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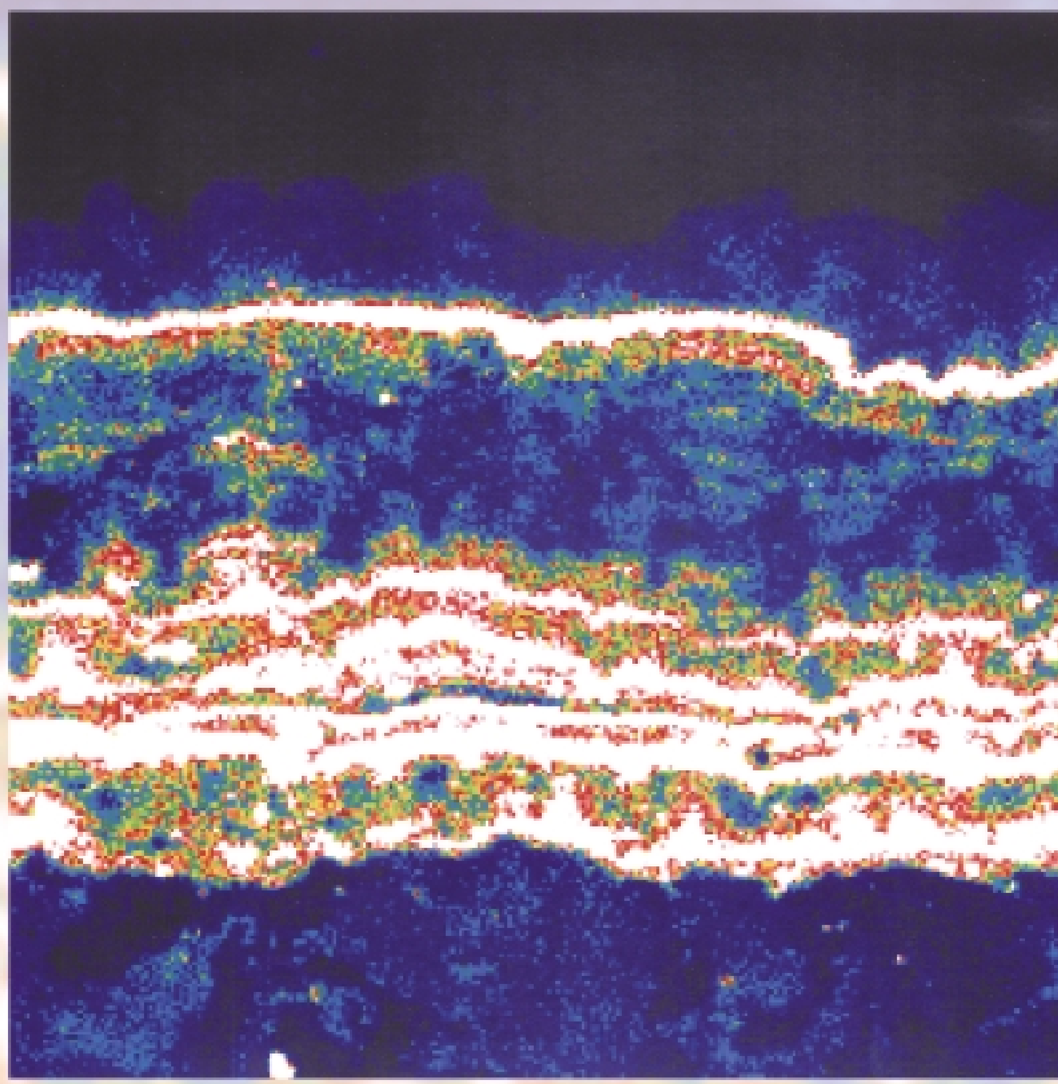
Rock Varnish: Recorder of Desert Wetness?



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GSA TODAY

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On the cover: Chemical microlaminations of Ba in rock varnish from a late Pleistocene alluvial-fan surface in Death Valley, California, as determined by X-ray electron microprobe mapping (128 × 128 μm). Bright layers in the image are enriched in Ba (1.0–4.0 wt%) and blue layers are depleted in Ba (<0.5 wt%); the red-orange layers contain intermediate amounts of Ba (0.5–1.0 wt%). The topmost Ba-poor blue layer is interpreted to represent the Holocene dry period, and the Ba-rich bright layers to represent glacial-age wet periods. These bright layers possibly correlate with the Younger Dryas and Heinrich events in the North Atlantic region. The basal blue layer represents the Ba-poor substrate rock. Note that post-depositional chemical leaching has altered some Ba-rich bright layers in the middle to upper portion of the image into blue layers. See "Rock Varnish: Recorder of Desert Wetness?," by Broecker and Liu, p. 4–10.

Rock Varnish: Recorder of Desert Wetness?

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ABSTRACT

Rock varnish is a thin coating (<200 μm) of a cocktail rich in Mn, Fe, and clay minerals that is ubiquitous in desert regions. It has become the center of a contentious controversy revolving around its use to date geomorphic surfaces and/or to evaluate past climate conditions. We observe pronounced temporal variations in Mn and Ba concentration that are similar over large regions and that likely relate to variations in paleo-wetness. The mode of formation of varnish remains uncertain, but anthropogenic Pb concentrated in outermost varnish layers indicates its continued formation, and experiments using cosmogenic Be suggest that, while precipitation is a primary control, dust, dew, and aerosols may also be important in delivering the ingredients of varnish. We suggest several steps that may lead to rejuvenation and future breakthrough in varnish studies.

INTRODUCTION

Over the years, the suggestion of a large-scale geographic pattern of planetary wetness has emerged, namely, during glacial time, the extratropical deserts were wetter and at least some tropical areas were drier than they are now. A dramatic switch to present conditions occurred 15500 yr B.P. at the onset of the Bølling-Allerød warm, a brief return to interglacial conditions preceding the Younger Dryas cold snap (12000 yr B.P.). For example, at this time, equatorial Africa's Lake Victoria, which was dry during last glacial time, was rejuvenated, and the Great Basin's Lake Lahontan suddenly shrank from its highest shoreline to a size ten times smaller (Broecker et al., 1998). If it could be demonstrated that this pattern was indeed global, then we would have strong evidence that a major change in the dynamics of the atmosphere's Hadley cell (upwelling of air in the tropical convergence zone coupled with downwelling in the extratropics) occurred. The problem is that detailed and well-dated climate records in desert regions are very hard to come by. This is especially true for times beyond the useful range of ^{14}C dating (i.e., ~30000 yr). Rock varnish has the potential to yield wetness records extending back to the last interglacial period for each of the world's desert regions.

However, the study of rock varnish has been put in jeopardy by controversies revolving around the reliability of dating rock varnish (Dorn, 1996; Beck et al., 1998) and of correlations among varnish records (Reneau et al., 1992; Reneau, 1993). Radiometric dating of varnish itself has not proven possible. First of all, the varnish contains virtually no carbon. Further, its near-unity ratio of $^{232}Th/^{238}U$ activity precludes ^{230}Th dating. The cation-ratio method proposed by Dorn (1983) has received heavy criticism (Bierman and Gillespie, 1991; Reneau and Raymond, 1991). In an attempt to date the geomorphic surfaces on which the varnish forms, Dorn has published 200 or so radiocarbon ages (Dorn et al., 1989; Dorn et al., 1992a, 1992b). But, as shown by Beck et al. (1998), a large number of Dorn's samples are mixtures of a coal-like substance with very little ^{14}C and pyrolyzed wood with an apparent radiocarbon age of several thousand years. Hence, this approach has also fallen into disrepute, as has the cation-ratio method. There also have been claims that no reliable climate signals exist in the chemical stratigraphy of rock varnish (Reneau et al., 1992; Reneau, 1993).

Despite these setbacks, we are convinced that rock varnish does indeed bear an amazing record of wetness in Earth's desert regions. Rather than being measured in centimeters of accumulation per millennium, the sedimentary record in varnish is measured in micrometers of accumulation per millennium. Instead of being found in depositional basins many kilometers wide, varnish records are found in tiny "basins" with spans of only a millimeter or so. The climate record in varnish is contained in variations of its color and chemical composition. Varnish from Death Valley shows a particularly large range, with MnO_2 concentrations extending from a low of 4% in the Holocene to a high of 40% during parts of the last glacial period (Fleisher et al., 1999; Fig. 1). We suspect but cannot yet prove that the greater the rainfall, the higher the MnO_2 content of varnish. In this paper, we will try to convince the reader of the potential offered by the rock varnish record by attempting to answer questions most often posed by critics.

Is the Record in Varnish Free from Flaws?

The answer to this question is "no." As is the case for most sedimentary sequences, erosional truncations and diagenetic alteration complicate the reading of the varnish record. Extreme care must be taken in order to minimize these imperfections. We have developed our own set of criteria. In the field, we look for the most stable rock surfaces with the highest probability of having the most complete varnish stratigraphy (but not necessarily the most extensive, darkest, or thickest varnish cover). In the laboratory, we look for varnish "microbasins" (i.e., varnish-filled dimples in the rock surface) that have a width-to-depth ratio of ~10, for they contain the most complete varnish microstratigraphy. Thin sections are cut to pass through the centers of selected dimples. A transmitted-light microscope helps in determining whether the varnish has distinct color layers that extend uninterrupted across the entire microbasin. Because accumulation does not necessarily begin at the same time in all microbasins on a given surface, comparisons reveal which of the basins contains the longest sequence of color variations. Element maps and element line profiles are then obtained using an electron microprobe on these thin sections.

