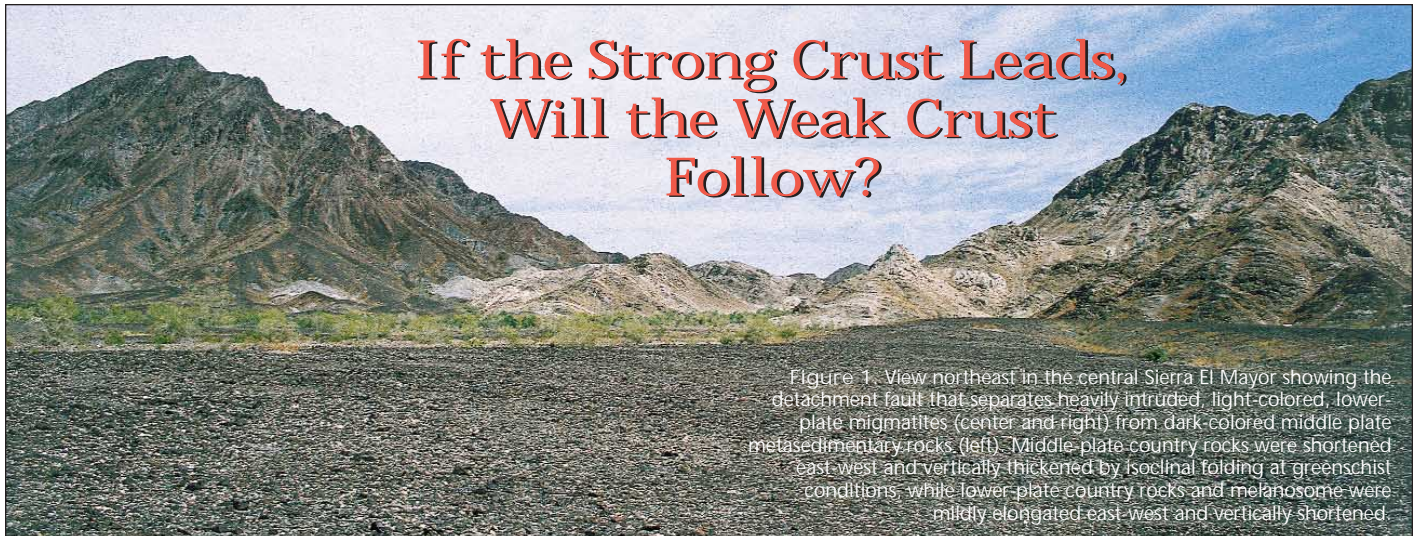


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We're Almost There!
See p. 3



If the Strong Crust Leads, Will the Weak Crust Follow?

Figure 1. View northeast in the central Sierra El Mayor showing the detachment fault that separates heavily intruded, light-colored, lower-plate migmatites (center and right) from dark-colored middle plate metasedimentary rocks (left). Middle-plate country rocks were shortened east-west and vertically thickened by isoclinal folding at greenschist conditions, while lower-plate country rocks and melanosome were mildly elongated east-west and vertically shortened.

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ABSTRACT

Contemporaneous deformation at different levels of the continental crust can be strongly heterogeneous, resulting in disparate bulk deformation patterns between crustal levels. In each of three examples from diverse tectonic settings, exposed rocks from different crustal levels differ greatly from one another in strain geometry. Such heterogeneity of deformation is likely to be controlled by rheological differences and boundary conditions. If strong three-dimensional heterogeneity of strain in deforming continental crust is the norm rather than the exception, many assumptions commonly used in interpretation of vertical profiles of modern and ancient crust, in dynamic and kinematic modeling, and in inference of ancient plate motions could be inappropriate.

INTRODUCTION

It has long been known that rock deformation patterns vary greatly with rock type, temperature, pressure, strain rate, differential stress, and fluid conditions, among other controlling factors. Spatial and temporal variability of any of these factors leads to heterogeneous strain on a variety of scales, ranging from that of lithospheric plates to individual thin sections.

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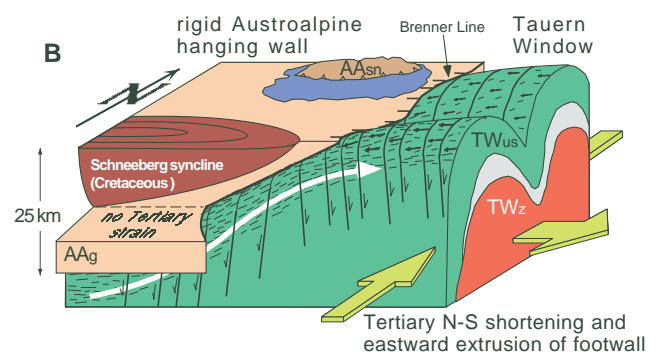
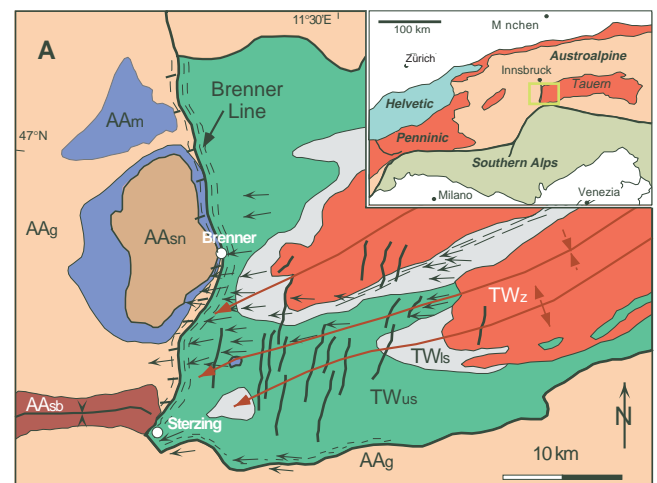


Figure 2. Tectonic map (A) and block diagram (B) showing key features of the Brenner Line footwall (Tauern window) and hanging wall (Austroalpine units); yellow box in inset shows location. Footwall units are Zentralgneis basement (TWz) and Lower and Upper Schieferhülle cover sequences (TWls and TWus); Austroalpine units are gneisses (AAg), Mesozoic cover (AAm), metasedimentary rocks of the Schneeberger syncline (AAsb), and overthrust Steinach nappe (AAsn). Deformation and metamorphism in AA units predate 70 Ma. Ductile mylonites, upright folds, and high-angle normal faults in the Tauern window developed during Oligocene-Miocene extrusion.

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In Memoriam

John L. Burnett
Sacramento, California
September 1998

Willard C. Gere
Menlo Park, California
September 20, 1998

Clyde T. Hardy
Logan, Utah
October 13, 1998

Ruth Hopson Keen
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Long Island, New York
September 11, 1998

James B. Rucker
Carriere, Mississippi

William V. Sliter
Menlo Park, California
October 1997

William G. Wahl
Corbyville, Ontario
July 10, 1998

Crust continued from p. 1

The most important boundary at the plate scale could be the rheological gradient that decouples rigid lithosphere from weaker underlying mantle asthenosphere (e.g., Karato and Wu, 1993) and allows major differences between their motions. This nearly complete decoupling leads to a situation where three-dimensional lithospheric-plate velocity fields are known with centimeters-per-year precision, but comparative motions of the underlying upper mantle are very poorly known (e.g., Montagner, 1994).

Continental crust is also mechanically and rheologically stratified, some crustal levels being weaker and less rigid than others (e.g., Brace and Kohlstedt, 1980). Weak lower or middle crust can allow decoupling of upper crust from underlying mantle (e.g., Molnar, 1988; Hopper and Buck, 1998) and probably affects deformation style(s) of the continental crust as a whole (Buck, 1991; Royden, 1996).

Different strain magnitudes and geometries can develop coevally between different crustal levels as a result of rheological stratification. These differences are difficult to observe, but we believe that they are common, if not typical, in tectonically active regions. Nevertheless, strain characteristics of one crustal level are commonly extrapolated to other crustal levels, compared in two-dimensional

vertical profiles, or used to infer major orogenic motions and past plate motions.

We discuss three examples of contrasting coeval deformation patterns between different crustal levels and consider their implications for vertical profiles, dynamic models, and inferences of relative plate motions. Our examples are from diverse settings, including a continental collision zone (Alps), an accretionary prism (Japan), and a convergent-margin batholith (Baja California; Fig. 1).

EXAMPLE 1—TAUERN WINDOW, EASTERN ALPS

The Alps formed in response to roughly north-south convergence between Eurasia and the Adriatic microplate in late Cretaceous through mid-Tertiary time. Convergence resulted in closure of the Tethys ocean and partial subduction of European continental crust. Syncollisional, orogen-parallel extension, as in the Brenner area (Fig. 2), was important (Behrmann, 1988; Selverstone, 1988; Ratschbacher et al., 1991; Mancktelow and Pavlis, 1994). The footwall of the Brenner Line underwent strong contractional strain during Tertiary orogenesis, whereas the hanging wall remained essentially rigid.

The Brenner Line normal shear zone marks the western margin of the Tauern window, which is a metamorphic core

complex exposing middle and lower crustal schists and gneisses of European affinity beneath the structurally higher Adriatic plate (Austroalpine nappes; Fig. 2A). The north and south margins of the window are dominated by left-lateral and right-lateral zones, respectively, and rocks of the western window were extruded upward and eastward (Ratschbacher et al., 1991; Fig. 2B). The Brenner shear zone excised >10 km of crust during 30 to 60 km of top-to-west slip (Axen et al., 1995).

Despite juxtaposition during collision, Tauern and Austroalpine rocks record very different metamorphic histories. Footwall rocks reached high-pressure, greenschist-to-amphibolite facies metamorphic conditions between 30 and 20 Ma (Blanckenburg et al., 1989; Christensen et al., 1994) in response to Austroalpine overthrusting (Selverstone, 1985). In contrast, the hanging-wall rocks attained medium-pressure metamorphic conditions before 70 Ma (Frank et al., 1987).

Structural differences also exist across the Brenner Line normal fault. Footwall rocks are highly sheared and recrystallized (mylonitized) for several kilometers (Fig. 2) below the Brenner Line, with common top-to-west shear indicators (Selverstone, 1988; Axen et al., 1995). Rocks and early-formed mylonites (35 to 30 Ma; Christensen et al., 1994) exposed in the western Tauern window are folded into two upright, large-amplitude antiforms (Lammerer and Weger, 1998; Selverstone, 1988). These mylonites are overprinted upward by younger top-to-west mylonites that become less folded as the Brenner Line is approached, and the Brenner Line itself is broadly warped by large folds (Axen et al., 1995). These observations indicate that north-south convergence continued during east-west extension and unroofing of the Tauern window.

Syn- to postmylonitic, high-angle normal faults are abundant within the footwall near the Brenner Line (Fig. 2). These faults probably formed in response to buoyancy forces induced by unroofing, and they have both west- and east-down displacements (Axen et al., 1995). Fluid-inclusion data show that west-down faults were active at 15–25 km depth, whereas east-down faults later affected the same rocks at 3–8 km depth (Selverstone et al., 1995). Footwall exhumation processes from ~25 to 5 km were thus both ductile and brittle. We infer that Brenner Line slip, mylonitization, antiform growth, and high-angle faulting were coeval in mid-Oligocene to late Miocene time (Selverstone, 1988; Selverstone et al., 1995; Axen et al., 1995).

In contrast, the Austroalpine hanging wall is essentially unextended internally. Mylonites are locally present 200 m above the Brenner Line (Selverstone, 1988), but

Crust continued on p. 4

Support Your Society—The Sequel

Gail Ashley, President, Geological Society of America

Two years ago Eldridge Moores, who was then president of GSA, wrote eloquently about the vital importance of members' support of GSA's Second Century campaign. At that time, in September 1996, contributions to the campaign amounted to \$4.7 million. Since then, the total has nearly doubled and now stands at more than \$9.3 million.

As your current president, I am privileged, both for myself and on behalf of my predecessors in office during the campaign, to applaud this wonderful commitment to GSA's activities and influence. The generosity of GSA's members and friends has brought us to within \$700,000 of our campaign goal. More important, this generosity has had a measurable impact on the growth and success of GSA's programs of education and outreach.

Two years ago, Eldridge Moores described GSA's emerging plan to ensure better efforts and results in communicating the crucial importance of the geosciences to society. I am pleased to report that in every area of targeted activity, the volunteer and financial support of GSA's membership has made measurable differences. The activities Eldridge outlined were:

New efforts to enhance GSA's publications. The fundamental goal of the publications program is to serve individual members as well as the academic, research, and applied geoscience communities. Owing to the dedication of GSA's editors and the headquarters publications staff:

- *Geology* has held its place as the foremost journal in its field and draws a wide range of manuscripts.
- The *GSA Bulletin* remains one of the most frequently cited journals of geoscience.
- GSA has successfully co-ventured with the Association of Engineering Geologists in publishing the journal *Environmental and Engineering Geoscience*.
- *GSA Today* has broadened its contents, and readers have responded enthusiastically.
- Increases in nonmember subscription prices have put the publications program on a sound fiscal footing.

Science Awareness through Geoscience Education (SAGE). This program's ambitious plans have become reality, and new plans are being made.

- The Earth and Space Science Technological Education Project has completed two series of highly successful summer workshops for middle school science teachers to help them integrate earth science into their curricula.

- Geological Education through Intelligent Tutors has produced its first multimedia earth science CD-ROM, "Energy in the Earth Systems," scheduled for release in January 1999.
- SAGE is collaborating with other geoscience organizations to support implementation of earth and space science curriculum standards in high schools and to develop an earth systems science core curriculum for higher education non-geology majors.
- The Partners for Education Project now has 1,800 volunteers interacting with science teachers and students from kindergarten to university level, and 600 of these volunteers are on-line as e-mail Partners.
- Plans have been developed for the Colorado Rock Park Project, an outdoor exhibit representing Colorado's geology, geography, and history. The project is expected to be a model for similar educational installations elsewhere in the country.

Institute for Environmental Education (IEE). IEE has successfully promoted the participation of the geoscientific communities in the integration of sound scientific information into policy discussions and decisions.

- IEE initiated and led a series of special-focus workshops to facilitate the transition of the National Biological Service into the USGS/Biological Resources Division.
- A second mentorship program, the Mann Mentorships in Applied Hydrogeology, has been added to the Shlemon Mentors in Applied Geology to encourage dialogue between students and professional geologists from outside academia.
- To facilitate cooperative leadership in integrating the earth, life, and social sciences, IEE partnered with the Ecological Society of America and the USGS to present a specialized workshop, "Enhancing Integrated Science."
- IEE has collaborated with other organizations to present two workshops focusing on predictive modeling for environmental policy making.
- The Congressional Science Fellowship, maintaining an effective voice for the geosciences in Congress, has been increased to an 18-month tenure to increase continuity.
- A new program providing stipends for summer internships at national parks supported two interns in its first year and six interns in its second year; it is set to grow to 10 interns for the summer of 1999.

Support Your Society continued on p. 4

Crust *continued from p. 3*

are absent elsewhere. Similarly, evidence for north-south Tertiary shortening is prevalent in the footwall, but absent in the hanging wall. For example, the Cretaceous Schneeberg syncline in the hanging wall is on strike with one of the major Tertiary antiforms in the footwall (Fig. 2B), but was unaffected by formation of the antiform. Alpine-age fabrics are absent in hanging-wall rocks and their Cretaceous mica cooling ages preclude Tertiary heating or penetrative deformation (Frank, 1987).

The upper and lower crust in this region thus responded differently to Tertiary plate convergence. The western Tauern rocks record east-west lower crustal flow and north-south shortening contemporaneous with semipenetrative, mid-crustal, brittle faulting, whereas the overlying Austroalpine rocks underwent only insignificant synchronous deformation (Fig. 2B). A geologist working in the Austroalpine units would infer an episode of north-south contraction associated with moderate heating during the Late Cretaceous, followed by cooling and relative quiescence until the present. In contrast, a geologist working in the western Tauern window would infer extreme east-west stretching and north-south contraction from ~35 Ma until <10 Ma. Both are correct, but each tells only a part of the story.

EXAMPLE 2—SANBAGAWA AND SHIMANTO BELTS, SOUTHWEST JAPAN

High-pressure-low-temperature rocks of the Sanbagawa belt (Fig. 3) form part of a classic “paired metamorphic” belt (Miyashiro, 1961). Recently, the importance of retrograde metamorphism and

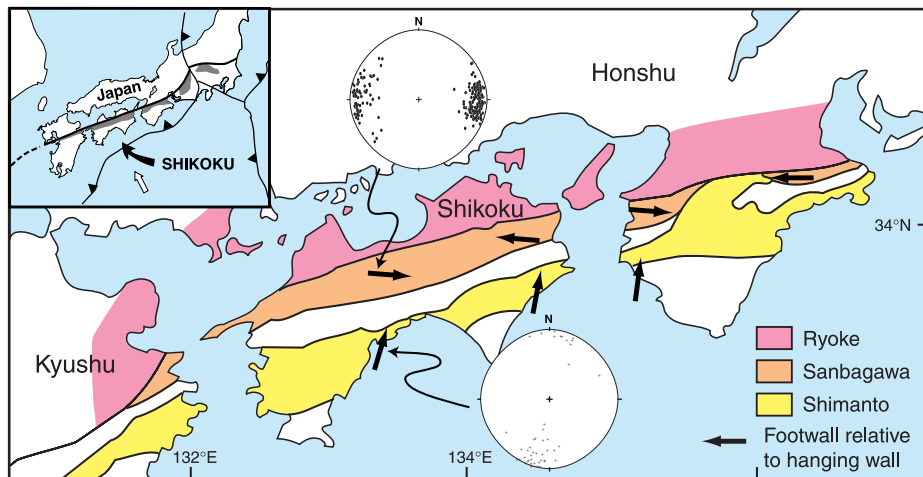


Figure 3. Location map and representative structural data (stretching lineations) from the Sanbagawa and Shimanto belts. Units locally present between these belts (no pattern) represent either transitional packages (e.g., Banno, 1998) or klippe derived from units exposed on Honshu Island (Isozaki and Itaya, 1991; Taira et al., 1992). Arrows show mean trends of lineations and sense of movement of footwall with respect to hanging wall. Shimanto belt records consistent north-directed underthrusting, whereas Sanbagawa belt shows different senses of movement at different structural levels.

recrystallization has been emphasized in the region. Wintsch et al. (1999) have suggested that retrograde fabrics formed as the Sanbagawa belt was extruded eastward during Late Cretaceous oblique plate convergence. Thermal and biostratigraphic data suggest that extrusion was driven, at least in part, by underplating of the younger, more seaward Shimanto belt (Kimura, 1997). The kinematic histories of the two belts, however, are strikingly different and suggest substantial crustal-scale heterogeneities in strain (Wintsch et al., 1999).

The Sanbagawa belt forms a generally north-dipping package of regional-scale nappes and folds below the Cretaceous Ryoke magmatic arc and above the accreted rocks of the Cretaceous Shimanto belt

(Fig. 3). The belt comprises two tectonostratigraphic units: the Besshi and the Oboke (Takasu and Dallmeyer, 1990). The structurally higher Besshi unit is composed largely of pelitic, mafic and siliceous schists with deep marine protoliths. Peak metamorphic conditions of this unit generally range from epidote-glaucophane to epidote-amphibolite facies (~550 °C and 10 kbar) (Banno, 1986; Miyashiro, 1961), the highest-grade rocks occurring in the core of an east-striking, regional-scale fold (Takasu et al., 1994; Wallis, 1998). The Oboke unit has a distinctly lower metamorphic grade, reaching only pumpellyite-actinolite facies. Wintsch et al. (1999) and Hara et al. (1992) proposed that the Oboke represents a more deformed and deeply buried equivalent to the Shimanto belt.

Support Your Society *continued from p. 3*

Restructuring of GSA Meetings. During the past two years, the Annual Program Committee has initiated numerous enhancements to provide more flexible opportunities and to promote excellence in the scientific presentations at the annual meetings. Some of the changes were introduced in 1998; more will be implemented by 1999; and more still are being planned for the future.

- Pardee keynote symposia, supported with funds from the Joseph T. Pardee bequest, present up to eight leading-edge topics, selected by a review panel, to illustrate the breadth and significance of the geosciences.
- Topical sessions offer up to 70 predetermined topics, combining both invited and volunteered papers.
- Hot topics, expressly chosen for their controversial aspects and impact on the geoscientific community, are noontime debates available to all attendees.
- Technical wizardry has enabled Web-based development of a session proposal system, an abstracts scheduling system, and GeoTimer for on-line abstract and session searches in advance of the meeting.

- To expand national and international perspectives, program chairs for the technical program and hot topic sessions will be chosen through a process of member-wide search and selection.
- The chairs of the Annual Program Committee, the Penrose Conference Committee, and the Continuing Education Committee have met to form a professional development consortium to promote a coordinated approach to program planning for professional geologists.

Internationalization. In an increasingly active effort to facilitate GSA's broader outreach:

- International Secretary Ian Dalziel has met with geoscientists abroad who have confirmed an interest in joint programming.
- GSA has formed a task force on international activities and, for the past two years, has brought representatives of international surveys to the annual meeting.
- In a related initiative, a fund established in memory of Charles Lum Drake will provide grants to young foreign geoscientists to attend geoscientific meetings in the United States, forming a counterpart to the 28th IGC Fund that sends American geoscientists to meetings abroad.
- GSA is supporting the 30th IGC, to be held in Brazil, and more Penrose Conferences are being held outside the United States.

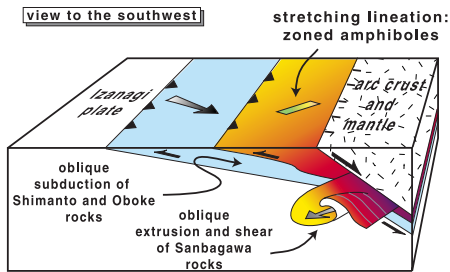


Figure 4. Kinematic interpretation for extrusion and exhumation of the Sanbagawa belt. Movement of the Sanbagawa from west to east (present coordinates), slightly up the dip of the subducting slab to shallower structural levels, is inferred to have been driven by a combination of oblique plate convergence, underplating, tectonic thinning, and partial closure of the subduction channel (see also Wintsch et al., 1999). Regional-scale recumbent fold deforms peak metamorphic isograds and is based, in part, on Wallis (1998).

Structural and thermochronologic data from the Sanbagawa belt suggest a progressive 60 m.y. cooling history as it was exhumed and extruded from west to east. High-grade rocks of the Besshi unit cooled through ~500 °C at 94 Ma, through ~350 to 400 °C at 86 to 76 Ma (Takasu and Dallmeyer, 1990), and were at the surface by ~50 Ma, because they are overlain by unmetamorphosed Eocene sedimentary rocks. Whole-rock ⁴⁰Ar/³⁹Ar (Takasu and Dallmeyer, 1990) and zircon fission-track (Shinjoe and Tagami, 1994) ages from the Oboke unit indicate Late Cretaceous cooling. Penetrative, retrograde fabrics, including east-trending stretching lineations, asymmetric shear fabrics, and sheath folds (Faure, 1985; Hara et al., 1977; Hara et al., 1990; Toriumi, 1985; Wallis and Banno, 1990a), document lateral flow, although the dominant flow direction is debated (e.g., Faure, 1985; Hara et al., 1992; Wallis and Banno, 1990b). Top-to-west shear

Strategic Long-Term Planning. Over the past two years, a special Committee on Long-Range Planning has developed a series of ambitious strategies to build further on the gains made. Recommendations adopted by Council in October reinforce GSA's commitments

- to our science, expressed in professional meetings and publications and enhanced by extending electronic communications, increasing research and educational grants, and focusing on promoting integrative systems science through collaborations with earth, life, planetary, and social scientists;
- to society, expressed in fostering the education and outreach that bring earth science and its professionals to ever wider, increasingly diverse audiences of students and the general public;
- to our members, by ensuring GSA's vitality and effectiveness as a respected and objective voice on behalf of the geosciences.

As GSA embarked on its second century in 1998, the leadership looked back to assess what GSA had accomplished. The Second Century campaign evolved as the necessary means to augment the programs that defined GSA's proven excellence. At the outset, the goal of \$10 million seemed daunting, yet attainment

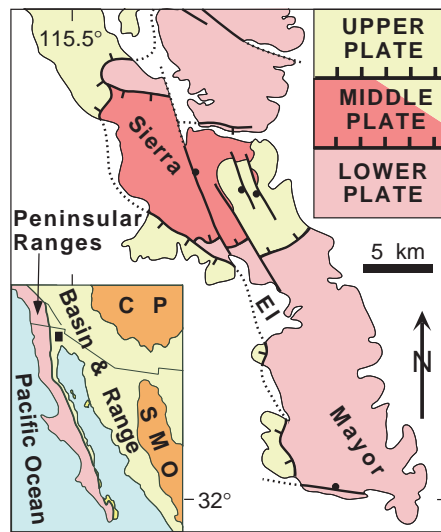


Figure 5. Tectonic map of Sierra El Mayor, Baja California, showing distribution of upper-, middle-, and lower-plate rocks and of late Cenozoic detachment faults (heavy lines with tick marks) that separate them. Yellow is sedimentary strata and red and pink are crystalline basement. Inset of southwestern North America shows location (black square); CP is Colorado Plateau; SMO is Sierra Madre Occidental.

seems to dominate high structural levels, whereas top-to-east shear appears to dominate lower structural levels (Wallis, 1995), suggesting that the middle of the Sanbagawa belt was extruded from west to east (Fig. 4). Extrusion was apparently driven by underplating of rocks represented by the modern Oboke and Shimanto belts.

The Shimanto belt is latest Early Cretaceous to latest Cretaceous in age (Taira, 1985) and was being accreted and metamorphosed as the Sanbagawa belt was cooling and being exhumed (Hasebe et al., 1997; Hasebe et al., 1993; Tagami et al.,

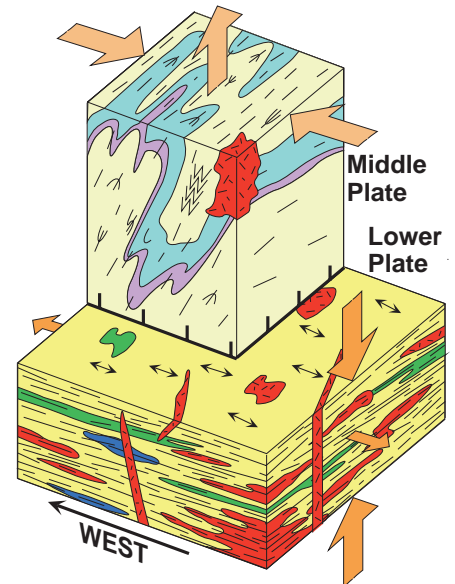


Figure 6. Schematic Cretaceous structures and deformation (orange arrows) of the Sierra El Mayor middle and lower plates, which are now juxtaposed across a younger detachment fault (heavy line with tick marks). Middle plate was thickened vertically and shortened east-west. Lower-plate metamorphic rocks were flattened vertically, which was at least partly offset by vertical inflation owing to sill emplacement, and stretched slightly east-west.

1995). The Shimanto belt comprises coherent turbidite sequences and interlayered belts of shale-rich tectonic melange. Metamorphism was relatively low grade, and illite crystallinity, vitrinite reflectance, and zircon fission-track studies document peak metamorphic conditions of ~225 °C (DiTullio and Hada, 1993; Hasebe et al., 1993). Other zircon fission-track data indicate peak metamorphism at about 75 to 60 Ma (Hasebe et al., 1993), similar to K-Ar

Crust *continued on p. 6*

is within reach. We can all be proud not only of the achievement but of the activities that the achievement has made possible.

As we approach the millennium, we now call on the membership to look ahead and to contribute to what GSA will be. The challenges to us, as geoscientists and as members of GSA, have not diminished. But the results of our program initiatives, and of our fund-raising efforts in support of those initiatives, give us the confidence to anticipate that we can meet the challenges.

And with your help, we will. The \$9.3 million raised so far is proof that GSA's efforts are worthy of support. I invite all of you to contribute to the efforts. If you have already given, we thank you most sincerely and urge you to renew your gift. If you have not yet made a gift, now is the time when every dollar is a step closer to \$10 million—or beyond!

You have recently received a mailing offering you an opportunity to contribute to the success of GSA's Second Century campaign. I hope you will give careful thought to an investment to benefit our Society, our colleagues, and our science.

For further information about how you can make a gift, please contact the GSA Foundation office at 1-800-472-1988, ext. 154. ■

ages of cleavage-forming micas (Agar et al., 1989; MacKenzie et al., 1990). Structural and kinematic data from the Shimanto belt, however, indicate north-south shortening or north-directed underthrusting (Byrne and DiTullio, 1992) rather than east-west elongation as in the Sanbagawa belt (Fig. 3). Thus, structural fabrics from these two belts have essentially the same age but preserve very different kinematic axes, suggesting substantial crustal-scale heterogeneities in strain.

EXAMPLE 3—SIERRA EL MAYOR, BAJA CALIFORNIA

The Sierra El Mayor lies in the extended region just east of the stable Peninsular Ranges (Fig. 5; Gastil et al., 1975). Late Cenozoic, brittle, low-angle normal (detachment) faults juxtapose rocks from three different crustal levels (Axen and Fletcher, 1998). The Cretaceous deformation histories of the middle and lower plates are discussed here. The middle plate consists mainly of metasedimentary rocks and various mid-Cretaceous granitic bodies, the lower plate exposes the roots of the plutonic-metamorphic suite (Fig. 1), and the upper plate is made up of Cenozoic sediments.

