human Resources, IGS, 615 East Peabody, Champaign IL 61820. AA/EEO/ADA Employer.

TENURE-TRACK FACULTY POSITION IN HYDROLOGICAL SCIENCE UNIVERSITY OF VIRGINIA

The Department of Environmental Sciences at the University of Virginia invites applications for a tenure-track assistant professorship in the hydrological sciences. The department is an interdisciplinary community of process-oriented scientists representing hydrology, ecology, geosciences, and the atmospheric sciences. The department offers B.A., M.S., and Ph.D. degrees.

The Department seeks candidates with clear interest and potential for advancing our understanding of the controls and dynamics of the landscape-scale terrestrial water cycle. In particular, we seek to augment our existing strengths through the addition of a colleague studying terrestrial water reservoirs (either surface or subsurface), possibly involving interaction with changing climate and vegetation communities. We encourage applications from diverse areas of hydrological science (e.g., ground-water-surface water interactions in coastal areas, land-surface water dynamics inferred through remote sensing, land cover controls on hydrology of large basins, etc.) Regardless of specialization, the ideal candidate will be a process-based scientist working at the landscape scale.

The successful candidate will be expected to develop outstanding programs in research and teaching at both the undergraduate and graduate levels. Applicants must show demonstrated excellence in their research and a strong commitment to quality teaching. A Ph.D. in hydrology or related field.

Send statements of research and teaching interests, curriculum vitae, and the names and addresses of three referees to: James N. Galloway, Professor and Chair, University of Virginia, Department of Environmental Sciences, P.O. Box 400123, Charlottesville, VA 22904-4123.

Evaluation of applications will begin on 15 November 2000. All applications must be received by 01 January 2001. In addition to the printed application, we would appreciate having a PDF file of the application e-mailed to us at hydrology@mail.evsc.virginia.edu, though this is optional. We especially encourage applications from underrepresented groups. For additional information, see the department Web site at www.evsc.virginia.edu. The University of Virginia is an equal opportunity/affirmative action employer.

**TENURE TRACK FACULTY POSITION IN
THE GEOLOGICAL SCIENCES
UNIVERSITY OF VIRGINIA**

The Department of Environmental Sciences at the University of Virginia invites applications for a tenure-track assistant professor in geological sciences. The department is an interdisciplinary community of process-oriented scientists working in the areas of geosciences, hydrology, ecology, and atmospheric sciences. The Department offers B.A., M.S., and Ph.D. degrees.

The Department seeks candidates with the skills and interest to advance our understanding of geochemical and/or surface processes effective at landscape or larger scales (e.g., coastal environments, hillslopes, watersheds, continental margins). The ideal candidate will embrace the opportunity to work within our interdisciplinary mix of research areas. Ph.D. in geosciences or related field required.

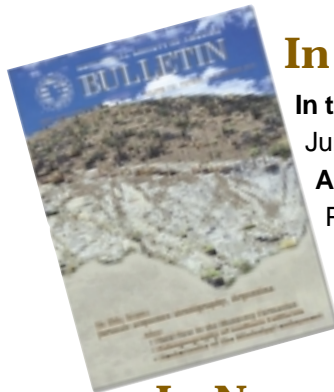
The successful candidate will be expected to develop outstanding programs in research and teaching at both the undergraduate and graduate levels and to participate in teaching our undergraduate core course in physical geology. Applicants must show demonstrated excellence in their research and a strong commitment to quality teaching.

Send statements of research and teaching interests, curriculum vitae, and the names and addresses of three referees to: James N. Galloway, Professor and Chair, University of Virginia, Department of Environmental Sciences, P.O. Box 400123, Charlottesville, VA 22904-4123.

Evaluation of applications will begin on 15 November 2000. All applications must be received by 01 January 2001. In addition to the printed application, we would appreciate having a PDF file of the application e-mailed to us at geosciences@mail.evsc.virginia.edu, though this is optional. We especially encourage applications from underrepresented groups. For additional information, see the

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department Web site at www.evsc.virginia.edu. The University of Virginia is an equal opportunity/affirmative action employer.

**ASSISTANT PROFESSOR,
KANSAS STATE UNIVERSITY**

The Department of Geology at Kansas State University invites applications for a tenure-track assistant professor position to start August 2001. We are looking for a productive geoscientist with expertise in petrology, with preference given to applicants with an interest in field-based applications of petrology to tectonic problems. The successful candidate will be expected to teach mineralogy, petrology, and other courses at the undergraduate and graduate level, and to develop an active, externally funded research program that will complement those of the current faculty (see our Web site for details: <http://www.ksu.edu/geology/>). The Ph.D. in geology is required. Kansas State University is located in the tall-grass prairie of the Flint Hills in northeastern Kansas, and has state-of-the-art laboratory facilities that include new SEM and stable isotope ratio mass spectrometer labs, GIS and remote sensing, and other capabilities (see links to other K-State departments from our Web site). K-State is ranked by the Carnegie Foundation as a Doctoral/Research-Extensive university. Applications should be received by November 27, 2000, and should include a letter of application, a resume and publication list, a statement of teaching interests, a list of equipment needs, and a description of research proposal ideas. In addition, applicants should arrange to have at least three letters of recommendation sent to: Jack Oviatt, Department of Geology, Kansas State University, Manhattan, KS 66506-3201 (Tel: 785.532.6724; fax: 785.532.5159; e-mail: joviatt@ksu.edu). Women and minorities are encouraged to apply. Kansas State University is an equal opportunity/affirmative action employer.

**UNIVERSITY OF TORONTO
DEPARTMENT OF GEOLOGY
EARTH AND PLANETARY MATERIALS**

The Department of Geology invites applications for a tenure-stream position at the St. George campus in the field of earth and planetary materials. The position is at the assistant professor level and is made available through a major endowment that has created the McRae-Quantec Chair in Geosciences, a senior position to be held by the

Chair of the department. We encourage applications from candidates in all specialties within this broad field. Postdoctoral experience will be an important asset but applicants must be able to demonstrate their ability for independent research and a potential for collaboration with existing research programs described on our Web site: www.geology.utoronto.ca. In addition to establishing an internationally recognized independent research program, the successful candidate must have a strong commitment to teaching; she/he will be expected to teach upper level undergraduate courses in fields related to their specialization as well as general introductory courses.

The Department of Geology is well equipped with analytical and experimental facilities to support earth and planetary materials research. More information on facilities and programs is available on our Web site.

Applicants should send a vitae, statement of research plans and the names of three referees to the Chair, Department of Geology, University of Toronto, 22 Russell Street, Toronto, Ontario M5S 3B1, Canada, by December 1, 2000. They should also arrange for their referees to send supporting letters directly to the above address or by e-mail to chair@geology.utoronto.ca. The position is available July 1, 2001.

In accordance with Canadian immigration requirements this advertisement is directed to Canadian Citizens and permanent residents of Canada.

The University of Toronto is strongly committed to diversity within its community. The University especially welcomes applications from visible minority group members, women, Aboriginal persons, persons with disabilities, and others who may add to the diversity of ideas.

**JUNIATA COLLEGE, HUNTINGDON, PENNSYLVANIA
ASSISTANT PROFESSOR OF GEOLOGY**

The Department of Geology at Juniata College invites applications for a full-time, tenure-track position in structural geology at the rank of assistant professor. Candidates should have a Ph.D. in geology and significant field experience. Teaching duties will include structural geology, hydrogeology, and other courses at the introductory and advanced level that will complement existing departmental strengths. The candidate should have strong field and applied skills and is expected to mount a student-centered

CALENDAR

2001 Meetings

June

June 24–28, Digital Earth 2001, Fredricton, New Brunswick. Information: Sheri Flanagan, Public Relations Coordinator, Digital Earth 2001 Organizing Committee, 264 Rookwood Avenue, Fredricton, NB E3B 2M2, Canada, (506) 458-8533, fax 506-459-3849, www.digitalearth.ca. (Abstract deadline: December 1, 2000.)