Based on the examination of tens of thousands of varnished rocks in the field and thousands of thin sections in the lab, it appears to us that randomly sampled varnish surfaces rarely record reliably the full sequence of chemical events that transpired since the geomorphic surface was created. Further, random sections are often compromised by solution events, erosion, and peeling. Thus, lack of care in the selection of varnish

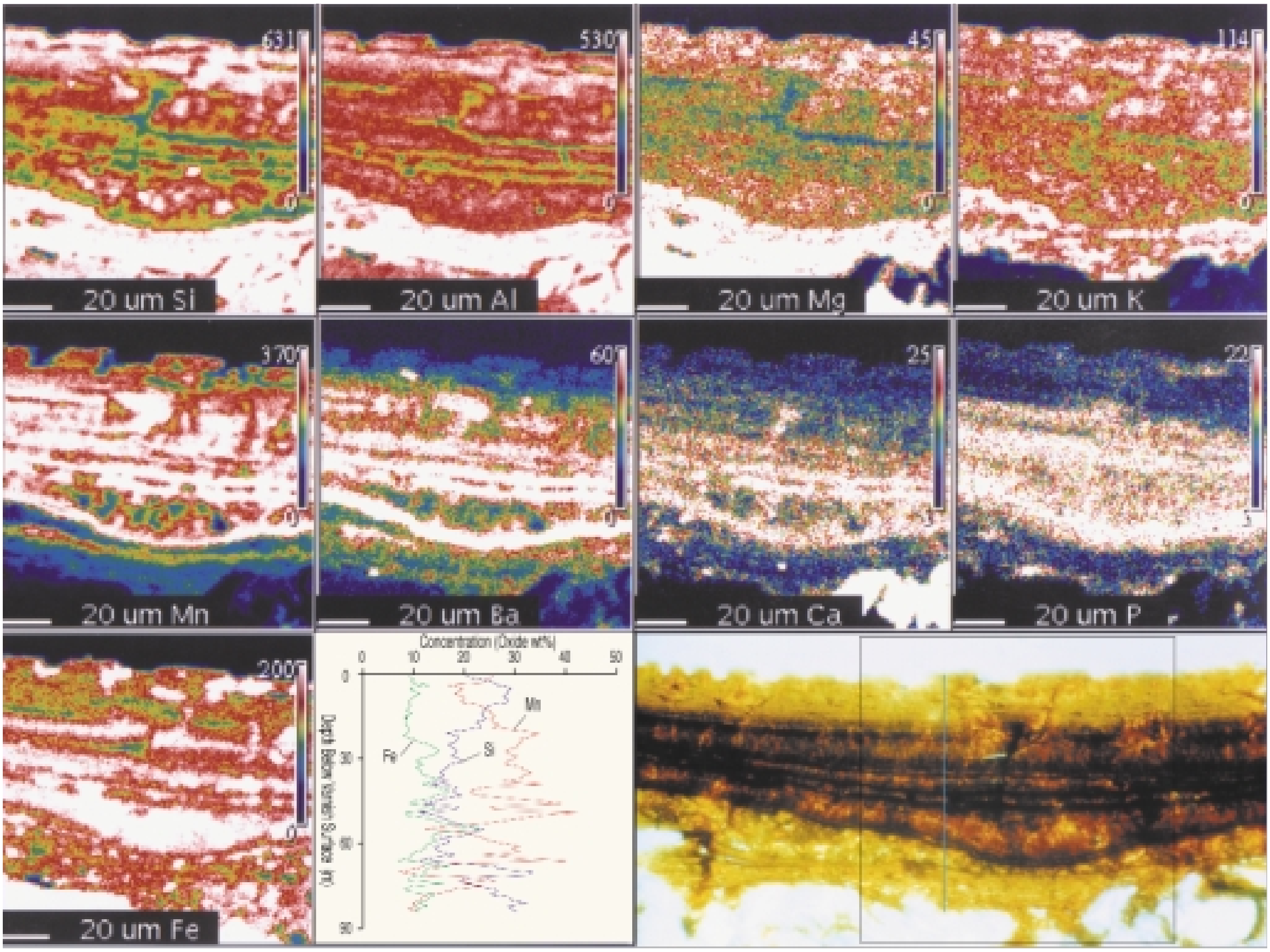

Figure 1. Photograph (lower right) and electron microprobe element maps produced from a varnish thin section from Death Valley, California. Si, Al, Mg, and K achieve their highest concentrations in yellow layer at top of varnish (interpreted to be Holocene) and in yellow layer at base of varnish (interpreted to be last interglacial). In contrast, Mn, Ba, Ca, and P achieve their highest concentrations in dark layers (interpreted to represent last glacial time). Fe shows smallest glacial-to-interglacial change in concentration. Probe-mapped portion of varnish marked by square in photograph. Profile of Mn, Si, and Fe contents was taken along a traverse designated by vertical blue line in photograph. White-blue patches at the base of thin-section photograph are minerals in host rock.

microbasins may have led to many of the negative results found in the varnish literature.

Are Variations in Chemical Composition of Varnish a Reflection of Changes in Regional Environmental Conditions?

One piece of evidence in support of a "yes" answer comes from studies of varnish from throughout the dry regions of the western United States. While the absolute MnO_2 concentrations vary from place to place, the pattern of its concentration with depth in varnish microbasins is similar over the entire region. As shown in Figure 1, the outermost (interpreted to be Holocene) varnish is consistently lower in MnO_2 than varnish ~10 µm down (i.e., glacial age), and when the varnish record extends back into what we consider to be the last interglacial period, MnO_2 contents akin to those for the Holocene are found. Furthermore, during what we consider to be glacial time, a number of fluctuations from high to intermediate MnO_2 are seen. In transmitted light, the low-MnO_2 content varnish is yellow, the intermediate-MnO_2 content varnish is orange, and the high-MnO_2 content varnish is black (Perry and Adams, 1978). The zone in the varnish that we infer to represent the last glacial period is characterized by a series of black bands separated from one another by orange bands (Fig. 1). While the dating remains uncertain, it is tempting to correlate these black bands with the six Heinrich events and the Younger Dryas (Liu and Dorn, 1996). Although Ba is present in much lower concentrations than is Mn, it may prove to be a better proxy. This is because as the MnO_2 content rises so also does the ratio of BaO to MnO_2. As a consequence, the BaO concentration has a higher signal-to-noise ratio than does the MnO_2 concentration (Figs. 2 and 3). While for the most part Ba is not present as $BaSO_4$ (i.e., the SO_4 concentration is far lower than the BaO concentration), there are spikes in the BaO record resulting from the presence of $BaSO_4$ (Reneau et al., 1992). These inclusions are rare and can easily be deleted from the record based on the SO_4 concentration.

Independent evidence regarding the wetness record for the western United States drylands comes from reconstructions of the sizes of closed-basin lakes. As the water reaching these lakes must be balanced by evaporative loss, their sizes reflect the excess of precipitation over evaporation in their drainage basins. Over a wide geographic area and regardless of position relative to the source of precipitation (e.g., Lake Lahontan and Lake Bonneville; see Benson et al., 1990; Lake Estancia; see Allen and Anderson, 1993), all the lakes were far larger during glacial time. Further, they achieved their maximum sizes late in glacial time (i.e., ~15 500 yr B.P., just before the onset of the Bølling-Allerød warm in the northern Atlantic region). Then, after shrinking to near their present size, there is some evidence that they were rejuvenated during the Younger Dryas (Smith and Street-Perrott, 1983; Benson et al., 1995). This suggests that the entire Great Basin was somewhat wetter than it is now during late glacial time and probably also during the Younger Dryas.

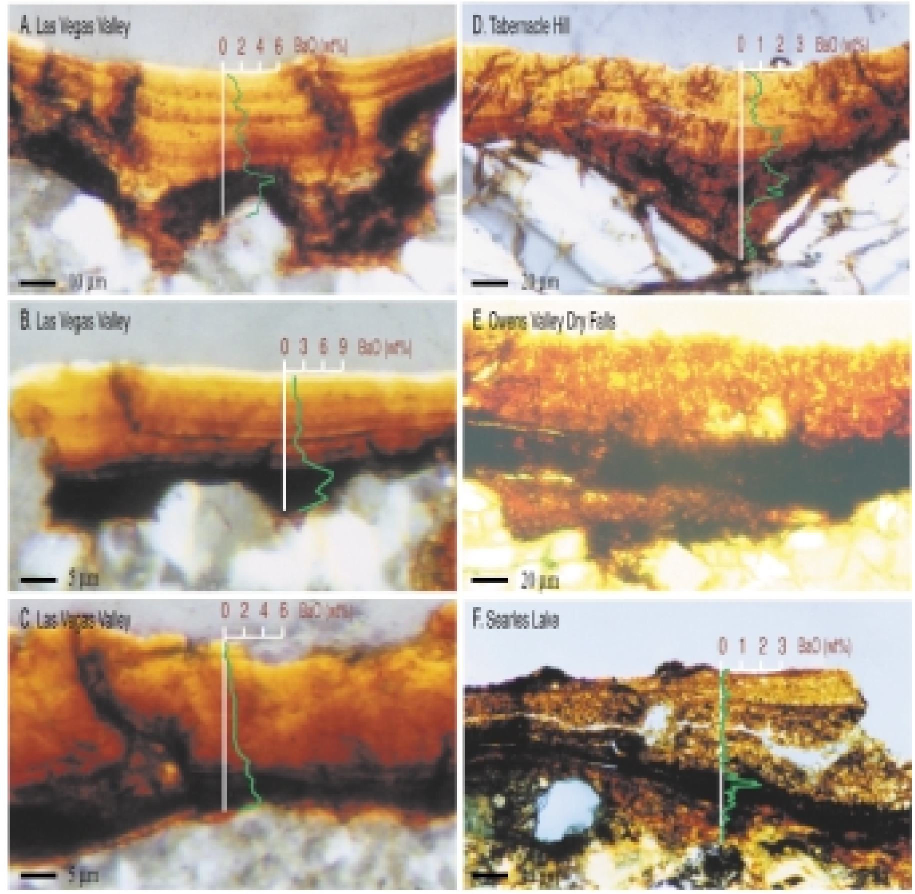

Figure 2. Left: Three varnish thin sections from ~13 ka alluvial-fan surfaces in Las Vegas Valley, southern Nevada. **Right:** Three varnish thin sections from ~16 ka geomorphic features of Tabernacle Hill lava (Utah), Owens Valley Dry Falls, and Searles Lake high shorelines (California). Also shown are electron microprobe line profiles of Ba concentration in five of these varnish thin sections. Note that high Ba corresponds to dark layers, interpreted to be glacial time.