The metamorphic grade of middle-plate metasedimentary rocks ranges from middle greenschist to lower amphibolite facies (Siem and Gastil, 1994; Axen and Fletcher, 1998); higher-grade rocks are present near granitic intrusions. Compositional layering is isoclinally folded at all scales and overprinted by a penetrative cleavage that is axial planar to north-trending folds (Fig. 6). In pelitic units, euhedral, 1 to 3 mm garnets preserve compositional gradients that probably reflect prograde growth. Granitic bodies are locally present, are unfoliated, and are discordant to country-rock foliation.

The lower plate comprises upper-amphibolite facies migmatitic gneiss (sillimanite + K-feldspar-grade) with subhorizontal flattening foliation (Fig. 6; Axen and Fletcher, 1998). Rare mineral lineations and elongate pressure shadows around garnets trend east-west. Mesoscopic folds are sparse. Granitic units that are broadly coeval with similar units in the middle plate are common and occur as concordant sills, discordant dikes, and centimeter-scale incipient melt segregations parallel to foliation. Garnets in pelitic rocks are typically anhedral, 3 to 15 mm across, strongly embayed by reaction with quartz and biotite, and compositionally homogeneous except for narrow retrograde rims. Bands of hornblende-bearing amphibolite with calc-silicate margins are common.

Preliminary analysis of metamorphic conditions indicates that the detachment

fault between the middle and lower plates removed at least 2 km of crust. In particular, andalusite + biotite assemblages in middle plate pelitic rocks indicate peak metamorphic conditions at less than ~10 km depth (Spear, 1993), whereas the disappearance of muscovite and appearance of migmatite in the lower plate suggest the reaction muscovite + plagioclase + quartz = sillimanite + K-feldspar + melt, which takes place above ~3.5 kbar or deeper than ~12 km (Spear and Kohn, 1996). Also, preliminary $^{40}\text{Ar}/^{39}\text{Ar}$, fission-track, and (U-Th)/He thermochronology of lower-plate rocks (Axen et al., 1998) suggests 5 to 7 km of Neogene tectonic unroofing, which limits horizontal middle-plate translation over the lower plate to <20 km for reasonable fault dips.

Middle-plate structures reflect regional trends, so we are confident that lower-plate structures evolved beneath structures like those in the middle plate. Middle-plate folds probably formed in response to east-west shortening and vertical thickening (Fig. 6) with minor north-south elongation. Although these folds are now largely recumbent, rotation of non-conformably overlying east-dipping sediments back to horizontal brings their axial planes into line with the typical steeply dipping, north-striking folds of the region.

In contrast, lower-plate country rocks record mainly vertical shortening and minor east-west elongation in the absence of noncoaxial shearing (Fig. 6). Where the middle plate is absent and upper-plate sedimentary rocks rest directly above lower-plate gneiss along a brittle detachment fault, the sedimentary rocks generally dip <30° (Siem and Gastil, 1994; Vásquez-Hernández et al., 1996), implying only minor rotation of the fault, its footwall, and the flattening foliation. The high-temperature lower-plate fabrics probably developed in the weak, hot, fluid-like lower part of the middle crust where the rocks could not support differential stress as high as that causing folding in the middle plate. Concordant sills and leucosome (partial melt) were emplaced or generated, respectively, in rocks with anisotropic tensile strength that was greater parallel to foliation than perpendicular to it (e.g., Lucas and St-Onge, 1995). The sills inflated the column vertically, such that the bulk strain ellipse is difficult to characterize.

Existing data are consistent with middle- and lower-plate structures being coeval. For example, regional east-west shortening was common in the Peninsular Ranges during batholith emplacement (e.g., Todd et al., 1988), events we interpret as recorded by middle-plate folds and lower-plate migmatites, respectively. However, better determination of local geochronology is needed.

Thus, broadly coeval principal strain directions in the two levels were very

different: middle-plate strain is dominated by east-west shortening, whereas lower-plate strain is dominated by vertical flattening. Middle-plate deformation probably records subhorizontal(?) maximum principal stress of tectonic origin, whereas lower-plate deformation apparently records subvertical maximum principal stress due to lithostatic load at temperatures where much lower differential stress could be maintained.

DISCUSSION, IMPLICATIONS, AND CONCLUSIONS

Our examples illustrate very different, but contemporaneous, principal strains from one crustal level to the next. In the Brenner area in the Alps, the upper crust was essentially rigid, while subjacent levels were extruded laterally with a cigar-shaped bulk strain ellipse imparted in and below a normal shear zone. In southwest Japan, structurally higher but hotter rocks were unroofed and elongated east-west, while cooler, underlying rocks were underplated and shortened north-south. In the Sierra El Mayor in Baja California, mid-crustal rocks were shortened east-west and thickened vertically, while underlying crustal rocks were slightly elongated east-west and shortened vertically at long-term geological rates and incrementally inflated vertically by sill intrusion.

Strain heterogeneity between different crustal levels primarily reflects rheological differences. In the Sierra El Mayor, the lower plate was hotter and weaker than the middle plate, and sill emplacement was controlled by rock strength anisotropy rather than regional stress. In the Alps, the Brenner footwall was weaker than the Austroalpine units due to the combined effects of temperature and rock type. High strains and metamorphic grades, sheath folding, and regionally folded metamorphic isograds in the Sanbagawa belt indicate that it was less rigid than the underlying Shimanto belt. Metamorphic and thermal inversion within the Sanbagawa belt, and between it and the underlying Shimanto belt could be the cause. Fluid released from the subducting Shimanto belt would have also hydrated and weakened the overlying Sanbagawa belt during retrograde conditions.

Thus, flow geometries and strain in weak crustal levels can be largely controlled by complex regional and local boundary conditions. For example, eastward extrusion of the Brenner line footwall is consistent with rigid boundaries to the north, west, and south, and relatively free boundaries above and to the east. Similarly, eastward lateral flow of the Sanbagawa belt during northward underplating of the Shimanto belt could have been directed by the geometry of the overlying, relatively rigid crust and mantle of the arc (Fig. 4).

The heterogeneities we describe comprise *strain partitioning*, which is a natural consequence of acquisition of strain in rocks given their heterogeneous and evolving material properties. Strain partitioning is currently used in at least three ways. The first describes coeval but spatially separate zones of orthogonal simple shear, typically along oblique plate margins where strike-slip faults are separated from genetically related dip-slip faults (e.g., Fitch, 1972; Stock and Hodges, 1989). The second refers to different deformation mechanisms that contribute, coevally or not, to the bulk strain in a rock body (e.g., Ramsay and Huber, 1983). The third involves zones in which strain magnitude is higher than in the surroundings, as in the cores of shear zones (e.g., Mohanty and Ramsay, 1994). None of these usages fits our examples well. To unify these various concepts, we suggest a general definition: *strain partitioning is the natural division of strain into discrete parts in one or more of these mutually compatible ways: (1) kinematic division of strain onto distinct structures, (2) spatial variation of strain orientation and/or magnitude, and (3) distribution of strain among different deformation mechanisms within the same body.* Also, distinguishing between coeval, progressive, and temporally distinct strain partitioning is desirable.

If strong three-dimensional strain heterogeneity is as common as we suggest (existing examples are too numerous to cite), then there are serious implications for characterization of continental crust. For example, various types of vertical profiles are widely used in geophysical and geological studies (e.g., seismic reflection profiles, two-dimensional dynamic and kinematic models, balanced and restored cross sections). These profiles can be very useful in upper crustal studies, where deformation commonly may be adequately characterized in two dimensions, but their construction and interpretation typically hinges on a lack of motions into and out of the profile plane. These two-dimensional analyses will not adequately represent the (typical?) tectonic evolution of regions with strong three-dimensional strain partitioning.

Our examples also show the difficulty inherent in inferring paleo-plate motions from deformed rocks in ancient orogenic belts. The plate tectonic framework of the Brenner area in the Alps is relatively well known from combined seafloor data and the present positions of the continents (e.g., Dewey et al., 1989). However, without this, very different plate kinematic models could result from reconstructions based independently on the Austroalpine vs. the Tauern strain records. In the Japanese and Mexican examples, inferences about ancient plate motions would depend strongly on the level of exposure studied.



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Complex vertical strain partitioning could be the norm rather than the exception in geologically complex areas where perturbations of regional and local boundary conditions, heat flow, tectonic and topographic load, and rock strength are complex and evolving. Description and modeling of active and inactive orogenic belts should take into account three-dimensional heterogeneous strain, or have strong reasons for its dismissal, before two-dimensional models are given total credence.

The strain patterns of the weak levels of the present middle to lower crust are particularly poorly known, because of inaccessibility and the weak dependence of most geophysical imaging techniques on strain patterns. Analogy to ancient examples will likely be key to understanding the distribution of heterogeneous deformation in continental crust, and to surficial processes that may affect or be affected by such heterogeneity.

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Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. These reports present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

Agreement(?) on the FY 1999 Budget Agreement

Yesterday, our administration and the Democrats in Congress reached agreement with the Republican leadership on a fiscally responsible balanced budget that seizes this moment of prosperity and wisely invests it in the future. By standing together, we were able to achieve historic victories for the American people.

—President Bill Clinton
October 16, 1998

Are you kidding? Only God knows what is in this monstrosity.

—Senator Robert Byrd (R—WV)
October 20, 1998

Three weeks after the start of Fiscal Year 1999 (FY99), and following a bitter eight-day struggle during which the federal government nearly shut down three different times, agreement was finally reached and legislation passed and signed which permitted the continued operation of the federal government for the remainder of FY99. Much of FY99's nonmilitary funding was included in a massive \$520 billion budget package signed by President Clinton on October 21. A paper copy of the bill, the Omnibus Consolidated and Emergency Supplemental Appropriations Act, 1999, weighs 40 pounds, contains 2,825 pages, and is 16 inches high. This bill, covering health, education, foreign aid, justice, and transportation programs, is only one of about a half-dozen pieces of legislation necessary to fund the operation of the government in FY99. Among other items contained in this funding package are \$17.9 billion for the International Monetary Fund (IMF) and \$21 billion for emergencies ranging from natural-disaster mitigation, to farm relief, to facilitating fixing the year 2000 (Y2K) computer problem. The bill can be viewed at <http://icreport.loc.gov/icreport/hr4328.pdf>.

Many members of the House admitted to not fully knowing the contents of the final budget package. Representative Peter A. DeFazio (D—OR) was quoted as saying, "Heck, half the members could not even lift it, let alone read it." Some members of the Senate were equally confused and distressed by the extended and secretive process that produced the final budget package. The October 22 *Washington Post* quoted Senator Rod Grams (R—MN) as

saying, "Today I was asked to be nothing more than a rubber stamp for a deal made by a handful of individuals who presumed they had the power to speak for all of us."

Notwithstanding the politics, the collective FY99 legislation funds some new or expanded science and education activities. One education initiative attempts to improve the quality of U.S. education by funding the hiring of 100,000 new teachers, to reduce class size in the early grades. Another effort would substantially increase funding for a clean-water initiative, to help restore U.S. lakes and rivers now too polluted for fishing and swimming (see April 1998 *GSA Today*, Washington Report). The budget also contains a substantial increase in funding to address the issue of global climate change.

One very apparent feature of the budget is the large number of pieces of special-interest legislation included during the final push to complete the budget package. These include an extended duck-hunting season in Mississippi, interstate construction in Arkansas, and the creation of a Bob Dole Institute at the University of Kansas.

Here is a summary of many of the newly approved initiatives related to science, the environment, and education. Clean, safe water for America—\$1.7 billion, an additional \$230 million or 16% increase from last year for the Clean Water Action Plan, a five-year initiative to help communities and farmers clean up the almost 40% of America's surveyed waterways still too polluted for fishing and swimming. In addition, the budget provides \$2.15 billion to the States in financing for clean-water construction projects.

Expansion of the National Science Foundation—A 7% increase, from \$3.4 billion in FY98 to \$3.7 billion in FY99, to support science and engineering research across all fields and disciplines. NSF supports nearly half of the nonmedical basic research conducted at universities. Next Generation Internet—More than \$100 million for this federal R&D initiative that will connect more than 100 universities at speeds up to 1,000 times faster than today's Internet, and that will establish the foundation for the networks and applications (e.g., telemedicine, distance learning) of the 21st century. Funding global climate change investigations—An increase of more than \$1 billion, 26% more than last year, to support research investments that will reduce greenhouse gas emissions, oil consumption, and energy costs for consumers and businesses by promoting increased energy efficiency and clean energy technologies. More high-quality teachers with smaller class sizes—\$1.2 billion in FY 99 to hire 100,000 new teachers to reduce class size in the early grades to a national average of 18. The Administration argued that smaller classes will help in recruiting high-quality teachers and will insure that students receive more individual attention. After-school programs—\$200 million to expand programs and serve a quarter of a million children. Child literacy initiative—\$260 million to provide competitive grants to states to help children read well by the end of third grade. The intent is to improve teachers' ability to teach reading effectively; promote family literacy programs to help parents be their child's first teacher; and improve the quality of tutoring programs by supporting tutor training. Pell Grants—\$7.7 billion, an increase of \$359 million over FY98, increasing the maximum Pell Grant award from \$3,000 to \$3,125; this is 36% higher than in 1994. This year, approximately 4 million students will receive Pell Grant awards. Education technology—A \$114 million increase over FY98 budget levels to ensure that every child has access to computers, the Internet, high-quality educational software, and teachers who can use technology in the classroom. New learning anytime, anywhere initiative—\$20 million for the Education and Labor Departments to implement a new initiative to enhance and promote distance learning opportunities, learning outside the usual classroom settings, via computers and other technology—for all adult learners. Teacher recruitment—\$75 million for new teacher quality programs designed to recruit and prepare teachers to teach in high-poverty areas. Training new teachers to use technology effectively—\$75 million to

train new teachers how to use technology to improve student achievement. Head Start—A \$313 million increase to fund up to an additional 36,000 slots for children, striving to reach 1 million participants by 2002.

Charter schools—\$100 million, a 25% increase, toward President Clinton's goal of creating 3,000 high-quality charter schools, which will educate more than half a million students by early in the next century. These public schools started by teachers, parents, and communities are given flexibility in decision-making, in exchange for high levels of accountability for results.

Hispanic education initiative—Increases of \$524 million to enhance educational opportunities for Hispanic students.

Summer jobs—Expanded work study to help nearly 1,000,000 students work their way through college. The final budget agreement provides \$870 million, a \$40 million increase over the FY 1998 level of \$830 million.

Gear-Up—\$120 million to help up to 100,000 low-income middle-school children prepare for college.

Expansion of National Institutes of Health (NIH) for biomedical research—Almost \$2 billion expansion of NIH research funding, a 14% increase, the largest-ever dollar increase in funds for the NIH. This increase will fund a wide range of cutting-edge research on issues such as Alzheimer's disease, AIDS, diabetes, cancer, and genetic medicine.

Advanced Technology Program—\$204 million, \$11 million more than last year, which will allow for about \$66 million in new awards to develop high-risk technologies that promise significant commercial payoffs and widespread economic benefits.

Food-safety initiative—\$79 million to expand food-safety research, risk-assessment capabilities, education, surveillance activities, and food import inspections.

Preserving fragile lands—An additional \$325 million, a \$55 million increase from last year, through the Land and Water Conservation Fund will be used to acquire dozens of natural and historic sites around the country, including winter range for Yellowstone bison, New Mexico's Baca Ranch, and the last remaining private-land stretches of the Appalachian Trail.

Protecting endangered species—An additional \$32 million in FY99, a 23% increase from last year, for protection and recovery of endangered and threatened species, as well as enhancements for important habitats.

Expansion of Department of Energy's science budget—An 8% increase in the science budget, including support for the National Spallation Neutron Source.

Cleaning up "Brownfields"—An additional \$91 million for grants for site assessment and community planning, addressing problems related to these abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.

HIV and AIDS prevention and treatment—\$1.4 billion for Ryan White Care Act activities, to prevent and treat HIV and AIDS. This funding level includes a 61% increase for the AIDS drug-assistance program, which provides funds to states to help uninsured and underinsured people with life-saving treatments for HIV and AIDS. In addition, Congress provided about \$630 million for HIV-prevention activities at the Centers for Disease Control and Prevention. There is also an increase of more than \$350 million to help prevent and treat HIV and AIDS, including special efforts to address the needs of the minority community.

Lead poisoning prevention—A \$20 million increase for lead poisoning pre-

vention for HUD's Office of Lead Hazard Control, to reduce the threat posed by childhood lead poisoning and other housing-related environmental health hazards. Financial stability to Tennessee Valley Authority (TVA)—\$50 million, to allow TVA to better provide for the citizens of the seven states (Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia) that it serves. The agreement will let TVA refinance part of its debt to compensate for the loss of federal funds for its nonpower programs. The final budget also prevents TVA from losing the Land Between the Lakes Recreation Area.

However, an initiative to provide funds to accelerate Superfund cleanups with a goal of completing a total of 900 cleanups by 2001 failed to be included. President Clinton had requested an additional \$650 million—a 40% increase over FY98. The parties could not reach agreement over this issue. This initiative, along with the kitchen sink, may be the only items not lumped in the FY99 budget. ■

1999-2000
GSA

Congressional Science Fellowship

The Geological Society of America is accepting applications for the 1999-2000 Congressional Science Fellowship. The Fellow selected will spend a year, or optionally 16 months, in the office of an individual member of Congress, a congressional committee, or a congressional support agency for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow in seeking a congressional staff position.

CRITERIA

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

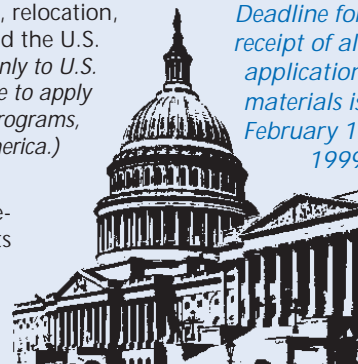
AWARD

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

TO APPLY

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from: Cathleen May, Director, IEE, Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140.

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





Eric M. Riggs, Dawn G. Marsh, University of California, Riverside, CA 92521, eriggs@citrus.ucr.edu

The Indigenous Earth Sciences Project: Exploring the Synthesis of Southern California Native American Traditional Knowledge and the Earth Sciences

Improving science education and science literacy has long been a priority within the geoscience community. The existence of this column within the pages of *GSA Today* and the many organizations devoted to teacher support within the earth sciences are testaments to that commitment. However, in recent years it has become very clear that more still needs to be done both locally and nationally if science literacy is going to increase, and that efforts must be made to reach out to all segments of our population.

In particular, various ethnic and cultural groups are persistently underrepresented in all fields of science, and earth science is no exception (see Matthews and Smith, 1994 and references therein). Native Americans are one cultural group especially poorly represented in all basic sciences, the geosciences again included (see table). Reasons for the underrepresentation of many minority groups, and particularly for Native Americans, are often linked to basic pedagogical and cultural styles that may not be automatically compatible with the teaching and research styles common to much of basic science (Nelson-Barber and Estrin, 1995).

In the belief that the geosciences offer a unique and culturally more compatible avenue between Western science and Native America, and with the support of the National Science Foundation, we have launched the Indigenous Earth Sciences Project. The project is initially a set of three conferences, starting in mid-February and ending in mid-May of 1999,

Native Americans in Graduate Programs in Science and Engineering, 1995

Major field	Number	Percentage of grad. population
Psychology	331	0.61
Social sciences	434	0.48
Agricultural sciences	58	0.48
Health fields	342	0.44
Mathematics	70	0.38
Biology	214	0.36
Earth sciences	53	0.34
Engineering, total	231	0.21
Computer science	55	0.16
Total, science and engineering	1,524	0.36

Source: National Science Foundation

designed to focus on three central issues in the relationship between the geosciences and Native America in the greater southern California region (see box). It is our goal that this project will expand to include field trips, site- and issue-specific meetings over geoscience activities on reservation and trust lands, and more direct Native American participation and involvement in the earth sciences. This model, if successful, may also be applied anywhere in the country or in the world wherever indigenous peoples maintain both occupation and some degree of sovereignty over their traditional ancestral lands.

Ground Truth

The entire Native American population in the United States in 1994 (the most recent available census data) was estimated at around 2.2 million, which works out to about 0.9% of the entire U.S. population. However, Native American participation in graduate-level science is disproportionately low, averaging about 0.36% of the entire graduate population. Why aren't there more Native Americans in science and engineering? The three major reasons are economic, cultural, and historical.

If one correlates annual family income and the likelihood of completing a college degree, some of the underrepresentation of Native Americans in science can be attributed to a more general underrepresentation in academia. Fully 31% of Native American families live below the poverty level, compared to only 13% of the general U.S. population. Correspondingly only 9% of native people complete a B.A. or B.S. degree, compared to 20% of the population at large.

A wide variety of cultural barriers must be overcome also. Much of science is taught as a unidirectional flow of information from expert to novice, and student input to the learning process and knowledge discovery is minimal at best. This style is not particularly compatible with the hands-on, participatory teaching style preferred by many Native American communities. Additionally, there is a deeper cultural conflict with the perception of the role of the scientist as a controller, manipulator, or exploiter of the natural world (Murray, 1997). Native American students are raised with a strong cultural connection to all the processes and cycles of the

earth and nature, and they often find a Western approach to science unpalatable.

Historically, the relationship of Native Americans with the scientific community has always been problematic. Since the first meeting between Europeans and the indigenous peoples of the Americas, the indigenous or "traditional" knowledge of the North American Indian has largely been excluded from the accumulated knowledge of the American scientific community. Native Americans have also many times been unfortunate victims of the abuses of misapplied science. Therefore, to facilitate participation of Indian people in science, the scientific community must come to terms with the logic behind the Native American community's distrust and sometimes outright hostility toward "Western" scientific knowledge.

The Why Questions

Why should the earth science community and other scientists be concerned about these facts? Why are the earth sciences likely to be any more culturally accessible to Native Americans than any other science? Preserving and enhancing the diversity of cultures and approaches to knowledge is important for preserving the vitality of science. Each culture carries with it a set of basic assumptions about the world and different ways of asking questions. Science thrives on the differences of opinion among its practitioners; therefore, adding to the diversity of cultures and peoples represented in science can only invigorate creativity and innovation in research. The earth sciences, and all sciences, stand to benefit from increased understanding and interest generated among underrepresented groups.

Our upcoming conference series really sets out to answer or at least explore the questions. What does the geoscience community stand to gain from a closer relationship with Native Americans? and What do Native communities have to gain from us? Even though these questions are mirror-images of each other, the answers are worlds apart.

Southern California Native America

Southern California is the ancestral (and in many cases current) home of many distinct tribes. Southern California Indians, until recently, lived out their lives in these familiar territories. This confined

and intimate knowledge of a geographic territory may be able, at best, to contribute to a body of scientific knowledge, and at the least, to provide the scientific community the tools necessary for communicating effectively with their Native American colleagues.

Southern California has been populated by Native Americans for at least 12,000 years, and possibly much longer. People have explored the lands of southern California for millennia, and those people are still here to talk to about what they've found. Many of the descendants of the original inhabitants of these lands now live in different places in California, generally because of forced relocations, but the cultures still survive, including the mythology and cultural traditions born out of these places.

The Cahuilla Indians, for example, have traditionally been keen observers of the natural world, and cultural value was placed on the precision and dependability of observations (Bean, 1972). They have lived for millennia in and near the deserts and mountains of southeastern California, so it is no wonder that their world view places man as part of a larger natural system that is characterized by unpredictability and rapid change. Earthquakes, floods, major environmental changes, landslides were all incorporated into their social history, as it was perceived that there was no difference between society and nature.

It is not hard to see, therefore, that geologists might find useful historical facts, sequences of events, or observations of processes embedded in the mythology and oral history of Native Americans. This information is not likely to be as precise as standard scientific information, but it may constrain or inform new investigations into southern California geology. This idea is essentially the basis of ethnogeology: providing an equal intellectual footing for both systems of knowledge.

Possibly the most tangible aspect of the interaction between geologists and native people in southern California is that Native Americans currently exercise some degree of autonomy over a relatively large part of the southern California desert. Some of these areas, such as the Torres-Martinez reservation in the Coachella Valley, have proven to have substantial economic value. The tribe has negotiated with the Kennecott Corporation for mining the ore deposit, which has the potential to become a major gold mine. The Chemehuevi tribe and the Pauma Band of Mission Indians, both in southern California, are members of the Council of Energy Resource Tribes, because of deposits on their lands. Access to these resources or access to do research means understanding the people who control the land, which entails understanding their culture and values. Sensitivity to these issues can help any interactions go more smoothly.

Why Is Earth Science a Good Bridge between Science and Native Americans?

Contrary to trends in most of "Western" science, geoscience curricula and research efforts have evolved to emphasize the connectivity and interrelations of the contributing processes which make up observed natural phenomena, such as the multitude of interactions among the atmosphere, hydrosphere, biosphere, and lithosphere. Many Native American cultures adopt a similarly integrative approach to knowledge of their natural environments (e.g., Semken and Morgan, 1997). The principle of uniformitarianism, one of the central ideas of geoscience, assumes that process and change are constant over very long periods of time. The same idea is found in the cultural philosophy of, for example, the Cahuilla people, as illustrated above. Again, the geosciences present a more culturally accessible avenue to many Native American world views.

The training of earth scientists is also fundamentally different from that in many other physical sciences, and it is philosophically closer to the educational styles common among Native American peoples. For example, field work and other "experience-based learning" early on in students' careers helps them understand the essential components of earth sciences far faster and more deeply than those students whose learning is limited to the classroom environment. Nelson-Barber and Estrin (1995) identified this same approach as common pedagogy within Native American cultures.

The earth sciences are an attractive career option for many young Native Americans, mainly because of the eminent practicality of the discipline. American Indians have historically chosen to become lawyers, engineers, doctors, etc., mainly because of the direct value they can bring to their home tribes. The geosciences can be useful for the same reasons. Many tribes, especially in the Western United States, own or are in control of economic deposits of various geologic commodities, and they daily face issues related to hydrology, environmental geology, engineering geology, and biogeography. The earth sciences community, therefore, has a unique opportunity to attract talented scientists from the Native American community and will benefit, along with the other sciences, from the input of new ideas and new perspectives.

The Conference Program

The three-session conference program is designed to facilitate open, honest, and off-the-record discussions and exploration of all of these issues involving Native Americans and geoscientists who live and work in southern California and surrounding regions. We are striving to schedule presentations representing a range of

THE INDIGENOUS EARTH SCIENCES PROJECT

General Conference Program

Scientific and Traditional Interpretations of Southern California Landscapes, Geology, and Natural History
February 13-14, 1999

Submission deadline: November 25, 1998
LATE SUBMISSIONS WILL BE CONSIDERED — PLEASE CONTACT THE COORDINATORS

Earth Science Education in Native American Populations: Strategies, Styles, and Goals
April 17-18, 1999

Submission deadline: January 29, 1999

The Economics and Politics of Earth Science on Native Lands: A Meeting and Discussion About Tribal Land Issues Related to Economic and Environmental Geology
May 22-23, 1999

Submission deadline: March 5, 1999

For details, see

<http://www.ucr.edu/history/IESP>

points of view, incorporating plenty of unstructured but moderated time for substantial discussions. To better accomplish this, we will let the details of the conference sessions be driven, to a large extent, by the submissions we receive. In general, we feel that if participants come away from these inaugural conferences with nothing more than a new view of their neighbors and a few different perspectives of the earth, then we will have succeeded.

How To Contribute, Where To Look for More Information

We are seeking participants and contributors from both the earth sciences and Native American communities. The evolving conference agenda will be posted on the project's Web site (<http://www.ucr.edu/history/IESP>). The Web site also has details on submission deadlines and instructions, confirmed presenters, and other relevant information as it becomes available.

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Reflections of a Scientist-Citizen

David J. Verardo,
1997–1998 GSA Congressional Science Fellow



What a difference 16 months make. Last year when I contemplated the state of our profession, I was often confused by the seeming lack of consideration given to science and technical issues by the United States Congress. I attributed this condition to the largess of legislators when it came to such issues. I believed what I heard from other scientists: that legislators were disinterested; because I had never spent much time with those who made their living at legislating, it seemed a comfortable opinion. After 16 months on Capitol Hill, I see things differently.

Now I see the problem as emanating from scientists more than from legislators. In my daily office routine, I see that many national and international legislative issues involve science. What is often missing is not the political will to make a decision, but easy access to basic and understandable scientific information on which to base an informed decision. It is this last point that is most troubling. The responsibility for decision-making is shared by those who provide the technical information and those who provide the legislative initiative. For discussion, let us focus on the role of the scientist-citizen in the legislative process.

Scientists and Legislators

Legislative initiatives begin with an idea. The idea is generated in response to either an immediate need or a long-term goal. For example, providing funds for disaster relief is an immediate need; a disaster strikes and the government responds with assistance. A longer range policy goal might be to examine the questions, Can we mitigate natural disasters to protect our citizens and reduce economic losses? If so, how do we proceed? These questions provide a geoscientist an easy entree to the legislative world. Within, however, lies a conundrum.

Legislators and their staff are familiar with the results of natural hazards such as earthquakes, hurricanes, and floods but often know little about the science behind these events. Scientists, on the other hand, know quite a bit about hazards. The legislator's knowledge of how to legislate a solution and the geoscientist's intimate understanding of natural hazards are a natural fit. Both groups can exploit the common bond between them—creativity—to develop sound public policy. This common bond, however, is rarely recognized and infrequently exploited because of a lack of communication.

From the scientist's point of view, we should communicate more effectively. For starters, we should communicate directly

with legislators on a regular basis. Yearly communication by office visits or letters does very little to foster good public policy. Communicating in a manner that is incomprehensible to someone not trained in science is equally ineffective. Many geoscientists see little use in talking with legislators. Before this year, for example, my knowledge of the federal budget process could have been reduced to the old saw about babies being brought by storks. By analogy, I thought money came from "the government" via some nebulous process that spits out cash from a federal agency. As ridiculous as this sounds, my comprehension of the process was not very different from that of many of my more experienced colleagues. In all honesty, is it substantially different from your current understanding?