June 24–July 1, International Commission on the History of Geological Sciences Meeting—Geological Resources and History: Rocks and Dinosaurs, Portugal. Information: Manuel Pinto, Conference President, Department of Geosciences, University of Aveiro, 3810-Aveiro, Portugal, 351-2-34-370-744, fax 351-2-34-370-605, mpinto@geo.ua.pt. (Abstract deadline: January 1, 2001.)

Only new or changed information is published in *GSA Today*. A complete listing can be found in the Calendar section on the Internet: www.geosociety.org.

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research program that exploits our advantageous setting in the Valley and Ridge Province. The Department consists of three full time faculty and about 30 majors, of whom an unusually high proportion go on to graduate school. The department is well equipped, with petrographic microscopes, powder XRD, a rock preparation laboratory, and access to much additional field and laboratory equipment. Preliminary interviews will be conducted at the annual meeting of the GSA in Reno, Nevada, November 2000.

Juniata College is a co-educational, liberal arts college with an enrollment of 1,300 in rural central Pennsylvania, highly regarded for academic excellence. It has long had an outstanding reputation of educating young scientists. Juniata is committed to gender and cultural diversity and encourages applications from women and minorities.

Send letter of application; curriculum vitae; three letters of recommendation; transcripts; and a concise statement of current and long-term teaching, research and career goals by December 4 to: Mrs. Gail Leiby Ulrich, Director of Human Resources, Juniata College, Huntingdon, PA 16652. AA/EOE.

SEDIMENTARY GEOLOGY UNIVERSITY OF NEBRASKA—LINCOLN

The Department of Geosciences at the University of Nebraska—Lincoln invites applications for the newly endowed Mr. and Mrs. J.B. Coffman Chair in Sedimentary Geology. We seek an outstanding geoscientist with a solid record of scholarly achievements within the broad field of sedimentary geology. Candidates may present any area of specialization, but experience in, or association with, the petroleum industry will be considered a plus. We expect to make the appointment at the full professor level with tenure, but strong applicants at the advanced associate professor level will also be considered. The successful candidate will be expected to conduct a vigorous program of research and to participate in teaching and other academic activities appropriate for a senior faculty member at the University of Nebraska—Lincoln.

The University of Nebraska—Lincoln is an AAU, Research-I land-grant institution with a distinguished tradition of research, education, and service. It has approximately 23,000 students and is designated as the principal research and graduate institution in the state.

The Department of Geosciences currently includes 14 full-time faculty and eight part-time faculty shared with other UNL units, and has strong associations with the State Museum, Conservation and Survey Division, and the School of Natural Resource Sciences. The Department has solid undergraduate programs in geology and meteorology and approximately 40 active graduate students (Masters and Ph.D.). For further information about the Department of Geosciences, see our Web site at <http://www.unl.edu/geology/geohome.html>. Questions concerning the position or the Department can be addressed to the Department Chair (Norman D. Smith) by telephone (402-472-2663) or e-mail (nsmith3@unl.edu). Applicants should send a letter of interest, current resume, and the names and addresses of at least four references to: Professor David Loope, Chair, Coffman Chair Search Committee, Department of Geosciences, 214 Bessey Hall, UNL, Lincoln, NE 68588-0340.

The review of applicants will begin January 8, 2001, and continue until the position is filled. The University of Nebraska—Lincoln is committed to a pluralistic campus community through Affirmative Action and Equal Opportunity and is responsive to the needs of dual career couples. We assure reasonable accommodation under the Americans with Disabilities Act; contact David Loope at 402-472-2647 for additional information.

ASSISTANT PROFESSOR – GLOBAL CHANGE UNIVERSITY OF AKRON

Applications are invited for one tenure-track position at the level of assistant professor (open specialty) in the Department of Geology, University of Akron. Qualifications include a Ph.D., a proven record of obtaining external funding, recent refereed publications, and a desire to teach and conduct research at the undergraduate and graduate (Masters) level. The department seeks to add an exceptional individual who can increase graduate student enrollment by establishing an energetic, externally funded research program. Candidates are preferred whose research is closely related to our interdepartmental and external research theme built around investigations of the "Terrestrial Record of Quaternary Environmental and Climatic Change." The successful candidate must also possess excellent communication and teaching skills and will be expected to teach discovery-based earth science classes for general education students and education majors and upper level courses in his or her area of expertise. Applicants are encouraged to review faculty profiles at <http://www.uakron.edu/geology> to ensure their specialty will augment rather than duplicate

existing faculty research and teaching strengths. The successful candidate will join an active department that includes five new hires in the past five years. The University of Akron is a state-supported university with an enrollment of ~25,000 students and is located in northeastern Ohio. Candidates should submit a curriculum vitae, one page statement of research and teaching interests, and the names of three references (with e-mail and telephone number) to: Dr. David Steer, Department of Geology, University of Akron, Akron, OH 44325-4101. E-mail inquiries are welcome and should be directed to steer@uakron.edu. Applicants must possess a Ph.D. at the time of application. Application deadline is 5 p.m. EST, January 2, 2001. The University of Akron is an Equal Education and Employment institution.

KENT STATE UNIVERSITY ANNOUNCES THREE TENURE-TRACK FACULTY POSITIONS SURFACE-WATER HYDROLOGIST

The Department of Geology at Kent State University seeks to hire a surface-water hydrologist at the tenure-track assistant professor level beginning Fall semester, 2001. The successful candidate should possess the Ph.D., have a strong background in the geological sciences, and be able to interface well with other faculty working in a variety of water-related specialties. Specific research interests are open and may include, but are not limited to, such areas as quantitative analysis of fluvial systems; engineering applications; wetlands and groundwater-surface water interaction; vadose-zone hydrology; or coastal processes and engineering. We seek a scientist with experience in numerical modeling as well as interest in pursuing laboratory and field-based problems. Responsibilities will include teaching advanced undergraduate and graduate courses in hydrology; assisting with instruction of the introductory geology course in Environmental Geology; advising M.S. and Ph.D. candidates; and developing a strong, funded research program. The initial course load will be two courses per year, giving the successful candidate time to seek external funding and pursue research.

LOW-TEMPERATURE AQUEOUS GEOCHEMISTRY

The Department of Geology at Kent State University seeks to hire a low temperature aqueous geochemist at the tenure-track assistant professor level beginning Fall semester, 2001. The successful candidate should possess the Ph.D., have a strong background in the geological sciences, and be able to interface well with other faculty working in a variety of water-related specialties. Specific research interests are open and may include any of the broad range of water-related studies such as the chemistry of water-sediment interactions; trace-element or major-element geochemistry; organic geochemistry; geomicrobiology; environmental geochemistry; or the chemical modeling of natural systems. Responsibilities will include teaching advanced undergraduate and graduate courses in hydrology; advising M.S. and Ph.D. candidates; developing a strong, funded research program, and assisting with instruction of one of the introductory geology courses including Environmental Geology, Physical Geology, or Oceanography. The initial course load will be two courses per year, giving the successful candidate time to seek external funding and pursue research.

SEDIMENTARY GEOLOGIST

The Department of Geology at Kent State University seeks to hire a "soft-rock" geologist at the tenure-track assistant professor level beginning Fall semester, 2001. The successful candidate should possess the Ph.D., have a strong background in the geological sciences, and be able to interface well with other faculty working in a variety of paleontologic, tectonic, and sedimentary specialties. Specific research interests are open and may include such areas as carbonate sedimentology, tectonic evolution of sedimentary basins, sequence stratigraphy, or biostratigraphy. We seek a scientist with experience and interest in pursuing laboratory and field-based problems. Responsibilities will include teaching our basic senior level course in stratigraphy; assisting with instruction of one of the introductory geology courses in oceanography or Earth history, developing and teaching advanced undergraduate and graduate courses in the discipline; advising M.S. and Ph.D. candidates; and developing a strong, funded research program. Ability and interest in teaching our summer field course is also desirable. The initial course load will be two courses per year, giving the successful candidate time to seek external funding and pursue research.