How Can Time Be Assigned to the Varnish Record?

Because no way has been found to obtain reliable radiometric ages of the varnish itself, it is possible to build a stratigraphy only by compositing varnish records formed on substrates of known age such as from rock surfaces on raised shorelines, basalt flows, alluvial fans, and moraines. Means exist to radiometrically date these geomorphic features. While radiocarbon is the most obvious choice, in desert regions the pickings are slim. Algal carbonates deposited from the waters of expanded glacial-age lakes (Benson et al., 1990) and black mats deposited in springs that were active during wet periods (Quade et al., 1998) are among the few choices. In a few cases, U-series dating has been successfully applied to algal carbonates dating beyond the range of radiocarbon. Basalt flows can in some cases be accurately dated based on the ^{40}Ar produced by the decay of radiopotassium. However, it is exposure dating based on the in situ production of cosmogenic isotopes that offers the greatest promise. This is especially true for glacial moraines and for lava flows. While potentially also applicable to cobble fans and wave-cut shorelines, all too often the rocks associated with these features have undergone prior exposure to cosmic rays.

Only two horizons in the western United States varnish stratigraphy have as yet been adequately dated. The age for one of these horizons is based on the radiocarbon dating of a fan alluviation and "black mat" episode in the southwestern United States (Haynes, 1967; Bell et al., 1998; Quade et al., 1998). These dates establish this event as a correlative of the Younger Dryas. The synchronous timing of paleo-spring deposition and fan alluviation suggests that the same wet event that supported spring flow also rejuvenated mountain piedmonts leading to the formation of cobble fans over black mats (Bell et al., 1998). The varnish on cobbles from these now-abandoned fan surfaces yields a record covering approximately the past 12 000 yr B.P. (Fig. 2; Liu et al., 2000).

The second well-dated level in the stratigraphic record kept in varnish is at 15 500 yr B.P. By chance, three well-dated sites in the Great Basin yield age control close to this age: the Tabernacle Hill basalt flow in Utah, the highest shoreline of Searles Lake in California, and Dry Falls, through which the outflow of Owens Lake, California, passed (Benson et al., 1990; Cerling, 1990). Varnishes from all three locales show the same pattern (Fig. 2).

While as yet not directly dated, a third prominent horizon is the sharp upward transition in color from yellow to black, which very likely represents the end of the last interglacial (Figs. 1 and 3). Based on varnish stratigraphies from radiometrically dated lava flows in the Cima volcanic field, California, and the Lathrop Wells volcanic field, Nevada

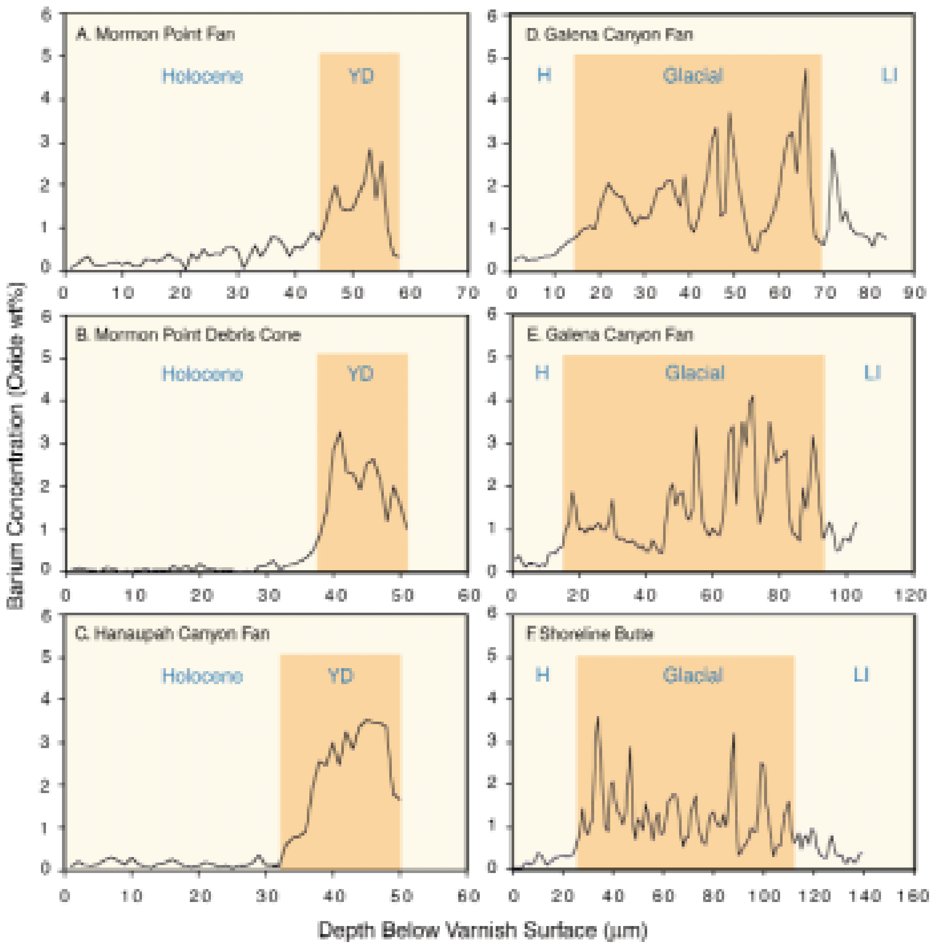

Figure 3. Electron microprobe line profiles of Ba concentration in varnish samples from Death Valley, California, interpreted to extend back to time of Younger Dryas (YD) (left three panels) and of the last interglacial (LI) (right three panels). Mean growth rates in these varnishes are 4–5 µm per millennium (A, B, C) and 1–2 µm per millennium (D, E, F). Note that sample F was from the Blackwelder highstand of Lake Manly in Death Valley that was U/Th dated at between 120 and 200 ka (Hooke and Dorn, 1992). Also note that microprobe element maps and thin-section photograph of sample D are shown in Figure 1. H—Holocene.

(Wells et al., 1995; Heizler et al., 1999), it is reasonable that this transition has an age of roughly 72000–77000 yr. Further, as this transition does not show up in varnish formed on ejecta from the well-dated Arizona Meteor Crater (Nishiizumi et al., 1991; Phillips et al., 1991), it is surely older than 50000 yr. One of the records shown here (Fig. 3F) comes from the Blackwelder highstand of Lake Manly in Death Valley, which, based on U/Th ages, likely formed during the penultimate glaciation (Hooke and Dorn, 1992). We tentatively place this boundary as the equivalent of the end of marine isotope stage 5, approximately 74000 yr B.P. (Martinson et al., 1987).

The ages of the black layers that lie between layers marking the base of the glacial section and layers at 15500 yr B.P. can be very roughly estimated by assuming that the mean rate of varnish accumulation was more or less the same for each orange-black pair. On this basis, the black layers appear to correlate with the pine intervals in the Lake Tulane pollen record and the intervening orange layers with oak intervals (Grimm et al., 1993).

Few varnish records extend back into the penultimate glaciation. As does paint, varnish appears to lose its grip on the host rock with age. This tendency to "peel" seems to correlate with thickness. Wind abrasion also reduces the varnish thickness. Varnish thicker than 200 µm is rarely found.

Some geologists and archaeologists have speculated that the basal age of the varnish can be estimated from its thickness. But as documented by Liu and Broecker (2000), such estimates are extremely misleading. Not only does varnish grow at a wide range of rates, but also, as just mentioned, its ultimate thickness appears to be limited by wind abrasion and its tendency to peel.

Does the Chemical Makeup of Varnish Reveal any Useful Information Regarding its Mode of Origin?

Oxides of Mn, Fe, Ca, Mg, Si, and Al dominate rock varnish. Ca correlates with Mn. Mg, Al, and Si anticorrelate with Mn (Reneau et al., 1992). Only the FeO content of varnish remains nearly unchanged through the entire record (Fig. 1).

One puzzling aspect of varnish chemistry is the enrichment of the large lithophile elements (i.e., Ba, U, Th, and the rare earth elements). Their concentrations are an order of magnitude higher than in shale or average igneous rock (Fig. 4). It is interesting to note that despite the fact that Th is highly particle reactive and U is not, they are not separated from one another in rock varnish. Thus, whatever process is responsible for their enrichment is not influenced by the large difference in their chemical affinities.