Information: Top Priority

So, what to do? First, understand that providing information to legislators is imperative, as is lobbying. This last word is one of the least understood in our lexicon and one of the most feared in scientific circles. Scientists like to perceive themselves as dispassionate observers in pursuit of truth. Never mind that data collection and hypothesis testing are hardly unbiased. Still, when compared to other activities, science tries to be inclusive.

Nevertheless, we make decisions and judgements about data regularly. Perhaps the problem lies in fear. We often make recommendations with anonymity. I have seen scientists who are expert in an issue pending before Congress state emphatically that they cannot make a definitive recommendation because they do not have all the facts and, consequently, know too little. They act as though Congress somehow knows more. This is foolhardy behavior. It trivializes the value of science and makes the scientist seem cowardly, if not outright foolish. Making a recommendation seems to worry some scientists. It should not, however; judgment is a normal part of our professional life, and we are looked upon for decisions. We cannot smugly pat ourselves on the back for carefully collecting data yet bemoan the fact that the data do not make it into public policy. We can ill afford to believe that we can just "do our science."

No data set is ever complete. This is true in our profession more than most. Geoscientists are always dealing with incomplete data sets, models as works in progress, and the frustrating truth of professional life that we often come upon the scene after the fact. This inherent uncer-

tainty in our professional work can be our greatest asset with legislators. Legislators are often called upon to react, just as we are. Anticipating the result of policy decisions that are based on limited data is not so different from evaluating past geologic events to guide future actions. Even though our professional work is surrounded by uncertainty, time and time again it has yielded reliable predictive tools. It is not uncertainty that inhibits understanding; it is poor explanation of the *meaning* of uncertainty to the public.

Responsibility

Nothing I have seen this year dissuades me from the view that freedom is not free. It is fitting that these words are on the Korean War Memorial; that war came to symbolize the military actions typical of the last half of the 20th century—both sides declared victory, despite ambiguous results. In policy struggles, science is used by both sides to declare victory. Each side points to the data. Often, however, one side picks the data that support its position. Without a contrary voice decrying such arbitrary exemptions or offering a single recommendation based on the totality of the best available data, Congress and the public are left to decide for themselves as to the course of action. Are you satisfied that these groups are qualified to make such decisions? We have a responsibility to act as constituents and participants in democracy. We have a responsibility to explain ourselves. If we do not act on our own behalf, who will?

We should exploit two important bonds between geoscientists and legislators. We should recognize that uncertainty is ever present and that our professional practice, and that of legislators, requires a high degree of creativity. If we build on this common ground, we can develop sound public policy.

Good-Bye

Since this is my last article as a congressional science fellow, I take this opportunity to thank the Geological Society of America and the U.S. Geological Survey for providing me with the unique professional opportunity to work in the U.S. Congress. I also thank many professional colleagues who provided advice on a wide range of science and policy issues during my tenure on the Hill. The congressional science fellowship is one of the finest professional experiences available to geoscientists and serves our profession and country well. It is my hope that the program will be expanded, that more mid-career professionals will find it possible to participate, and that our profession will learn to utilize the knowledge gained by such an experience. ■

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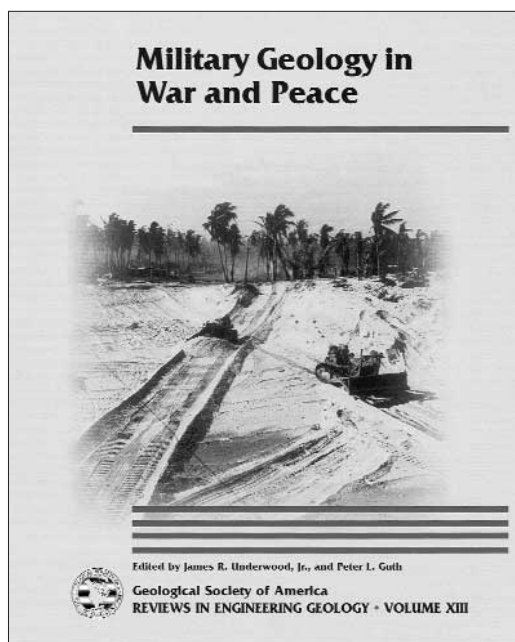
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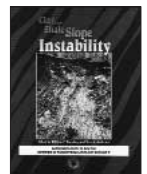
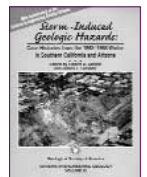
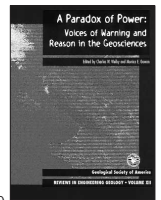
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As noted elsewhere in this issue of *GSA Today*, we are close to concluding the Second Century Fund Campaign initiated in 1992 with a goal of \$10 million. Currently, revenues and pledges in support of the campaign stand at just more than \$9.3 million. With your help, the target is achievable. Let's see if we can announce successful completion at the Annual Meeting in Denver in 1999. Remember, your donations to the campaign support GSA activities that, in turn, support you yourselves and our profession.

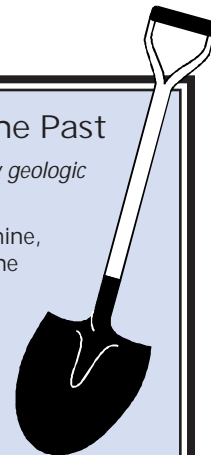
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Digging Up the Past

Most memorable early geologic experience:

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—Allen F. Agnew



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For further information and applications, contact: Fellowship Office, National Research Council, 2101 Constitution Ave., Washington, DC 20418, (202) 334-2872, fax 202-334-3419, infofell@nas.edu, <http://fellowships.nas.edu>. Applications may be downloaded from the Web site or filled out on line. The application deadline is *January 4, 1999*.

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For more information and application materials, see <http://www.orau.gov/ober/hollaend.htm>, or contact: Hollaender Postdoctoral Fellowships, Science and Engineering Education, MS 36, Oak Ridge Institute for Science and Education, P.O. Box 117, Oak Ridge, TN 37831-0117, (423) 576-9975. Deadline for applications is *January 15, 1999*.

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Evolution of Ocean Island Volcanoes

Conveners:

Dennis Geist, Department of Geology and Geological Engineering, University of Idaho, Moscow, Idaho 83844
Wendy Bohrsen, Department of Geology, Central Washington University, Ellensburg, Washington 98926-7418
Karen Harpp, Department of Geology, Colgate University, Hamilton, New York 13346

The GSA Penrose Conference "Evolution of Ocean Island Volcanoes" convened in the Galápagos Islands, Ecuador, June 4–12, 1998. The conference was cosponsored by the Charles Darwin Foundation and the International Association for Volcanology and Chemistry of the Earth's Interior. An international group of 65 scientists met in Darwin's islands to assess our current understanding of the evolution of ocean island volcanoes, to forge new interdisciplinary alliances, and to evaluate the course of future research.

Field Excursion and Keynote Presentations

The conference began with a five-day field trip to examine ocean islands in various stages of volcanic evolution. Several geologists who have had field experience in the Galápagos, as well as three Galápagos National Park naturalist guides, led the trip. Keynote talks were given between stops.

San Cristobal, the first stop, lies at the older, eastern end of the archipelago. It has experienced numerous Holocene eruptions and has erupted more diverse magma types than most ocean island volcanoes, ranging from mid-ocean ridge-like tholeiites to more typical alkaline basalts. Tectonically, the Galápagos hotspot is unusual because it lies adjacent to the Galápagos spreading center. Dennis Geist and Karen Harpp discussed the complexities that may have arisen from the conjunction of hotspot and ridge magmatism, including non-age-progressive volcanic activity, geographically widespread eruptions of similar age, a diversity of rock types atypical of ocean island volcanoes, and unusual spatial patterns displayed by isotope ratios and trace elements. Another stop, Española island, also lies at the eastern end of the archipelago. Unlike San Cristobal, however, activity on Española ceased ca. 3 Ma, and the island is strongly disrupted by normal faults.

Alexander McBirney described the history of geological exploration of the archipelago, focusing on the writings of Darwin. At the time of his voyage, Darwin had a keen interest in geology—petrology in particular. On the basis of astute field observations, he addressed issues that continue to be debated today, such as the role of crystal fractionation, the tectonic alignments of the islands, and hydrovolcanism. Mark Kurz reviewed the controversial

interpretations of helium isotope data from the Galápagos and other ocean islands, especially the meaning of temporal changes in the helium isotopic ratios at certain volcanoes. After presenting several hypotheses for the unusually high abundance of primordial ^3He in ocean island basalts, he suggested that these rocks provide modified samples of the lower part of the mantle. Some participants raised concerns about these interpretations in light of radiogenic isotopic evidence for ancient subducted lithosphere as a source of ocean island magmas.

Bob Reynolds led the trip to Sierra Negra, an active volcano on the westernmost island of Isabela. The volcano summit offered impressive views of the caldera and the remarkable sinuous ridge that may be the result of recent, shallow intrusion beneath the caldera floor. Wendy Bohrsen summarized the different evolutionary styles of ocean island volcanoes the world over. Although there are broad unifying themes, there is also an extraordinary diversity in terms of their style of eruption, petrologic character, and mantle sources. Clearly, it is misleading to consider any single ocean island chain as "typical." Notably, although Hawaii is commonly considered the basis of comparison for all other ocean islands, volcanism there is probably best viewed as an extreme end-member—i.e., the most vigorous hotspot on Earth. Peter Mougini-Mark presented a synthesis of planetary volcanism, including spectacular images of volcanoes from Venus and Mars. He proposed that Galápagos shields may be the best analogues for some extraterrestrial volcanoes.

At Alcedo, another of the active western shields, trip participants saw fallout deposits from the archipelago's largest siliceous eruption. Geist and McBirney debated whether these highly evolved rocks originated by crystal fractionation of a basaltic magma or by crustal anatexis. Dave Bercovici presented a keynote talk on important recent breakthroughs in fluid dynamic models of mantle plumes. Perhaps most important are conclusions about entrainment of mantle material during plume ascent. Previous modeling may have suggested entrainment because of unrealistic starting conditions in the models; in the more realistic case where plumes originate at a finite boundary layer, results indicate that they do not entrain surrounding material to significant

extents. This is important because geochemists have called on entrainment to explain much of the diversity observed at hotspot volcanoes.

The focus at Santiago volcano, in the central, thus middle-aged, part of the archipelago, was on surge-deposited tephra and shallow-submarine geology. Mike Garcia presented an update of recent work on the Hawaiian Islands, including evidence for crustal assimilation by basaltic magmas, petrologic processes in the submarine (Loihi) stage, and time-series data from the ongoing Puu Oo eruption. Bill White gave an overview of isotopic constraints on ocean island volcanism, the main point being that there is an emerging consensus among isotope geochemists that ancient subducted lithosphere is reactivated to form ascending plumes, eventually constituting the principal source of most ocean island magmas.

On day five, the participants disembarked on Santa Cruz island, the location of the Charles Darwin Research Station, our hosts for the remainder of the conference. The scientific program was designed to take a top-down look at ocean island geology, starting with volcanic processes and ending in the mantle.

Volcanic Processes

Don Swanson, in a keynote talk on hazards generated by ocean island volcanoes, emphasized that work in Hawaii has shown that such volcanoes do not just emit quiescent flows of basalt. If groundwater and magma interact at shallow levels, enormous explosions can occur, and the giant landslides that are promoted by rift zone processes, although infrequent, present extreme potential for destruction both directly and as a result of the giant tsunamis that they may cause. Several posters addressing case studies of hazards at various ocean island volcanoes underscored that because of increasing population pressure, more and more neighborhoods are being built in locations that are potentially in the paths of destructive lava flows. Scott Rowland reviewed the variations in morphology of ocean island volcanoes, noting the complexities introduced by the presence of vents, lava flows, pyroclastic flows, intrusive events, and the consequences of erosion. One of the most important distinctions in the morphology

Volcanoes *continued on p. 19*

CALL FOR NOMINATIONS REMINDERS

PENROSE AND DAY MEDALS, AND HONORARY FELLOWSHIP

Nominations for 1999 Penrose and Day Medals and for Honorary Fellowship in the Society are due by FEBRUARY 1, 1999.

YOUNG SCIENTIST AWARD (DONATH MEDAL)

The Young Scientist Award is for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award consists of a gold medal called the Donath Medal and a cash prize of \$15,000.

For the year 1999, only those candidates born on or after January 1, 1964, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1999 award must include biographical information; a summary of the candidate's scientific contributions to geology (200 words or less); a selected bibliography (no more than 10 titles); and supporting letters from five scientists in addition to the person making the nomination.

Deadline for nominations for 1999 is FEBRUARY 1, 1999.

OFFICERS AND COUNCILORS

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).

Deadline for nominations for service in 2000 is FEBRUARY 5, 1999.

DISTINGUISHED SERVICE AWARD

The GSA Distinguished Service Award recognizes individuals for exceptional service to the Society. GSA Members, Fellows, Asso-

ciates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees are selected by the Executive Committee, and all selections are ratified by the Council. Deadline for nominations for 1999 is MARCH 1, 1999.

JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a \$1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund.

The paper must be selected from GSA or state geological survey publications; it must be selected from those published during the preceding three full calendar years; and the nomination must include a paragraph stating the pertinence of the paper.

Nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land-use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers). Deadline for nominations for 1999 is MARCH 1, 1999.

NATIONAL AWARDS

The deadline is April 30, 1999, for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award.

Volcanoes *continued from p. 18*

of different ocean island volcanoes is the presence (e.g., Hawaii) or lack (e.g., Galápagos) of rift zones. Two features that can be important in the development of rift zones are the presence of sediments (which may permit rift zone development) and whether new volcanoes grow on pre-existing ones. Additional talks and posters characterized the submarine stages of volcanism and emphasized the importance of stresses that develop during ascent and intrusion of dikes and in magma reservoirs.

Howard Snell, director of conservation for the Charles Darwin Research Station, spoke on the geologic controls of biodiversity and the evolution of new species in the Galápagos. He highlighted controlling factors such as distances between emerged islands, sea-level changes, and ages of different islands, presenting quantitative links between these factors and speciation. One aspect that may be overlooked by geologists is the importance of very small islands, which may serve as ecological staging areas.

Lithospheric Controls on Ocean Island Magmatism

Doug Toomey discussed seismic evidence for magma chambers and partial

melting, emphasizing the extraordinary results from the East Pacific Rise MELT experiment. Most important is that the partial melt zone is much wider and deeper than many models have suggested. Unfortunately, comparable surveys have not been accomplished yet in the ocean island environment. One of the principal problems is that in many places, notably Hawaii, the lithosphere is too thick to image the melt zone with existing technology. Clearly, such a survey in an archipelago like the Galápagos could revolutionize our understanding of melting and melt transport in the ocean island setting.

Participants discussed the origin of chemical diversity among ocean island volcanoes, specifically the importance of lithosphere-magma interaction. In contrast to traditional assumptions, recent evidence suggests that many ocean island magmas are measurably affected by lithospheric assimilation. This topic is of more than provincial petrologic importance because of the overwhelming role ocean island basalts have played in modern interpretations of mantle dynamics. It was suggested that although assimilation may be important in some settings, it is recognizable, and the isotopists may not be altogether misinterpreting mantle signatures. L. Kenny Rubin discussed the use of actinide-series disequilibria and noted

that, in general, the lack of reliable eruption ages from this technique is linked to complexities in processes of melting and differentiation, the low abundances of the necessary elements in many minerals, and analytical difficulties. Several posters highlighted measurements of magmatic water, halogens, and oxygen isotopic ratios, exploring how magmas interact with hydrothermal systems and the extent to which they interact. Others dealt with the controls of regional tectonic stresses on the volcanic and petrologic development of ocean island volcanoes and the relationship between alkaline and tholeiitic magmas from several archipelagos. The scale of chemical diversity was a recurring theme, and the findings illustrate that compositional variation can occur on scales as small as melt inclusions and as large as volcanic edifices.

Mantle Processes

Ocean-island volcanoes have played the primary role in revealing large-scale dynamic features and long-term evolution of Earth's mantle. Two aspects of ocean islands provide essential evidence in this view: (1) the time-transgressive nature of hotspot tracks and their supposed fixity, and (2) the isotopic and trace element

Volcanoes continued on p. 20

compositions of ocean-island basalts. Paul Wessel reviewed the "hotspotting" technique, whereby all volcanoes in a chain are backtracked to indicate the position of their source. He reached two important conclusions. First, many island chains either are not produced by fixed hotspots or, if they are, positions of the islands have been shifted by secondary processes. Second, there is evidence for a major reorganization of the Pacific and surrounding plates ca. 6 Ma. Alice Gripp presented the results of her latest update of a global inversion for absolute plate motion, which may cast some doubt on this reorganization event. One conclusion emerged from the discussions: Absolute motion of the plates, particularly for the past few million years, is not as well understood as many would hope.

Erik Hauri reviewed isotopic evidence for lateral compositional variability in the Hawaiian plume. Osmium isotopic evidence indicates that the variability is not related to lithospheric interactions. Despite geodynamic results indicating that entrainment of lower mantle is insignificant, isotopic evidence suggests the contrary. Deuterium measurements on melt inclusions presented at the conference may eventually constrain the time scales of mantle mixing and residence times. In an overview of helium isotopic data for many ocean islands, Dave Graham attributed helium isotopic variations to a spectrum of processes, the most significant being plume flux, velocity of the overlying plate, and proximity to a plate margin. Al Hofmann, who was one of the first to suggest that mantle plume compositions include a significant contribution from ancient subducted lithosphere, argued that the elevated strontium concentrations found in some ocean island basalts may be attributable to ancient gabbro in mantle plumes—trace element evidence from Hawaii indicates that gabbro-derived eclogites may constitute an important plume component.

Ocean Island Volcanic Processes

In a synopsis of recent research on a variety of ocean island provinces, Dave Clague presented an overview of the evolution of Hawaiian volcanism. MacDonald's pioneering model of the evolution of the world's largest volcanoes has been revised as a result of petrologic, volcanological, geochemical, and geophysical studies of the submarine stage at Loihi, as well as greater understanding of the causes of the evolution of Hawaiian volcanism. For example, evidence reviewed by several participants, including Clague, Hauri, and Rhodes, points to a concentrically zoned plume. Volcanoes appear to be dragged from edge to center to edge of the plume,

thus producing notable variations in geochemical compositions. Significant questions remain; for example, the mechanism by which the plume becomes zoned is not fully understood, and there is controversy over the internal structure of the volcanoes, especially the nature of the submarine deposits. The upcoming Hawaiian Scientific Drilling Project, retrieving core from the deep interior of Mauna Kea, may enhance our understanding of petrologic and geochemical changes with time.

Dominique Weis's research on Kerguelen and its hotspot track and Kaj Hoernle's description of ocean island volcanoes of the eastern Atlantic showcased the extensive amount of data collected on ocean islands in the Indian and Atlantic oceans. Kerguelen is unique because it records 115 m.y. of hotspot volcanism. Kerguelen's lavas have remarkably consistent (and unique) radiogenic isotopic ratios, indicating that the plume source has been supplying chemically homogeneous magma continuously over this time span. Secular changes in magma production rates and some trace element ratios indicate decreasing extents of partial melting with time. Volcanoes of the Canary, Selvagen, and Madeira archipelagos are unusual because they lie on a very slow-moving plate and near a continental margin. Despite these complexities, the age and isotopic ratios of these volcanoes appear to be consistent with a mantle rich in ancient subducted sediments (the so-called HIMU component). In a demonstration formed by Anita Grunder, David Graham, and Wendy Bohron, Hofmann demonstrated the latest high-technology method of mixing chemically distinct mantle "components."

Plume-Ridge Interaction

The Galápagos is one of the best locations to study the interaction between mantle plumes and mid-ocean ridges; the Galápagos spreading center produces "excess" magma and has anomalous geochemical features, and the lavas have many characteristics in common with typical mid-ocean ridge basalt. Godfrey Fitton compared plume-ridge interaction at Iceland and the Galápagos via examination of excess niobium in the two provinces. He proposed that whereas the Galápagos exhibits a strong contribution from the mantle region that produces mid-ocean ridge basalt, the vast majority of Icelandic basalts show little evidence of MORB components. Derek Bostok emphasized the fluid nature of the niobium/iodium ratio. Dave Christie considered the ridge's perspective, discussing geochemical and tectonic features of the Galápagos spreading center and focusing on the influences on the ridge segments that propagate away from the hotspot. The data appear to support flow of plume material in

both directions down the axis of the ridge. Moreover, the isotopic zoning observed in the Galápagos islands is partly preserved during this flow. Posters in this session were directed to detailed geophysical and geochemical studies of Iceland, the Reykjanes ridge, St. Paul–Amsterdam, and Easter Island. Dave Naar showed that the transforms in the Galápagos region are relatively young; thus, there is not likely to be a large difference in lithospheric thickness across the archipelago, as previously assumed. Instead, the pseudo-faults of propagating rifts may channel the flow of plume material to a ridge.

The Continental Connection

Mantle plumes are also thought to produce continental volcanoes, such as those of continental flood basalt provinces and the Yellowstone–Snake River Plain. Although the chemistry of magmas produced by continental hotspots is complicated by the thicker and compositionally variable lithosphere, the ease of access and continuous record provide some advantages.

Gene Humphreys presented results from a tomographic study of the eastern Snake River Plain that has provided a remarkable image of the crust and mantle in the region. The axis of the plain is underlain by seismically slow upper mantle, which grades laterally to fast mantle under the parabolic wake of the hotspot. This spatial pattern is attributable to the presence of a partial melt zone that extends to 150 km and is surrounded by a zone of melt-depleted upper mantle. These results seem to be inconsistent with a deeply-rooted plume that pancakes against the lithosphere, as had been described by Bercovici earlier. Instead, self-perpetuating convective overturn caused by melt buoyancy may drive Yellowstone magmatism. Mike McCurry reviewed the petrology and geochemistry of the Snake River Plain, and also concluded that simple mantle-plume models may be inappropriate. Posters explored the connection between continental flood basalts, oceanic plateaus, and ocean island volcanoes. Although the case for the island-plateau connection appears strong, the link between ocean islands and continental flood basalts is much less clear: Are the chemical and eruptive differences due to the thicker continental lithosphere, or are the associations tectonically unrelated?

Summary

Participants reached several conclusions at this conference.

1. Although there are broad similarities in some characteristics among ocean island chains, all ocean island chains are unique in some ways. This is likely the

result of the complex interaction among factors such as age, thickness, composition of lithosphere, proximity to a mid-ocean ridge, rate of plate motion, magma chamber dynamics, characteristics of the associated plume (if present), and different magma sources. Broad-scale similarities of particular characteristics may lead to the development of a spectrum of models for hotspot evolution and volcanic processes.

2. The assumed plume origin of many "hotspots" has been questioned on the basis of observations such as lack of age-progressive volcanism and simultaneous eruption of volcanoes that are geographically widespread. This underscores the question of the "origin" of plumes. If "strong" plumes come from the core-mantle boundary, as has been suggested, do "weaker" plumes come from a shallower boundary layer? Are other hypotheses, such as lithospheric cracking, tenable as explanations for some ocean island magmatism? Resolution of these questions requires integration of geochemistry and geophysics. In particular, as technology improves, the highly successful MELT experiment and the tomographic images from Yellowstone may provide templates for understanding crustal and mantle structure beneath ocean islands.

3. Evidence for chemical diversity of ocean island magmas abounds, but its origin remains incompletely explained. It is crucial that we improve our understanding of the physical nature of the chemically distinct mantle "components." While there seems to be a consensus that a major component of ocean island magmas is recycled oceanic lithosphere, the origin of much of the isotopic and trace element diversity remains unresolved. In addition, there is no consensus regarding the contribution lithospheric mantle makes to geochemical signatures of some ocean island volcanoes.

4. While there is evidence that some hotspot chains are characterized by coherent spatial and temporal variations in chemistry, the origin of such patterns is controversial. The apparent success of the Hawaiian zoned-plume model, where entrainment is called upon to generate chemical variations within the plume itself, is tempered by an apparent lack of support in geodynamical models. Yet, helium isotope signatures suggest some contribution from a relatively undegassed region, probably located in the lower mantle. Resolution of this controversy will require interdisciplinary studies that address both geochemical and geophysical constraints on plume-mantle interaction.

5. It is likely that volcanic hazards associated with ocean islands have been underestimated. As demonstrated at this conference, it is of paramount importance to acknowledge the potential consequences of giant landslides and associated tsunamis as well as recognize the possibility of highly explosive eruptions on volcanoes previously assumed to be quiescent. Identification and mitigation of the hazards being generated by increasing population density are essential. Progress in this arena relies on detailed mapping and dating of ocean island volcanoes, greater communication between geoscientists and public officials, and increased effort on the part of geoscientists to educate the public about volcanoes.

ACKNOWLEDGMENTS

We thank Galápagos Travel, whose staff coordinated flights and arranged for field trip boats; the Charles Darwin Research Station staff, especially Ximena Naranjo, Rob Bengsten-Smith, and Heidi Snell; and Jack Nelson, who arranged accommodations at Hotel Galápagos.

The Geological Society of America and a grant from the National Science Foundation assisted in funding the student and post-doc participants. The International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) also provided travel funds. ■

Participants

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David Bercovici
Wendy Bohrsen
Jackie Caplan-Auerbach
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Dave Clague
Alice Davis
Bernard Deruelle
Rachel Ellisor
Godfrey Fitton

Fred Frey
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Alice Gripp
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Karen Harpp
Erik Hauri
Kaj Hoernle
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Jeff Standish
Hubert Staudigel
Don Swanson
Doug Toomey
Frank Trusdell
Brian Upton
Paul Wallace
Barry Weaver
Dominique Weis
Paul Wessel
Bill White

CALL FOR NOMINATIONS: Technical Program and Hot Topics Chairs

The Technical Program Chair (TPC) has the final responsibility over the entire GSA Annual Meeting technical program, including the review and acceptance of keynote and topical session proposals (January–February) and the scheduling of all sessions for the annual meeting (July–early August) in coordination with the Joint Technical Program (JTPC) representatives. This chairmanship also includes active participation over a three-year commitment in the Annual Program Committee, which meets twice a year (usually March and August).

The Technical Program Chair must have a broad perspective on the geological sciences and be efficient, organized, fair-minded, flexible, and committed to organizing a dynamic meeting. Some experience with technical program scheduling would be helpful, especially membership on the GSA Joint Technical Program Com-

mittee within the past 5 years. The TPC must be able to work regularly and interactively on the Web and Internet, and must be a GSA member.

The Hot Topics Chair organizes four spirited lunchtime debates during the GSA Annual Meeting and makes sure that the titles of the debates reflect their controversial and lively nature. Responsibilities include locating, organizing, and securing debate organizers who will identify topics and speakers.

To Nominate Volunteers: Contact the GSA Meetings Department for a nomination form: (303) 447-2020, ext. 186, snace@geosociety.org. Nominations are due January 31, 1999.





LETTER

The article "Slope Failure and Shoreline Retreat ..." (*GSA Today*, August 1998) provided an overview of the impact of heavy rainfall as a result of El Niño weather conditions. The team of contributors certainly has extensive background and undoubtedly quite an accumulation of experience dealing with the several types of landslides and slope failures described in the article. Thus, I am puzzled and disappointed at the statement "The map is a generalized depiction of potential hazard; any area thus identified may require a detailed site analysis by a *geotechnical engineer*" (p. 5, lines 17–20, from top of right-hand column; emphasis added).

A practitioner in the discipline of engineering geology is by training and experience likely the best qualified to perform a detailed site analysis and collect the requisite data, rather than a geotechnical engineer. The geologic and soils parameters can then be given to a geotechnical or civil engineer for numerical analysis.

Detailed mapping, geologic sections, interpretation of low sun angle, oblique or vertical aerial photography, and consideration of shallow soil and bedrock attitudes, strength, and drainage characteristics are among the skills called upon that are likely to be best performed by the geologic discipline rather than the engineering discipline. Should investigation proceed to exploration, it is the engineering geologist who will drill and log the 24 inch bucket holes, excavate test pits and log them, install slope indicators and piezometers, draw geologic sections, and estimate the risk of continued or renewed movement of the unstable mass.

J. L. McNey
Fullerton, CA 92835-4065 ■

December Issue of *GSA Bulletin* Features Status Report of Women and Men in the Geosciences

Nancy Riggs, Associate Editor, *GSA Bulletin*, Northern Arizona University
Lynn Walter, Editor, *GSA Bulletin*, University of Michigan—Ann Arbor

The December 1998 *GSA Bulletin* features another in its continuing series of overview articles. "Achieving equity between women and men in the geosciences," by Allison Macfarlane and Sheryl Luzzader-Beach, is an exceptionally thorough and scholarly contribution that brings us up-to-date on the status of gender issues in the earth sciences. The last in-depth contribution of this type in a *GSA* publication appeared in *Geology* in 1987.

Macfarlane and Luzzader-Beach surveyed more than 200 men and women faculty at universities across the United States to track the numbers of men and women in different classes of faculty positions (i.e., temporary non-tenure-track, lecturer, assistant professor, associate professor, and professor). They also surveyed and summarized men's and women's respective experiences in research, publishing, mentoring, collaborating, and managing family life and careers. These data were combined with statistical compilations on professional participation of women and men in the earth sciences published by the American Geological Institute (AGI) and the National Science Foundation (NSF) over the past 10 years.