The Department presently has 10 full-time faculty members, 80 undergraduates and 35 graduate students. Faculty are presently involved in research in tectonics, sedimentary petrology, sedimentology, paleontology, micropaleontology, paleolimnology, limnology, wetlands and surface water-groundwater interactions, hydrogeology, climate change, landform development and geomorphology, slope stability,

and engineering geology. The department maintains 22 research laboratories and is well equipped for both applied and basic geologic research. There are excellent opportunities for cooperative research and teaching within the Department and with members of the Water Resources Research Institute, which promotes cooperative research among a large, multidisciplinary group of faculty from geology, biology, chemistry, and geography. Review of applications will begin on January 15, 2001. Candidates should send a letter of application, curriculum vitae, transcripts, a statement of research and teaching interests, and three letters of recommendation to Dr. Donald Palmer, Department of Geology, Kent State University, Kent, OH 44242. Phone 330-672-2680 or 330-672-0091, fax 330-672-7949, www.kent.edu:80/geology/, e-mail geology@kent.edu. Kent State is an equal opportunity/affirmative action employer.

GEORGIA SOUTHERN UNIVERSITY ASSOCIATE OR ASSISTANT PROFESSOR

The Department of Geology and Geography invites applications for the tenure-track position of associate or assistant professor in geography with teaching and research interests in geographic information science (GIS) (geographic information systems, remote sensing, global positioning systems, and related spatial analytical techniques). The successful candidate will also share responsibility for introductory level courses and sponsorship of student research. Preference will be given to candidates with research interests in application of GIS to land-use planning, transportation, health, and environmental issues. Preference will also be given to candidates with prior undergraduate teaching experience. A doctoral degree in geography or a closely related field must be completed by the position starting date of August 1, 2001. Salary will be commensurate with qualifications.

The Department of Geology & Geography offers the BS degree with major in geography, and BA & BS degrees in geology. Facilities include the Distance Learning Lab, Earth Science Computer Applications Lab with 14 workstations, and the Applied Coastal Research Lab at the Sideway Institute of Oceanography. The Spatial Analysis & Geographic Information Systems Lab is a dedicated computer laboratory for GIS, GPS, and cartography, and includes 20 workstations, a dedicated server, and extensive associated hardware and software.

Please direct a letter of application including a statement of research and teaching interests, a curriculum vitae, supporting documentation (such as reprints and evidence of teaching effectiveness), and the names, addresses, and telephone numbers for three references to: Dr. Mark R. Welford, Search Committee Chair, Department of Geology and Geography, Georgia Southern University, Statesboro, GA 30460-8149. The postmark deadline for applications is December 11, 2000.

The names of applicants and nominees, resumes, and other general non-evaluative information are subject to public inspection under the Georgia Open Records Act. Individuals who need reasonable accommodations under the Americans with Disabilities Act in order to participate in the search process should notify the Search Committee Chair. GSU is an Equal Opportunity/Affirmative Action Institution.

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

The Department of Geography and Earth Sciences invites applications for a tenure track geoscientist (Ph.D. required) at the assistant professor level with research expertise in surface-near surface processes in one of the following areas: soil science, hydrogeology, contaminant transport or low-temperature aqueous geochemistry. The successful candidate will be expected to develop a strong and externally funded research program encompassing both the basic and applied aspects of the shallow subsurface environment.

The individual hired will be expected to teach at both the introductory and upper division undergraduate levels in areas of her/his specialization, complement and interact with existing faculty, and contribute to student research experiences. The ability to teach introductory and advanced earth systems, especially the interaction of the hydrosphere with the lithosphere in the near-surface environment, is desirable.

The Department of Geography and Earth Sciences has 22 faculty, 9 of whom are earth scientists. The department offers BA and BS degrees in earth sciences, a BS degree in geology, and is establishing a Master's in Earth Sciences to begin in the Fall of 2001. The department also offers a Master's in Geography with an environmental analysis track. There are approximately 60 undergraduate earth sciences majors with about 20 graduating each year.

The position begins in August 2001. Interested individuals should submit a letter articulating qualifications, teaching interests and experience, research goals, and a curriculum vitae with the names of at least three references to Dr. Owen J. Furuseth, Chair, Department of Geography and

Earth Sciences, University of North Carolina, Charlotte, NC 28223. Review of applications will begin January 15, 2001, and will continue until the position is filled. AA/EEO

STRUCTURAL GEOLOGY TENNESSEE TECHNOLOGICAL UNIVERSITY

The Department of Earth Sciences, Tennessee Technological University, invites applications for an entry-level, tenure-track, assistant professor position starting August 1, 2001. Requirements: Ph.D. in structural geology (ABD considered) and the ability to teach undergraduate courses in structural geology and geologic field methods. It is desirable that candidates be able to teach one or more of the following courses: engineering geology, geologic hazards, or applied environmental geophysics. It is expected that candidates be able to develop a research program that will involve undergraduates, such as mapping projects in the southeastern USA. Review of applicants will begin December 1, 2000. The application pool will remain open until the position is filled. For complete information on the position and application instructions, visit the departmental Web site at <http://www2.tntech.edu/www/acad/earth/> or contact Dr. Frank W. Stapor Jr. at P.O. Box 5125, TTU, Cookeville, TN 38505; 931-372-3695 (phone), 931-372-3363 (fax), FStapor@tntech.edu (e-mail). AA/EEO.

ASSISTANT PROFESSOR IN SOLID-EARTH GEOPHYSICS (SEARCH EXTENDED) INDIANA UNIVERSITY, BLOOMINGTON

The Department of Geological Sciences at Indiana University, Bloomington, is seeking an outstanding scientist for a tenure-track position in solid-earth geophysics at the assistant professor level. We are seeking a colleague in any area of solid-earth geophysics whose areas of research will maximize linkages among active field- and analytical-based research programs in our department (<http://www.indiana.edu/~geosci/>). Applicants should include a personal statement describing research and teaching interests, a detailed curriculum vitae, and the names and addresses of four references. Applications should be submitted before November 15, 2000, but the position will remain open until filled. Applications should be sent to: Geophysics Search Committee Chair, Department of Geological Sciences, Indiana University, 1001 East 10th Street, Bloomington, IN 47405.

Indiana University, as an Equal Opportunity/Affirmative Action Employer, encourages the candidacies of women and minorities.

CALIFORNIA STATE UNIVERSITY, LOS ANGELES FACULTY POSITION IN GEOSCIENCE EDUCATION

The Department of Geological Sciences at California State University, Los Angeles invites applications for a full-time, tenure-track assistant professor position in the area of Geoscience education. The successful candidate is expected to have a strong interest or background in training geoscience teachers. The department is presently participating in developing the Better Educated Science Teacher (BEST) program, a four-year undergraduate degree designed to produce well-trained, credentialed teachers in earth sciences. Candidates that complement the department's strengths in environmental and applied geology are preferred. The position will start in Fall 2001 at an initial salary commensurate with qualifications and experience.

The applicant must have a Ph.D. in geology from an accredited institution of higher education. He/she must have a demonstrated potential for effective teaching using a variety of methodologies, a demonstrated ability and/or interest in working in a multiethnic, multicultural environment, and potential for scholarly and creative activity. Duties will include teaching at the undergraduate and graduate level, directing graduate students, maintaining an active research program, participating in University service, and student advising.

California State University, Los Angeles, a comprehensive urban university and one of 23 campuses that comprise the California State University system, offers programs in more than 50 academic and professional fields. The campus is located at the eastern edge of Los Angeles, adjacent to the western San Gabriel Valley, with more than 19,000 full and part-time students reflecting the rich, ethnic diversity of the area. The University hires on the basis of merit and encourages qualified minorities, women, and persons with disabilities to apply.

In addition to meeting fully its obligations under federal and state law, Cal State LA is committed to creating a community in which a diverse population can live and work in an atmosphere of tolerance, civility, and respect for the rights and sensibilities of each individual, without regard to economic status, ethnic background, political views, sexual orientation, or other personal characteristics or beliefs. The University is an equal opportunity/Title IX employer. Upon request, reasonable accommodation will be provided to individuals with protected disabilities to (a) complete the

employment process and (b) perform essential job functions when this does not cause undue hardship.