The dominance of the element Mn has led a number of authors to propose that the deposition of varnish is negotiated by bacteria that derive their energy by its oxidation (e.g., see Raymond et al., 1992). While this is an appealing hypothesis, direct evidence is lacking. One puzzle in this regard is why the ratio of Mn to Mg + Al + Si differs between times of glacial and interglacial climates. It could be the result of a higher rate of Mn accumulation during the wetter glacial times diluting a more nearly constant accumulation of Mg-Al-Si. If so, the varnish growth rate during glacial time would have been greater than during the Holocene. On the other hand, were the Mn accumulation rate constant and the difference in composition the result of a higher Mg-Al-Si accumulation rate during the Holocene, then the Holocene accumulation rates would be expected to have been higher than those during glacial time. Unfortunately, it is not possible to use the relative thicknesses of Holocene and glacial varnish to reliably distinguish between these two models. Not only does the ratio of the thicknesses

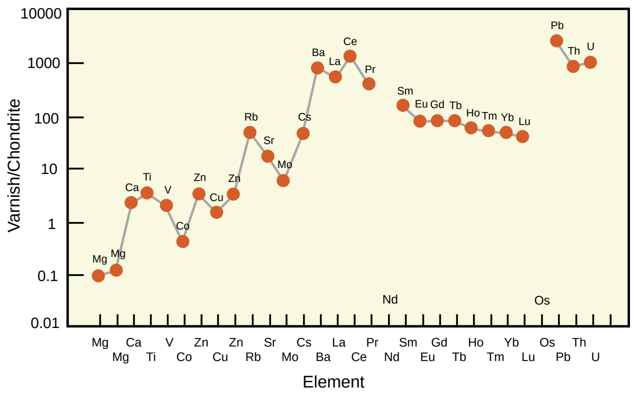

Figure 4. Plot of ratio of concentrations for a series of elements in varnish relative to their concentrations in chondritic meteorites. Large lithophile elements (Ba, the rare earth elements, Pb, U, and Th) are very highly enriched. U and Th in varnish range up to 20 times their concentrations in shale. Measurements made by Bill McDonough using Harvard laser inductively coupled plasma system.

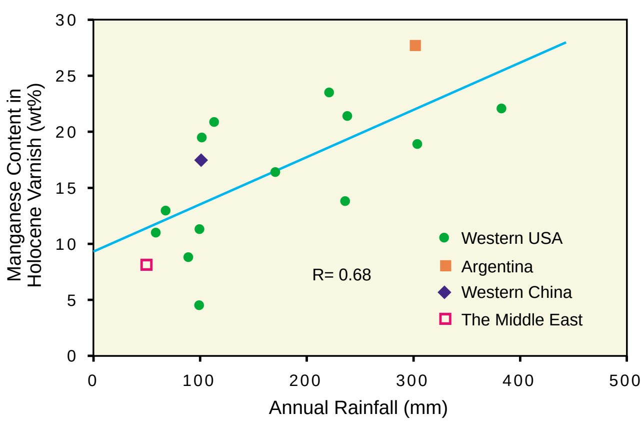

Figure 5. Plot of average Mn content (measured as MnO wt%) of Holocene varnish from western United States, Argentina, western China, and the Dead Sea graben of the Middle East. Nonzero y-intercept of trend line suggests that varnish receives some of its Mn from "dry" fallout and that Mn content increases by 4% per 100 mm of rainfall. But, because the scatter about the trend line is large (±6%), Mn content in varnish cannot be used as an absolute paleo–rain gauge.

vary from microbasin to microbasin on the same rock surface, but also it often changes from one side of a microbasin to the other.

The chemical form of the Mg-Al-Si component of the varnish is the subject of debate. The fact that X-ray diffraction patterns reveal the presence of clay minerals in the varnish suggests that trapped dust grains account for this component (Potter and Rossman, 1977). Because these minerals are not resolved in electron probe maps, they must be sub-micrometer in size. Thus, it is equally possible that these elements are mainly authigenic rather than detrital in origin.

How Do We Know That the MnO_2 Content of Varnish is Related to Wetness?

One way this might be demonstrated is by regressing the mean MnO_2 content of Holocene varnish against today's mean annual precipitation. This has been done for a number of sites in the Great Basin of the western United States (Fig. 5). There is a trend toward higher MnO_2 content with increasing precipitation. The best-fit trend line to these results indicates that were there no precipitation, the varnish would contain ~9% MnO_2. The slope of the mean trend line indicates an increase of ~4% MnO_2 per 100 mm of precipitation.

The nonzero intercept suggests that precipitation is not the only vehicle for delivery of the ingredients of varnish. Perhaps delivery in dust, aerosols, and dew also are important. In order to test whether this might be the case, we created (together with Willard Moore of the University of South Carolina) a varnish garden on Columbia's Biosphere 2 campus, bringing in varnished rocks from Panamint Valley, California, and from McDowell Mountain, Arizona. These rocks were placed exactly as they were originally situated and were exposed to the elements for eight months. Four of the eight were equipped with rain shields activated to move into place over the varnished rock by the rain itself. The other four had no shields. After the exposure, the varnish was analyzed for the presence of ^7Be, a 53-day–half-life radioisotope produced in the atmosphere by cosmic-ray bombardment. The ^7Be was chosen because it is the only naturally occurring tracer with a half-life short enough to permit interactive experiments. During the exposure period at Biosphere 2 (about 4 half-lives of ^7Be), more than 95% of the ^7Be that accumulated at the original locale would have decayed. Hence, the ^7Be measured must have been added during the exposure at Biosphere 2.

The result of this interactive experiment was that the four varnished rocks that were shielded from the rain accumulated only 38% ± 10% the amount of ^7Be as did those that were not equipped with rain shields (W. Moore, 2001, written commun.). Thus, at least to the extent that Be acts as a stand-in for MnO_2,

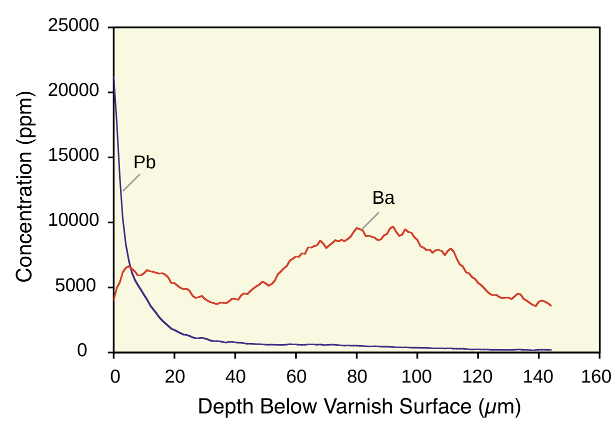

Figure 6. Plot of Pb and Ba concentrations (in ppm) vs. depth in varnish from eastern California indicating anthropogenic sources of Pb. As shown by separate experiments in which varnish was plated with Au and Ag, deep penetration of anthropogenic Pb is an artifact of analysis. Because growth rate of this varnish is only ~10 μm per millennium, excess Pb (likely from gasoline) must be contained in a layer <1μm thick. Instead (as do the Au and Ag plating), it extends more than 10 μm into the varnish.

roughly a third of the accumulation is delivered by some combination of dew, dust, and aerosols. This result is consistent with the relationship between MnO_2 concentration and precipitation (previously discussed). There is, however, a potential flaw in this experiment. Measurements of the integrated inventory of ^{10}Be (half-life 1.6 m.y.) in varnishes of known basal age showed that several percent of the ^{10}Be produced in the overlying air column accumulated (W. Moore, 2001, written commun.). In contrast, several tens of percent of the ^{7}Be produced in the overlying air column accumulated. One explanation for this difference could be that during its 75-day mean life, ^{7}Be atoms are merely absorbed on the varnish surface rather than built into it. Were they to have survived longer, perhaps subsequent rains would have removed a sizeable fraction.

Is Varnish Still Forming?

During the past 100 yr, a host of anthropogenic substances have been added to the atmosphere, which might alter the growth rate and chemistry of rock varnish. Manmade acids threaten to dissolve away previously accumulated varnish. On the other hand, excess deposition of dust and aerosols might enhance the growth of varnish. In an attempt to get a handle on these anthropogenic impacts, we have made measurements of short-lived natural radioactivities (^{7}Be and ^{210}Pb), of nuclides produced during nuclear bomb tests (^{137}Cs and Pu), of Pb released to the atmosphere from automobiles, and of Zn released from smelters. All of these entities have been documented in varnish (Fleisher et al., 1999). Pb shows an amazing tenfold increase in concentration in the outer 1 μm relative to its ambient Holocene concentration, clearly demonstrating the anthropogenic impact on varnish chemistry (Fig. 6). The presence of a large excess of ^{210}Pb (half-life 22 yr) in varnish can only be explained by deposition from the atmosphere. The ^{222}Rn that leaks from soils decays in the atmosphere, producing ^{210}Pb, which is carried back to Earth's surface in rain and in aerosols. Based on the ^{210}Pb inventories in varnish, Fleisher et al. (1999) estimate that the accumulation in varnish represents about 10% of that produced by the decay of radon in the overlying air column.

Will Rock Varnish Ever Become a Widely Applied Proxy for Desert Wetness?

On the time scale of a decade, the answer is almost certainly "no." Too many questions regarding its mode of origin and the relationship of its chemical composition to local environmental conditions remain unanswered. Further, far too few varnish records are available from well-dated geomorphic surfaces. And last, how long will it be before some young scientist comes along who is brave enough to pick up where we leave off?

Nevertheless, several steps might lead to rejuvenation and breakthrough in varnish studies.

(1) Continued development of rigorous criteria for the selection of varnished rocks, and the recognition of defects (Liu, 1994).