Although some of the conclusions Macfarlane and Luzzader-Beach draw are

not surprising (women hold temporary, non-tenure-track positions in higher proportions than do men), some are very thought provoking (generational differences are more pronounced in areas of research process and academic setting than are sex-based differences). The authors identify personal and institutional strategies to improve gender equity in the earth sciences. They suggest that universities hire more women (striving for critical mass), that departments provide "strong and appropriate support" for junior women (and men) going through the tenure process, and that universities address proactively the problems encountered by dual-career couples, a common dilemma for earth science faculty hires. These strategies may find effective application by many of us in departments challenged by continuing underrepresentation of women and ethnic minorities.

Reviewer Margaret Rees (professor of geosciences, University of Nevada, Las Vegas) says, "I am glad that *GSA Bulletin* is willing and able to publish these very important data. I will be eagerly awaiting this publication so we can take it to the administration as well as have it available for debates in the hallways and at departmental faculty meetings." ■

CALL FOR *GSA Today* Correspondent for Student Matters

GSA seeks a Member or Fellow willing to coordinate and be responsible for a regular (monthly) contribution for *GSA Today* dealing with matters of interest to undergraduate and graduate student members of the Society. *GSA* headquarters will provide administrative support for the correspondent. The one-year renewable appointment begins in March 1999.

Please send a statement of interest and a short vita to:

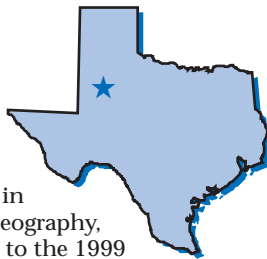
Director of Publications
Geological Society of America
P.O. Box 9140
Boulder, CO 80301
plehr@geosociety.org

South-Central Section Awards 1998 Grants

The South-Central Section has awarded grants to five graduate students who applied to the *GSA* Research Grants program. The awardees are: Heather K. Wood, University of Kansas, for "Sedimentology, Stratigraphy and Paleocology of Upper Miocene Carbonate Complexes, Fernan Perez region, Southeastern Spain"; Patrick Doherty, University of Oklahoma, for "Lithofacies Distribution and Reservoir Characterization of Pennsylvanian Phylloid Algal Mounds; Western Orogrande Basin, New Mexico"; Donald M. Schuy, Baylor University, for "Hydrology and Soil Dynamics of a Newly Constructed Wetland: Somerville Wildlife Management Area, Lee County, Texas"; Salah El-Din Ragab Mahmoud, University of Texas at Dallas, for "Integrated Palynology and Sequence Stratigraphy of the Upper Cretaceous–Lower Tertiary of the Paras-La Popa Basin, North Mexico and Maverick Basin, South Texas"; Aaron J. Martin, Rice University, for "Stratigraphic Relations in the King Lear Formation: Implications for the Cretaceous Paleogeography of the Black Rock Desert Region, Northwest Nevada."

SOUTH-CENTRAL SECTION, GSA 33rd Annual Meeting

Lubbock, Texas
March 15-16, 1999



The Department of Geosciences of Texas Tech University in conjunction with the Departments of Economics and Geography, Civil Engineering, and Plant and Soil Science invite you to the 1999 annual meeting of the South-Central section of the Geological Society of America. The meeting will be held March 15-16, at the Holiday Inn Civic Center in Lubbock, Texas. Pre- and postmeeting field trips are scheduled.

LOCATION

Lubbock is located on the Southern High Plains, the largest plateau in North America. It is the hub of a diverse agricultural industry, and as such is the focus of research relating to environment, water supply and quality, climate effects, and waste disposal. It lies at the intersection of Interstate 27 and U.S. highways 62, 82, and 84. Inexpensive air connections can be made via Southwest, American, Continental, and Delta. A street map of Lubbock is available on the Web at: www.lubbock.com. Lubbock is also the location of a world-class archeological site, the Lubbock Lake Site. This Texas State Park and museum preserve a 12,000-year record of habitation, the longest continuous record known in North America. Other locations of interest to visitors include the Museum of Texas Tech and the Ranching Heritage Center. Finally, Lubbock is home to three award-winning wineries that are open for touring and wine tasting. Lubbock weather in March is generally mild, with occasional displays of airborne movement of particulate matter.

SYMPOSIA

1. Paleontology and Stratigraphy of Cretaceous and Tertiary Strata in West Texas and Northern Mexico. (Sponsored by Paleontological Society South-Central Section.) Thomas M. Lehman, Texas Tech University, and Francisco J. Vega, Instituto de Geología, Ciudad Universitaria.
2. Proterozoic and Early Paleozoic Magmatism and Tectonics in Southern Laurentia. Melanie Barnes, Texas Tech University, and Elizabeth Y. Anthony, University of Texas—El Paso.
3. Aeolian Processes and Geomorphology. Jeffrey Lee, Texas Tech University.
4. Environmental Applications of Geology in the Southern High Plains. Ken Rainwater, Texas Tech University.
5. Calcium Carbonate-Enriched (Caliche) Horizons in the Soils of the Southwest. Susan Casby-Horton, Natural Resources Conservation Service, and B. L. Allen, Texas Tech University.

6. Applications in Geophysics. Harold Gurrola, Texas Tech University.
7. Environmental Applications of Stable Isotopes. Haraldur Karlsson, Texas Tech University.

UNDERGRADUATE RESEARCH POSTER SESSION

This session, sponsored by the Geology Division of the Council on Undergraduate Research, will showcase senior theses and other undergraduate research projects. Topics may vary over a wide spectrum (e.g., see GSA abstract form), but a student must be listed as the lead author and be the major preparer of the poster. In section 5 of the GSA abstract form, place a check before "student author presenter" and write "CUR poster session" immediately below. For further information, contact Diane Smith, Dept. of Geosciences, Trinity University, (210) 736-7656, fax 210-736-8264, dsmith@trinity.edu.

STUDENT WORKSHOP

Basic Well Log Analysis. Lithology Logging, Sunday, March 14. This course is a review of different methods used by the subsurface geologist to identify and map lithologies using petrophysical well logs. The course begins with a review of the petrophysical well logs used to identify lithologies and will include how they work, what they measure, their evolution, and corrections that are applied. The review will cover gamma ray, spontaneous potential, neutron, density, sonic, photoelectric logs. The following cross-plot methods used to identify lithologies will be discussed: neutron-density, neutron-sonic, density-sonic, M-N plot, and MID plots. The application of these various cross-plots will be presented, and an example of each type using data from the Silurian Fusselman Formation in West Texas. Spontaneous potential alpha and "clean" gamma ray mapping will be presented.

The course will end with two problems: (1) use of cross plots in determining lithology from a formation in west Texas, and (2) application of gamma ray and SP

logs to log facies mapping in a Pennsylvanian sandstone in central Texas.

Limit: 30; fee: \$20, including lunch, refreshments, and, if necessary, transportation to and from the Holiday Inn. Contact George Asquith, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3154, fax 806-742-0100, gicga@ttu.edu.

FIELD TRIPS

All trips will depart from and return to the Holiday Inn Civic Center, 801 Avenue Q, Lubbock. Trip fees include transportation (vans) during the trip, lunch, refreshments, and a guidebook. Registrants are responsible for their own housing arrangements. For further information, contact the field trip leader or the Field Trip Coordinator C. C. (Tex) Reeves, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3115, fax 806-742-0100.

1. Stratigraphy of the Caprock Escarpment. Sunday, March 14. Thomas Lehman, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3148, fax 806-742-0100, tlehman@ttu.edu. Maximum 20, minimum 9. Cost: \$45.

We will examine the stratigraphy of the Caprock Escarpment as exposed in Caprock Canyons State Park in Briscoe County, Texas. During a seven-mile (roundtrip) hike up the South Prong of the Little Red River, we will see outcrops of the Permian Quartermaster Formation, Triassic Dockum Group, Tertiary Ogallala Formation, and Quaternary Blackwater Draw Formation.

2. Quaternary Stratigraphy of the Southern High Plains. Sunday, March 14. Vance Holliday, Dept. of Geography, University of Wisconsin, Madison, WI 53706-1491, (608) 262-6300, holliday@geography.wisc.edu. Maximum 20, minimum 8. Cost: \$40.

We will examine exposures of eolian and lacustrine sediments and associated soils in and near Lubbock, Texas. Stops include the type Blanco Formation (Pliocene), type Blackwater Draw Formation (Pleistocene), a small playa exposure

South-Central *continued on p. 24*

REGISTRATION FEES		
	Full meeting	One day
Professional—		
Member	\$55	\$50
Nonmember	\$65	\$50
Student—		
Member	\$25	\$30
Nonmember	\$35	\$30
K-12 Professional	\$20	
Guest or Spouse	\$20	

South-Central *continued from p. 23*

(Holocene), and exposures of valley fill and a lunette (both late Quaternary) at the Lubbock Lake archaeological landmark. The tour will include only light walking.

3. Geology of Palo Duro Canyon. Sunday, March 14. Gerald Schultz, West Texas A&M University, Canyon, (806) 651-2580, fax 806-651-2928, gschultz@faculty.WTAMU.edu. Maximum 20, minimum 8. Cost: \$50.

We will concentrate on the geology of Palo Duro Canyon, the Grand Canyon of Texas. Probable stops include the Caprock Caliche, including the basal Potter gravels, fluvial (channel and floodplain) redbeds of the Triassic Dockum Group, continental sabhka deposits, and deformed gypsum deposits of the Permian Quartermaster Formation.

4. Nuclear Waste Storage at the WIPP Site, New Mexico. Wednesday, March 17. C. C. Reeves, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3115, fax 806-742-0100, and Judy Reeves, Compliance Services Group, (806) 748-0040. Maximum 20, minimum 8. Cost: \$40.

The Waste Isolation Pilot Plant near Carlsbad, New Mexico, is the nation's first facility for the deep geological disposal of radioactive transuranic waste left from the production of nuclear weapons. After a short mandatory safety training session, we will visit the above-ground waste handling facility. From there we will go underground (2150 feet) to the waste repository, in the Permian Salado Formation, a thick evaporite sequence (mostly halite) extending from about 850 feet to 3000 feet below the surface. The facility is designed to isolate the wastes through natural encapsula-

tion owing to the plastic quality of the salt. A technical discussion will follow.

ABSTRACTS

Abstract deadline: *December 15, 1998.*

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

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

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

Attendees are encouraged to order an abstract booklet with their annual dues. There will be only a limited number of abstract booklets available for purchase on-site.

PROJECTION EQUIPMENT

Please bring your own loaded carousel trays. There will be two projectors for each oral session, and overhead projectors will be available, as will a small number of carousel trays. Posters will be displayed on 8' x 4' boards. Details of the poster display session will be sent to individual authors after acceptance of abstracts.

EXHIBITS

Facilities for business, educational, and governmental exhibitors will be available in the Holiday Inn Civic Center. Space rental is \$125 commercial, which will include one complimentary registration, and \$50 educational. Exhibitors are encouraged to set up Sunday afternoon for registration and the welcoming party. For more information, please contact Susan Tomlinson, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3200, fax 806-742-0100, gislt@ttu.edu.

BUSINESS MEETINGS AND SOCIAL EVENTS

Welcoming Party. Sunday, March 14, 7 p.m., exhibit hall. On-site registration will be available, and those who have preregistered may pick up their name badges, tickets for the dinner, and abstract booklets.

Meeting Banquet. Monday, March 15, 7 p.m., Holiday Inn. A special lecture presentation will follow. Banquet tickets should be purchased in advance; only a

South-Central *continued on p. 26*

HOUSING FORM — *Holiday Inn Civic Center, Lubbock, Texas*

South-Central Section, Geological Society of America
Sunday, March 14–Tuesday, March 16

Arrival Date _____ Departure Date _____

PERSON REQUESTING HOUSING (type or print)

Last Name _____ First _____

Institution or Firm _____

Address or P.O. Box _____

City _____ State/Province _____ ZIP Code _____

Phone: () _____ () _____
Work Home

Place reservation in name of: _____

Name of all other occupants:

RATES PER ROOM*

Single-Quad Occupancy \$65 Atrium Suites \$79

SPECIAL NEEDS Smoking Room Nonsmoking Room Special Room
 Special Room Requirements _____

*Enclose check or money order (for amount of one night's lodging) payable to Holiday Inn Civic Center or major credit card number and date of expiration.

Reservations must be received prior to February 14, 1999

Telephone reservations accepted: (806) 762-1200; 800-HOLIDAY; fax 806-763-2656.

Type of Card _____ Card Number _____

Name as it appears on the credit card _____

Exp. Date _____ Signature _____

SEND THIS FORM AND REMITTANCE OR CREDIT CARD INFORMATION TO:
Holiday Inn Civic Center, 801 Avenue Q, Lubbock, TX 79401.

PREREGISTRATION FORM

Lubbock, Texas
March 15-16, 1999

GSA South-Central Section

Preregistration Deadline: February 19

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (last name first) _____

 Employer/University Affiliation _____

 State or Country _____

Mailing Address (use two lines if necessary) _____

 City _____ State _____

ZIP Code _____ Country (if other than USA) _____
 (A) GSA (B) NAGT (C) PS

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on your guest's badge _____

 City _____ State or Country _____

Please inform us by February 26 of any special considerations that you or your guest require.
 I will need special considerations.

Cancellation Deadline: February 26

MAIL TO:
GSA SOUTH-CENTRAL SECTION MEETING,
P.O. BOX 9140, BOULDER, CO 80301-9140
 FAX TO: 303-447-0648

Remit in U.S. funds payable to:
1999 GSA South-Central Section Meeting
(All preregistrations must be prepaid. Purchase Orders not accepted.)

Payment by (check one):
 Check American Express VISA MasterCard

Card Number _____ Expires _____
 Signature _____

Register one professional or student per form.
 Copy form for your records.

REGISTRATION FEES	Full Meeting	One Day	Qty.	Amount
Professional Member*	(10) \$55 <input type="checkbox"/>	(11) \$50 <input type="checkbox"/>	1	\$ _____
Professional Nonmember	(14) \$65 <input type="checkbox"/>	(15) \$50 <input type="checkbox"/>	1	\$ _____
Student Member*	(30) \$25 <input type="checkbox"/>	(31) \$30 <input type="checkbox"/>	1	\$ _____
Student Nonmember	(32) \$35 <input type="checkbox"/>	(33) \$30 <input type="checkbox"/>	1	\$ _____
K-12 Professional	(60) \$20 <input type="checkbox"/>		1	\$ _____
Guest or Spouse	(90) \$20 <input type="checkbox"/>		1	\$ _____

* Member fee applies to any current Professional OR Student Member of GSA or Associated Societies listed at left. Discount does not apply to guest registrants.

SPECIAL EVENT

1. Conference Dinner.....March 15 (201) \$25 _____ \$ _____

WORKSHOP

1. Student Workshop: Basic Well Log AnalysisMarch 14 (601) \$20 1 \$ _____

FIELD TRIPS

1. Stratigraphy of the Caprock Escarpment.....March 14 (401) \$45 1 \$ _____
2. Quaternary Stratigraphy, Southern High PlainsMarch 14 (402) \$40 1 \$ _____
3. Geology of Palo Duro Canyon.....March 14 (403) \$50 1 \$ _____
4. Nuclear Waste Storage, WIPP Site, NMMarch 17 (404) \$40 1 \$ _____

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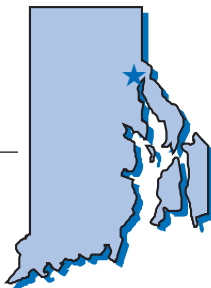
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 Ref. A/P 2006 _____
 Refund ck# _____

TOTAL FEES \$ _____

(____) _____ Business Phone _____
 (____) _____ fax _____
 (____) _____ Home Phone _____

NORTHEASTERN SECTION, GSA 34th Annual Meeting

Providence, Rhode Island
March 22-24, 1999



The hosts for the 1999 meeting of the Geological Society of America Northeastern Section are geologists from the University of Rhode Island, Rhode Island Geological Survey, Wellesley College, Boston College, Lincoln Environmental, Inc., and Applied Science Associates, Inc. Meeting in conjunction with the GSA Northeastern Section will be the Eastern Section of SEPM, the Northeastern Section of the Paleontological Society, the Eastern and New England Sections of the National Association of Geoscience Teachers, the Association for Women Geoscientists, and the Council on Undergraduate Research Geology Division. The meeting will be held at the Westin Hotel, Providence, Rhode Island.

REGISTRATION

Preregistration discounts are given to members of GSA and the associated societies listed on the preregistration form. Please indicate your affiliation(s) to register using the member rates. Students and K-12 teachers must show a *current ID* in order to obtain these rates. Students or teachers not having a current ID when registering on site will have to pay the professional fee. Preregistration forms

must be received at GSA no later than *February 12, 1999*. Please register only one professional or student per form and retain a copy for your records.

If you preregister, you will not have to wait in long registration lines to pick up badges in the registration area, because they will be mailed to you two weeks prior to the meeting. Save yourself time and money—preregister today. Advance registration is required for many of the special

activities because of participation limits. Use the preregistration form provided in this announcement.

Registration will not be processed unless full payment is received. Unpaid purchase orders are NOT accepted as valid registration. Charge cards are accepted as indicated on the preregistration form. If using a charge card, please recheck the card number given. Errors will delay your registration. The confirmation sent to you by GSA will be your only receipt.

Badges are needed for access to all activities, from 8 a.m. Monday through noon Wednesday. Guest registration is required for those attending guest activities, technical sessions, or the exhibit hall. Guest registrants MUST be accompanied by a registered professional, a student, or a K-12 teacher. A guest is defined as a non-geologist spouse or friend of a professional, student, or K-12 teacher registrant.

All registrations received after February 12, 1999, will be considered on-site registrations and charged accordingly. Absolutely no registrations should be mailed or faxed after February 19. All forms received after February 12, regardless of when postmarked, will be held for on-site processing. Delegates who will

Northeastern *continued on p. 27*

South-Central *continued from p. 24*

limited number of tickets will be available during registration.

Departmental Heads and Chairs Luncheon Meeting. Monday, March 15, noon. For further information, contact Calvin Barnes, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, (806) 742-3106, fax 806-742-0100, gical@ttu.edu.

STUDENT PAPER AWARDS AND TRAVEL ASSISTANCE GRANTS

Awards will be presented for the Best Oral Student Paper and Best Student Poster at the meeting. Awards will be based on quality of research and effectiveness of presentation. To be eligible, the abstract must list only student authors and must be identified clearly as a student paper.

The South-Central Section of GSA will award travel grants to GSA student members who give papers (oral or poster) of which she or he is the presenter and author or co-author at the meeting. To be eligible for travel assistance grants, students must be currently enrolled in an academic department in the South-Central Section and certify their student membership in GSA. Applications for travel assistance may be obtained from James E. Barrick, Dept. of Geosciences, Texas Tech University, Lubbock, TX 79409-1053,

(806) 742-3107, fax 806-742-0100, ghjeb@ttu.edu. Applications must be received by *December 15, 1998*.

PREREGISTRATION

Preregistration deadline: *February 5, 1999*.

Please take advantage of the lower registration fees and preregister. All field trip participants must register for the meeting.

Members pay less! You can join now or at the meeting. Come visit the GSA Membership Services area for new member applications, reinstatements, dues payment, address changes, questions, or concerns. Contact GSA's Membership Department at (303) 447-2020 for further information.

CANCELLATION POLICY

Cancellations must be received in writing at GSA on or before February 12, 1998. After February 12, 1998, no cancellations will be processed.

ON-SITE REGISTRATION

Petroleum Room, Holiday Inn Civic Center
Sunday, March 14, 5 p.m. to 7 p.m.
Monday, March 15, 7:30 a.m. to 4 p.m.
Tuesday, March 16, 7:30 a.m. to 11:30 a.m.

HOUSING

A block of rooms is reserved in the Holiday Inn Civic Center, within walking distance or a short drive from several restaurants and clubs. The hotel contains a swimming pool, exercise room, restaurant, and lounge. It offers shuttle service to and from Lubbock International Airport. The Texas Tech campus is a 5-minute drive from the hotel. Campus can also be reached via the city bus service.

The Holiday Inn is offering a special room rate of \$65 for single through quad occupancy and \$79 for Atrium suites. Cut-off date for this rate is *February 14, 1999*. Please make your reservations directly with the hotel; if calling, ask for the South-Central Section, Geological Society of America block.

Hotel address: Holiday Inn Civic Center, 801 Avenue Q, Lubbock, TX 79401. For reservations, call 1-800-HOLIDAY, or call the hotel at (806) 763-1200, by fax at 806-763-2656.

OTHER INFORMATION

It is our goal that this program be accessible to all persons. If you have a special dietary or physical need, please let us know via the registration form. ■

Northeastern *continued from p. 26*

attend only a short course or workshop must pay at least the one-day registration fee. Registration fees do not include provisions for insurance of participants against theft or property damage. Participants and accompanying guests are advised to take out whatever insurance they consider necessary.

Cancellations, Changes, and Refunds

All requests for additions, changes, and cancellations must be made in writing and received by February 19, 1999. *No refunds or credits will be made on cancellation notices received after this date.* Refunds for fees paid by credit card will be credited according to the card number on the preregistration form. There will be NO refunds for on-site registration, *Abstracts with Programs*, and ticket sales.

Members pay less!

You can join now or at the meeting. Come visit the GSA Membership Services area for new member applications, reinstatements, dues payment, address changes, questions, or concerns. Contact GSA's Membership Department at (303) 447-2020 for further information.

ON-SITE REGISTRATION SCHEDULE

Westin Hotel 1st floor Coat Room
 Sun., March 21 4 p.m. to 8 p.m.
 Mon., March 22 7 a.m. to 4:30 p.m.
 Tue., March 23 7 a.m. to 4:30 p.m.
 Wed., March 24 7 a.m. to 10 a.m.

ACCESSIBILITY FOR REGISTRANTS WITH SPECIAL NEEDS

The GSA Northeastern Section is committed to making every event at its 1999 meeting accessible to all people interested in attending. If you have special requirements (such as an interpreter or wheelchair accessibility) indicate this on the meeting registration form or contact Jon Boothroyd, Dept. of Geology, University of Rhode Island, Kingston, RI 02881 (401) 874-2265, fax 401-874-2190, boothryd@uriacc.uri.edu. *Please let us know of your needs by February 15, 1999.*

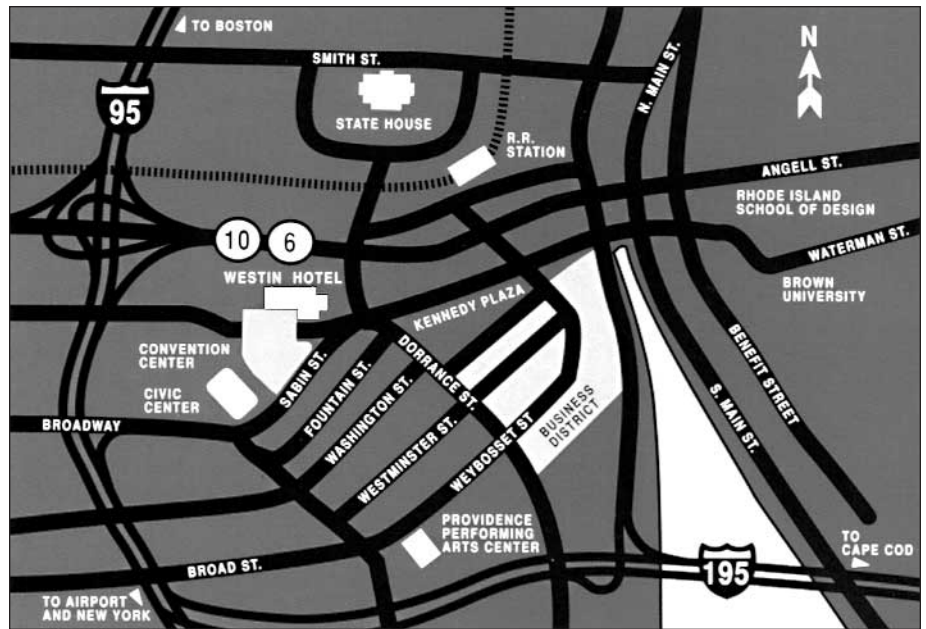
WEATHER

Providence weather during March varies. Mid-March temperatures range from lower 30s to 60s °F. Clear weather, rain, sleet, snow, or a combination of these are all possible.

LOCATION AND DIRECTIONS

Meeting registration, technical sessions, poster sessions, and exhibits will be in the Westin Hotel, Providence, Rhode Island. For those arriving by air, the Westin operates a shuttle to and from T. F. Green State Airport. Those arriving

	Advance (by 2/12/99)		On site (after 2/12/99)	
	Full Meeting	One Day	Full Meeting	One Day
Professional—				
Member	\$70	\$40	\$ 85	\$50
Nonmember	\$85	\$45	\$100	\$55
Senior Professional Member (70+)	\$25	\$20	\$ 30	\$25
Student—				
Member	\$25	\$20	\$ 30	\$25
Nonmember	\$35	\$30	\$ 40	\$35
K-12 Professional	\$30	\$15	\$ 40	\$20
Guest or Spouse	\$15		\$20	



PROVIDENCE AREA

by automobile from the south should take exit 22 off Route I-95 at West Exchange Street, bear right at the split to the stop light at Gaspee Street. Turn right and continue right to the Westin. The entrance to the parking garage adjoining the Westin is down the street on the right.

Those arriving from the north on Route I-95 should also take Exit 22 and proceed following the directions given above.

TECHNICAL PROGRAM

The technical program will begin at 8 a.m., Monday, March 22, and end at noon on Wednesday, March 24. Oral sessions will normally include 15 minutes for presentation and 5 minutes for questions and discussion. Two 35 mm carousel slide projectors, two screens, and one overhead projector will be provided for each oral session. Speakers are encouraged to bring their slides already loaded into carousel trays.

Speaker-Ready Room. A speaker-ready room (Waterplace 1) will be available for previewing slides. The room will be open Sunday, March 21, 6-10 p.m.,

Monday, March 22 and Tuesday, March 23, 7-9 p.m., and Wednesday, March 24, 7 a.m.-noon. Additional carousel trays may be signed out from the speaker-ready room.

Additional computer technology or Internet access will be provided at direct additional cost to the presenter(s). Those individuals desiring these services must make their own arrangements. For those wishing additional technical services, please contact: Nasir Hamidzada, University of Rhode Island, (401) 874-4071, fax 401-874-2190, nasir@uriacc.uri.edu.

Poster sessions will allow three hours of display time; the authors must be present for two hours. Two 4' x 4' and one 4' x 8' tack boards will be provided for each U-shaped booth. Access to electrical outlets and furniture for poster sessions must be requested well in advance.

General questions on format of sessions should be addressed to Technical Program Co-Chair Anne I. Veeger, 315 Green Hall, Dept. of Geology, University

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Northeastern *continued from p. 27*

of Rhode Island, Kingston, RI 02881, (401) 874-2184, veeger@uriacc.uri.edu.

For general questions on equipment contact Nasir Hamidzada (address above).

In addition to general technical sessions organized by discipline, the following symposia, theme sessions, and special poster sessions are planned.

SYMPOSIA

General information regarding symposia may be obtained by contacting Technical Program Co-Chairs Anne I. Veeger, (401) 874-2184, veeger@uriacc.uri.edu, or David E. Fastovsky, 315 Green Hall, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2185, defastov@uriacc.uri.edu.

1. History of the Connecticut River Valley Since Deglaciation. (*Sponsored by SEPM Eastern Section.*) Gail Ashley, Dept. of Geological Sciences, Rutgers University, Wright Geological Laboratory, 610 Taylor Rd., Piscataway, NJ 08854, (732) 445-2221, gmashley@rci.rutgers.edu; Janet Radway Stone, U.S. Geological Survey, East Hartford, Connecticut (860) 291-6748, jrstone@usgs.gov.

2. Saving the Beach: Successes and Problems. (*Sponsored by SEPM Eastern Section.*) Jon Boothroyd, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2191, boothryd@uriacc.uri.edu; William Cleary, University of North Carolina—Wilmington, clearyw@uncwil.edu.

3. Integrating Science in the Decision-making Process: Managing Estuarine Habitats in Narragansett Bay. Laura Ernst, Rhode Island Coastal Resources Management Council, Stedman Government Center, Tower Hill Rd., Wakefield, RI 02879, (401) 222-2476, ricrmc@riconnect.com; Thomas Ardito, Narragansett Bay Project, Providence, (401) 222-3961, ext. 7237; Christopher Galagan, Applied Science Associates, Inc., Narragansett, (401) 789-6224, ext. 30, chris@appsci.com.

4. Sediment Input and Dispersal in Shallow-Water Environments. Neal Driscoll, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, (508) 457-2000 ext. 2619, ndriscoll@whoi.edu; Dave Twichell, USGS, Woods Hole, Massachusetts.

5. Hydrogeologic Issues Behind "A Civil Action"—Woburn, Massachusetts. (*Sponsored by the Hydrogeology Division.*) Chuck Myette, EMCON Inc., 3 Riverside Dr., Andover, MA 01810, (978) 682-1980, cmvette@emconinc.com; E. Scott Bair, Ohio State University, Columbus, bair.1@osu.edu.

6. Extensional Basins in the Northeast Appalachians: Stratigraphy, Sedimentology, Tectonics, and Resource Potential. (*Sponsored by SEPM*

Eastern Section.) Margaret D. Thompson, Dept. of Geology, Wellesley College, Wellesley, MA 02181, (781) 283-3029; Sandra M. Barr, Acadia University, Wolfville, Nova Scotia, sandra.barr@acadiau.ca; Charles E. Mitchell, cem@acsu.buffalo.edu, and Robert D. Jacobi, rdjacobi@acsu.buffalo.edu, SUNY at Buffalo.

7. Events and Dynamics in the Acadian Orogeny: Foreland Basin and Mountain Belt Perspectives. Chuck Ver Straeten, Dept. of Geology, Gustavus Adolphus College, St. Peter, MN 56082, (507) 933-7307, cverstra@gac.edu.