Applicant documentation should include the following: letter of application describing teaching background and interests and research experience, curriculum vitae, names and contact information for three references, and transcript (official or unofficial) from institution awarding highest degree. Employment contingent upon proof of eligibility to work in the United States. Review of applications will begin on December 1, 2000. Address applications, required documentation, and/or requests for information to Dr. Kim Bishop, Department of Geological Sciences, California State University, Los Angeles, 5151 State University Drive, Los Angeles, CA 90032-8203. kbishop@calstatela.edu. Department Web page: <http://www.calstatela.edu/dept/geology/>.

WIESS VISITING PROFESSORSHIP RICE UNIVERSITY DEPARTMENT OF GEOLOGY AND GEOPHYSICS

We invite applications for the Wiess Visiting Professorship in Earth Sciences. We particularly encourage scientists in fields allied with our department's focus areas: computational geophysics, seismology, tectonics, geochemistry, sedimentology and global change. The visiting professor funds provide one semester of salary for a visitor to conduct research at Rice, and can be used to extend a normal sabbatical leave. A research stipend is also provided. The Professorship is available for the 2000-2001 academic year.

Information on the Department of Geology and Geophysics and the Center for Computational Geophysics can be found at <http://terra.rice.edu>.

Send a resume to Chair, Wiess Visiting Professorship Committee, Department of Geology & Geophysics, MS-126, Rice University, P.O. Box 1892 Houston, TX 77251-1892.

Rice University is an equal opportunity, affirmative action employer.

ENVIRONMENTAL GEOLOGY DEPAUW UNIVERSITY

The Department of Geology and Geography at DePauw University invites applications for a tenure-track position in Environmental Geology at the rank of Assistant (Instructor for ABD) or Associate Professor to begin August 15, 2001. We desire a person who is broadly trained in the geosciences with expertise in hydrogeology and/or geochemistry. The successful applicant will teach a variety of courses for undergraduate students including physical geology, physical geography, geochemistry, and applied hydrogeology; will develop research projects for undergraduate students; and will possess excellent field and/or computational skills. DePauw University is a nationally ranked, selective liberal arts University. We offer nationally competitive faculty salaries, an excellent faculty development program to support teaching and research initiatives, and a pretenure sabbatical leave program. Rank and salary will be commensurate with experience. Screening of applications will begin November 1, 2000, and we will conduct preliminary interviews at the Geological Society of America Meeting in Reno, NV. Applicants should send a letter describing their teaching pedagogy and research interests, vita, transcripts of all academic work, and three letters of recommendation to Dr. Frederick M. Soster, Chair, Department of Geology and Geography, DePauw University, Greencastle, IN 46135. Closing date for applications is December 15, 2000. DePauw University is an affirmative action, equal opportunity employer. Women and minorities are especially encouraged to apply.

EARTH SURFACE PROCESSES UNIVERSITY OF NORTH DAKOTA

The Department of Geology and Geological Engineering at the University of North Dakota invites applications for a tenure-track faculty position in earth surface processes, at the assistant professor level. We are particularly interested in candidates with strengths in global change, remote sensing, or soil science. A Ph.D. in the geological sciences is required. The successful applicant will be expected to teach undergraduate and graduate courses in his/her area of specialty, and to develop a strong research program. The position is available August 16, 2001. Closing date for applications will be January 15, 2001, or as soon thereafter as a suitable pool of applicants is obtained. We will be interviewing candidates at the Reno GSA meeting.

The successful applicant must have the Ph.D. degree at the time of appointment. Salary will depend on qualifications and experience. Interested applicants should send a letter of application, resume, and the names of three referees to: Richard D. LeFever, Chair, Department of Geology and Geological Engineering, University of North Dakota, Grand Forks, ND 58202-8358. Telephone: (701) 777-2811. Fax: (701) 777-4449. For further information about the

Department, please visit our Web site at <http://www.und.nodak.edu/dept/geology/>.

The University of North Dakota is an Equal Opportunity/Affirmative Action Employer.

GEOPHYSICS-GEODYNAMICS UNIVERSITY OF FLORIDA

The Department of Geological Sciences invites applications for a tenure-track assistant professor appointment to be made for the 01-02 academic year in the area of geophysics-geodynamics. Applications should include a statement of interests and career goals in teaching and research, CV, and the names and addresses of at least three referees. We seek a quantitative, process-oriented scientist capable of establishing a strong, independent research program that will complement existing programs in geochemistry, paleoclimatology, and tectonics (see web.geology.ufl.edu).

Applications should be addressed to Professor David A. Foster, (dfoster@geology.ufl.edu) University of Florida, Department of Geological Sciences, 241 Williamson Hall, P.O. Box 112120, Gainesville, FL 32611-2120; 352-392-223; fax 352-392-9294.

The University of Florida is an equal opportunity employer; qualified women and minorities are especially encouraged to apply.

PETROLOGIST, UNIVERSITY OF WISCONSIN—MILWAUKEE

The Department of Geosciences at the University of Wisconsin—Milwaukee seeks to hire a petrologist at the tenure-track assistant professor level. Applicants must hold a Ph.D. in geology, and have demonstrated field and research experience in petrology. Postdoctoral experience is desirable. The successful candidate is expected to conduct an active research program, and teach undergraduate and graduate courses in igneous/metamorphic petrology, geochemistry, mineralogy (on an occasional or team-taught basis) and related subject areas. Information is available online regarding the department at <http://www.uwm.edu/Dept/Geosciences/>.

Candidates must mail a curriculum vitae with a research plan, a statement of teaching philosophy, and the names of three references to Mark Harris, Chair, Department of Geosciences, University of Wisconsin—Milwaukee, P.O. Box 413, Milwaukee, WI 53201 (fax: 414-229-5452; e-mail: mtharris@uwm.edu), postmarked by December 1, 2000. The University of Wisconsin—Milwaukee is an Equal Opportunity/Affirmative Action Employer.

HYDROGEOLOGY/GEOPHYSICS PORTLAND STATE UNIVERSITY

The Geology Department of Portland State University seeks to fill a tenure track assistant professor position in the area of hydrogeology/geophysics to begin Fall 2001. The successful candidate is expected to teach undergraduate and graduate courses and conduct a vigorous externally funded research program, including supervision of master's students in Geology and master's and Ph.D. students in Environmental Sciences and Resources. Primary interest is in numerical modeling of earth science systems, with emphasis in hydrogeology and geophysics. Candidates should also be interested in applying their knowledge and skills to the general education of undergraduate students. Secondary areas of interest could include laboratory simulations, analogue modeling of earth systems, geographical information systems or secondary education. The new faculty should interface with ongoing studies in geomicrobiology, igneous petrology, soils, glaciology, contaminant modeling, beach, lacustrine and estuarine processes. The Ph.D. is required by the date of hire. A detailed resume including two letters of professional references and a statement of research and teaching interests must be received by December 15, 2000. Applications should be sent to: Hydrogeology/Geophysics Search Committee, Geology Department, Portland State University, Portland, Oregon 97207-0751. Fax: (503) 725-3025. E-mail: streckm@pdx.edu. The Geology Department home page is <http://www.geol.pdx.edu>. Portland State University is an equal opportunity/affirmative action institution.

GLACIAL GEOLOGIST/GEOMORPHOLOGIST NORTH DAKOTA GEOLOGICAL SURVEY

The North Dakota Geological Survey announces a permanent position opening for a geologist. Successful applicant will be responsible for generating surficial geologic maps at a scale of 1:24,000 as well as creating, supervising, and publishing reports on projects dealing with various environmental and economic issues and with other topics relating to the geology and mineral resources of North Dakota.

Applicants should have a minimum of a master's degree in geology as well as geologic mapping experience above and beyond the traditional summer field course. Emphasis should be on glacial geology, but training in the field or

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GeoTrip *Awesome Forces on an Active Plate Boundary*

North and South Islands, New Zealand, March 1–22, 2001,

21 nights, 22 days (Total commitment: February 27–March 22 due to international flights.)