(2) Continued efforts to analyze a large number of samples from each area in an attempt to distinguish the regional signal from the local noise. The Ba record seems the most promising in this regard.

(3) Cooperation with researchers conducting cosmogenic isotope dating of geomorphic features in desert regions, which will allow essential comparison of varnish stratigraphies from a large number of dated surfaces.

(4) New studies to establish the lag time for nucleation of varnish. Perhaps the best hope will be through studies of geomorphic features associated with the Younger Dryas climate fluctuation.

(5) Comparisons between varnish records and records from the sediments of desert lakes. While the interpretation of the latter is subject to its own set of problems, ongoing drilling programs will produce a number of detailed lake sediment records spanning the last glacial period.

(6) Chemical and radiochemical measurements on material leached from the surfaces of varnish samples collected along downwind traverses away from the Nevada Test Site and away from selected smelters. The strategy would be to compare the relative abundances of anthropogenic entities captured in the varnish with those in soils. Such studies could provide clues to the chemical selectivity of the processes responsible for varnish formation.

(7) Further efforts to establish whether varnish formation is the product of the activity of living organisms (Taylor-George et al., 1983; Nagy et al., 1991; Staley et al., 1991; Grote and Krumbein, 1992). As part of our Biosphere 2 experiment, we subjected half of the varnished rocks to weekly ultraviolet irradiation, but found that this treatment did not diminish the uptake of ^{7}Be. However, as the ^{7}Be may have been absorbed onto the varnish surface rather than incorporated into the varnish, this experiment was likely flawed. If this distinction is to be made, efforts by clever bacteriologists will be required.

CONCLUSIONS

Rock varnish is a substance meriting serious study. Even if its application as a recorder of past desert environments fails to pan out, its mode of origin certainly constitutes a riddle that is bound to captivate inquiring minds. It may also be important for understanding a likely habitat for the most primitive living organisms.

ACKNOWLEDGMENTS

This research was funded by the U.S. Department of Energy. We thank those people who have provided great help in our study of rock varnish over the past five years. Lamont-Doherty's Marty Fleisher, Sidney and Gary Hemming, and Bob Anderson not only made isotopic analyses for us, but they also provided numerous suggestions that pushed forward our thinking. The University of South Carolina's Willard Moore carried out the ^{210}Pb and ^{7}Be analyses. Biosphere 2's Allen Wright built, equipped, and maintained our varnish garden. While at Harvard, Bill McDonough and Roberta Rudnick conducted the laser inductively coupled plasma measurements of the minor elements in varnish. Bob Finkel of Livermore National Laboratory conducted the ^{10}Be measurements. Charlie Mandeville of the American Museum of Natural History helped us in electron probe analyses. John Bell of Nevada Bureau of Mines and Geology and Norman Meek of California State University (San Bernardino) assisted us in collecting varnish samples in the field. Lamont-Doherty's Teddy Koczynski aided us in setting up and maintaining our thin section facility. Reviews by Jay Quade, Fred Phillips, and two anonymous readers, plus editorial comments by Karl Karlstrom, helped improve the manuscript. Lamont-Doherty Earth Observatory contribution 6205.

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Notice of Council Meeting

Meetings of the GSA Council are open to Fellows, Members, and Associates of the Society, who may attend as observers, except during executive sessions. Only councilors, officers, and section representatives may speak to agenda items, except by invitation of the chair. Because of space and seating limitations, you will need to notify the Acting Executive Director prior to the meeting if you plan to attend.

The next meeting of the Council will be at 1 p.m., Tuesday, Nov. 6, at the GSA Annual Meeting in Boston.

DIALOGUE

GSA's Reason for Existence: Geoscience for All Audiences

Sharon Mosher, *GSA President*

What is GSA's overriding reason for existing? At first blush, an easy question to answer. GSA, like most scientific societies, is known for high-quality publications, meetings, and conferences. GSA is important to most of us because it provides a high-profile way to disseminate our research results. GSA also actively promotes scientific research: Conferences, meetings, and publications stimulate us intellectually, leading to the development and testing of new ideas; some conferences are designed to promote interaction between scientists working on specific problems; and, GSA directly supports research through student research grants. As members, we contribute our time through reviewing articles, helping set up meeting programs, or serving as editors, technical program chairs, and session conveners. Nearly all of GSA's efforts—through volunteers, staff members, and financial support—concentrate on these areas.

Is this the only reason GSA exists? A harder question, but like most large, well-established scientific societies of our stature, GSA has accepted that it has a responsibility to do more. We need to educate the public, the media, public policy makers, educators, and students about the geosciences. Recognizing that this type of education and outreach is part of GSA's core mission, GSA Council has agreed to hire a senior staff member to focus on and coordinate these activities.

For us as members, the personal relevance of this part of GSA's mission is not as well defined as it is for the more traditional activities. Most scientists prefer to concentrate on research or professional activities, and spending time on outreach or K–12 education is not even a consideration. And nearly all of us shy away from any contact with the press or public officials.

We are concerned, however, when shopping malls are built on environmentally sensitive aquifers or when hospitals are built on active faults. We are appalled when we find out what our children are —or are not— being taught in school. When National Science Foundation funding for fundamental research is cut, or lawmakers make uninformed decisions

Sharon Mosher, GSA President

on global warming, evolution, or flooding along the Mississippi, we wish someone would do something. But most of us didn't get into science to do that—if we had wanted to interact with the public or politicians, we would have chosen a different profession.

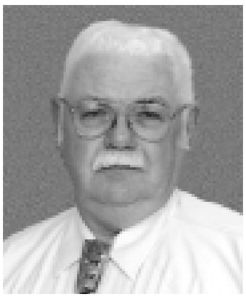
Here is where our society can, and should, take an active role. GSA can provide the leadership to help us—as members—be effective. GSA can help us learn how and when to talk to legislators or the media. Through workshops and meetings, we can learn about successful methods others have used to make an impact in teaching or outreach, stimulating us to do the same or to find new approaches. GSA also can organize educational and outreach programs that accomplish multiple objectives that we as individuals can't accomplish. GSA already has a number of effective programs in place, and with effective leadership can do much more. We, as members, can serve as volunteers with varying levels of time commitment, just as we do for publications or meetings. And those of us who don't have the time or inclination to volunteer but who understand the need can contribute a few dollars to our society to help ensure that effective programs have adequate funding.

Does this mean GSA is moving away from science? No, we have simply increased the audience. Our efforts in disseminating and promoting science within our scientific community is undiminished by our acceptance that we need to include the broader community as well. Science is an integral part of everything GSA does.

GSA Foundation Update

Donna L. Russell
Director of Operations

Christopher Mathewson Appointed to the Board of Trustees


Christopher Mathewson

The Foundation is very pleased to announce that Chris Mathewson has become a new member of the Foundation's Board of Trustees. Mathewson is currently a professor of engineering geology at Texas A&M University in College Station, Texas, as well as the executive director of the Association of Engineering Geologists (AEG).

Mathewson received his bachelor of science degree in civil engineering in 1963 from Case Institute of Technology in Cleveland, Ohio. He received his master of science and doctoral degrees in geological engineering from the University of Arizona in 1965 and in 1971. Mathewson served as a commissioned officer in the National Ocean Survey in the late 1960s, working on ocean charting and marine geophysical surveys in the Pacific and on coastal hazards in Hawaii. He has carried out research on coastal and river processes, expansive soils, urban planning, surficial processes, natural hazard analyses and mitigation, archaeological site preservation, and engineering geology of surface lignite mines.

A member of GSA since 1966, Mathewson is currently a GSA Fellow. He has served on many committees and has been a member of the Geologists Board of Examiners and the National Association of State Boards of Geology. He also has served as president of the American Geological Institute, president of AEG, and chair of the GSA Engineering Geology Division.

Mathewson has received many awards, including the Claire P. Holdredge Award and the Floyd T. Johnston Service Award from Texas A&M University and the Meritorious Service Award from the GSA Engineering Geology Division.

"Regardless of the task, Chris tackles it with enthusiasm, energy, wit, wisdom, and passion," said Lee J. Suttner, President of the Foundation. "Combined with his deep loyalty to GSA and impressive professional stature, his addition to the Board does much to ensure the Foundation's success in obtaining continued support for the Society's programs."

Welcome to the Board, Chris!

Focus on a Foundation Fund: GEOSTAR

The Board of Trustees approved the establishment of the GEOSTAR fund as part of the celebration of GSA's 100th anniversary in 1988. The ultimate goal is to grow the fund to a multimillion-dollar level, which will provide substantial ongoing support for GSA's Research Grant Program. Only income earned on the endowment is available for disbursement in the grants program.

GSA research grants have often supported the early work of famous earth scientists—men and women who have moved the science into new dimensions or found the answers to questions that have persistently puzzled a generation of workers. Quotes from grant recipients—"This funding has been invaluable to the success of my research," "Grants such as the Society's research grants will undoubtedly become even more important to students pursuing independent projects as other funding remains tight," and "I would like to express what an honor this grant is to me because of the great respect I have for GSA"—substantiate the importance of the GSA Research Grant Program, and justify the continued need for financial support from the Foundation's GEOSTAR fund.

In the past, GEOSTAR has relied on larger gifts from GSA members, other individuals, industry, and institutions, and this broad spectrum of donors will remain the Foundation's focus for increasing this fund.

The GEOSTAR Fund's net assets at the end of April 2001 were $136,381.00

Most memorable early geologic experience

A wartime (WWII) Brazil trip for the Signal Corps. My Navy pilot looped while I fiddled wth an uncinched seat belt.