8. A Comparison of the Relative Importance of Magma Mixing and Fractionation in New England and Cordilleran Settings. John B. Reid Jr., School of Natural Sciences, Hampshire College, Amherst, MA 01005, (413) 582-5568; Daniel P. Murray, University of Rhode Island, Kingston, dpmurray@uriacc.uri.edu.

9. What's Hot and What's Not: Changing Directions in Geologic Inquiry in New England. Daniel P. Murray, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2197, dpmurray@uriacc.uri.edu; John B. Reid Jr., Hampshire College, (413) 582-5568.

10. Science Standards: Comparison of Versions, Adoption Mechanisms, and Resources for Successful Implementation. James I. Sammons, Jamestown Middle School, Jamestown, RI 02835, (401) 423-7015, jamesas@ids.net; Peter Leddy, Norton High School, Norton, Massachusetts (508) 285-0160, volcano@ici.net.

THEMES

Theme sessions are similar to symposia in that they focus on specific topics, but each is an open forum where the papers are volunteered. General information regarding theme sessions may be obtained by contacting Anne I. Veeger or David E. Fastovsky (see symposia).

1. El Niño 1997–1998—Impact on Mid-Atlantic to New England Coastal Zones. Joseph P. Klinger, Rhode Island Coastal Resources Management Council, Stedman Government Center, Tower Hill Road, Wakefield, RI 02879, (401) 222-2476, ricrmc@riconnect.com; Duncan Fitzgerald, Boston University, dunc@crsa.bu.edu.

2. Late Holocene Salt Marsh Dynamics. Jeffrey P. Donnelly, Dept. of Geological Sciences, Brown University, Box 1846, Providence, RI 02912, (401) 863-2810, Jeffrey_Donnelly@brown.edu; Thompson Webb III, Brown University, Thompson_Webb_III@brown.edu.

3. Late Quaternary Deglaciation and Sea-Level Rise in Southern New England and Adjacent New York and New Jersey. Ralph Lewis, State Geological and Natural History Survey of Connecticut, Dept. of Environmental Protec-

tion, Natural Resources Center, 79 Elm St. Store Level, Hartford, CT 06106, (860) 424-3540, ralph.lewis@po.state.ct.us.

4. Age of the Earth, Evolution, and Empiricism in Science. Samuel A. Bowring, Dept. of Earth, Atmospheric, and Planetary Sciences, MIT, 77 Massachusetts Ave., Bldg. 54, Rm. 1124, Cambridge, MA 02139, (617) 253-1520, sbowring@mit.edu; David E. Fastovsky, University of Rhode Island, Kingston, defastov@uriacc.uri.edu.

5. Devonian Sedimentology, Stratigraphy, and Paleontology of Eastern North America. John Bridge, Dept. of Geological Sciences and Environmental Studies, SUNY-Binghamton, Binghamton, NY, 13902, (607) 777-2831, jbridge1@mail.arco.com.

6. Environmental Isotope Geochemistry: Applications in the Geosciences. Anne I. Veeger, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, (401) 874-2187, veeger@uriacc.uri.edu.

7. Use of Geologic Models in Hydrogeologic Investigations. Leslie A. DeSimone, U.S. Geological Survey, Water Resources Division, 28 Lord Rd., Suite 280, Marlborough, MA 01752, (508) 490-5023, lidesimone@usgs.gov.

8. Hydrogeology in the Regulatory Arena: Addressing Uncertainty in Practice. (*Sponsored by the Hydrogeology Division.*) Donald I. Siegel, Earth Sciences, 204 Heroy Laboratory, Syracuse University, Syracuse, NY 13244, (315) 443-3607.

9. Economic Mineral Deposits in Northeastern North America. Robert J. Altamura, Dept. of Geosciences, Penn State University, University Park, PA 16802, (814) 234-5011, boba@geosc.psu.edu; William M. Kelly, New York State Geological Survey, Room 3140 CEC, Albany, NY 12230, (518) 474-7559, wkelly@museum.nysed.gov.

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

11. Actualism in Paleontology, Using Physiology of Modern Organisms as Analogies for Paleontological Interpretation. (*Sponsored by the Paleontological Society.*) Paul Strother and Cynthia Fisher, Dept. of Geology and Astronomy, West Chester University, West Chester, PA 19383, (610) 436-2203, cfisher@wcupa.edu.

12. Teaching with Fossils. (*Sponsored by the Paleontological Society*) (POSTER ONLY) Paul Strother and Steve Good, Dept. of Geology and Astronomy, West Chester University, West Chester, PA 19383, (610) 436-2203, sgood@wcupa.edu.

13. Use of Multimedia and Internet for Enhancing Undergraduate Geological Education—Examples, Experi-

Northeastern *continued on p. 30*

PREREGISTRATION FORM

GSA Northeastern Section

Providence, Rhode Island
March 22-24, 1999

Preregistration Deadline: **February 12**

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (last name first) _____

Employer/University Affiliation _____

City _____ State or Country _____

Mailing Address (use two lines if necessary) _____

City _____ State _____

ZIP Code _____ Country (if other than USA) _____

Circle member affiliation (to qualify for registration member discount):
(A) GSA (B) AWG (C) CUR (D) NAGT (E) PS (F) SEPM

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on your guest's badge _____

City _____ State or Country _____

Cancellation Deadline: **February 19**

MAIL TO:
GSA NORTHEASTERN SECTION MEETING,
P.O. BOX 9140, BOULDER, CO 80301-9140

OR
FAX TO:
GSA 303-447-0648 OR 303-447-1133

CREDIT CARD USE ONLY. Fax line open 24 hours. Do not send another copy by mail.

Please inform us by February 15 of any special considerations that you or your guest require.
 I will need special considerations.

Remit in U.S. funds payable to: 1999 GSA Northeastern Section Meeting
(All preregistrations must be prepaid. Purchase Orders not accepted.)

Payment by (check one):
 Check American Express VISA MasterCard

Card Number _____ Expires _____

Signature _____

Register one professional or student per form.
Copy form for your records.

PREREGISTRATION FEES

Professional Member*	Full Meeting	One Day	Qty.	Amount
Professional Member*	(10) \$70 <input type="checkbox"/>	(11) \$40 <input type="checkbox"/>	1	\$
Professional Member (70 & older)*	(12) \$25 <input type="checkbox"/>	(13) \$20 <input type="checkbox"/>	1	\$
Professional Nonmember	(14) \$85 <input type="checkbox"/>	(15) \$45 <input type="checkbox"/>	1	\$
Student Member*	(30) \$25 <input type="checkbox"/>	(31) \$20 <input type="checkbox"/>	1	\$
Student Nonmember	(32) \$35 <input type="checkbox"/>	(33) \$30 <input type="checkbox"/>	1	\$
K-12 Professional	(60) \$30 <input type="checkbox"/>	(61) \$15 <input type="checkbox"/>	1	\$
Guest or Spouse	(90) \$15 <input type="checkbox"/>	N/A	1	\$

*Member fee applies to any current Professional OR Student Member of GSA or Associated Societies listed at left. Discount does not apply to guest registrants.

SPECIAL EVENTS

1. Paleontological Society Luncheon	March 22	Professional (301) \$18	\$
		Student (301) \$11	\$
2. AWG Breakfast	March 23	Professional (302) \$15	\$
		Student (302) \$ 8	\$
3. NAGT Luncheon	March 23	Professional (303) \$18	\$
		Student (303) \$11	\$
4. Annual Banquet	March 23	Professional (306) \$27	\$
		Student (306) \$15	\$
		Chicken (306)	\$
		Prime Rib (304) \$30	\$
		Salmon (305) \$29	\$
		Professional \$30	\$
		Student \$15	\$

WORKSHOP

1. Roy Shlemon Mentor Program	March 21	(601) \$10	\$
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SHORT COURSES

1. Water Waves and Coastal Processes	March 21	Professional (501) \$70	\$
		Student (501) \$30	\$
2. Practical Hydrogeology	March 21	Professional (502) \$80	\$
		Student (502) \$30	\$

FOR OFFICE USE

A _____ V _____ M _____

CK# _____ DR _____ CR _____

Bal. A/R 1233 _____

Ref. A/P 2006 _____

Refund ck# _____

TOTAL REMITTED FEES \$ _____

() _____ Business Phone _____

() _____ fax _____

() _____ Home Phone _____

Northeastern *continued from p. 28*

ences, Evaluating Effectiveness. (ORAL AND POSTER PRESENTATIONS) Gary A. Robbins, Dept. of Geology and Geophysics, University of Connecticut, 354 Mansfield Rd., Storrs, CT 06040, (860) 486-1392, robbins@uconnvm.uconn.edu.

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

15. Progress in Geologic Mapping: Seabed, Shoreline, and Upland. (POSTER ONLY) Christopher Galagan, Applied Science Associates, Inc., 70 Dean Knauss Dr., Narragansett, RI 02882-1443, (401) 789-6224, ext. 30, chris@apppsci.com.

16. Undergraduate Research. (*Sponsored by the Council on Undergraduate Research, Geology Division.*) (POSTER ONLY) David G. Bailey, Dept. of Geology, Hamilton College, 198 College Hill Rd., Clinton, NY 13323, (315) 859-4142, dbailey@hamilton.edu.

SHORT COURSES

Water Waves and Coastal Processes. Sunday, March 21, 8 a.m.–5 p.m., Kent Room. Cost: \$70 professional, \$30 student, max. 30, min. 15. Cy Galvin, Coastal Engineer, P.O. Box 623, Springfield, VA 22150, (703) 569-9187, galvincoastal@juno.com.

Practical Hydrogeology: How To Make Do with Scant "Real World" Data. Sunday, March 21, 8 a.m.–5 p.m., Newport/Washington Room. Cost: \$80 professional, \$30 student, max. 55, min. 15. Donald I. Siegel, Dept. of Earth Sciences, 307 Heroy Geology Laboratory, Syracuse University, Syracuse, NY 13244-1070, (315) 443-3607, disiegel@mailbox.syr.edu.

WORKSHOP

Roy Shlemon Mentor Program in Applied Geology. Sunday, March 21, 9 a.m.–5 p.m., Bristol Room. A one-day workshop for graduate students and advanced undergraduate students on professional opportunities and challenges in the applied geosciences. Cost: \$10.

STUDENT AWARDS AND TRAVEL ASSISTANCE

The GSA Northeastern Section will give awards for the best oral paper and best poster session presented by students.

The GSA Northeastern Section will award travel grants to students who present papers (oral or poster) of which she or he is author or co-author and the presenter at the meeting. The section will also

HOUSING FORM — *Westin Hotel, Providence, Rhode Island*

Northeastern Section, Geological Society of America
Sunday, March 21–Wednesday, March 24

Arrival Date _____ Departure Date _____

PERSON REQUESTING HOUSING (type or print)

Last Name _____ First _____

Institution or Firm _____

Address or P.O. Box _____

City _____ State/Province _____ ZIP Code _____

Phone: () _____ () _____
Work Home

Place reservation in name of: _____

Name of all other occupants:

RATES* PER ROOM (*price does not include 7% state sales and 5% city room-use tax.*)

Single/Double Occupancy \$117 Triple/Quad Occupancy \$137

Check-in time is 4:00 p.m. (earlier on request) Check-out time is noon.

SPECIAL NEEDS Smoking Room Nonsmoking Room Special Room
 Special Room Requirements _____

*Enclose check or money order (for amount of one night's lodging) payable to Westin Hotel (Providence), or major credit card number and date of expiration. No cancellations accepted within 48 hours of arrival.

Reservations must be received prior to February 16, 1999; reservations received after that date will be accepted on a space-available basis only and the group rate will not be guaranteed.

Telephone reservations accepted: (401) 598-8000; (800) WESTIN-1; fax 401-598-8200.

Type of Card _____ Card Number _____

Name as it appears on the credit card _____

Exp. Date _____ Signature _____

SEND THIS FORM AND REMITTANCE OR CREDIT CARD INFORMATION TO:

Reservations, Westin Hotel, One West Exchange St., Providence, RI 02903

award student research grants to undergraduates in 1999. Applications for travel assistance (deadline: February 16, 1999) and guidelines for student research proposals may be obtained from Kenneth N. Weaver, Secretary-Treasurer, Northeastern Section, GSA, c/o Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21221-5210, (410) 554-5532, fax 410-554-5502.

EXHIBITS

Companies or organizations wishing to sell or display publications, scientific equipment, or other products, services, or public relations materials may rent a display area for the duration of the meeting. The exhibit area will be adjacent to the poster area, and morning and afternoon beverage service will be in the immediate

vicinity. The 8 ft × 8 ft booths framed with 8-ft-high rear drapes and 3-ft-high side drapes are \$300 for commercial exhibitors, and \$200 for educational, government, and nonprofit organizations. A table, two chairs, and a sign will be provided for each booth. Exhibitors may set up either Saturday evening, March 20 or Sunday morning onward, March 21. Exhibits will be open 6–9 p.m. on Sunday, March 21; 8 a.m.–5 p.m. and 7:30–9:30 p.m. on Monday, March 22; and 8 a.m.–5 p.m. on Tuesday, March 23. Deadline for reserving space is *March 1, 1999*. For further information and space reservation, contact Chris Galagan, Exhibits Coordinator, Applied Science Associates, 70 Dean Knauss Dr., Narragansett, RI 02882, (401) 789-6224, chris@apppsci.com.

SPECIAL EVENTS

GSA Northeastern Section Management Board Meeting. Sunday, March 21, 5-7 p.m. Westin Hotel, Executive Boardroom.
 Welcoming Reception. Sunday, March 21, 6-9 p.m. Westin Hotel, Narragansett Ballroom. Nonalcoholic beverages and hors d'oeuvres will be served. A cash bar will be available for beer, wine, and mixed drinks.

Northeastern Section of the Paleontological Society Luncheon. Monday, March 22, noon-1:30 p.m. Cost: \$18 for professionals, \$11 for students. Preregistration required.

SEPM Eastern Section Business Meeting and Reception. Monday, March 22, 4:30-6:30 p.m. Open to all SEPM members. Refreshments will be served.

Map Blast '99, the Sequel. Monday, March 22, 7:30-9:30 p.m. This informal session is for the display and discussion of newly published, unpublished, or in-progress geologic maps of any sort. Maps should have a title and a stand-alone explanation. This is not a poster session, and abstracts are not required. Authors must be present. Refreshments available. Contact Jon Boothroyd, Dept. of Geology, University of Rhode Island, Kingston, RI, 02881, (401) 874-2265, fax 401-874-2190, boothryd@uriacc.uri.edu.

Association for Women Geoscientists Breakfast. Tuesday, March 23, 6-8:30 a.m., Waterplace 2. Cost: \$15 for professionals, \$8 for students. Preregistration required.

Northeastern Section of NAGT Luncheon and Business Meeting. Tuesday, March 23, noon-1:30 p.m. Waterplace 2. Cost: \$18 for professionals; \$11 for students. Preregistration required.

Annual GSA Northeastern Section Reception and Banquet. Tuesday, March 23, 6-9 p.m., Westin Hotel, Narragansett Ballroom. Cost: \$27-30 for professionals; \$15 for students. Preregistration required for the banquet. Reception prior to the banquet is free. A very limited number of banquet tickets will be available for sale on Wednesday evening only.

ACCOMMODATIONS

A large block of rooms has been reserved for meeting participants at the Westin Hotel (1-800-WESTIN-1) or (401) 598-8000, fax 401-598-8200. Single or double, \$117 plus tax; triple or quad \$137 plus tax. These will be assigned on a first-come, first-served basis. After the block is filled, and regardless of the cutoff date, preregistrants will be given the option of a comparable nearby hotel that has been selected to serve as an overflow facility. For meeting planning purposes, and to ensure the guaranteed room rates, it is imperative that you reserve your room(s)

Northeastern *continued on p. 32*

ORDER FORM — 1999 GSA Abstracts with Programs

To purchase copies of *GSA Abstracts with Programs*, you may use this form. *Prepayment is required.* Members, provide member number and deduct your 20% discount. Check your records to make sure you have not previously purchased any of these publications on your dues statement, or through Publication Sales. No refunds for duplicate orders.

Meeting	Meeting Dates	List Price	Quantity	Amount	
South-Central	3/15-3/16	\$15		\$	
Northeastern	3/22-3/24	\$15		\$	
Southeastern	3/25-3/26	\$15		\$	
Rocky Mountain	4/8-4/10	\$15		\$	
North-Central	4/22-4/23	\$15		\$	
Cordilleran	6/2-6/4	\$15		\$	
Annual Meeting (Denver)	10/25-10/28	\$38.75		\$	
				Total	\$
<input type="checkbox"/> Check here if GSA Member Members deduct 20%. It will not be applied later. → -20%					\$
Member # _____				TOTAL	\$

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TO ORDER ELECTRONICALLY: Visit our Web site at www.geosociety.org

ON-SITE PURCHASES may be made in the registration area at each meeting. Supplies are limited.

Northeastern Section Announces Student Grant Programs

Undergraduate Student Research Grants. The GSA Northeastern Section student research grant program for 1999 is competitive and available only to undergraduate students. To be considered for a research grant, the student must be enrolled at an institution within the Northeastern Section and must be a student associate or member of GSA. Applications must be postmarked no later than *February 16, 1999.*

Grants will be awarded following the Northeastern Section Meeting in Providence, Rhode Island, in March 1999.

Student Travel Grant Program. The Northeastern Section student travel grant program is open to both graduate and undergraduate students. To be consid-

ered for a travel grant, the student must be the presenter of the paper, must be enrolled at an institution within the Northeastern Section, and must be a student associate or member of GSA. Applications must be postmarked no later than February 16, 1999.

Grants will be awarded approximately 10 days prior to the Northeastern Section Meeting in Providence, Rhode Island, in March 1999.

For further information or a copy of the application form(s), contact Kenneth N. Weaver, Secretary NEGSA, Maryland Geological Survey, 2300 St. Paul St., Baltimore, MD 21218, (410) 554-5532, fax 410-554-5502, kweaver438@aol.com. ■

SOUTHEASTERN SECTION, GSA 48th Annual Meeting

Athens, Georgia
March 25–26, 1999



The 1999 Southeastern Section meeting of the Geological Society of America will be hosted by the Department of Geology at the University of Georgia, Athens. Affiliated organizations meeting concurrently are the Southeastern Section of SEPM, the Southeastern Section of the National Association of Geology Teachers, and the Southeastern Section of the Paleontological Society. Please visit our Web site for further information: www.gly.uga.edu and then click on SE GSA.

SETTING

Athens–Clarke County (population 90,606) is situated within the rolling hills of the piedmont province of northeastern Georgia, southeast of the Blue Ridge Mountains and north of the extensive coastal plain province (see www.gly.uga.edu/GAGeology.html). The city is home to the University of Georgia, America's first state-chartered land-grant university (in

1785). In addition to a top-ranked library, UGA has one of the nation's largest map collections. The Southeastern Section meeting will be held in the Athens Classic Center, in the heart of downtown Athens and within easy walking distance to the university. Blooming azaleas, daffodils, tulips, and pleasantly cool weather make Athens beautiful in the spring.

REGISTRATION FEES

	Advance*	On-site
Professional—		
Member	\$75	\$90
Nonmember	\$85	\$95
Student—		
Member	\$35	\$35
Nonmember	\$40	\$40
K–12 Professional	\$30	\$30
Guest or Spouse	\$25	\$30
Field Trip Only Fee	\$ 5	\$ 5
One Day Registration—		
Professional	\$50	\$50
Student	\$20	\$20

*Deadline for preregistration is February 19, 1999

TRAVEL TO ATHENS

Athens is located about 70 miles east-northeast of Atlanta, Georgia. Athens can be easily reached by car via I-85 and GA 316 from Atlanta or I-85 (or I-20) and US 441 from locations north or south of

Southeastern continued on p. 33

Northeastern continued from p. 31

by February 16, 1999. When making reservations by phone, it is important that you state that you are attending the Geological Society of America Northeastern Section Meeting. Parking is \$10/day (self park or valet) in a connected parking garage. Illegal street parking may result in ticketing and/or towing. Mail the Housing Form directly to the Westin Hotel. To ensure guaranteed room rates, reserve your room before February 16, 1999. Cancellations must be received 48 hours before meeting.

GUEST ACTIVITIES

Pamphlets describing the activities listed and further information will be available during the meeting. Historic Houses Tour. Walk through the historic streets of Providence on a guided tour of some of the oldest buildings in America. Within walking distance of the Convention Center. (401) 831-8587. "The Hill." Have lunch in Little Italy. A walk under the pine cone arch brings you to another country. Dine in some of the world-class restaurants, eat some of the best pizza, and stroll into the sinful bakeries of The Hill. Within walking distance of the Convention Center. RISD Art Museum. The Rhode Island School of Design Museum has more than 65,000 works of art—antiquities, Asian art, paintings and sculptures, prints, drawings, photographs, costumes and textiles, as well as decorative arts—from every part of the world. "American Watercolors" is the

featured exhibit in March. Within walking distance of the Convention Center. Hours: Wednesday through Sunday 10–5, Friday 10–8, admission: \$5. (401) 454-6500.

Roger Williams Park and Zoo. One of Rhode Island's treasures—a full-scale zoo with exhibits of African plains, bats, penguins, gibbons, farmyard animals, snake house, and more. The main attraction is the polar bears and their new cub, Triton. Hours: 9 a.m.–5 p.m.; admission: \$6. *Transportation necessary.* (401) 785-3510.

Thayer St. and College Hill. Brown, RISD, and Johnson & Wales converge on Thayer Street. Good bookstores, restaurants, and shopping abound. Within walking distance of the Convention Center. The Arcade. Located in the heart of Providence, this Faneuil Hall-type building offers many stores and a food court that feeds much of Providence at lunchtime. Within walking distance of the Convention Center.

Ice Skating. Providence's own Rockefeller Center-like outdoor ice rink has skate rentals available, or you can bring your own. Within walking distance of the Convention Center.

"Sunset Boulevard"—The Broadway musical at Providence Performing Arts Center, March 23–28. Tickets range from \$36 to \$48. (401) 421-2787.

"Preface to an Alien Garden"—A play at the world-famous Trinity Repertory Theater. Tickets range from \$30 to \$34. (401) 351-4242.

"Madame Butterfly"—The New York

City Opera Company performs on March 26 at the Veterans Memorial Theater. (401) 831-3123.

CHILD CARE

Child care is available for the period of March 23 through noon March 25 at the Rhode Island Convention Center. Please contact Lesley Fastovsky for scheduling: (401) 789-8079, fax 401-874-2190, defastov@uriacc.uri.edu. *Deadline: February 23, 1999.*

REGISTRATION

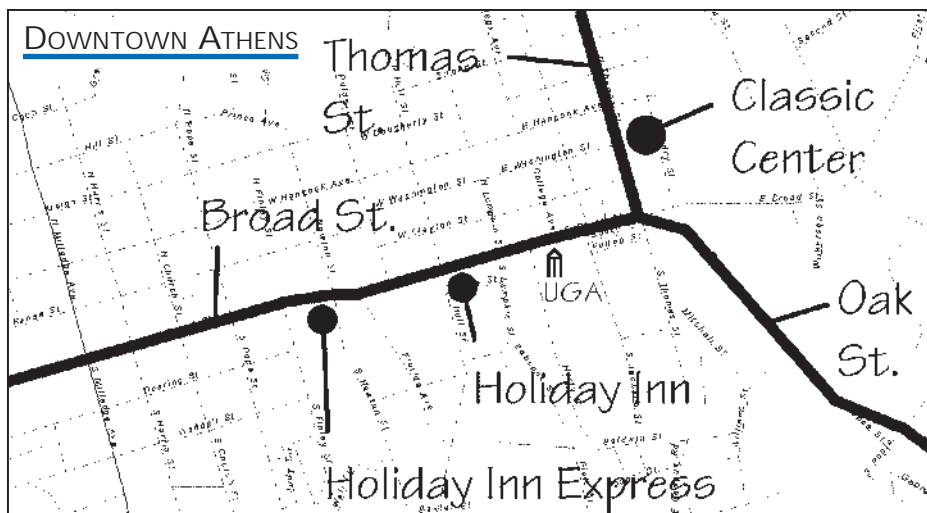
Preregistration deadline: *February 12, 1999.*

Registration will be handled by GSA headquarters. To obtain low registration fees and to assist planning by the local committee, please preregister.

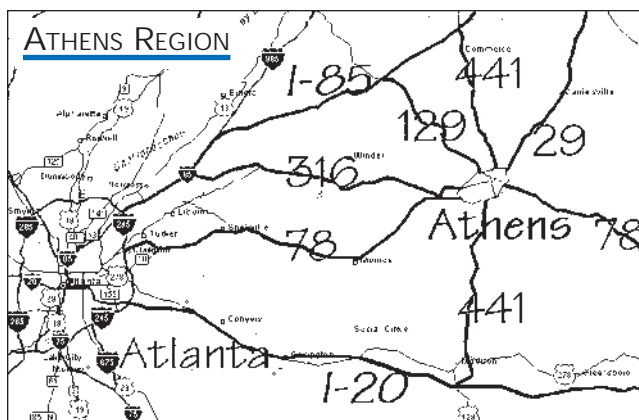
Members pay less! You can join now or at the meeting. Come visit the GSA Membership Services area for new member applications, reinstatements, dues payment, address changes, questions, or concerns. Contact GSA's Membership Department at (303) 447-2020 for further information.

DETAILED INFORMATION

For additional information or suggestions, contact the general chairs, O. Don Hermes (401) 874-2192, dhermes@uriacc.uri.edu, or Jon C. Boothroyd, (401) 874-2191, boothryd@uriacc.uri.edu, Dept. of Geology, University of Rhode Island, Kingston, RI 02881, fax 401-874-2190. ■



Athens (www.uga.edu/uga/travel_info.html). USAir Express (1-800-428-4322) has daily flights into the Athens Ben Epps Airport. A courtesy van is available from the Athens airport to the Holiday Inn, seven days a week between 7 a.m. and 11 p.m.; however, you must call the Holiday Inn to make the travel arrangements: (706) 549-4433. Car rental agencies are also located at the Ben Epps Airport. Your Cab Company is the only taxi service in Athens; call (706) 546-5844. Commercial ground shuttle service is available from the Atlanta airport to Athens via AAA Airport Express, Inc. (1-800-354-7874).



those attending guest activities, technical sessions, or the exhibit hall. Guest registrants **MUST** be accompanied by either a registered professional or student. A guest is defined as a nongeologist spouse or friend of a professional or student registrant.

Students and K-12 teachers must show a **current ID** in order to obtain reduced rates. Students or teachers not having a current ID when registering on site will be required to pay the professional fee.

Because badges have to be mailed, it is imperative that *all* preregistrations are *received* by the preregistration deadline of February 19. All registrations received after February 19 will be held for on-site processing and charged the on-site rates. If you preregister, badges will be mailed within two weeks prior to the meeting. Badges must be worn for access to all activities, 5 p.m. Wednesday, March 24, until 5 p.m. Friday, March 26.

To leave a message for an attendee at the meeting, call the Athens Classic Center: (706) 208-0900.

Members pay less! You can join now or at the meeting. Come visit the GSA Membership Services area for new member applications, reinstatements, dues payment, address changes, questions, or concerns. Contact GSA's Membership Department at (303) 447-2020 for further information.

REGISTRATION

Preregistration deadline:
February 19, 1999

Advance registration is required for many of the special activities because of participation limits and required guarantees for those activities. A reduced registration fee will be offered during the preregistration period to members of GSA and the associated societies listed on the preregistration form, and to students and pre-college teachers. Preregistration by mail will be handled by the GSA Registration Coordinator, P.O. Box 9140, Boulder, CO 80301-9140. Use the preregistration form provided in this announcement. Full payment **MUST** accompany the preregistration form. Unpaid purchase orders are **NOT** accepted as valid registration. Charge cards are accepted as indicated on the preregistration form. If using a charge card, please recheck the card number given. Errors will delay your registration. The confirmation card will be your receipt for payments. No other receipt will be sent.

Guest registration is required for

Cancellations, Changes, and Refunds

All requests for registration additions, changes, and cancellations must be made in writing and received by February 26, 1999. GSA will refund or credit preregistration fees for cancellations received in writing by February 26, 1999. *No refunds will be made on cancellation notices received after this date.* Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card will be credited according to the card number on the preregistration form. There will be **NO** refunds for on-site registration and ticket sales.

On-Site Registration Schedule

Classic Center, adjacent to the Ballroom area
Wed., March 24, 4:30 p.m. to 7 p.m.
Thur., March 25, 7:30 a.m. to 4:30 p.m.
Fri., March 26, 7:30 a.m. to 12 noon

Accessibility for Registrants with Special Needs

GSA is committed to making the Southeastern Section meeting accessible to all people interested in attending. If you need any auxiliary aids or services because of a disability, check the appropriate box on the registration form. If you have suggestions or need further information, contact Sam Swanson, Section Chair, Southeastern GSA, (706) 542-2415 or sswanson@uga.edu by February 24, 1999.

ACCOMMODATIONS

A block of rooms is reserved for attendees at specially reduced rates at the following hotels in downtown Athens: Holiday Inn (\$84 per night for a standard room, \$99 for a deluxe room; rates include double occupancy; no extra charge for an additional person). Holiday Inn Express (\$74 per night, for 1-2 guests; \$79 per night for 3-4 guests; \$5 per person for any additional). Rates do not include 14% sales tax. Attendees should make their own room reservations *before March 1, 1999*, by calling the Holiday Inn, (706) 549-4433, or Holiday Inn Express, (706) 546-8122, or the Holiday Inn Toll-Free Number (1-800-HOLIDAY). To reserve rooms by telephone, state your GSA connection and request a reservation number.