The spectacular 1995 Ruapehu eruption towering over The Grand Chateau, where GeoTrip participants will stay for two nights (photo T. Whittaker)

Scientific Leaders: Brad Ilg and Les Singh, Great Explorers Ltd.; Hamish Campbell, Te Papa and New Zealand Institute of Geological and Nuclear Sciences (GNS); Brent Alloway, GNS; Jack Grant-Mackie, University of Auckland; Yvonne Cook, University of Otago; Geoff Rait, John Gamble, Rodney Grapes, Warren Dickinson, Timothy Little, Jamie Shulmeister, and Hamish McGowan, Victoria University of Wellington (VUW). Some leaders may change without notice.

Brad Ilg, Managing Director of Great Explorers, will be leading the trip. A native of the western United States, he and his family emigrated to New Zealand in 1998. Before going to New Zealand, he conducted research and led educational

expeditions on the Colorado and Rio Grande Rivers in the southwest United States. He is a coauthor of the best-selling *Geologic Map of Grand Canyon* and of the book *Grand Canyon Geology*. He is now working on mountain-building processes related to the Alpine fault with Tim Little at VUW.

Hamish Campbell, coauthor of *Awesome Forces*, is a native New Zealander and son of a geologist. He is a geologist with the GNS and is the geologist for the National Museum of New Zealand. His specialty is paleontology and stratigraphy of New Zealand's Permian-Jurassic basement terranes. He has worked overseas in New Caledonia, Europe, Svalbard, California, Bolivia, and southeast Asia. His North

American experience includes work as a consulting engineering geologist following the Loma Prieta earthquake.

Rodney Grapes, native New Zealander and author of *Magnitude Eight Plus: New Zealand's Biggest Earthquake*, is chairperson of Geology at VUW. He has a special interest in New Zealand historical earthquakes and tectonic geomorphology. In addition, he has worked extensively on the mineralogy of low-grade rocks near Wellington and on the higher-grade rocks exposed along the Alpine fault. He also has an extensive knowledge of New Zealand history and prehistory, and he invariably includes background information and stories that relate to the areas visited.

Description

The accompanying photo embodies this GeoVenture: amazing geology, stunning scenery, and classic accommodations. During our journey, we will visit the three primary types of plate boundaries, witness the landforms they produce, travel from subtropical to alpine ecozones, and discuss how Earth and life systems interact in such complex settings. Included will be several boat excursions, helicopter flights, and stays in some of the world's most spectacular accommodations. Leg one of our six-leg journey begins in Auckland and takes us to the Bay of Islands. We will introduce Maori mythology and discuss the Treaty of Waitangi and the New Zealand wars (three days). Leg two focuses on the active volcanoes in Tongariro National Park, where we visit the Taupo Volcanic Zone, the Grand Chateau on Mount Ruapehu, and the Wairakei Geothermal Power Station (four days).

Leg three heads south toward Wellington where we discuss Sir Charles Lyell, the 1855 magnitude 8+ Wairarapa earthquake, Red Rocks on the South Coast, and the National Museum (three days). Leg four crosses Cook Strait by ferry and sails through the Marlborough Sounds. We visit the town of Nelson and spend two days in beautiful Abel Tasman National Park, with optional sea kayaking from our accommodations at the remote Awaroa Lodge in the heart of the park (four days). Leg five heads down the west coast along the Southern Alps and the Alpine fault. We spend two nights in Fox Glacier and take helicopter flights to and ice walks on the spectacular glacier. Crossing Haast Pass takes us to Otago gold country and the adventure capital of New Zealand—Queenstown. We then recross the rugged Southern Alps to spend a day in Fiordland National Park in Doubtful Sound. Then it is on to the famous alpine lodge, The Hermitage, in Mount Cook National Park, where we examine alpine geomorphology and meteorology (five days). Leg six takes

us through the high country of the McKenzie Basin toward the Banks Peninsula and on to Akaroa, one of the first New Zealand European settlements. On the next day we separate at Christchurch Airport and say our giddays. Note that all hikes are optional, and we will endeavor to have alternate activities available for nonhikers. Itinerary is subject to change due to weather and availability. See www.great-explorers.com/geo/GSA.html for detailed information about the trip.

Fees and Payment

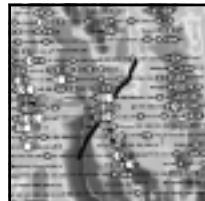
\$5,700 for GSA Members; \$5,800 for nonmembers. A \$500 deposit is due with your reservation and is refundable through Jan. 10, 2001. Total balance is due Jan. 10, 2001. Minimum: 20. Maximum: 45. Maximum guest/leader ratio 10:1. Included: New Zealand taxes; airfare return from Los Angeles; 13 different content leaders; all ground transportation; several boat rides; two helicopter flights; guided ice walk; a flight to Doubtful Sound; guidebook; *Awesome Forces* book; lodging for 21 nights based on double occupancy; and meals for 22 days. Tipping is not expected in New Zealand. *Single accommodations are limited and available only at certain properties. The single supplement fee would be paid on-site directly to the property.* Not included: alcoholic beverages.

Add-On to Australia or Tahiti

Trip participants may travel on to a guided outback Australia adventure or stop on the Pacific Island of Tahiti for additional fees. ■

GeoVentures 2001

GeoVentures, a special benefit created for GSA members, are also open to guests and friends interested in geology. GeoVentures encompass adult educational and adventure experiences of two kinds: GeoTrips and GeoHostels. Both are known for expert scientific leadership. Fees depend on the length of the trips and the destinations and include lodging and meals as noted. GeoHostels last for six days and are held on or near a college campus or field station. Lectures and field trips are site-based with the group returning to the same place each evening. GeoTrips, on the other hand, can last for up to three weeks and involve extensive traveling between sites.



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GEOVENTURES REGISTRATION

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

Name _____

Institution/Employer _____

Mailing Address _____

City/State/Country/ZIP _____

Phone (business/home) _____

Guest Name _____

GSA Member # _____

	DEPOSIT PER PERSON	NO. OF PERSONS	TOTAL PAID DEPOSIT
GT002—New Zealand	\$500	_____	\$_____
TOTAL DEPOSIT			\$_____

VISA MasterCard American Express Discover Diners Club

Credit Card # _____ Exp. Date _____

Signature _____

MAIL OR FAX REGISTRATION FORM AND CHECK OR CREDIT CARD INFORMATION TO:

2001 GSA GeoVentures, Member Services
P.O. Box 9140, Boulder, CO 80301
fax 303-447-1133 or 303-443-1510

MAKE CHECKS PAYABLE TO: GSA 2001 GeoVentures

Classifieds *continued from p. 27*

classroom in glacial geology, geomorphology, Tertiary stratigraphy, and sedimentology are all desirable. Experience in aerial photographic interpretation and mapping experience at the 1:24,000 scale is desirable. Applicants should have strong writing and public communication skills and knowledge of GIS. Preference will be given to applicants with demonstrated experience in communicating geologic knowledge to a lay audience both through written and oral communications.

Starting annual salary will be between \$32,400 and \$34,000 plus benefits for this permanent position. Please apply by letter stating qualifications to Ms. Karen Gutenkunst, North Dakota Geological Survey, 600 East Boulevard Ave., Bismarck, ND 58505. Include a resumé and the names and addresses of three or more references. Phone (701) 328-8000 for more information.

Preliminary interviews for this position will be conducted at the GSA meeting in Reno (November 2000). Deadline for applications is December 31, 2000, but position will remain open until it is filled.

For more information about the North Dakota Geological Survey, see <http://www.state.nd.us/ndgs/>.

The North Dakota Geological Survey is an Equal Opportunity Employer.

TENURE-TRACK FACULTY POSITION IN STABLE ISOTOPE GEOCHEMISTRY UNIVERSITY OF KENTUCKY

The Department of Geological Sciences at the University of Kentucky invites applications for a tenure-track position at the assistant professor level in the field of stable isotope geochemistry beginning Fall 2001. The successful applicant will be expected to establish a state-of-the-art stable isotope analytical facility with a research emphasis on low-temperature environmental systems and processes such as (but not limited to) groundwater and surface water contamination, biogeochemistry, sedimentary geochemistry, organic geochemistry, and paleoclimatology. The candidate should be able to collaborate with faculty engaged in research in high-temperature stable isotope geochemistry (metamorphic processes, fluid-rock interaction, igneous petrogenesis, deformation processes), organic petrology (dispersed organics and coal macerals), and hydrogeology (contaminant fate and transport). Applicants should possess the Ph.D. and have a proven publication and funding record. The successful applicant will be expected to establish a funded, productive research program, including supervision of graduate student research. In addition to current faculty within the department, opportunities exist for collaboration with scientists from the Kentucky Geological Survey, Center for Applied Energy Research, Department of Chemistry, Kentucky Water Resources Research Institute, College of Agriculture, and Medical Center. Teaching responsibilities include geochemistry courses at the graduate and undergraduate level.