—Fred M. Pough

Enclosed is my contribution in the amount of
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Please credit my contribution to the:

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- ☐ Other: _________________ Fund

☐ I have named GSA Foundation in my will.

GSA Foundation

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drussell@geosociety.org

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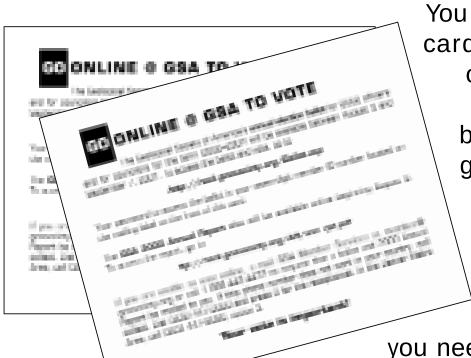
Attention Voting Members



You should have received a postcard in the mail with instructions on how to access our secure Web site and your electronic ballot. The site also posts biographical information on each candidate, and you'll find the 2000 Annual Report there as well.

If you have not yet received these instructions, or if you need paper copies of the ballot, candidate biographies, and / or Annual Report sent to you, please call Member Services at (303) 447-2020, 1-888-443-4472, or member@geosociety.org.

Voting deadline: Ballots must be submitted electronically or postmarked by September 7.

2002 Officer and Councilor Nominees

GSA Council announces the following officer and councilor candidates. Biographical information on all candidates will be available August 9 at www.geosociety.org or by calling GSA Member Services at (303) 447-2020 or 1-888-443-4472.

President (2002)
Tony Naldrett, Toronto, Ontario

Vice-President (2002)
B. Clark Burchfiel, Cambridge, Mass.

Treasurer (2002)
John E. Costa, Portland, Ore.

Councilor (2002–2004), Position 1*
Richard W. Galster, Edmonds, Wash.
Richard E. Gray, Greensburg, Pennsylvania

Councilor (2002–2004), Position 2
Andrew H. Knoll, Cambridge, Mass.
Judith Totman Parrish, Tucson, Ariz.

Councilor (2002–2004), Position 3
Ronald M. Clowes, Vancouver, B.C.
G. Randy Keller, El Paso, Tex.

Councilor (2002–2004), Position 4*
David M. Fountain, Laramie, Wyoming
David J. Bottjer, Los Angeles, California

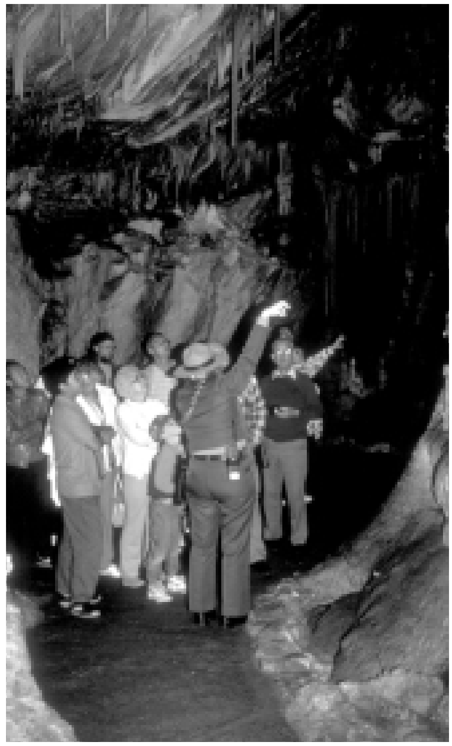
*Roy J. Shlemon and Grant Garven will not be running for councilor as originally indicated in the July issue of *GSA Today*.

GSA Reaches Out to America's Public Lands with GeoCorps America™

GSA's summer internship program began in 1996 with a partnership with the National Park Service's Geologist-in-the-Parks Program. In that first year, GSA placed two interns in national parks. This year, 32 geoscientists at all points in their careers were placed in 25 national parks and six national forests. And the expansion doesn't stop there!

Now called GeoCorps America™, GSA's internship program continues to grow. GSA plans to have 50 positions in 2002 and hopes to double the number of positions each year starting in 2003. Additional partnership—with the U.S. Department of Agriculture Forest Service—is helping the program achieve its goals, as is a change to embracing all levels—from undergraduates to retired geologists—and all kinds of geoscience expertise. GSA also has added "off-season" projects that go beyond summer opportunities.

Through GeoCorps America, GSA strives to gradually increase the presence of geoscientists on public lands, thereby increasing the permanent hiring of geoscientists, enhancing the transfer of geoscience knowledge to land managers and the public, and raising awareness of the geosciences. Park and forest managers propose high-priority projects in research, resource management, interpretation, and/or education



that require geoscience expertise that is not readily available to them. This program benefits the nation's public lands by providing needed expertise. In addition, it brings new opportunities to geoscientists, all of whom are members of GSA.

Examples of GeoCorps America projects are: excavating and preparing fossil specimens at Florissant Fossil Beds National Monument; researching, developing, and presenting interpretive programs on barrier island and coastal geology at Assateague Island National Seashore; mapping, reclaiming, and monitoring disturbed areas of Capulin Volcano National Monument; training and coaching seasonal interpreters in Grand Canyon National Park; monitoring the Muldrow Glacier in Denali National Park and Preserve; and developing educational programs on the geology of Indiana Dunes National Lakeshore.

In order to continue expanding GeoCorps America, GSA is seeking financial support from individuals, companies, and organizations. At $3,000 per 10-week session, the cost is minimal, but the long-term benefit to the geoscience community, the public, and the nation's public lands is great. If you are interested in becoming a sponsor of GeoCorps America, please contact Karlon Blythe, kblythe@geosociety.org, (303) 447-2020, ext. 1136. If you are interested in becoming a GeoCorps America participant, stay tuned. Position descriptions for 2002 will be posted at www.geosociety.org in December 2001.

2001 GeoCorps America™ Participants

GeoCorps America™ participants are working on public lands throughout the country. If you'd like to join the ranks next year, check for position descriptions in December at www.geosociety.org.

Kimberly E. Butzin, Badlands National Park

Meghan M. Hicks, Big Bend National Park

Lily J. Wong, Capulin Volcano National Monument

Kristin M. Farris, Carlsbad Caverns National Park

Chad K. Hults, Denali National Park and Preserve

Rebecca A. Lincoln, Florissant Fossil Beds National Monument

Peter J. Rose, Fossil Butte National Monument

Noelle A. Steele, George Washington Birthplace National Monument

William M. Capps, Indiana Dunes National Lakeshore

Linda M. Centeno, Inyo National Forest

Alisha R. Miller, Klamath National Forest

Eric M. Butler, Lake Meredith National Recreation Area and Albates Flint Quarries National Monument

Robert S. Merkel, Lake Roosevelt National Recreation Area

Erin E. Bittner, Lassen National Forest

Benjamin B. Mirus, Los Padres National Forest

Elizabeth Zenker, Mammoth Cave National Park

Brittina A. Argow, Mount Rainier National Park

Sherrie C. Landon, Navajo National Monument

Clay B. Partain, Ozark National Scenic Riverways

Sue Clements, Petrified Forest National Park

Scott R. Brown, Point Reyes National Seashore

Jonathan M. Achuff, Rocky Mountain National Park

Lisa A. Glonek, Santa Monica Mountains National Recreation Area

Chad T. Berner and **Samuel E. Prentice III,** Sierra National Forest

Andrew J. Caneday and **Gwenda J. Schlomer,** Siskiyou National Forest

Sarah L. Hanson, Sunset Crater National Monument

Scott R. Brown, Whiskeytown National Recreation Area

Letha C. Honea, Wupatki National Monument

Andrea K. Stanley, Yellowstone National Park

Stacie L. Hartung, Zion National Park

Payback Time

Karlon Blythe
Program Officer—Outreach

You might look at this article as just another call for mentors for GSA's student outreach programs. My hope is that it will rekindle the memory of a time when you were the recipient of some sorely needed mentoring.

The most often-repeated comment I see on evaluation forms completed by participating mentors is, "I wish someone had told me what I just shared with these students when I was a student." Asked if they would participate as a mentor again, the unanimous answer for the past two years has been a resounding, "YES—in a heartbeat!"

Share Your Perspective—Two Programs are Available

Two mentor programs for applied geoscience are offered through GSA's Science & Outreach: the John F. Mann Mentor Program in Applied Hydrogeology (program sites determined by individual mentors) and the Roy J. Shlemon Mentor Program in Applied Geology (offered only at GSA Section Meetings). While these programs are implemented in different ways and vary subtly in their objectives, both are designed to extend the mentoring reach of individual professionals who offer students a "glimpse through the window" on potential careers in applied geology. As you may remember from your school days, students typically find this kind of real-world advice out of reach.

If you are planning to attend a 2002 Section Meeting or live within easy travel to a Section Meeting site, won't you consider donating a couple of hours to share your perspective as an applied geoscientist with some interested students—over a free lunch—during the course of the Section Meeting? Section Meetings this year are scheduled for Corvallis, Ore., Cedar City, Utah, Lexington, Ky., Alpine, Tex., and Springfield, Mass.

Find out how you can make a difference to tomorrow's geoscientists by contacting Karlon Blythe, Program Officer, at kblythe@geosociety.org, or (303) 447-2020, ext. 1136.

GSA Journals Take the Plunge Into the Latest Wave in Publishing

Online Manuscript Submission and Peer Review

The journals *GSA Bulletin* and *Geology* are now using a Web-based manuscript submission and peer-review system. This leap was the last step in a two-year-long quest to find the right system for GSA, and it's the first step toward making GSA's publishing process more efficient, accommodating, and accessible to authors and reviewers worldwide.