Parking. Meeting attendees who stay at the Holiday Inn and Holiday Inn Express may park in the adjacent parking area at no cost. Others may park in downtown parking decks, including areas adjacent to the Classic Center, for a fee. If you wish to reserve a space in a downtown parking lot, please contact Vicki Mullis, (706) 542-2427, vickim@gly.uga.edu before February 24, 1999. Limited shuttle service will be provided from the Holiday Inn and Holiday Inn Express to the Classic Center in the morning, midday, and late afternoon.

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WELCOME PARTY

The welcoming party on Wednesday evening, March 24, will be from 6 to 8 p.m. in the exhibits area at the Classic Center. This will be an excellent time to visit the exhibits and meet colleagues while enjoying light food and beverages. All attendees must register before the party. On-site registration will be available in the Classic Center prior to the party.

TECHNICAL PROGRAM

Ten symposia and 13 theme sessions are planned for the meeting. Please contact the conveners for more information. Additional sessions are scheduled for volunteered papers.

Symposia

1. The Relevance of Environmental Ethics to the Geosciences: The Case of Coastal and Marine Environments. Dorinda G. Dallmeyer, Dean Rusk Center, University of Georgia, Athens, GA 30602, (706) 542-5141, dorindad@arches.uga.edu.
2. Precambrian Rocks in the Southern Appalachians: Nature, Age, Distribution, and Tectonic Significance. Calvin F. Miller, Geology Dept., Vanderbilt University, Nashville, TN 37235, (615) 322-2232, millercf@ctrvx.vanderbilt.edu; Paul Fullagar, University of North Carolina, pdfullag@pop.unc.edu.
3. Ultramafic Rocks and Eclogites in the Southern Appalachian Orogen: Petrology and Tectonic Significance. Loren A. Raymond, Dept. of Geology, Appalachian State University, Boone, NC 28608, (704) 262-3049, raymondla@appstate.edu; Rich Warner, Clemson University, rich.warner@ces.clemson.edu.
4. Tectonic History and Deformation Processes in the Southern Appalachians. Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 974-6565, bobmap@utk.edu; Jim Wright, Rice University, jwright@owl.net.rice.edu; Sandra Wyld, University of Georgia, swyld@gly.uga.edu.
5. New Developments in Carolina Terrane Geology: Igneous, Metamorphic, and Tectonic. Mark Colberg, mrc@gly.uga.edu, and Alberto Patiño-Douce, klingon@gly.uga.edu, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2394.
6. Environmental Research and Remediation at the Savannah River DOE Site. Christopher Romanek, SREL, Drawer E, Aiken, SC 29802, (803) 725-5883, romanek@srel.edu.
7. Memorial Symposium in Honor of Robert Frey: Ichnology, Taphonomy, and Education. *Sponsored by the Southeastern Section of the Paleontological Society.*

Stephen Henderson, Dept. of Geology, Emory University—Oxford College, Oxford, GA 30267, (770) 784-8345, shender@emory.edu; Anthony J. Martin, Emory University, Atlanta, paleoman@learnlink.emory.edu.

8. Cenozoic Patterns in Paleontology. Debra Krumm, Harbor Branch Oceanographic Museum, 5600 U.S. Route 1, Ft. Pierce, FL 34946, (561) 465-2400 ext. 428, krumm@hobi.edu.
9. Geologic and Digital Geologic Maps (Posters). Mike Higgins, Applied Mapping Systems, Inc., 162 Spring Dr., Roswell, GA 30075-4849, (770) 641-1268, fax 770-631-5088, appliedmapping@mindspring.com or mhiggins@mindspring.com; Mark Steltenpohl, Auburn University, steltmg@mail.auburn.edu.
10. John Dennison Retirement Celebration Symposium. Richard Diecchio, Dept. of Geography & Earth Science, George Mason University, Fairfax, VA 11030-4444, (703) 993-1208, rdiecchi@gmu.edu; Lisa Pratt, Indiana University, prattl@indiana.edu.

Theme Sessions

1. Geomorphic and Other Terrestrial Records of Quaternary Climate Change in the Southeast. David Leigh, Dept. of Geography, University of Georgia, Athens, GA 30602, (706) 542-2346, dleigh@arches.uga.edu; Andrew Ivester, University of Georgia, Athens, ivester@athens.net.
2. Biogeochemical Interactions and Processes. Johnson R. Haas, Dept. of Geography and Earth Sciences, University of North Carolina, Charlotte, NC 28223, (704) 547-4252, jrhaas@email.uncc.edu.
3. Recent Advances in Crystalline Rock Hydrology. John Clarke, U.S. Geological Survey, 3039 Amwiler Rd., Atlanta, GA 30360, (770) 903-9170, jclarke@usgs.gov.
4. From Microbes to Flowers: The Geologic Record of Photosynthesis. Julie Bartley, Geology Dept., State University of West Georgia, Carrollton, GA 30118, (770) 830-2315, jbartley@westga.edu.
5. Paleozoic Puzzles: Problems in Biostratigraphy and Stratigraphy. Jack Hall, Dept. of Earth Sciences, University of North Carolina, Wilmington, NC 28403-3490, (910) 962-3488, hallj@uncwil.edu; Carl Stock, University of Alabama, Tuscaloosa, cstock@wgs.geo.ua.edu.
6. Tectonic History and Deformation Processes in the Southern Appalachians. Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 974-6565, bobmap@utk.edu; Jim Wright, Dept. of Geology and Geophysics, Rice University, jwright@owl.net.rice.edu; Sandra Wyld, University of Georgia, Athens, swyld@gly.uga.edu.

7. Geology, Mineralogy, Genesis, and Industrial Use of Kaolin Deposits from the Southeastern United States. Jessica Elzea, Thiele Kaolin Company, P.O. Box 1056, Sandersville, GA 31082, (912) 552-3951, jessica.elzea@thielekaolin.com.
8. Undergraduate Research Poster Session. *Sponsored by the Council for Undergraduate Research.* Joel B. Thompson, Marine Sciences, Eckerd College, 4200 54th Ave. S., St. Petersburg, FL 33711, (813) 864-8991, thompsjb@eckerd.edu.
9. Advances in Archaeological Geology. Kent Schneider, USDA—Forest Service, 1720 Peachtree Rd. NW, Atlanta, GA 30367, (404) 347-7250, schneider_kent/r8@fs.fed.us.
10. Standard-Based K-12 Geoscience Education in the Southeast. *Sponsored by Southeastern Sections of NAGT and GSA (Education Committee).* Don Byerly, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 974-6007, fax (423) 974-2368, dbyerly@utk.edu.
11. Approaching Questions of Origins in Earth Science Education—Creative Solutions to Evolving Controversies. *Sponsored by the Southeastern Sections of NAGT, GSA (Education Committee), and Paleontological Society.* Jon Bryan, Earth Sciences, Okaloosa-Walton Community College, 100 College Blvd., Niceville, FL 32578-1294, (850) 729-5246, bryanj@owcc.net; Michael Gibson, University of Tennessee, Martin, mgibson@utm.edu.
12. Environmental Geochemistry and Health. *Sponsored by Southeastern Section Committee on Geology and Public Policy.* June Mirecki, Dept. of Geology, 58 Coming St., College of Charleston, Charleston, SC, 29424, (843) 953-8278, mireckij@cofc.edu.
13. Coastal Plain Geology of the Southeastern United States. *Sponsored by Southeastern Section of SEPM.* John T. Haynes, Dept. of Geography and the Earth System Sciences, George Mason University, Fairfax, VA 22030-4444, (860) 963-5616, jthaynes@umd5.umd.edu.

PROJECTION EQUIPMENT

All slides must be 2" × 2" and fit a standard 35-mm carousel tray. Bring your own loaded carousel trays, or be prepared to rent trays on site for \$5 per day per tray. Two 35-mm slide projectors and two screens will be available for each oral technical session. One overhead projector will be available in each room. Labeled trays must be handed to the projectionist at least 20 minutes prior to the beginning of the session. A speaker-ready room for previewing slides will be provided at the Athens Classic Center.

PREREGISTRATION FORM

GSA Southeastern Section

Athens, Georgia
March 25-26, 1999

Please print clearly • THIS AREA IS FOR YOUR BADGE

Name as it should appear on your badge (last name first) _____

 Employer/University Affiliation _____

 City _____ State or Country _____

 Mailing Address (use two lines if necessary) _____

City _____ State _____
 ZIP Code _____ Country (if other than USA) _____


Circle member affiliation (to qualify for registration member discount):

- (A) GSA (B) NAGT (C) PS (D) SEPM

GUEST INFORMATION • Please print clearly • This area is for badge

Name as it should appear on your guest's badge _____

 City _____ State or Country _____

 Please inform us by February 24 of any special considerations that you or your guest require.
 I will need special considerations.

(____) _____ Business Phone _____
 (____) _____ fax _____
 (____) _____ Home Phone _____

Preregistration Deadline: **February 19**
 Cancellation Deadline: **February 26**

MAIL TO:
GSA SOUTHEASTERN SECTION MEETING, P.O. BOX 9140, BOULDER, CO 80301
FAX TO: 303-447-0648

Remit in U.S. funds payable to: 1999 GSA Southeastern Section Meeting
(All prereregistrations must be prepaid. Purchase Orders not accepted.)

Payment by (check one):

- Check American Express VISA MasterCard

Card Number _____ Expires _____
 Signature _____

PREREGISTRATION FEES

	Full Meeting	One Day	Qty.	Amount
Professional Member*	(10) \$75 <input type="checkbox"/>	(11) \$50 <input type="checkbox"/>	1	\$ _____
Professional Nonmember	(14) \$85 <input type="checkbox"/>	(15) \$50 <input type="checkbox"/>	1	\$ _____
Student Member*	(30) \$35 <input type="checkbox"/>	(31) \$20 <input type="checkbox"/>	1	\$ _____
Student Nonmember	(32) \$40 <input type="checkbox"/>	(33) \$20 <input type="checkbox"/>	1	\$ _____
K-12 Professional	(60) \$30 <input type="checkbox"/>		1	\$ _____
Guest or Spouse	(90) \$25 <input type="checkbox"/>		1	\$ _____
Field Trip Only	(1) \$ 5 <input type="checkbox"/>		1	\$ _____

* Member fee applies to any current Professional OR Student Member of GSA or Associated Societies listed at left. Discount does not apply to guest registrants.

GUEST EVENTS

1. Historic Athens and State Botanical Garden	March 25	(101) \$ 30	1	\$ _____
2. Georgia's Antebellum Showcase: Madison	March 26	(102) \$ 50	1	\$ _____

FIELD TRIPS

1. Ordovician and Silurian of Northwest Georgia	March 24	(401) \$ 40	1	\$ _____
2. Dahlonega Gold Belt, Findley Mine	March 24	(402) \$ 35	1	\$ _____
3. Elberton Granites: Geology and Processing	March 24	(403) \$ 25	1	\$ _____
4. Coastal Geology, Paleontology: Sapelo Island	March 26-28	Professional (404) \$285	1	\$ _____
		Student (404) \$110	1	\$ _____
5. Geotraverse, Georgia-S. Carolina	March 27-28	(405) \$130	1	\$ _____
6. Graves Mountain	March 27	(406) \$ 35	1	\$ _____
7. Crystalline Rock Hydrology, Lawrenceville	March 27	(407) \$ 25	1	\$ _____
8. Tertiary-Cretaceous Stratigraphy, Paleontology	March 27	(408) \$ 30	1	\$ _____
9. Geology, Geomorphology of Stone Mountain	March 27	(409) \$ 50	1	\$ _____

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TOTAL FEES \$ _____

Register one professional or student per form.
 Copy form for your records.

POSTER SESSIONS

Four half-day poster sessions are planned, including Symposium 9 (Geologic and Digital Geologic Maps) and Theme Session 8 (Undergraduate Research Poster Session). Posters will consist of one horizontally hung 5' × 8' tackboard. The best way to attach poster materials to these boards is with tacks. Poster sessions will be set up for four hours, and authors will be available for two hours to discuss their work.

STUDENT RESEARCH PROGRAMS

The Council for Undergraduate Research will sponsor a student poster session (Theme Session 8), to showcase senior theses and other undergraduate research projects. First authors must be undergraduate students and are responsible for the bulk of the research, preparation of the posters, and presentation of the results. For more information, contact Joel B. Thompson, Marine Sciences, Eckerd College, 4200 54th Ave. S., St. Petersburg, FL 33711, 813-864-8991, thompsjb@eckerd.edu.

K-12 AND K-16 THEME SESSIONS, WORKSHOPS, AND FIELD TRIP

For K-12 teachers, Theme Session 10 will have a keynote speaker and a panel discussion and will focus on important issues in standards-based geological education. For more information, please contact Don Byerly, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 974-6007, fax 423-974-2368, dbyerly@utk.edu. Theme Session 11 will be run as a workshop and will focus on creation and evolution topics for K-16 teachers. This workshop will attempt to clarify various scientific, philosophical, and religious issues that may enter into any discussions of cosmological, geological, or biological origins. For more information on Theme Session 11, please contact Jon Bryan, Earth Sciences, Okaloosa-Walton Community College, 100 College Blvd., Niceville, FL 32578-1294, (850) 729-5246, bryanj@owcc.net or Michael Gibson, Dept. of Geology, Geography, and Physics, University of Tennessee at Martin, Martin, TN 38238-5039, (901) 587-7435, mgibson@utm.edu. The geology and geomorphology of Stone Mountain, Georgia, will be the featured field trip for earth science education teachers. This field trip is sponsored by the Southeastern Section of NAGT. For further information, please contact Pamela Gore, Geology Dept., Georgia Perimeter College, Clarkston, GA 30021-2396, (404) 299-4099, pgore@gpc.peachnet.edu or James Whitney, (706) 542-2027, jwhitney@arches.uga.edu.

SPECIAL ACTIVITIES

GSA Southeastern Section Management Board Meeting, Wednesday, March 24, 1999, 4:30-6 p.m., President's Room, Holiday Inn.
GSA Southeastern Section Campus Liaison Breakfast, Thursday, March 25, 1999, 6:30-8 a.m., Corporate Room, Holiday Inn.
GSA Southeastern Section Business Meeting, Thursday, March 25, 1999, 5-5:30 p.m., Classic Center.
GSA Southeastern Section Student Support Committee, Thursday, March 25, 1999, noon, Holiday Inn.
GSA Southeastern Section Committee on Geology and Public Policy Meeting, Thursday, March 25, 1999, noon, President's Room, Holiday Inn.
GSA Southeastern Section Ph.D.-Granting Earth Science Program Chairs Breakfast Meeting, Friday, March 26, 1999, 7-8 a.m., Corporate Room, Holiday Inn.
GSA Southeastern Section Education Division and NAGT Officers and State Representatives Combined Breakfast Meeting, Friday, March 26, 1999, 6:30-8 a.m., Athena Room, Holiday Inn.
GSA Second Century Fund Meeting, Thursday, March 25, 1999, 5-5:30 p.m., Classic Center.
Paleontological Society Southeastern Section Business Meeting, Thursday, March 25, 1999, in session room immediately following Symposium 7.
SEPM Southeastern Section Business Meeting, Thursday, March 25, 1999, noon, Corporate Room, Holiday Inn.

EXHIBITS

Exhibits by business, educational, and governmental institutions will be located conveniently in the Athena Ballroom of the Classic Center. The number of booths is limited, so plan to reserve space early. The Classic Center has 24-hour security. Exhibits will be open Wednesday evening from 6 to 8 p.m., Thursday, 9 a.m. to 5 p.m., and Friday, 9 a.m. to noon. For further information and space reservations contact Barbara Ruff or Vicki Mullis, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2652, bruff@gly.uga.edu or vickim@gly.uga.edu.

FIELD TRIPS

All field trip participants must register for the meeting. The deadline for preregistration for the field trips is *February 19, 1999*. Preregister using the form in this announcement. Registration at the meeting for postmeeting field trips may be possible if trip logistics and space permit. If trips are undersubscribed and canceled, participants will be notified no fewer than 10 days before the meeting, and all field trip fees will be refunded after the meeting. Be aware of cancellation penalties

imposed by the airlines. Plan alternatives in advance should your trip be canceled. There will be no refunds if participants fail to show up on time for reasons other than serious illness or other emergencies. Sponsoring agencies assume no liability whatsoever for failure of participants to show up for a trip, for missed connections, or for injury, loss, or damage during or resulting from transportation on the field trips. The number of participants on most trips is limited, so register early. Further information will be sent to trip participants later. Contact the field trip leaders for the details about specific field trips. For general questions concerning field trips, contact Erv Garrison, (706) 542-1097, egarriso@gly.uga.edu, or Sue Goldstein, (706) 543-2397, sgoldst@gly.uga.edu, Dept. of Geology, University of Georgia, Athens, GA 30602.

Premeeting

1. Ordovician and Silurian of Northwest Georgia. March 24. *Sponsored by Paleontological Society Southeastern Section.* Anthony J. Martin, Emory University, Geosciences Program, Atlanta, GA 30322, (404) 727-6476, paleoman@learnlink.emory.edu; Andrew Rindsberg, Geological Survey of Alabama, arindsberg@ogb.gsa.tuscaloosa.al.us.

Fossil biota, including trace fossils and their sedimentary relationships, will be examined in three spectacular outcrops from northwest Georgia: Dug Gap (Dalton), Ringold Gap (Ringold), and Maddox Gap (Naomi). Cost: \$40, including transportation, guidebook, lunch, and soft drinks. Limit: 28.

2. The Dahlongega Gold Belt as Exemplified by the Findley Mine, Dahlongega, Georgia. March 24. Jerry German, Georgia Dept. of Transportation, Office of Materials and Research, 15 Kennedy Dr., Forest Park, GA 30297, (404) 363-7589, jerry.german@dot.state.ga.us.

This stop will provide an opportunity to examine the main workings of the Findley Mine and the sequence of rocks along the Pumpkinvine Creek Formation-Canton Formation contact that is host to at least 15 abandoned gold mines in the Dahlongega area. Gold was mined intermittently in the area from about 1825 to 1935. Cost: \$35, including transportation, guidebook, lunch, and refreshments. Limit: 40.

3. Elberton Granites: Geology and Processing. March 24. Sam Swanson, (706) 542-2415, sswanson@uga.edu, and R. D. Dallmeyer, (706) 542-7448, dallmeyr@arches.uga.edu, Dept. of Geology, University of Georgia, Athens, GA 30602.

This trip will focus on the geology of the Elberton granite and the associated stone industry centered in Elberton, Georgia. We will visit the Elberton quarries, the stone-cutting sheds, and the waste piles

from the stone cutting. Participants will have the opportunity to see state-of-the-art stone cutting in operation. A special effort will be made to allow participants to collect a suite of rocks, not only from the Elberton granite, but also from the extensive waste piles where rocks from many localities can be found. Hard hats and steel-toed shoes are required. Cost: \$25, includes only transportation; participants must purchase own lunch, at mid-day stop. Limit: 28.

Postmeeting

4. Coastal Geology and Paleontology: Sapelo Island. March 26–28. *Sponsored by Paleontological Society Southeastern Section.* Susan T. Goldstein, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2397, sgoldst@gly.uga.edu; Jon O. Garbisch, Marine Institute, Sapelo Island, Georgia, jgarbisch@peachnet.campus.mci.net.

During two days on Sapelo Island, participants will visit modern and comparable relict Holocene sites, current research sites, and several historical sites on the barrier island. Cost: professionals \$285; students \$110. Professional rate includes accommodation in the historic R. J. Reynolds mansion; student-rate participants will stay in Marine Institute apartments; meals and beverages on the island, transportation on the island, and a field trip guidebook are also included. Transportation to the island and fee (\$2) for the ferry trip are participant's responsibility. Limit: 25 professionals, 20 students.

5. A Geotraverse Across the Western Part of the Southern Appalachian Acadian Metamorphic Core, Eastern Blue Ridge to Western Inner Piedmont, NE Georgia–South Carolina. March 27–28. Robert D. Hatcher, Jr., Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410, (423) 974-6565, bobmap@utk.edu; John M. Garihan, Furman University, garihan@furman.edu.

Exposures along a Southern Appalachian traverse display structural and metamorphic relations used to interpret a complex mid-Paleozoic tectonic history for the Blue Ridge and inner Piedmont. On Sunday, we will focus on the emplacement history of the Sugarloaf Mountain thrust in the vicinity of Ceasars Head, South Carolina, along the spectacular escarpment of the Blue Ridge front. Cost: \$130, including transportation, lodging and some meals. Limit: 20.

6. Graves Mountain, Georgia: Mineralogy, Economic Geology, and Environmental Problems. March 27. Dave Wenner, Doug Crowe, and Paul Schroeder, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2652, dwenner@arches.uga.edu; Todd Rasmussen, School of Forest Resources, University of

Georgia, Athens, trasmuss@smokey.forestry.uga.edu.

This trip will focus on the economic geology, mineralogy, and environmental geology of Graves Mountain, a metamorphosed submarine hot-spring-type deposit. The mineralogy is characterized by a diverse assemblage of aluminosilicate phases, rutile, lazulite, hematite, pyrite, and quartz. The deposit is renowned for museum-quality rutile crystals. The site is currently being remediated to neutralize acid mine drainage and associated environmental problems. Cost: \$35, including transportation, lunch, refreshments, and guidebook. Limit: 75.

7. Crystalline Rock Hydrology, Lawrenceville, Georgia. March 27. Melinda Chapman, U.S. Geological Survey, Water Resources Division, 3039 Amwiler Rd., Suite 130, Atlanta, GA 30360, (770) 903-9131, mjchap@usgs.gov.

A USGS fractured-bedrock study area offers opportunities for discussion and demonstration on the correlation of surface geologic maps with borehole geophysical data. Cost: \$25, including transportation. Limit: 20.

8. Tertiary-Cretaceous Stratigraphy and Paleontology of the South-Central Coastal Plain of Georgia. March 27. *Sponsored by SEPM Southeastern Section.* John R. Anderson, Science Dept., Georgia Perimeter College, 2101 Womack Rd., Dunwoody, GA 30038, (770) 551-3121, janderso@gpc.peachnet.edu; Lynn Zeigler, Georgia Perimeter College, Clarkston, (404) 299-4102.

The trip will include a visit to a kaolin mine near Sandersville, a look at an enigmatic limestone unit near Tennille, and a few more stops to view lower Tertiary stratigraphy. Cost: \$30, including transportation, lunch, and guidebook. Limit: 25.

9. Geology and Geomorphology of Stone Mountain, Georgia. March 27. *Sponsored by NAGT Southeastern Section.* James A. Whitney, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2027, jwhitney@arches.uga.edu; John Dennison, University of North Carolina, Chapel Hill; Pamela Gore, Georgia Perimeter College, Clarkston, pgore@gpc.peachnet.edu.

We will examine various igneous and erosional features of the Stone Mountain granite in a transect from the edge to the middle of the body while hiking the trail to the top of the mountain. Stops will also be made to view the recent human modification to the structure. Cost: \$50, including transportation, refreshments, and lunch. Limit: 40.

GUEST ACTIVITIES

Several guest activities are planned during the meeting.

1. Historic Athens and the State Botanical Garden of Georgia. Thurs-

day, March 25. Visit historic downtown Athens and the Taylor-Grady House (Greek Revival Home, ca. 1845) in the morning, lunch at the exquisite Garden Room Cafe, and enjoy a guided tour of the State Botanical Garden of Georgia. Cost: \$30, includes transportation, lunch, entrance fees, and guided tours. Limit: 40; minimum: 10.

2. Georgia's Antebellum Showcase: Madison. Friday, March 26. Tour beautiful historic Madison, including visits to several antebellum homes, including the Rogers House (ca. 1810), the Rose Cottage (ca. 1890), and the Madison-Morgan Cultural Center (ca. 1895). Lunch will be on your own with 10 Madison Downtown dollars. In the afternoon, explore the numerous antique and specialty shops of Madison. Cost: \$50, includes transportation, entrance fees and guided tours. Limit: 40; minimum: 10.

PUBLICATIONS

A limited number of the *Abstracts with Programs* will be available during on-site registration. To guarantee a copy for on-site pickup, please order one when you preregister. Advance copy purchases made through GSA Membership or Publication Sales require prepayment and will be mailed approximately three weeks prior to the meeting. Refunds for duplicate orders will not be made. Field trip participants will get guidebooks as part of their field trip fees. A limited number of guidebooks will be for sale at the meeting.

STUDENT TRAVEL GRANTS

Limited funds for travel support for students presenting papers at the meeting are available from the GSA Southeastern Section. Students must be members of GSA to apply. For information contact Harold Stowell, Dept. of Geology, University of Alabama, Tuscaloosa, AL 35487-0338, (205) 348-5098, hstowell@wgs.geo.ua.edu. All information and necessary forms may be found at one of two Web sites: www.geo.ua.edu/segsa/travel.html or www.gly.uga.edu/segsa99/travelgrants.htm. Travel grant requests must be postmarked no later than *March 1, 1999*.

OTHER INFORMATION

For information concerning the technical program, please contact Mike Roden (mroden@arches.uga.edu) or Sally Walker (symposia and theme sessions; swalker@gly.uga.edu), (706) 542-2396. For questions regarding the poster sessions, please contact Steven Holland (stratum@gly.uga.edu), (706) 542-0424. For other questions and suggestions, contact the local program chair, Sam Swanson, sswanson@uga.edu, (706) 542-2415. All are at Dept. of Geology, University of Georgia, Athens, GA 30602. ■

IDiG '99



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July 17 – 23, 1999

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ALL APPLICATIONS MUST BE
SUBMITTED ON THE 1999 FORMS
AND POSTMARKED BY
FEBRUARY 1, 1999

1999 Research Grants Program for Students



The primary role of the Research Grants Program is to provide partial support for research in earth science by 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. Eligibility is not restricted to GSA members. New application forms are available each fall in the geology departments of colleges and universities offering graduate degrees in earth sciences. Forms are mailed to GSA Campus Representatives, department secretaries, and chairpersons in the United States, Canada, and Mexico. Application forms and information will be available on GSA's Web page, <http://www.geosociety.org>, as of December 1, 1998. Applications may be downloaded from the Web but may *not* be submitted by e-mail. They are also available upon request from the Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. *Please use only the current 1999 application and appraisal forms.*

Confidential evaluations from two faculty members are required from candidates for the M.S. or Ph.D. degree and must accom-

pany applications submitted. PLEASE USE THE "APPRAISAL OF APPLICANT" FORMS, WHICH ACCOMPANY THE 1999 APPLICATION FORMS. APPLICATION FORMS WILL NOT BE ACCEPTED BY FACSIMILE OR E-MAIL.

The Geological Society of America awarded over \$300,000 in grants in 1998. The grants went to 187 students doing research for advanced degrees. The average amount awarded was \$1654. The largest grant was \$2500, but there is no predetermined maximum amount. 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 Grants funds, and numerous dedicated research funds that have been endowed at the GSA Foundation by members and families.

The Committee on Research Grants will meet in April to evaluate applications and award grants. In April, all applicants for grants will be informed of the committee's actions by the Executive Director of the Geological Society of America.

POSITION ANNOUNCEMENTS (from Employers using GSA's Employment Service at the 1998 Annual Meeting)

PALEOBIOLOGY AND SURFICIAL PROCESSES BOWLING GREEN STATE UNIVERSITY

The Department of Geology invites applications for two tenure-track, assistant professor positions starting in August, 1999. In both cases, the successful applicant would be expected to teach at the undergraduate and graduate level, maintain an active research program, supervise M.S. thesis projects, and contribute to the department's emphasis in environmental geology (GIS, remote sensing, hydrogeology, and engineering geology) and natural resources. In addition, participation in the summer geology field camp (New Mexico and Colorado) would be desirable.

(1) Paleobiology: We seek an invertebrate paleobiologist with additional areas of specialization that are open but could include the Phanerozoic history of biodiversity, global environmental change, animal-sediment relationships or related topics. Teaching assignments could include introductory geology, historical geology, invertebrate paleobiology, and advanced courses in the candidate's specialty.

(2) Surficial Processes: We seek a quantitative geomorphologist with additional areas of specialization that are open, but could include coastal geomorphology, glacial geomorphology, pedology, or related topics. Teaching assignments could include introductory geology, geomorphology, and advanced courses in the candidate's specialty.

Department facilities include: GIS/remote sensing laboratory (SGI and Sun workstations), classroom computing facility, geochemistry laboratory (AAS, SEM, XRD), sedimentology and hydrology laboratories, mineral kinetics laboratory, geophysical equipment (magnetometer, gravity meter, resistivity, shallow seismic, GPS), optical petrology laboratory, sample preparation facilities, sediment core laboratory, and field vehicles.

A Ph.D. is required. Applications (including a complete resume, a statement of teaching interests, a statement of research interests, and three original letters of recommendation) should be sent to: Chair, Faculty Search Committee, Department of Geology, Bowling Green State University, Bowling Green, OH 43403. Applications should be received no later than February 1, 1999. BGSU is an AA/EEOC employer, and women, minorities, veterans, or individuals with disabilities are urged to apply.

HYDROGEOLOGIST

The Department of Geological Sciences, California State University, Fullerton, invites applications for a tenure-track position at the Assistant Professor level, starting August 1999. Applicants should have the following credentials and capabilities: 1. a Ph.D. in geology or hydrogeology, 2. a primary interest in teaching and achieving excellence in teaching, 3. a field-based orientation with experience in groundwater modeling, and 4. a commitment to developing a research program that includes undergraduate and graduate students.

Teaching responsibilities will include physical geology, hydrogeology, field hydrology, graduate courses in the new faculty member's area of expertise, and participation in our summer hydrology field camp at Mammoth Lakes, CA. Expertise in G.I.S., exploration geophysics and/or contaminant hydrogeology/hydrogeochemistry is a plus. See the full text of this announcement at <http://geology.fullerton.edu/geology/>.