Interested applicants should send a cover letter, curriculum vitae, a brief statement of research and teaching interests, copies of relevant research publications, and the names, addresses, and e-mail addresses of at least three references to: Dr. David P. Moecher, Stable Isotope Search Committee Chair, University of Kentucky, Department of Geological Sciences, Lexington, KY 40506-0053.

The committee will begin reviewing applications on Nov. 1, 2000. For additional details of the position see www.uky.edu/AS/Geology/isotopes. The University of Kentucky is an Affirmative Action employer, and applications from minority and female applicants are encouraged.

TENURE-TRACK FACULTY POSITION IN APPLIED SEISMOLOGY UNIVERSITY OF KENTUCKY

The Department of Geological Sciences at the University of Kentucky invites applications for a tenure-track faculty position at the assistant professor level in the area of applied seismology beginning Fall 2001. The successful candidate will be expected to build upon an existing program in earthquake seismology, engineering, and hazard reduction. Ability to obtain funding for earthquake research from state and federal sources is essential. Existing facilities include a regional strong-motion and seismic monitoring network (comprising 15 short/intermediate period seismometers and 10 strong-motion accelerometers), which is concentrated on the New Madrid Seismic Zone. A wide range of supporting field equipment is also available, and the successful candidate will be given start-up funding with which to purchase additional equipment. This position offers a broad range of opportunities for cooperation with other departments and agencies (e.g., Kentucky Geological Survey, Department of Civil Engineering at UK, Kentucky Transportation Center, and Central United States Earthquake Consortium). In addition to assuring continuity of our earthquake research program, our new colleague will be

expected to enhance geophysical research within the department. Departmental programs currently emphasize tectonics, applied geosciences including engineering geology and hydrogeology, and energy resources. In addition to developing a vigorous research program, the new faculty member will be expected to develop and teach challenging courses at both the undergraduate and graduate levels.

Interested applicants should submit a cover letter including a brief statement of research and teaching interests, curriculum vitae, copies of relevant research publications, and the names, addresses and e-mail addresses of at least three referees to: Dr. Sue M. Rimmer, Geophysics Search Committee Chair, Department of Geological Sciences, University of Kentucky, Lexington, KY 40506-0053. Applicants will be expected to show a proven record of publication and funding, and experience beyond the Ph.D. is desirable. The committee will begin to review the applications on November 1, 2000. The University of Kentucky is an Affirmative Action employer, and applications from minority and female applicants are encouraged.

UNIVERSITY OF DENVER, DEPARTMENT OF GEOGRAPHY ASSISTANT PROFESSOR – ENVIRONMENTAL OR QUATERNARY GEOLOGY

The Geography Department at the University of Denver seeks an environmental or Quaternary geologist for an entry level, tenure-track assistant professor position. The successful candidate will be expected to teach basic undergraduate courses in introductory geology, rock and mineral identification, sedimentology and stratigraphy, and more advanced (upper level) undergraduate and graduate courses in other specialized areas (such as fluvial geomorphology, glacial processes, soils, geologic applications of GIS and/or remote sensing technology, historical geology, etc.) Preference will be given to applicants with demonstrated skill in the use of geographic information systems and/or remote sensing technology and their ability to incorporate technology in their course offerings. The successful candidate will be expected to solicit extramural funding, maintain an active research program, and supervise graduate student research projects. Ph.D. required by September 1, 2001. Salary competitive.

The Geography Department at the University of Denver includes a strong physical geography program with emphases in hillslope processes, Quaternary studies, climate change, and applied geomorphology. The department consists of nine faculty members and offers the PhD in physical and human geography, the MS in GIS, the MA and BA degrees in geography, the BA and BS degrees in environmental science, and a geology minor. In addition, unique curricular opportunities include a strong field research component in upper level classes and an extended 10-week field quarter during the academic year. Facilities include fully equipped soils, sedimentology, and palynology laboratories, three computer laboratories with a variety of GIS and remote sensing software, and access to the University's Mt. Evans research field station. Denver is the western regional headquarters for most federal agencies, including the U.S. Geological Survey, U.S. Forest Service, and the Environmental Protection Agency, which offers unique opportunities for research collaboration. Additional information about the department is available on the Web at <http://www.du.edu/geography>.

Applicants should submit letter of application, statement of research interests, curriculum vitae, official transcripts, teaching evaluations or other evidence of teaching quality, and arrange to have three letters of recommendation forwarded to: Dr. Michael J. Keables, Search Committee Chair, Department of Geography, University of Denver, Denver, CO 80208. Screening of completed applications begins January 15, 2001, and will continue until the position is filled.

The University of Denver (Colorado Seminary) is an Equal Opportunity institution. It is the policy of the University not to discriminate in the admission of students, in the provision of services, or in employment, on the basis of race, color, religion, sex, national origin, age, marital or veteran status, sexual orientation, or physical or mental disability.

GEOPHYSICS/NEOTECTONICS PURDUE UNIVERSITY

The Department of Earth and Atmospheric Sciences, Purdue University seeks to fill two tenure-track positions as part of a focused effort to continue building in the area of dynamic interactions between deep-Earth, crustal and surface processes. The positions are offered at the level of assistant professor, but exceptionally qualified candidates at the associate professor level will be considered. We encourage applications from scientists interested in collaborative research on tectonic processes such as the growth and decay of orogenic belts, orogenic controls on climate, and fault movements in areas of active tectonics.

Areas of research specialization may include, but are not limited to, geophysics applied to tectonic problems; mapping crustal and/or upper mantle with seismic methods; geodetic measurements of surface deformation and crustal strain using Global Positioning Systems, Side Aperture Radar, and other techniques; tectonic geomorphology; and neotectonics.

The EAS Department is a growing multidisciplinary department that consists of 27 faculty with a broad range of interests in the earth sciences. We are committed to sustaining a vital and innovative research and teaching program that unifies all areas of earth science research and teaching. We welcome applicants that will contribute to and strengthen ongoing programs in atmospheres, oceans, and climate; solid earth geophysics; geochemistry, and tectonics. Examples of these and other programs can be found on our Web page at www.eas.purdue.edu.

Candidates should possess a Ph.D. degree in some area of the earth sciences. The successful applicant will establish a vigorous externally funded research program, and teach traditional and specialized courses in earth science, at both the undergraduate and graduate levels. Applicants should submit their curriculum vitae, statement of research and teaching interests, and the names of at least three references to: Chair, Geophysics/Neotectonics Search Cmt., Dept. of Earth & Atmospheric Sciences, 1397 Civil Engineering Building, Purdue University, West Lafayette, IN 47907-1397, USA.

Consideration of applications will begin December 15, 2000, and the search will continue until the positions are filled.

Purdue University is an equal opportunity/affirmative action employer and has a policy of being responsive to the needs of dual career couples.

UNIVERSITY OF CALIFORNIA, RIVERSIDE ASSISTANT PROFESSOR OF SOIL-LANDSCAPE RELATIONS

Position: Assistant professor of oil-landscape relations. Date available: July 1, 2001. Responsibilities: Applications are invited for a tenure-track faculty position directed at studying soil resources at landscape to regional scales. The successful candidate is expected to develop an independent research program in which the spatial distributions of soil properties are quantitatively analyzed to address issues related to the use and conservation of land, water, air, and biological resources. The appointee will emphasize a broad-scale approach within a strong, dynamic, and growing soil and water science program. S/he will also have the opportunity to bring a soils perspective into collaborations with other scientists addressing landscape and regional issues, such as plant and wildlife habitats, agricultural sustainability, urban and rural interfaces, mediation of non-point source pollution, and water and watershed management.