Authors can now submit manuscripts to *GSA Bulletin* and *Geology* from any Internet-connected computer, with any operating system and any platform, anywhere in the world, day or night. The system also allows authors to check the status of their papers and add updated files at a later date from any Internet connection. The only software required to use the system is Adobe Acrobat Reader (available for free from www.adobe.com).

Authors who do not have Internet access may continue to submit their manuscripts via mail or courier. In these cases, the GSA editorial staff will place the papers into the online system, so these authors still benefit from its streamlined review and editorial process.

AllenTrack Gets Nod from GSA

GSA headquarters staff members, the journal science editors, and members of the GSA Publications Committee have been researching online systems for a couple of years. "The first systems on the market were—as is often the case with new technology—pretty pricey and not perfect for our journals," said Jon Olsen, GSA's director of publications. "But the promise of what such a system could do for journal authors, reviewers, and editors kept our interest."

AllenTrack, the system GSA is using, was developed by eJournalPress in Bethesda, Maryland, and is maintained by Allen Press in Lawrence, Kansas. Allen Press typesets, prints, and publishes scientific, technical, and medical journals, books, online publications, and CD-ROMs for more than 300 societies and organizations. In business since 1935, Allen Press printed its first scientific journal—*The Wilson Bulletin*, an ornithological journal they still print today—in 1952.

The online system saves paper, saves money spent on shipping, and saves time spent in transit. Authors can submit their papers in minutes, without making a trip to the post office or calling for a courier pickup.

Access to papers is controlled by login and user privileges, so authors can be assured their papers are not accessible to anyone but those authorized to see them. For example, science editors have access to the papers they are assigned and to title and author information of the papers assigned to their co-editors. Associate editors and reviewers have access to the papers they have been asked to read.

Submitting papers to *GSA Bulletin* and *Geology*

- Go to http://gsa-bulletin.allentrack.net or http://gsa-geology.allentrack.net. The first time you use the system, you'll register for an account. You'll use your account login and password when you return to the site to check on the status of your paper.
- The first time you log on, you'll have two choices: Submit a Paper or Author Guidelines. (Take a look at those guidelines—it will save you time and help you make the best use of the system.) After you submit a paper, you'll have a third option that links you to information on your submission.
- Once your files are uploaded to the database, they are converted as needed to PDF files that can be viewed, downloaded, and printed. Most word-processing files (e.g., Word, WordPerfect, text, Postscript and rich text format) are convertible. Figures can be uploaded in JPEG, TIFF, GIF, EPS, PDF, or Postscript formats.
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- As you go through the steps, keep an eye out for red arrows. These indicate that you need to take action on something.
- Converting most files takes from five to ten minutes, but as we all know, sometimes a large file, such as one of a complicated figure, takes longer. Conversion time also depends on the speed of your connection. In any case, the time saved by the new system makes up for any delay in uploading files. No more making multiple copies of your text and figures, packaging your manuscript, and shipping it to GSA. The system also saves time during the review process. No three-week wait for that paper to get to the expert in Australia!
- Once a paper is in the system, it is assigned a tracking number and a science editor, and it is ready to enter the peer-review process.

Visit the Editorial Staff in Boston

GSA journal science editors and GSA staff members will be available at the Annual Meeting in Boston to answer your questions and demonstrate the online manuscript submission system. Look for the editorial area at the GSA Bookstore in the Exhibit Hall, Hynes Convention Center.

Back from the Field? While you're writing up your notes for that next manuscript submission to *GSA Bulletin* or *Geology*, take a look at these guidelines for figures. Clip this page and keep it handy, or go to the Publications section at www.geosociety.org.

Figure Guidelines

All illustrations, whether line drawings or photographs, are considered figures. Identify each with the author's name and number them consecutively, at the bottom, outside the image area. GSA electronically scans illustrations or uses software files. To ensure the best possible results, please prepare art for illustrations according to the following guidelines. These guidelines are also posted at www.geosociety.org (go to Publications, Author Information).

clip and save

Electronic Figure Files

We can use the following formats, as long as the version of the application is noted and the file is labeled with the correct extension: Corel Draw = .cdr, Canvas = .cvs, Freehand = .fh, Illustrator = .ai, and Photoshop = .psd. If you create either .tif or .eps files, they must be between 300 and 600 dpi resolution. Save figure files by author name, figure number, and extension. Make sure that the hard copy of the figure that you send matches the electronic file of the figure. Files created in any application other than those listed above should be saved as a .tif or .eps. Do NOT send low resolution .jpg images.

Adobe Illustrator Files. We consider Illustrator to be the best program for creating figures that need, as ours do, to be imported into another program for commercial printing processes. However, this refers to figures actually created in Illustrator, not figures created in another program and then imported to Illustrator.

Canvas Files. Unless they are very simple graphics, older Canvas files almost always create problems. Canvas is generally set up to create graphics to print on a laserwriter, and is not meant for commercial printing processes. If you have used Canvas to prepare your figures, please be advised that GSA might have to scan the figures (see instructions on how to prepare scannable artwork).

Freehand Files. When a Freehand file is saved as an EPS to be imported into another program, pattern fills sometimes disappear and labels sometimes change font or disappear. It is best to supply "native" Freehand files, since those can be converted better.

Corel Draw Files. Most files can be used with few problems.

Photoshop Files. Most Photoshop files can be used with few problems, just make sure that the resolution is high enough.

Best Resolution. Many graphics contain imported scans. Some of these have been scanned at such a high resolution that it takes over a half an hour to print. Generally, imported halftones should not be scanned at higher than 300 dpi (dots per inch); line art is usually good at 300 dpi, but if there are fine lines or screens, they can go up to 600 dpi—never more than this, however. If you have a single file over 10 megabytes, please call us, since files this size can cause delays and problems with our printer.

Placed/Imported Images. All images that have been placed or imported into your figure file must accompany this file on disk (i.e., if you import a photograph into illustrator called photo.tif, you must supply this photo.tif electronic file along with your Illustrator file).

Fonts in Drawing Programs. Select each word/phrase and convert the text to outlines or paths so that the text becomes an object. This will eliminate font problems. (Illustrator, Corel Draw, Freehand, and Canvas are examples of drawing programs).

Invisible Elements. Many graphics files contain unnecessary "invisible" elements. These are sometimes imported graphics that the creator of the file has traced over and then set not to print. To save out printer time, it is best to delete the unnecessary element rather than just set it not to print.

Color Figures. Authors are responsible for all costs associated with printing in color. Many color graphics cause problems because they have been saved as RGB (red, green, blue) rather than CMYK (cyan, magenta, yellow, black). When these are converted from RGB to CMYK for commercial printing, the colors may not be exactly the same. If these colors are used to distinguish elements on a chart or map, this isn't a problem, but if it is a color photograph, it can be problematical. To avoid this, color graphics must be created as CMYK files, and color proofs must be scannable four-color proofs and not printouts from a color laserwriter or ink-jet printer. The colors from a laserwriter or ink-jet printer will not match the colors on the final four-color printer copy.

General Guidelines for All Figures

- Look at recent articles in the GSA journal you plan to publish in and compare the look and style of your art with figures accompanying these articles.
- Submit figures as close to final size as possible. We do not require figures at exact final size, but we prefer to reduce figures by no more than 50%. No figure should be larger than one 8.5" × 11" page.
- All figures prepared by computer should be submitted as laser prints on high-quality laser print paper. If possible, print copies at 300 dots per inch (not 600 or more dots per inch) and 65 lines per inch. Be sure your disk file contains only final figures.
- You may substitute high-quality photocopies of photographs for review purposes, but original slides or prints of photos must be submitted for publication. Do not submit Photo Mechanical Transfers (PMTs). Do not send photographs taken by digital cameras, either in file or hardcopy format. Digital camera photographs are generally not of high enough quality for most publishing purposes.
- Keep at least one "original quality" copy of all figures. GSA cannot be responsible for material that is lost or damaged in the mail.
- Label all figures (both hardcopy and electronic file) with author name and figure number.

Style Guidelines

Lines and Labels in Graphs, Maps, and Legends

- Use clean black lines, no finer than 1 point. Avoid hairlines, as they often disappear with reduction.

———— 1 pt. line

- Except for proper nouns, all labels should have the first letter of the first word capitalized, with all other words being lowercased.
- On maps, please include latitude (in degrees north or south) and longitude (in degrees west or east), a north arrow, and a scale in kilometers.
- On maps, all labels referring to bodies of water must be in an italic font; all other physiographic features are in a roman font.
- Graphs must have all axes and lines labeled.
- General titles of illustrations should appear in the figure caption, not in the figure itself.

Lettering

- Use a clear, sans serif typeface such as Helvetica or Arial.
- All lettering should be at least 9 pt. type size (⅛ inch or 3 mm high) before reduction. After reduction, no text should be smaller than 1 mm high.
- The largest lettering should not be more than two to three times the size of the smallest lettering.
- Avoid making the lettering too large for the figure. This can result in a "cartoonish" appearance.
- Avoid the use of small boldface lettering because the open spaces in the letters tend to fill in when reduced.
- Place a white background behind lettering that crosses a dark or textured area in a figure.

Fill Patterns

- If possible, use patterns (Fig. 1) instead of dot fill patterns. When fine or smooth fills are scanned, mottled patterns often result.
- Dot fills must be between 20% and 70% black. The scanner “sees” <20% black as white and >70% black as black.
- Any fills that represent different values in the same illustration must differ by at least 20%. For example, fills that are 20% black and 30% must not be used on the same figure, but fills that are 30% black and 50% black are acceptable for use on the same figure (see Fig. 2).