To apply, please send the following: a detailed curriculum vitae; a letter telling about yourself and detailing how you meet the qualifications outlined above; 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; a statement of your future research plans and goals; and 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. Brady Rhodes, Chair, Search Committee, Department of Geological Sciences, California State University, P.O. Box 6850, Fullerton, California 92834-6850. Applications will be accepted until January 15, 1999.

California State University, Fullerton, is an Affirmative Action/Equal Opportunity Employer.

DICKINSON COLLEGE STRATIGRAPHY/SEDIMENTOLOGY/PALEONTOLOGY

Applications are invited for an anticipated one-year position at the assistant professor level starting July 1999. Teaching duties will include introductory Historical Geology lecture and lab, Physical Geology lab, an upper level

elective in the candidate's field, and possible supervision of student research projects. The Ph.D. is required and some teaching experience is desirable.

Dickinson is a highly selective, liberal arts college of 1,850 students located in the geologically diverse Valley and Ridge, Blue Ridge, and Mesozoic lowland provinces of south-central Pennsylvania. The department has four full-time faculty and graduates about 10 majors per year. The facilities include a dedicated soft rock lab, excellent analytical instrumentation and computers, and a full range of field equipment for soft rock studies. The successful candidate will have a strong commitment to and excitement about undergraduate teaching and research as well as experience in the lab and field.

Send letter of application, a statement of teaching and research interests and objectives, curriculum vitae, and names and postal and e-mail addresses of three referees to: Dr. Gene Yagodinski, Department of Geology, Dickinson College, P.O. Box 1773, Carlisle, PA 17013-2896. Deadline for applications is February 1, 1999.

Dickinson College is an affirmative action/equal opportunity employer. Women and minorities are encouraged to apply.

GEOLOGISTS/HYDROGEOLOGISTS/ GEOPHYSICISTS/GEOCHEMISTS

The IT Group (formally known as International Technology Corporation) is readily expanding. We are nationally recognized as a leader in the field of environmental management services. The IT Group employs approximately 4,800 people, and is approaching \$1 billion in revenues.

Successful candidates will have at least a BS/BA degree in geology or related field. We have openings for enthusiastic people with experience ranging from entry level to those candidates with 5 or more years of experience. Positions require field assignments and travel in addition to office work. Superior writing and communications skills are preferred. We offer a competitive salary and benefits package. These are challenging positions working in a team environment with a growing company.

Preferred backgrounds would include experience in environmental remediation and reviewing of documents, preparation of documents, proposals, and cost estimates. PG registration a plus. Good communication skills a must. For immediate consideration fax resume to 609-584-7080 or e-mail to earl_j@ohm.com.

LAURENTIAN UNIVERSITY AT SUDBURY STRUCTURAL GEOLOGY

The Department of Earth Sciences seeks applications for a tenure-track faculty position at the Assistant Professor level in structural geology effective July 1, 1999. The successful candidate will teach at the undergraduate and graduate level, supervise research students and maintain a vigorous research programme. This person will have expertise in structural analysis, a strong commitment to field-based research, and experience in or a desire to work on ore deposit-related structural problems.

Mineral deposits and Precambrian geology are a particular strength of the Department at the research and post-graduate level. In 1997 an NSERC Industrial Research Chair in Mineral Exploration was established in the department. The Chair is Director of the Mineral Exploration Research Centre, which carries out applied and fundamental research into the genesis of magmatic and hydrothermal ore deposits both in Canada and internationally.

Laurentian University is a bilingual institution and an equal opportunity employer. It has a policy of passive bilingualism (English/French) as a condition of tenure; free second language instruction is available. Applications are encouraged from all qualified individuals, including women, aboriginal peoples, members of visible minorities and persons with disabilities. Please submit an application, with complete curriculum vitae and the names and addresses of three referees, to: Dr. Richard James, Chair, Department of Earth Sciences, Laurentian University, Ramsey Lake Road, Sudbury, Ontario P3E 2C6, Canada. Telephone: (705) 675-1151, ext. 2263; fax 705-675-4898; e-mail: rjames@nickel.laurentian.ca.

POSTDOCTORAL FELLOWSHIPS IN GEOLOGY/GEOCHEMISTRY

The Geology and Geochemistry Group (EES-1) of the Earth and Environmental Sciences Division at Los Alamos National Laboratory invites applications for postdoctoral research in geology and geochemistry. Candidates with strong quantitative, numerical modeling, spatial analysis and/or thermodynamics skills are preferred, and must have exceptional academic and publication records. Areas

the group is interested in strengthening include: land surface processes, chemical oceanography, hydrogeochemistry, organic geochemistry, neotectonics and seismology, volcanology, and geothermal energy. Suitable candidates will be asked to develop a short research proposal, on an important scientific problem, in collaboration with a staff member. Sponsoring staff will select applicants based on common research interests and the strength of the application. Successful applicants will have significant access to outstanding analytical equipment and computing facilities. For further technical information contact Dr. M. James Aldrich at jaldrich@lanl.gov. A Ph.D. completed within the last three years or soon to be completed is required. Sponsored candidates will compete for a Director's Fellowship, and outstanding candidates may be considered for the prestigious J. Robert Oppenheimer, Richard P. Feynman, or Frederick Reines fellowships. Submit a resume and publications list along with a cover letter outlining current interests and the names, addresses and phone numbers of at least three references to: Postdoc-jobs@lanl.gov (no attachments please), or submit TWO COPIES to: Postdoc Program Office, MS-P290, Los Alamos National Laboratory, Los Alamos, NM 87545. Note: GeoToday - PD 984130 must be referenced in the e-mail Subject Line (or the address) and cover letter. Los Alamos National Laboratory is an Affirmative Action/Equal Opportunity Employer.

ASSISTANT PROFESSOR MARIETTA COLLEGE

Tenure-track position available for August 1999 in the area of surface processes or related areas such as geomorphology and environmental geology. Responsibilities include: teaching introductory courses in physical or historical geology and environmental geology for both majors (geology, petroleum engineering, environmental science) and for general education; design and teach advanced courses in areas of expertise for geology and environmental science majors; develop existing GIS facility into a campus resource; direct undergraduate research projects. A Ph.D. in geology is required, and a strong background in GIS/GPS applications to geology is strongly preferred. Send letter of application, resumé and 3 letters of recommendation, to Fred Voner, Chair, Department of Geology, Marietta College, Marietta, OH 45750. Review of credentials begins December 1, 1998. Marietta College is a private, non-sectarian, liberal arts college with an enrollment of 1300. The college was awarded a chapter of Phi Beta Kappa in 1860, only the 16th institution so honored. The City of Marietta is a historic river city located at the confluence of the Muskingum and Ohio Rivers. Marietta College is an equal opportunity educator and employer which values diversity. Women, minorities, and persons with disabilities are encouraged to apply.

ASSISTANT PROFESSORSHIP DEPARTMENT OF GEOLOGICAL SCIENCES UNIVERSITY OF MEMPHIS

Assistant Professorship seeks likely candidate. If you will be available, with a Ph.D., in the fall of 1999, and would like to share your love of teaching and research in a vibrant setting in either environmental geophysics or fluid process geomorphology, please answer this ad.

If interested, please send a letter of intent and interest, a curriculum vitae, and three letters of recommendation to: Chair, Search Committee, Department of Geological Sciences, University of Memphis, Memphis, TN 38152. Review of applicants will begin February 1, 1999, and will continue until the position is filled. Complete information about the position, the department and the Center for Earthquake Research and Information can be obtained by pointing your Internet browser to www.people.memphis.edu/~geosci/ or www.ceri.memphis.edu.

Phone: (901) 678-4356. Fax 901-678-2178. E-mail: rvansrdl@cc.memphis.edu

MICHIGAN STATE UNIVERSITY GEOLOGICAL SCIENCES

The Department of Geological Sciences announces a tenure-track position, at the assistant professor level, in sedimentology/stratigraphy beginning August 16, 1999. Applicants must show promise of an outstanding research program and be committed to excellence in teaching at both the undergraduate and graduate levels. Applicants should have expertise in physical sedimentology and stratigraphy. This position is broadly defined to attract outstanding candidates. Specialties could include reservoir and basin analyses, tectonic evolution of basins, record of

Position Announcements continued on p. 40

the Earth's climatic and oceanographic history. Preference will be given to applicants whose research interests include spatial and temporal variability in sedimentological processes and patterns using such tools as 3-D seismic, structural geology, dating techniques, and stratigraphy. Interested applicants should forward a curriculum vitae, official transcripts, statement of teaching and research interests, and names, addresses, telephone numbers, and e-mail addresses of three references to: Dr. Thomas A. Vogel, Chair, Department of Geological Sciences, Michigan State University, 206 Natural Science Building, East Lansing, MI 48824-1115. Application Deadline: January 5, 1999. Michigan State University is an Affirmative Action/Equal Opportunity Institution. Handicappers have the right to request and receive reasonable accommodation.

SURFICIAL PROCESSES/HYDROGEOLOGY

The Department of Geology at the University of Minnesota—Duluth seeks to fill a tenure-track position starting September 1999 at the assistant professor level in the general areas of hydrogeology or surficial processes to complement existing strengths. The subdiscipline is open. A Ph.D. in the geosciences is required at the time of appointment. We seek a versatile geoscientist who may collaborate with faculty in the Geology Department (<http://www.d.umn.edu/geology/>), the Large Lakes Observatory (<http://www.d.umn.edu/llo>), the Natural Resources Research Institute (<http://www.nrii.umn.edu>), or the Water Resources Sciences graduate program (<http://wrc.coafes.umn.edu/wrs/>).

The successful applicant will be expected to develop an active externally funded research program, to supervise undergraduate, masters, and doctoral students, and to teach undergraduate and graduate courses including courses in environmental geology and either geomorphology or hydrogeology.

Applicants should send a curriculum vitae, a statement of research and teaching interests, and the names, addresses, and telephone numbers of at least three references by January 15, 1999, to: Dr. Howard Mooers, Search Committee Chair, Department of Geology, Univer-

sity of Minnesota, 10 University Drive, Duluth, MN 55812. Prospective candidates with questions regarding this position may contact Howard Mooers by e-mail at hmoers@d.umn.edu.

The University of Minnesota is an equal opportunity educator and employer.

LECTURER/LABORATORY COORDINATOR UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Applications are invited for the position of lecturer and laboratory coordinator of introductory geology and earth sciences courses in the Department of Geography and Earth Sciences, University of North Carolina at Charlotte.

Primary responsibilities include lecturing in introductory geology lecture and lab courses and implementation and oversight of introductory geology and earth sciences labs in coordination with other faculty. Specific duties may include: development of lab exercises and manuals; maintaining lab equipment and supplies; training and scheduling lab instructors; developing and organizing field trips; and summer teaching (one course). The lecturer teaches an average of 9 contact hours per semester during the academic year.

The position is permanent full-time 12-month non-tenure track with full benefits. Applicants should have at least a masters in geology or earth sciences. Salary range is \$30,000 to \$32,000.

Send applications, including curriculum vitae, statement of teaching experience, and names and addresses of three referees, to: Dr. Wayne Walcott, Department of Geography and Earth Sciences, University of North Carolina at Charlotte, Charlotte, NC 28223 by January 15, 1999.

Additional information about the department and university is available at <http://ga-mac.uncc.edu/>

The University of North Carolina at Charlotte is an equal opportunity/affirmative action employer.

FACULTY POSITION UNIVERSITY OF ROCHESTER

The Department of Earth and Environmental Sciences at the University of Rochester has an opening for a tenure-track faculty position beginning in September 1999. We expect to appoint an assistant professor, but qualified candidates may also be considered at a senior level. Candidates with exceptional ability and motivation to develop an independent research program in the field broadly defined as sedimentary geology (including stratigraphy, paleontology, active tectonics and geomorphology) that complements the department's research and educational efforts are encouraged to apply. For information on our department, please visit our Web site: <http://www.earth.rochester.edu>. A Ph.D. at the time of appointment is required. Applicants should have a strong interest in teaching both undergraduate and graduate students, and will be expected to develop an externally funded research program involving Ph.D. students. Interested persons should send a curriculum vitae, the names and addresses of three references, and a brief description of research and teaching interests that includes the candidate's view of how their program would complement and strengthen our department to: Faculty Selection Committee, Department of Earth & Environmental Sciences, University of Rochester, Rochester, NY 14627-0221; fax 716-244-5689. Review of applicants will begin October 15, 1998, and continue until the position is filled. The university is an equal opportunity employer and encourages women and minority applicants.

GEOMORPHOLOGIST

The Department of Geology of the State University of New York, College at Cortland has a tenure-track position for a GEOMORPHOLOGIST beginning in August of 1999 at the Assistant Professor level. The successful candidate must have a Ph.D. at the time of appointment and an ability to teach courses in geomorphology, introductory level geology and glacial geology, and possibly meteorology and land-use planning. Contributions to the secondary education program and the departmental concentration in environmental science as well as participation in the field programs at the Brauer Geology Field Station are expected. The candidate is also expected to attract outside funding to support a research program involving undergraduate students. Additional information can be obtained from: <http://www.cortland.edu/Geology/>

Please send a statement of teaching and research interests, a complete CV, and names of at least three references to: James E. Bugh, Department of Geology, SUNY Cortland, P.O. Box 2000, Cortland, NY 13045. Review of applications will begin January 1, 1999, and continue until the position is filled. We have a strong commitment to the affirmation of diversity and have interdisciplinary degree programs in the areas of multicultural stud-

ies. State University of New York College at Cortland is an AA/EEO/ADA employer.

FACULTY POSITION IN CARBONATE SEDIMENTOLOGY UNIVERSITY OF TENNESSEE, KNOXVILLE

The University of Tennessee, Knoxville, is seeking qualified candidates for a tenure-track position at the Assistant Professor rank in carbonate sedimentology. The responsibilities include teaching historical geology, upper-level courses in the geology major, and graduate courses in the candidate's specialty; conducting scholarly research in geological sciences; supervising masters and doctoral students; and contributing to the administration of the department and the university, as required. Preference will be given to candidates who balance field and laboratory studies of carbonate depositional and diagenetic systems. All Ph.D. requirements must be completed by August 1999. Strong commitments to scholarly research and excellence in teaching are required. Women and minorities are encouraged to apply.

The position is available August 1, 1999. For full consideration, applicants should submit a curriculum vitae, transcripts, and arrange for three letters of reference to be sent to the search committee by January 15, 1999, to Dr. Theodore C. Labotka, Search Committee Chairman, Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410.

UTK is an EEO/AA/Title VI/Title IX/Section 504/ADA/ADEA Employer.

GEOCHEMIST/MINERALOGIST

The Department of Geosciences at Western Michigan University has a tenure-track opening at the assistant professor level for a geochemist/mineralogist. Low temperature aqueous or organic geochemistry or applied mineralogy are desirable specialties. A Ph.D. is required and must be in hand by August 1999. The successful candidate must be capable of teaching upper division undergraduate lecture and labs in mineralogy/petrology and one or more graduate courses in his or her specialty. The candidate will also be expected to develop a vigorous, externally funded research program.

The Geosciences Department maintains strong undergraduate majors in geology, hydrogeology, geophysics, and earth science. Graduate programs include M.S. and Ph.D. degrees. Laboratory facilities include XRD, SEM, light element stable isotope and water quality (organic and inorganic) labs. The department is moving into new laboratory facilities during the current academic year and funds are available for upgrading instrumental capabilities.

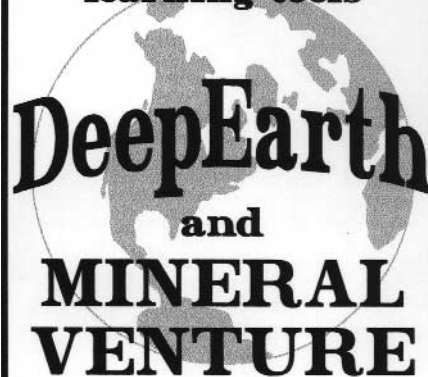
Western Michigan University has embarked upon a vigorous affirmative action program that encourages applications from under-represented groups. Send a letter of application, concise statement of research interests, vitae, academic transcripts, and three letters of recommendation to the Geochemist Search Committee, Department of Geosciences, Western Michigan University, 1201 Oliver Street, Kalamazoo, MI 49008. Further information on the department (<http://www.wmich.edu/geology>) and university (<http://www.wmich.edu>) can be viewed on our Web sites.

UNIVERSITY OF WISCONSIN—OSHKOSH

The Department of Geology invites applications for two tenure-track assistant professor positions. Ph.D. required; prior college teaching experience preferred. 1) Field-oriented structural geologist to teach and direct summer field camp and teach structural geology and field methods. Field camp accounts for about one-half of the teaching load, allowing flexibility in scheduling research and teaching during the regular academic year. Candidates also able to teach geophysics (in alternate years) will be given preference. Starts either June 14 or September 1, 1999. 2) Field-oriented sedimentary geologist with specialties in clastic sedimentology and/or paleontology to teach undergraduate courses in his or her specialties as well as freshman-level courses. Candidates also able to teach oceanography will be given preference.

Starts September 1, 1999. Candidates should be committed to undergraduate education and to developing a research program that includes undergraduates. Please submit a résumé, concise statements of your teaching and research interests and experience, transcripts (original or copy), and three letters of reference (sent by referees) by December 15, 1998 to Dr. Norris Jones, Chair, Department of Geology, University of Wisconsin—Oshkosh, Oshkosh, WI 54901. Information about the department, its programs, and research facilities can be found at <http://www.uwosh.edu/departments/geology/>. AA/EEO.

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Denver, Colorado October 25–28 Colorado Convention Center

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*Electronic Proposal Form Available
November*

Proposal form and guidelines
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See November *GSA Today* for a preliminary list of trips.

DENVER MINI-CALENDAR

1999 www.geosociety.org/meetings/99
January 6 — Symposia and Topical Proposals due to Technical Program Chairs
April 1 — Call for Papers published and distributed
May 1 — Electronic Abstract Submittal Form available on the GSA Web site
June 1 — Registration and housing information printed in June *GSA Today*
July 12 — Abstracts Deadline
September 17 — Preregistration and Housing Deadline

STUDENT TRAVEL GRANTS

The GSA Foundation has awarded \$4,000 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.

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North-Central—Robert Diffendal, Jr., (402) 472-7546, rfd@unlinfo.unl.edu	Southeastern—Harold Stowell, (205) 348-5098, hstowell@wgs.geo.ua.edu

SECTION MEETINGS

SOUTH-CENTRAL SECTION — March 15–16, 1999, Lubbock, Texas. Submit completed abstracts to: James Barrick, Dept. of Geosciences, Texas Tech, Lubbock, TX 79409-1053, (806) 742-3107, ghjeb@ttu.edu. *Abstract deadline: December 15, 1998.*

NORTHEASTERN SECTION — March 22–24, 1999, Providence, Rhode Island. Submit completed abstracts to: Anne I. Veeger, Dept. of Geology, University of Rhode Island, Green Hall, Kingston, RI 02881, (401) 874-2187, veeger@uriacc.uri.edu. *Abstract deadline: December 8, 1998.*

SOUTHEASTERN SECTION — March 25–26, 1999, Athens, Georgia. Submit completed abstracts to: Michael F. Roden, Dept. of Geology, University of Georgia, Athens, GA 30602-2501, (706) 542-2416, mroden@uga.cc.uga.edu. *Abstract deadline: December 14, 1998.*

ROCKY MOUNTAIN SECTION — April 8–10, 1999, Pocatello, Idaho. Submit completed abstracts to: Paul Link, Dept. of Geology, Idaho State University, 785 South 8th Ave., Pocatello, ID 83209-8072, (208) 236-3846, linkpaul@isu.edu. *Abstract deadline: December 29, 1998.*

NORTH-CENTRAL SECTION — April 22–23, 1999, Champaign-Urbana, Illinois. Submit completed abstracts to: C. Pius Weibel, Illinois State Geological Survey, 615 E. Peabody Dr., Champaign, IL 61820-6964, (217) 333-5108, weibel@igs.uiuc.edu. *Abstract deadline: January 11, 1999.*

CORDILLERAN SECTION — June 2–4, 1999, Berkeley, California. Submit completed abstracts to: George Brimhall, Dept. of Geology & Geophysics, University of California, Berkeley, CA 94720-4767, (510) 642-5868, brimhall@socrates.berkeley.edu. *Abstract deadline: February 19, 1999.*



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CALL FOR APPLICATIONS AND NOMINATIONS FOR

Geology Co-Editor

GSA is soliciting applications and nominations for the position of co-editor of *Geology*, to serve a three-year term, beginning in January 2000, as one of a two-editor team. Desirable characteristics for the successful candidate include:

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

GSA provides the editor with a small stipend as well as expenses for secretarial assistance, mail, and telephone.

If you wish to be considered, please submit a curriculum vitae and a brief letter describing why you should be chosen. If you wish to nominate another, submit a letter of nomination and the individual's written permission and c.v. Send nominations and applications to Peggy S. Lehr, Director of Publications, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, by April 14, 1999.

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Positions Open

THE OHIO STATE UNIVERSITY GENETIC STRATIGRAPHER

The Department of Geological Sciences at The Ohio State University invites applications for a tenure-track position in genetic stratigraphy. The position is at the assistant professor level, although a position at a higher rank will be considered and may begin as early as September 1999. Candidates with interests and demonstrated skills in interpreting the depositional architecture of sedimentary fill in basins are encouraged to apply. Particularly suitable areas of research interest include outcrop or subsurface-based sequence stratigraphy, chemostratigraphy, and computer modeling of stratigraphic sequences. A Ph.D. in geological sciences or a related field is required. Candidates should have a strong potential for funded research, have refereed publications, and have a commitment to teaching. The successful candidate can expect to interact closely with existing programs in sedimentology, biostratigraphy, paleobiology, Quaternary geology and global change, geophysics, and hydrogeology.

The successful candidate will be expected to maintain an active funded research program, advise graduate students, and contribute to the teaching mission of the department at both the undergraduate and the graduate levels.

The Department of Geological Sciences is a comprehensive earth sciences department, with 24 regular faculty that maintain close ties with interdisciplinary research centers on campus, including the Byrd Polar Research Center and the Center for Mapping.

To apply, send a curriculum vitae, statements of research and teaching interests, and names of three referees to Search Committee Chair, Department of Geological Sciences, 155 South Oval Mall, Columbus, OH 43210, USA. The search committee will begin reviewing applications on January 1, 1999, and will continue until a suitable candidate is hired. The Ohio State University is an equal opportunity/affirmative action employer. Women, minorities, Vietnam-era veterans, disabled veterans, and individuals with disabilities are encouraged to apply.

DEPARTMENT OF PHYSICAL SCIENCES KUTZTOWN UNIVERSITY IGNEOUS/METAMORPHIC GEOLOGIST

Applications are invited for a full-time, tenure-track faculty position at the Assistant Professor level beginning August 1999. A Ph.D. in hard rock geology is required along with a commitment to program development, excellence in undergraduate teaching, and undergraduate research. Primary teaching responsibilities include mineralogy, optical mineralogy, igneous and metamorphic petrology, and structural geology on a two-year cycle; and physical geology on a yearly basis. The teaching load consists of 24 contact hours per academic year. Successful interview and demonstration of ability are required qualifications. Submit a letter of application, curriculum vitae, undergraduate and graduate transcripts, a brief statement of teaching philosophy, plans for research involving undergraduates, and three letters of recommendation to: Chairperson of Geology Search Committee, Department of Physical Sciences, P.O. Box 730, Kutztown University, Kutztown, PA 19530 by December 28, 1998. Kutztown University is an AA/EEO employer. For information about the geology program see the Web page at <http://www.kutztown.edu/acad/geology>.

AQUEOUS GEOCHEMISTRY TOWSON UNIVERSITY

Towson University seeks to fill an entry-level tenure-track position for an Assistant Professor in aqueous geochemistry to begin fall of 1999. The successful candidate should have expertise in groundwater hydrogeology and contaminant transport and demonstrate a strong commitment to undergraduate teaching and research participation. Towson's geology program is a

concentration in the geosciences major and is housed within the Physics Department.

Responsibilities include teaching introductory geology courses on a rotational basis, aqueous geochemistry, groundwater hydrogeology, and supervision of undergraduate research. This position will support expansion of the geosciences program and a new interdisciplinary program in environmental science, and other courses may be developed. A viable research program involving undergraduates is expected. Teaching experience is desirable. Ph.D. required at the time of appointment. Salary is competitive.

Send curriculum vitae, statements of teaching philosophy and research interests, and names of three references to: Dr. Jonathan Filer, Geology Search Committee Chair, Department of Physics, Towson University, Towson, MD 21252. Review of applications will begin on January 8, 1999.

Towson University is an equal opportunity/affirmative action employer and has a strong commitment to diversity. Women, minorities, persons with disabilities, and veterans are encouraged to apply.

VASSAR COLLEGE OCEANOGRAPHY AND GEOPHYSICS

The Department of Geology and Geography at Vassar College invites applications for an entry-level tenure track position at the rank of assistant professor in oceanography and geophysics.

Candidates should hold a Ph.D. in geology, geophysics, or earth science at the time of appointment. The successful candidate will develop his or her own courses in oceanography (introductory level), geophysics (intermediate and advanced levels), and coastal processes (advanced level). In addition, the candidate will share teaching responsibilities for earth materials (mineralogy/petrology) and structural geology.

The successful candidate is expected to engage in a research program that will complement current departmental interests in Quaternary geology, sedimentology, and soils. In addition, she or he will be expected to involve undergraduates in research, either through senior thesis projects or through work on her or his own research projects. A vehicle for this is Vassar's Undergraduate Summer Research Institute (URSI) in which faculty and students conduct original research during a 10-week summer session.

Vassar College is a private liberal-arts college in New York's Hudson River valley. The Geology and Geography department presently consists of 3 geologists with specialties in sedimentology and Quaternary geology, and 4 geographers with specialties in cultural, urban, and physical geography. The geology program emphasizes surficial processes and is active in the environmental sciences and environmental studies programs. The program has ~20 students and graduates 6-8 students per year.

Instrumentation in the department includes XRD, laser-particle size analyzer, coulometer, fully equipped sedimentology, paleoclimatology, and clay mineralogy laboratories, GIS computer lab, and a meteorological station. In addition, the department shares an ICAPES with the department of chemistry. Vassar College also owns a 500-acre ecological preserve with a laboratory field station.

Send a letter of application, description of teaching and research interests and objectives, curriculum vitae, and the names, addresses, phone and fax numbers, and e-mail addresses of at least 3 references to: Search Committee Chair, Department of Geology and Geography, Box 735, Vassar College, Poughkeepsie, NY 12604.

Applications will be accepted until Dec. 15, 1998. The position will commence in August 1999. Vassar College is an Affirmative Action/Equal Opportunity Employer.

TENURE-TRACK FACULTY POSITION HYDROGEOLOGY, RUTGERS UNIVERSITY

The Department of Geological Sciences of Rutgers, the State University of New Jersey (New Brunswick), seeks to fill a tenure-track faculty position in the general field of hydrogeology beginning in September 1999. A Ph.D. is required at the time of appointment, which is intended to be at the rank of assistant professor. However, the department has recently been given approval to consider exceptional candidates for an appointment at a higher level.

We seek a candidate with strong research interests and the ability to develop a rigorous teaching program in hydrogeology at the undergraduate and graduate levels. The discipline is open, and candidates with a field, experimental, or computational approach to problems involving the interaction of the hydrological cycle and the Earth's crust are encouraged to apply. We are in any case

particularly interested to find someone who would complement current faculty strengths in such areas as sedimentary basins, geochemistry, and stratigraphy. Excellent opportunities also exist for collaborative research projects and access to facilities at other major units of the University.

A curriculum vitae, statement of research interests, and the names and addresses of at least three references should be sent by January 15, 1999 (extended from November 13, 1998) to Dr. Dennis Kent, Chair of the Search Committee, Department of Geological Sciences, Wright Lab, Rutgers University, 610 Taylor Rd., Piscataway, NJ 08854-8066. Rutgers University is an equal opportunity/affirmative action employer.

MISSISSIPPI STATE UNIVERSITY ASSISTANT PROFESSOR

Mississippi State University Department of Geosciences invites applications for a full-time, tenure-track position, Assistant Professor, starting fall 1999. Ph.D. required (ABD considered). The position is in geology with an emphasis in Gulf Coast geology, specialty open. Expertise in low temperature geochemistry is desirable. Applicant will be expected to teach courses in introductory geology, mineralogy, area of specialty, and other departmental needs. The successful applicant will be expected to complement existing strengths in environmental and soft rock geology, develop a research program involving M.S. students, and provide community service common at a state-supported institution.

The department currently has ten tenure-track faculty, five of whom are geologists, and two full-time instructors. B.S. and M.S. degrees are offered. Within geosciences there are four areas of emphasis: broadcast meteorology/climatology, environmental geoscience, geography, and professional geology. Distance learning programs have enrollments of over 400 undergraduate and graduate students. The department will soon move into completely renovated and expanded facilities.

Candidates should submit a letter of application indicating the position for which they are applying, a curriculum vitae, copies of transcripts, and names and addresses of three people who may be contacted for letters of recommendation. Screening of applicants will begin January 15 and continue until the position is filled. Women and minorities are encouraged to apply. Mississippi State University is an Affirmative Action/Equal Opportunity Employer.

Apply: Dr. Darrel W. Schmitz, Associate Professor of Geology, Department of Geosciences, P.O. Box 5448, Mississippi State, MS, 39762. Voice: (601) 325-3915. <http://www.msstate.edu/dept/geosciences>.