The appointee will be expected to teach a 1-quarter undergraduate course in soil resources beginning the first year and additional undergraduate and graduate course(s) related to his/her area of specialization in subsequent years. The appointee will direct graduate students in the Soil & Water Sciences and Environmental Sciences graduate programs.

Qualifications: Candidates must have a Ph.D. with strong training in soil science, particularly soil-landscape relations, soil morphology, and soil conservation/land use. S/he should have interest in, and experience with, methodologies applicable to landscape- and regional-scale studies, such as the use of soil survey databases, GIS, remote sensing, and geostatistical analysis. Candidates must possess a strong commitment to teaching excellence at both the undergraduate and graduate levels. Prior teaching experience is highly desirable.

Application Procedures: Candidates for this position are requested to submit a curriculum vitae, a statement of teaching/research interests, transcripts, the names and addresses of at least three references, and any other supporting documentation to Dr. Marylynn Yates, Chair, Department of Environmental Sciences, University of California, Riverside, CA 92521. The closing date for applications is December 11, 2000.

More information regarding the Department of Environmental Sciences can be found at: <http://envisci.ucr.edu/>. The University of California is an equal opportunity-affirmative action employer.

ASSISTANT PROFESSOR OF GEOLOGY CALIFORNIA STATE UNIVERSITY, FULLERTON

The Department of Geological Sciences, California State University, Fullerton, invites applications for a tenure-track position that will be filled at the rank of assistant professor, starting August 2001. We are looking for applicants whose primary interests are in teaching general education courses, and secondarily in developing a research program that includes undergraduate and graduate students. The

successful applicant will have the following credentials and capabilities:

Ph.D. in Geology with an interest in teaching geology to non-majors AND in coordinating the teaching activities of part-time faculty and graduate students; and research in an area of geology that supports senior and graduate theses.

We are looking for a versatile person who will commit himself or herself to the success of our general education program and who will add to our research programs. The new faculty member will oversee the department's general education course offerings and will supervise the graduate teaching assistants and part-time faculty. Teaching responsibilities may include physical geology, historical geology, and topics in geology such as geological hazards or environmental geology and upper division or graduate courses in the new faculty member's area of expertise. Research activities must result in publications in refereed journals.

CSU Fullerton is a large urban university dedicated to the preeminence of learning. Located 22 miles southeast of metropolitan Los Angeles, Fullerton is a full-service city renowned for its unique mix of residential, commercial and industrial, educational, and cultural environments that provide residents with an outstanding quality of life. The Department has nine full-time faculty with expertise in traditional and applied areas of geology. The nearby geological provinces provide abundant opportunities for field-based research, which the department emphasizes in its curriculum. We have about 50 undergraduate majors and have implemented a new master's degree program this year. Other information is available through our Web page at <http://geology.fullerton.edu/geology/>.

To apply, please send the following: (1) a detailed curriculum vita; (2) a letter of application that explains how you meet the qualifications outlined above; (3) a statement about teaching that includes a discussion of relevant course work and/or experience in preparation for teaching, a list of courses you would feel comfortable teaching, and a statement of your teaching philosophy; (4) a statement of your future research plans and goals; and (5) the names, addresses, phone numbers, and e-mail addresses of at least three references familiar with your teaching and research potential.

Send application to: Dr John Foster, Chair, Department of Geological Sciences, California State University, P.O. Box 6850, Fullerton, California 92834-6850. Applications will be accepted until November 15, 2000. Applications received after this date will be reviewed only if the position is not filled from the original pool of applicants.

California State University, Fullerton is an Affirmative Action/Equal Opportunity Employer. All personnel policies conform to the requirements of Executive Order 11246, the Americans with Disabilities Act (ADA) of 1990, Title IX of the Higher Education Amendments of 1972, and other federal regulations regarding nondiscrimination.

ASSISTANT PROFESSOR SOUTHERN METHODIST UNIVERSITY

The Department of Geological Sciences at Southern Methodist University invites applications for a tenure-track faculty position in the broad areas of surficial processes or geodynamics. We seek creative applicants with an excellent understanding of fundamental physical principles and processes, and a demonstrated ability to apply that understanding in a quantitative manner to important problems in the earth sciences. The department seeks an individual who will complement existing strengths in one or more of the following areas: geochemistry, petrology/tectonics, geophysics, planetary dynamics, terrestrial paleoecology. We anticipate making the appointment at the assistant professor level with the appointment to begin no later than Fall 2001. Applicants are required to have a Ph.D. by the beginning of the Fall 2001 semester. The successful candidate will be expected to teach at the undergraduate and graduate levels, supervise graduate research, and establish an externally funded research program in his or her field of expertise. The committee will begin its review of the applications on or about November 1, 2000. To ensure full consideration, the application should be postmarked by November 1, 2000. Candidates should submit their curriculum vitae, names and addresses of three references, and a written statement of teaching and research interests to: Dr. Lee McAlester, Chair, Department of Geological Sciences, P.O. Box 0395, Southern Methodist University, Dallas, Texas 75275-0395. E-mail: geol@mail.smu.edu and Web site: <http://www.geology.smu.edu>. SMU is an Affirmative Action/Equal Opportunity/Title IX Employer.

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Opportunities for Students

California Institute of Technology Postdoctoral Fellowships in Geological and Planetary Sciences. The California Institute of Technology announces two fellowships in earth and planetary sciences:

The O.K. EARL POSTDOCTORAL FELLOWSHIP, and The TEXACO POSTDOCTORAL FELLOWSHIP.

These awards are from funds endowed by ORRIN K. EARL, JR. and by the TEXACO PHILANTHROPIC FOUNDATION. Each fellowship carries an annual stipend of \$38,000 and offers a research expense fund of \$1,000 per year and one-way travel to Pasadena. The duration of each appointment will normally be for two years, contingent upon good progress in the first year, and beginning with the 2000-2001 academic year. Fellows are eligible to participate in Caltech's health and dental program.

These fellowships have been established to support the research of scientists typically within two years after receipt of their Ph.D. The intent of the program is to identify and support innovative and creative work in the earth and planetary sciences, with particular emphasis on interdisciplinary work. Applicants with training in physics, chemistry, biology, or computer science are urged to apply. The Caltech faculty is currently active in geobiology, geochemistry, geology, geophysics, petrology, seismology and atmospheric and planetary sciences. It is expected that each fellowship holder will be hosted by a division professor (designated by the division chairman) who will contribute to the fellowship support both financially and by providing intellectual guidance.

Application forms may be obtained by writing to Prof. E.M. Stolper, Chair, Division of Geological and Planetary Sciences, Mail Code 170-25, California Institute of Technology, Pasadena, CA 91125 (or send e-mail to: marcia@gps.caltech.edu).

COMPLETED APPLICATIONS WITH REFERENCES SHOULD ARRIVE AT CALTECH BY WEDNESDAY, DECEMBER 20, 2000.

Fellowship candidates will automatically be considered for other available postdoctoral positions at Caltech in their fields of interest.

Caltech is an Affirmative Action/Equal Opportunity Employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

Department of Geology University of Tuebingen. Two Ph.D. positions are currently available for students with interest in sedimentology and basin modeling: (1) Quantitative 3D basin modeling and palaeoceanographic simulation of the alpine molasse. (2) Analysis of the sedimentological and structural evolution of stratigraphic surfaces in the Los Angeles Basin. The basin modeling group at the Department of Geology University of Tuebingen focuses on the sedimentological and stratigraphical evolution of sedimentary basins. We are seeking candidates that are able to derive 3D basin models integrating outcrop and industry subsurface data. The models are generated in a modern workstation environment using high-end soft- and hardware. We require a German Diploma or equivalent M.Sc. degree in geology or geophysics. Applications with curriculum vitae and names and addresses of two referees are invited. For further information please contact: Dr. M. Peter Suess, Institut u. Museum für Geologie und Paläontologie Universität Tübingen, Sigwartstrasse 10, D-72076 Tübingen, Germany. Tel.: ++49(0)7071-29-74696, fax: ++49(0)7071-29-6990. E-Mail: suess@uni-tuebingen.de.

Rice Type Locale Field Trip: Oahu and Hawaii. January 4-14, 2001. Rice University Department of Geology and Geophysics. The 9-day field trip will visit the islands of Oahu and Hawaii, examining the type example of plume-related volcanic islands at various stages of evolution. Starting on Oahu, we will spend 3 days gaining an overview of the origin and growth stages of the Hawaiian volcanoes, then travel to the Big Island to study the causes and consequences of active volcanism in an oceanic setting. Also of interest will be the interactions between man and nature, including the early settlement of the islands by the Polynesians, continuing human influences, and finally, geologic hazards relating to life on the islands. A limited number of openings are available to scientists outside of Rice University to participate in this departmental field trip to Hawaii.

Undergraduate and graduate students interested in pursuing graduate studies in the earth sciences at Rice University in 2001-2002 are invited to apply for early admission to the graduate program, and for participation in the field trip. Expenses for students will be largely subsidized by Rice University. Deadline for field trip applications: November 15, 2000.

The Department of Geology and Geophysics at Rice University comprises 14 faculty involved in a broad range of research in the areas of earth structure and dynamics, earth systems science, and energy Resources. For applications, information about the field trip, and graduate programs in geology and geophysics at Rice, see <http://terra.rice.edu>, or e-mail sandraf@rice.edu.

Visiting Fellows and Students/Institute for Rock Magnetism. Applications are invited for visiting fellowships (regular and student) lasting for up to 10 days during the period from March 1, 2001, through August 31, 2001.

Topics for research are open to any field of study involving fine-particle magnetism, but preference will be given to projects relating magnetism to geological or environmental studies, or to fundamental physical studies.

A limited number of travel grants of up to \$750 are available to cover actual travel costs. No funds are available for per diem expenses.

Application forms and information necessary for proposal preparation may be obtained from IRM manager Mike Jackson at the address below, or on the Web at <http://www.geo.umn.edu/orgs/irm/irm.html>.

Short proposals (two pages, single-spaced text plus two forms and necessary figures and tables) are due by December 15, 2000, for consideration by the Institute's Review and Advisory Committee. Successful applicants will be notified in early February 2001. Proposals should be sent to: Facilities Manager, Institute for Rock Magnetism, University of Minnesota, 291 Shepherd Laboratories, 100 Union St. SE, Minneapolis, MN 55455-0128, 612-624-5274, fax: 612-625-7502.

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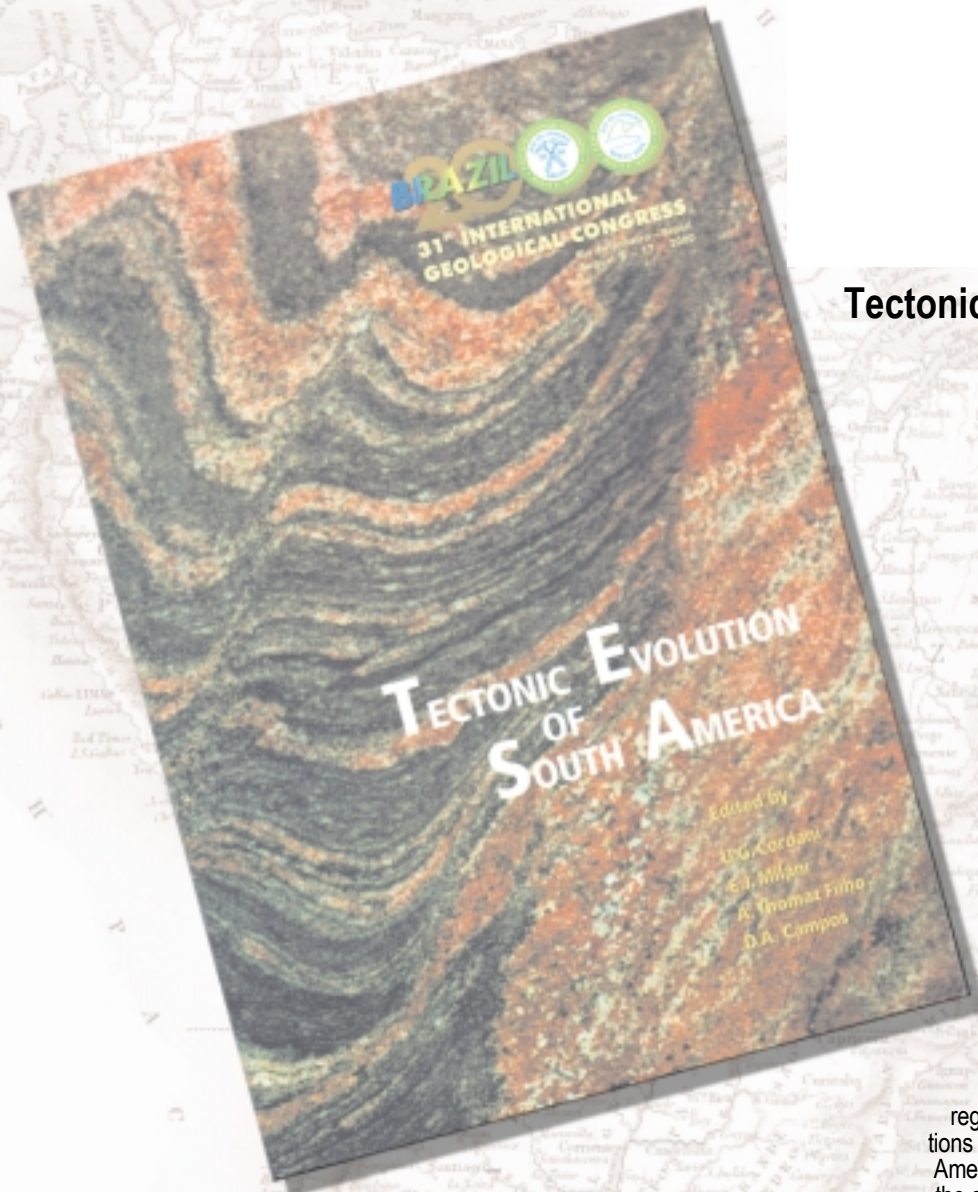


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Tectonic Evolution of South America

Edited by U.G. Cordani, E.J. Milani,
A. Thomaz Filho, and D.A. Campos

In partnership with the
31st International
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Organizing
Committee,
and with sup-
port from the
Departamento
Nacional de Pro-
dução Mineral and the
Academia Brasileira de
Ciências, GSA is distrib-
uting this comprehensive vol-
ume that summarizes the evo-
lution of the tectonostratigraphic
terrains of the South American
continent. It is the first compilation of
South American geology since 1953
and the first synthesis written since the
advent of global plate tectonics.

Published to coincide with the 31st Interna-
tional Geological Congress held in Rio de
Janeiro, Brazil, in August 2000, the volume pre-
sents the work of more than 70 authors in 25
regionally focused articles. The volume's first two sec-
tions are dedicated to the tectonic evolution of the South
American continent in the Precambrian. The first covers
the older cratonic units, and the second is related to the



Tectonic Evolution of South America

854 p.

ISBN 85-901482-1-1

\$60.00

Toll-free: 888-443-4472

Fax: 303-443-1510

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Late Proterozoic orogenic belts (those that took part in the agglutination of West Gondwana). Sections three and four are concerned with the Phanerozoic geologic history. The former deals with the extra-Andean region and includes a chapter on the large cratonic sedimentary basins of the continent. The latter's series of chapters describe the tectonic evolution of the Andean belt, which forms the backbone of South America. The final section of the volume summarizes the mineral and fossil fuel resources of South America, including a complete review of the continental basins and their associated petroleum megasystems; a review of the stratigraphy and resource estimates for the continent's coal deposits; a review of the Andean metallic ore deposits which represent more than 25% of the world's copper and more than a third of the world's molybdenum; and an overview of the Precambrian mineral deposits within the South American platform.

The editors and GSA present this volume as a comprehensive reference for the global geoscience community.