UNIVERSITY OF MARYLAND, COLLEGE PARK FACULTY POSITION, DEPARTMENT OF GEOLOGY

The Department of Geology at UM is searching for a tenure-track faculty member who has made fundamental contributions in shallow lithosphere, particularly crustal processes. We seek an outstanding scientist in one of the following broadly defined areas: structural geology and tectonics, or neotectonics. A Ph.D. is required at the time of appointment. The appointee is expected to develop and maintain an active, externally funded research program and to participate fully in teaching at the graduate and undergraduate levels, including courses in structural geology and tectonics. The department expects to fill this position by the beginning of fall semester 1999 or as soon as possible thereafter, most likely at the rank of Assistant Professor. Salary will be commensurate with experience.

Research strengths of the Department of Geology include the broad areas of mineralogy, petrology, and geochemistry, in particular of granites and associated mineralization; hydrological processes and integration of geomorphology, hydrology and ecology to understand surface environments; and isotope geochemistry in support of these areas and in mantle geochemistry, meteoritics, tectonics, carbonate diagenesis, sediment cycling, geochronology, stratigraphy, and paleoclimate studies. The Department of Geology encourages interdisciplinary approaches to the study of the Earth and participates in the Earth System Science Interdisciplinary Center. This new center has been formed through collaboration between the University of Maryland and NASA's Goddard Space Flight Center to carry out preeminent research and teaching programs in earth system science.

The University of Maryland is an affirmative action/equal employment opportunity employer. Applications should be submitted by December 11, 1998, for best consideration and should be submitted to: Chair, Search Committee, Department of Geology, University of

Students Practice Geologic Skills as Parks Interns

Early last summer, six geology undergraduates arrived at different national parks and monuments around the country. Along with their backpacks, hiking boots, and sleeping bags, they brought abundant energy and a hunger to learn. Twelve weeks later, they would return home. But for now, a wealth of opportunities to sharpen their geologic skills awaited them.

The students were participants in the 1998 National Parks Undergraduate Geology Summer Interns program administered by the Geological Society of America (GSA) in

cooperation with the Geologic Resource Division of the National Park Service. Thanks to the generosity of program sponsors, including the Shell Oil Company Foundation, the Frank A. Campini Foundation, and John and Carol Mann, the two internships of 1997 expanded to six for 1998.

Each of the six participating parks—Badlands, Death Valley, Denali, Lake Clark, and Petrified Forest National Parks, and White Sands National Monument—had its own set of high-priority geologic needs. None but Denali has a staff geologist, despite their stu-

pendous geological resources. Over the summer, the interns would help by addressing their park's most pressing needs. The interns organized fossil collections and databases, helped with geologic research, interpreted geologic features, staffed visitor centers, led geology walks and talks, and developed educational materials for park visitors and staff.

The parks provided the interns with housing in a trailer, apartment, cabin, or semipermanent tent shelter. The internship program provided stipends to cover travel, food, and living expenses. A park staff mem-



For Alison Anders, part of the fun of fieldwork at Lake Clark National Park and Preserve was simply getting there.

Lake Clark needed an intern who could do fieldwork, organize GIS databases, and develop educational materials. Alison filled the bill, assisting with fieldwork on landslides, volcanoes, and glaciers, working on the park's geologic GIS databases, and researching and producing a photo-and-text "flight-seeing" visitors' guide to the park's glaciers. She also helped staff the park visitor center, assisted with wildlife and water-quality studies, and conducted postfield labwork.

"I feel especially good about creating and renewing interest and awareness of geology at Lake Clark," Alison said. "It was great to have everybody talking about geology and stumping me with real questions that affected their jobs!"



Matt Hoskins helps out at the Pig Dig in Badlands National Park, where Oligocene vertebrate fossils are being excavated.

lege, he spent a year as an exchange student in Spain. He has also supervised construction and landscape crews and has worked as a kids' basketball coach and ski instructor.

Lake Clark National Park and Preserve, Alaska, Intern Alison Anders

Alison, from Minneapolis, Minnesota, is a senior at Carleton College, where she is studying both geology and mathematics. She is a trained Wilderness First Responder and has led extended wilderness backpacking and canoe trips.

Badlands National Park, South Dakota, Intern Matt Hoskins

Matt, from Fly Creek, New York, will graduate soon from Boston College, where his majors are environmental geoscience and Spanish. Matt loves sports and outdoor activities and has participated in Outward Bound. Before col-

Badlands National Park needed an intern to interact with park visitors and participate in paleontological fieldwork, so Matt staffed the visitor center, prepared and led public geology walks and talks, gave public tours of the park's active Pig Dig site, prepared written materials for visitors, and produced a Pig Dig video that will delight future visitors. He also assisted with excavation at the Pig Dig, provided on-site interpretation, and catalogued and prepared specimens.

Matt says his biggest contribution this summer was "the time I spent with the public, as well as the educational video of the Pig Dig. I feel great about it." He is happy that the materials he developed will continue to benefit visitors in the future.



Andrew Jeans helps visitors understand the origin of White Sands National Monument's snow-white gypsum sand dunes.

White Sands National Monument, New Mexico, Intern Andrew Jeans

Andrew Jeans, who grew up in Chester, New Hampshire, and attends Brigham Young University, is an accomplished public speaker. After he graduates, he plans to be a high school science teacher.

White Sands National Monument is a geologically fascinating location, and the park needed an intern who could help with interpretation of its geologic resources for the benefit of both visitors and staff. Andrew's combined background in teaching and geology was ideal. He led public geology walks and talks, helped lead teachers' workshops, and staffed the visitor center. He helped research the relationships between dune migration and vegetation and prepared new interpretive materials to help park staff present geology programs.

Andrew is particularly pleased with the geology slide presentation he researched and assembled for the park staff to use. He also collected a wealth of resources he will be able to use in the classroom and reports, "Creating and giving public programs and participating in teachers' workshops gave me valuable experience that will help me a lot as a teacher."

ber provided guidance to each intern, assigning their duties and monitoring their progress and well-being.

Most interns were surprised and pleased with the responsibility and independence they experienced. One said, "Nothing is set up like it is in the classroom, and there is no teacher to tell you if you're right or wrong." Another noted that the internship "helped me to see what geology out of an academic setting is like; it challenged me to find alternative plans and ways to go about a single project."

When asked what they learned during the summer, the interns' lists were long and eclectic. In addition to field methods,

research techniques, public speaking, preparing educational programs, new software, and a lot of geology, listed accomplishments included firing a shotgun, camping with grizzlies, shooting air photos, doing botany, planning a week in the field for 15 people, and "what it is to be a geologist."

The interns appreciated the chances they had to explore their parks. One wrote that his supervisor established a work schedule that included time each week for exploring the area and getting to know the greater context of the park. Several students commented that their parks had helpful orientation programs to prepare them to work with park visitors. Others mentioned that partici-

pating in wildlife and vegetation surveys or water- and air-quality studies gave them a broader understanding of the park's natural systems and their relationships to geology.

Would they do it all again? Their answer was a unanimous, "Yes!" The students grew in knowledge, experience, and confidence. Park staff, visitors, and researchers were rewarded by the students' energy, their fresh perspectives, and the geologic work they do. GSA and our outstanding program sponsors profit from supporting a successful, vibrant program whose positive outcomes will benefit visitors to the national parks for years to come.



Tessa Walker Watson explores backcountry geology in Denali National Park.

Denali National Park, Alaska, Intern Tessa Walker Watson

Tessa grew up in the wide-open spaces of western Colorado, and she has a wealth of hiking and camping experience. This past spring she graduated from Western State College, got married, moved—and left for Denali. Now reunited with her husband in Seattle, she is making plans for graduate school.

Denali needed an intern to finish identifying and cataloging the park's paleontologic collection into a usable resource for park staff and visitors. Tessa completed that

task, updated the park's GIS paleontological database, helped with research on Muldrow glacier, gleaned information from records of old mining claims, and hiked to remote localities to do surveying and other fieldwork.

Tessa said that she felt a great sense of accomplishment for completing the work on the park's fossil collection. She added, "I had an excellent intern experience. I was always given the support I needed from my supervisor and coworkers."



Jack Rogers takes a break amid slabs of ripple-marked sandstone at Petrified Forest National Park.

Petrified Forest National Park, Arizona, Intern Jack Rogers

Jack was a "nontraditional" undergraduate who came to school after retiring as a Chief Warrant Officer from the U.S. Army. He graduated from Tarleton State University this past summer and is beginning his graduate work in paleontology at Southern Methodist University. Jack's family includes a daughter, Michelle, who will graduate from college this semester. Jack says he was motivated by a strong desire to graduate first!

Petrified Forest personnel needed an intern to help research the park's vertebrate fossil sites and to help park staff understand

their geological and paleontological resources. Jack assisted with geologic research, helped prepare fossil samples, measured stratigraphic sections, researched general park geology, and helped with air-quality monitoring.

Adrian Hunt, Mesa Technical College, Tucumcari, New Mexico, reported that Jack discovered "only the fourth known Late Triassic dinosaur locality at the park" while assisting Hunt and his students this summer. Jack says he feels great about his discovery and about being an integral part of a field research project. He is also happy that his college courses prepared him to take full advantage of his internship.



Torrey Nyborg smiles through the heat in Death Valley National Park.

Death Valley National Park, California and Nevada, Intern Torrey Nyborg

Torrey is a senior at Portland State University, with dual majors in geology and biology. He would be there now, but his internship was so successful that he is at Fossil Butte National Monument in Wyoming,

working on an additional project. Torrey learned paleontological conservation techniques while studying at Cambridge University for a semester as an exchange student. He plans to pursue a doctorate in invertebrate paleontology and paleontologic conservation.

The internship at Death Valley National Park was added to the original program of five internships in response to generous program sponsors, extensive park needs, and a highly qualified pool of applicants. The park wanted an intern who could meet its critical geologic needs and assist with the identification, documentation, mapping, and preservation of its geologic and paleontological resources, someone who also could work with GIS databases and photography. Torrey inventoried and photographed rare fossil trackways, established GIS databases for fossil sites, produced a GPS map of the area, and provided input on developing preservation and monitoring plans for fragile paleontologic areas that will someday be open to the public.

Torrey says the prospect of fieldwork in 120-plus degree temperatures was a bit daunting but his love for paleontology prevailed. "Death Valley is a geologist's dream, and I was able to work on fossil vertebrate material of camels, horses, mastodons, birds, and cats that roamed Death Valley in a much more hospitable time period.... I hope to return." In fact, Torrey has applied for a National Park Foundation grant to do just that. ■

Maryland, College Park, MD 20742, USA. Applicants should provide a statement describing research and teaching interests, indicating how s/he envisions contributing to the department's research and teaching activities, a signed current curriculum vitae and the names and addresses of at least four referees. Applicants should ask referees to send letters directly to the Chair of the Search Committee as soon as possible. The Search Committee encourages applicants to submit copies of up to two recent publications in support of their candidacy.

**WESTERN STATE COLLEGE OF COLORADO
GEOMORPHOLOGY AND QUATERNARY GEOLOGY**

Western State College of Colorado invites applications for a tenure-track teaching position in geology with an emphasis in geomorphology and Quaternary geology. Teaching responsibilities include introductory courses in geology and geomorphology. Depending on expertise, the successful candidate will also be responsible for the development of undergraduate courses in some of the following areas: hydrogeology, hazard mitigation, recent earth history, and/or climate change in the intermountain west. Knowledge of and research interests in the Rocky Mountain West, and a strong commitment to field oriented research that involves undergraduate students is highly desirable. A Ph.D. and demonstrated excellence in teaching and advising undergraduates are essential. Previous experience supervising undergraduate research, involvement in interdisciplinary programs, and experience in GIS, environmental planning and/or mitigation are highly desirable.

To apply: Send a letter of application, curriculum vitae, statement of teaching philosophy and research goals, college transcripts, and three letters of recommendation to: Geology Search, Department of Natural and Environmental Sciences, Western State College, Gunnison, CO 81231. Applications must be postmarked by January 5, 1999. Position begins in the fall of 1999. For additional information, visit our home page (<http://www.western.edu>), or contact Dr. Robert Fillmore, phone (970) 943-2650; e-mail fillmore@western.edu, or Dr. Allen Stork, phone: (970)943-3044; e-mail astork@western.edu.

Western State College is an equal opportunity and ADA employer and specifically invites applications from women and individuals of diverse cultural or ethnic background. Western provides reasonable accommodations in the workplace and in the application process.

**LANDER UNIVERSITY
ENVIRONMENTAL GEOLOGIST**

Environmental Geologist: Assistant Professor, Tenure-track: August 1999. Required: Ph.D. in geology, geomorphology, or physical geography, ability to communicate in English. Teach physical and environmental geology, environmental science, and hydrogeology, coordinate ES degree program, and direct undergraduate research. Teaching experience and regulatory/consulting experience in environmental science preferred. Send application letter, CV, statement of teaching philosophy, unofficial transcripts, and names, addresses, and telephone numbers of three references to: Dr. Leonard Lundquist, Chair, Division of Biological and Physical Sciences, Lander University, Greenwood, SC 29649. Screening begins December 1, 1998, and continues until the position is filled. Applications from women and minorities are especially encouraged. <http://www.science.lander.edu/jobs.html>. AA/EEOE.

**MINERALOGY OR GEOBIOLOGY
NORTHERN ILLINOIS UNIVERSITY**

The Department of Geology and Environmental Geosciences invites applications for a tenure-track position to begin in August 1999 at the assistant professor level. We seek an outstanding scientist who can make important, innovative, and collaborative contributions working closely with other faculty to advance our strengths in the areas of groundwater/environmental studies, late Cenozoic global climate change, or crust-mantle cycles. Areas of focus that will be given preference include clay mineralogy, environmental mineralogy, biomineralogy, paleontology, paleoenvironmental studies, and synchrotron radiation studies of earth materials. The successful candidate will be expected to maintain a vibrant, externally funded research program involving B.S., M.S., and Ph.D. students and have a commitment to excellence in teaching at both the undergraduate and graduate levels. Evidence of the ability to generate external funding will be an important consideration. A Ph.D. in the geosciences or a related field is required. Applicants should send a curriculum vitae, list of publications, statement of teaching and research interests, and the names and addresses (including e-mail) of at

least three references to: Dr. Jonathan H. Berg, Chair, Department of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, IL 60115. For equal consideration, applications should be received by January 4, 1999.

NIU is a member of the Consortium for Advanced Radiation Sources and lies within commuting distance of Argonne National Laboratory. The department consists of 14 faculty, 30-40 graduate students, and 30-40 undergraduate majors. Women and minority scientists are particularly encouraged to apply. NIU is an equal employment opportunity/affirmative action institution.

**ASSISTANT PROFESSOR OF SOIL/
WATER SCIENCE/HYDROLOGY
UNIVERSITY OF CALIFORNIA, RIVERSIDE**

Date Available: July 1, 1999

Responsibilities: This 11-month, tenure-track position is 40% teaching and 60% research. The appointee will be expected to teach undergraduate and graduate courses related to soil and water science and to direct graduate students in the soil and water science and the environmental sciences graduate programs. The appointee will be expected to develop an independent research program in surface and/or subsurface hydrology which integrates hydrologic processes with pedological, ecological and biogeochemical processes. S/he will have the opportunity to work with other soil/water/environmental scientists in developing integrated approaches for the environmentally sound management of soil and water resources in agricultural, urban, and natural systems.

Qualifications: Candidates must have a Ph.D. with strong training and demonstrated interest in conducting research in surface and/or vadose zone hydrology, transport processes in soils and watersheds, and modeling. Experience in field experimentation and GIS applications in hydrology are highly desired. 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. Lanny J. Lund, Chair, Department of Environmental Sciences, University of California, Riverside, CA 92521. The closing date for applications is January 29, 1999.

The University of California is an equal opportunity/affirmative action employer.

**CHAIR, DEPARTMENT OF GEOLOGY
EAST CAROLINA UNIVERSITY, GREENVILLE, NC**

Applications are invited for the position of Chair, Department of Geology, College of Arts and Sciences, East Carolina University, effective August 1999.

The successful candidate will be charged with guiding the continuing development of a dynamic science department consisting of 9 faculty strongly committed to excellence in teaching and research. The Geology Department has BS professional and MS graduate degrees, and is one of the lead departments (geology, biology, and social sciences) in a recently approved interdisciplinary Ph.D. program in coastal resource management to start in August 1999.

East Carolina University is the third largest of sixteen institutions in the University of North Carolina system, with an enrollment of 17,500 students. The university consists of a College of Arts and Sciences, eleven professional schools, and a School of Medicine and has recently achieved Doctoral II status. The university and department are members of the N.C. Oceanographic Consortium and have close working ties with personnel at sister institutions having coastal and marine programs.

Field of specialization is open, but it should complement and dovetail with the new Ph.D. program. Requirements include: (1) A Ph.D. with a strong record of funded research and significant publications; (2) A clear vision of the future of earth sciences and a record of excellence in undergraduate and graduate teaching; (3) Excellent leadership capabilities and interpersonal skills; and (4) Administrative experience at the department level or equivalent. Appointment will be at the rank of tenured full professor with competitive salary and start-up funds.

Submit a letter of application outlining your qualifications; research, teaching, and administrative philosophy; reasons for seeking the position; a current vitae; copies of all degree transcripts (official copies required at time of employment); and names and contact information of four persons willing to provide recommendations. Send the completed package to: Dr. Robert Bernhardt, Chair of Search Committee, Department of Mathematics, East Carolina University,

Greenville, NC 27858-4353. The position is open until filled; screening begins on January 15, 1999.

An equal opportunity/affirmative action university. Accommodates individuals with disabilities. Applicants must comply with the Immigration Reform and Control Act.

**TRINITY UNIVERSITY
ONE-YEAR FACULTY APPOINTMENT**

The Department of Geosciences at Trinity University invites applications for a one-year term position. The appointment will be made at the rank of instructor and will begin August 1999.

A Ph.D. in geosciences (or directly related field, e.g. geochemistry) is required. The successful candidate must have a commitment to undergraduate teaching. Previous experience teaching at the college level is desirable. The teaching load will be nine to twelve contact hours per semester. Responsibilities include teaching introductory courses in geology (lecture and lab) and upper division courses in the candidate's area of expertise. The area of expertise is open, but should complement the strengths of the existing faculty in the department, which include structural geology, igneous petrology and geochemistry, volcanology, geophysics, oceanography, GIS and remote sensing, hydrology, and paleontology.

To apply, send a letter of intent, curriculum vitae, and three names of references to Diane R. Smith, Chair, Department of Geosciences, Trinity University, 715 Stadium Drive, San Antonio, TX 78212-7200. Closing date is February 15, 1999.

Trinity University is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

**HYDROGEOLOGY
UNIVERSITY OF MICHIGAN**

The Department of Geological Sciences seeks to fill a tenure-track position at the Assistant Professor level or, in exceptional cases, at a higher level. We seek a geoscientist with broad research interests in the physical and chemical aspects of hydrogeology. We are especially interested in applicants who have worked on large-scale regional or basin-scale fluid migration. Experience with field-based data sets, computational approaches, and environmental aspects of hydrogeology would also be attractive. We expect the applicant to develop a vigorous research program and to teach at both the graduate and undergraduate levels, including involvement in our new Environmental Geology degree program. Regular participation in introductory earth science courses is expected. A Ph.D. is required. Interested persons should send a curriculum vitae, names of five persons from whom the department may request letters of recommendation, and brief statements of their research and teaching interests to: Prof. Lynn M. Walter, Search Committee Chair, Department of Geological Sciences, University of Michigan, Ann Arbor, MI 48109-1063 (e-mail: lmwalter@umich.edu). To receive a careful evaluation this academic year, applications should be received by March 1, 1999. This search will continue until the position is filled. The University of Michigan is an affirmative action, equal opportunity employer.

FLORIDA ATLANTIC UNIVERSITY

Florida Atlantic University, Charles E. Schmidt College of Science, Department of Geography and Geology invites applications for two positions for the 1999-2000 academic year. Both positions require an earned Ph.D. and appointment begins in mid-August 1999.

Position 1. Tenure-track assistant professor of geology. The Department seeks additional faculty support in stratigraphy and sedimentology, modern field methods, and undergraduate field camp. Additional areas of expertise and interest from within the following: environmental geology, engineering geology, hydrogeology, and paleoenvironments. Documented ability and interest in quality teaching and a record of or demonstrable aptitude for funded research required.

Position 2. A non-tenure-track visiting faculty member to support our hydrogeological modeling program. Ability to teach graduate groundwater flow modeling and assist in an ongoing groundwater research program in south Florida is essential.

Responsibilities include appropriate teaching, scholarship, and service in support of the department's baccalaureate and masters programs. The department consists of 13 full-time geologists and geographers along with several part-time faculty and adjunct instructors. Salary is competitive.

Applicants should include a summary statement of qualifications and interests, academic transcript, curriculum vitae, and a list of references (references will be contacted directly). Apply: Ronald R. Schultz, Chair,

Department of Geography and Geology, Florida Atlantic University, Boca Raton, FL 33431. Phone (561) 297-3250, fax 561-297-2745, e-mail schultzr@fau.edu. Please visit our Web site at: <http://www.geogeo.fau.edu> for further information on our programs and faculty interests. FAU is an equal opportunity/equal access/affirmative action institution. Closing date is February 20, 1999. Positions are subject to availability of funding.

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Opportunities for Students

Postdoctoral Research Position. Applications are invited for a postdoctoral research position in the area of fluid inclusion, stable isotope, and trace element geochemistry applied to nuclear waste management issues. The position will involve petrography, micro trace element analyses, micro stable isotope analyses, and fluid inclusion studies. The successful candidate will work with a team of scientists from UNLV and the U.S. Geological Survey, but will be expected to plan and execute his or her component of the project with a minimum of supervision. The candidate will conduct petrographic studies, contribute to identifying analytical work to be conducted and will perform or supervise those analyses at various laboratories in the U.S.

Minimum requirements include a Ph.D. in geology or geochemistry, strong written and oral communication skills, and experience in petrographic studies. Experience in stable isotope and fluid inclusion studies is highly desirable. The position is funded through the U.S. Department of Energy and will be available for two years, pending satisfactory performance, with possible extension for a third year. Review of applications will begin December 1, and continue until a satisfactory candidate is found; however, a decision will not be made until after January 15, 1999. Salary will be commensurate with qualifications and experience. Availability of the position is contingent upon funding. UNLV is an affirmative action/equal opportunity employer. Minorities, women, veterans and the disabled are encouraged to apply.

Interested applicants should send a CV and letter of interest, and arrange to have three letters of recommendation sent to Dr. Jean S. Cline, Department of Geoscience, UNLV, 4505 Maryland Parkway, Box 454010, Las Vegas, NV 89154-4010. E-mail: jccline@nevada.edu. For more information visit our Web site at <http://www.unlv.edu>.

Planetary tectonics, University of Nevada, Reno.

Applications are invited from outstanding students for graduate work on the tectonics of Mars, with emphasis on faulting, fault-population statistics, slope stability, and rock mechanics. 1-2 new positions are anticipated to start in August 1999. The successful applicants will possess strong academic skills, be highly motivated, and have demonstrated prior experience in research. Ph.D. applicants preferred. Applicants must also have background and/or experience in planetary science and higher mathematics/numerical analysis; M.S. degree in planetary geology or geophysics would be an asset. Related attributes include good field and interpersonal skills along with proficiency in computer applications including Unix systems; engineering courses would be a plus. These research associations offer a generous stipend with tuition and fees. UNR is located in a setting ideal for related field work and world-class recreation.

Qualified and interested students should contact Dr. Richard Schultz, Geomechanics-Rock Fracture Group, Geological Engineering Program, Department of Geological Sciences/172, University of Nevada, Reno, NV 89557-0138; (508) 289-3459; e-mail (preferred), rschultz@whoi.edu. For information on specific program areas visit <http://unr.edu/homepage/schultz>. Application materials and Departmental information are available from ramos@mines.unr.edu.

Doctoral Student Opportunities. Petrology, geochemistry, and isotope geochemistry, Université Libre de Bruxelles, Belgium. The research group Isotopes-Petrology-Environment of the Department of Earth and Environmental Sciences at ULB has received funding for a multi-year project on the evolution of the Kerguelen mantle plume, southern Indian Ocean. Two 4-year positions for doctoral students are available, and applications are invited to start before the end of 1998, or as soon thereafter as possible.

WATER RESOURCES COORDINATOR State of Missouri

The Missouri Department of Natural Resources: "Preserving and Protecting Missouri's Natural, Cultural and Energy Resources."

The State of Missouri is seeking qualified candidates for its Water Resources Coordinator position within the Division of Geology and Land Survey. This position serves as deputy division director, assisting both the department director and the division director with planning, coordination and policy research concerning state and national water resource issues. The ideal candidate for this position will lead a team of individuals working to develop state and national water policy that ensures current and future protection of Missouri's water resources. Candidates must possess at least 5 years of experience in planning and project development, project evaluation and demonstrated experience in establishing and maintaining effective working relationships with representatives from government, industry, professional associations, citizen groups and the public. Communication and negotiation skills are critical to the position. In addition, candidates must be graduates from an accredited four-year college or university with a bachelor's degree in planning, public or business administration, environmental sciences, public health or closely related area.

The salary for this position is \$60,408. Cover letter, resume, college transcripts and three letters of reference attesting to credentials and professional accomplishments should be mailed to:

Water Resources Coordinator Vacancy, c/o Personnel Director,
Missouri Department of Natural Resources Personnel Program,
PO Box 176,
Jefferson City, MO, 65102.

Application materials should be received by January 11, 1999;

MoDNR is An Equal Employment /Affirmative Action Employer
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Missouri Department of Natural Resources

E E O - A A - V - D - M / F

The dissertation projects will involve detailed petrology and geochemistry of the basaltic lava sequences exposed on the Kerguelen Archipelago sampled during a long-term mapping program with two field seasons remaining, or drilled on the submarine Kerguelen Plateau during the upcoming ODP Leg 183, Dec. 1998-Jan. 1999. The projects will require characterization of mineral chemical variations, whole rock major and trace element geochemistry, and isotope geochemistry of age-constrained stratigraphic sections to better understand the evolution of plume-derived magmas in high-level magma chambers or during ascent, and the melting histories in a major mantle plume environment.

Brussels, the capital of the European Community, provides a multi-cultural environment in which to live, with easy access to the major cities and countryside of western Europe. English and French are the working languages. After-tax salary is about US\$15,000 per year, and complete health coverage is provided.

Interested students should contact Dr. Dominique Weis and/or Dr. James Scoates, Department of Earth and Environmental Sciences (DSTE), Université Libre de Bruxelles CP 160/02, Avenue F. D. Roosevelt 50, B-1050, Brussels, Belgium; Tel: +32-2-650-3748; fax: +32-2-650-2226; e-mail: dweis@ulb.ac.be or jscoates@ulb.ac.be. Prospective applicants should send a curriculum vitae, cover letter, and three letters of reference. For information on the Kerguelen project see our Web site at <http://homepages.ulb.ac.be/~dweis/research/KergArch.html>.

Graduate Research Opportunities in Geology, Geochemistry, Geophysics, and Space Physics at UCLA. The Department of Earth and Space Sciences at UCLA is seeking qualified graduate students to join our top-ranked research program in many related fields including volcanology, petrology and isotope geochemistry of active volcanoes around the Pacific Rim; tectonics of the Himalayas, Tibetan plateau, and the North American Cordillera; the origin, explosion, and extinction of life; seismology, earth structure, earthquake dynamics, mineral physics, and mantle dynamics; and the physics of the terrestrial and giant planets, including their climate, space environments, and interaction with the sun. Student support is available through combinations of competitive fellowships, and also graduate research and teaching assistantships. Our graduate programs offer an environment where students are encouraged to explore

the frontiers of science working in close collaboration with our faculty. UCLA has outstanding facilities for research including mass spectrometers for analysis of stable and radiogenic isotopes and rare gases, and high resolution ion microprobe, electron microprobe, experimental petrology laboratories, ongoing experiments on the Galileo, Mars Polar Pathfinder, FAST and Polar spacecraft, as well as superb instrument fabrication facilities, a GPS laboratory, one of the continent's most extensive libraries, and we are a principal institution in the Southern California Earthquake Center. Information about our programs can be obtained by visiting our website at <http://www.ess.ucla.edu> or by writing Spring Verity, Student Affairs Officer, Department of Earth and Space Sciences, University of California, Los Angeles, CA 90095-1567, or e-mailing verity@ess.ucla.edu, or by calling toll-free (888) ESS UCLA. Please note that applications are due by December 15, 1998, and can be submitted electronically via <http://www.gdnet.ucla.edu>.

INTERDISCIPLINARY STUDIES FIELD-ORIENTED PHYSICAL GEOGRAPHY, EARTH SCIENCES OR LIFE SCIENCES

The Hutchins School of Liberal Studies at Sonoma State University invites applications for the tenure-track position of Assistant/Associate Professor of Interdisciplinary Studies: Field-Oriented Physical Geography, Earth Sciences or Life Sciences beginning fall 1999. Candidates should have a broad academic background, expertise in two or more of the following fields: physical geography, oceanography, geology, biology and environmental sciences, and experience in field-based studies. Experience in interdisciplinary curriculum development, team-teaching and seminar-based learning is highly desirable. Postmark deadline: December 18, 1998 (for preferred consideration). Final postmark deadline for applications is January 22, 1999. Please request position announcement #A008-99/00, application requirement and program description available from Prof. Les Adler, Chair, Hiring Committee, Hutchins School, Sonoma State University, 1801 E. Cotati Avenue, Rohnert Park, CA 94928-3609, (707) 664-2491, fax 707-664-4400, e-mail les.adler@sonoma.edu, TDD (707) 664-2958. Information is also available at <http://www.sonoma.edu/hutchins/>. Women, ethnic minorities and those with disabilities are encouraged to apply.

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