Below is an example of a well done map, incorporating many of the guidelines listed above (Fig. 3).

- Good balance between line width, font sizes, and size of figure.
- Appropriate labeling of map components.
- Consistent font type and size.
- White outlines or boxes behind text with background fills.
- Proper use of uppercase and lowercase lettering.

However, these fill patterns may become mottled if scanned, and the fill patterns are so close they may not show enough contrast. The use of coarser patterns with greater contrast would improve this figure. See the diagrams for best patterns to choose.

This map was created in Freehand by the author and later converted to an Illustrator EPS file by GSA’s production staff. This is a perfect example where the final product appeared in press exactly as the author had created it.

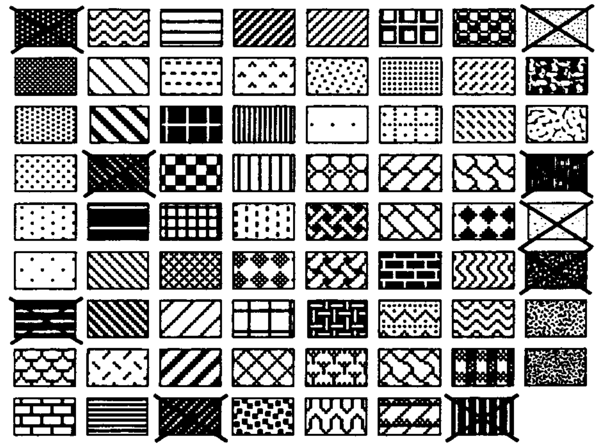


Figure 1. Fill Patterns available in Freehand and Canvas for Macintosh. Please do not use patterns that are crossed out in above example.

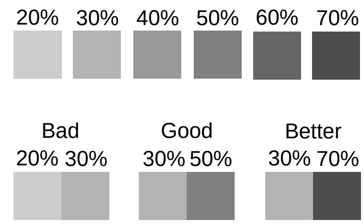


Figure 2. Dot Fill Patterns.

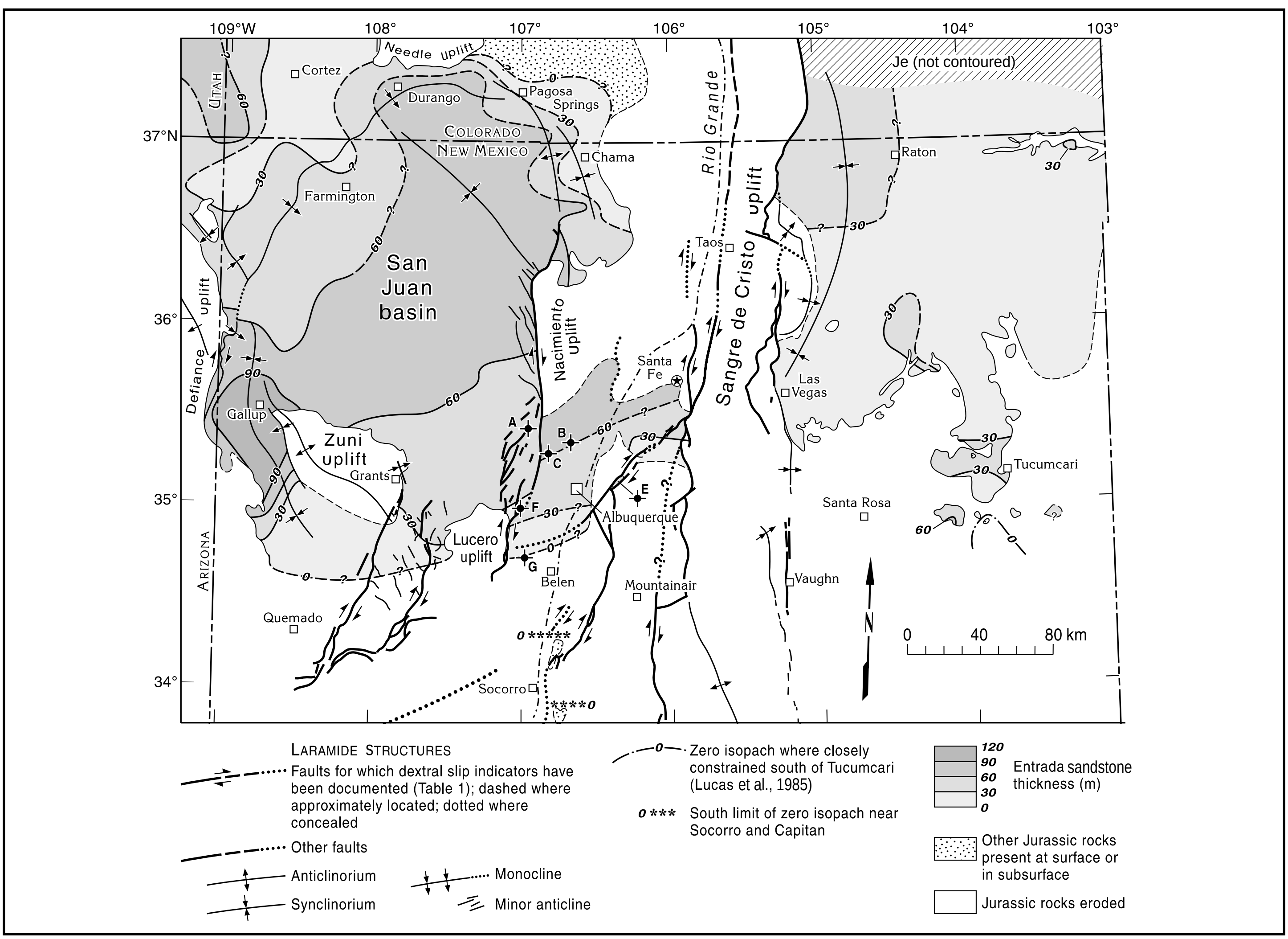
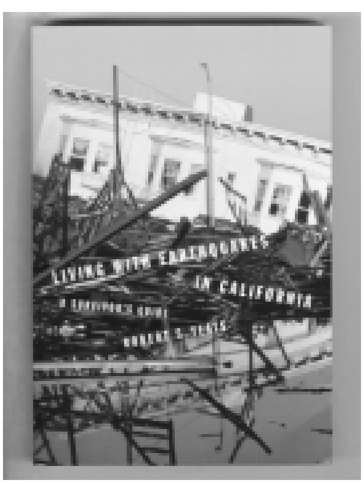


Figure 3. Taken from Cather, S.M., *Bulletin*, June 1999, v. 111, no. 6, p. 854.

clip and save

BOOK REVIEW



Living with Earthquakes in California—A Survivor's Guide

Robert S. Yeats, Oregon State University Press, Corvallis, Oregon, 2001, 406 p., $21.95.

This book is a must-have for students and their professors, for those living in California or thinking about moving to California, and for seasoned geologists practicing in California.

Yeats is a highly respected researcher and teacher in seismology, and with his extensive knowledge of the literature and the rocks from mapping, he documents chronologically the seismic events and explains what is known about the earthquakes using definitions, accounts, photographs, and excellent illustrations. The latter part of the book deals with practicalities such as building codes, federal agencies, and insurance and includes useful sections on earthquake preparedness.

As a leading researcher in the seismological community, Yeats reaches out to the student in the classroom and to the general public. In this very readable book, Yeats lays out a careful chronology, highlighting the people, events, and evolution of thought in seismicity that have led to our present-day understanding, and he outlines a variety of other factors that may lead to future forecasting and prediction. The writing style lacks unnecessary jargon, but where it is necessary, it is well done, and the chronology is enhanced with its good illustrations. The indexed volume has excellent references, a glossary, and a helpful listing of California earthquakes since 1700.

Using his own knowledge and his interpretations as one who keeps up on earthquake research, Yeats provides insights into the variables that may be at play in predicting and forecasting earthquakes. The volume serves as a call to action to fund courses and educate the general public, and it discusses how seismologists interact personally with other seismologists and the people and agencies involved in earthquake preparedness.

A companion volume to this book is Yeats' *Living with Earthquakes in the Pacific Northwest*. He organized a whole course around the first book, which was very popular.

Dorothy L. Stout
Cypress College
Cypress, California

The More Things Change...

In February and March, *GSA Today* featured a series on improving presentations ("When Presentations Go Bad—A Commentary," *GSA Today*, v. 11, nos. 2 and 3). The second part of the series covered the design and use of audiovisual materials and invited comments from readers.

GSA Fellow George Klein sent a suggestion to reprint an article by David Gallagher, published in *GSA Bulletin* in 1965, on slide preparation. Gallagher's rule, wrote Klein, "can easily be applied to a computer image, and in fact, when I did a test with the four images in Part II (of 'When Presentations Go Bad—A Commentary'), the two labeled 'good' passed the Gallagher test, and the two labeled 'poor' flunked. I recommend you resurrect Gallagher's note and republish it in *GSA Today*."

Here is that article. The technology has changed, but the wisdom remains.

On Lantern Slides

***David Gallagher**, U.S. Geological Survey, Menlo Park, California*

ABSTRACT

Before photography, look at the original from as many feet away as it is inches wide, and you will see it as it will look to the audience as a slide on the screen.

The preparation of good lantern slides has long been a problem, and much of the literature on the subject is more confusing than helpful. The following rule, simple to remember and easy to use, will ensure good lantern slides: Look at the original document that is to be photographed from as many feet away as it is inches wide, and it will look to you as it will to the audience when it is projected as a slide on the screen.

This easy test is soundly based upon the same physical and optical principles as all the equally correct but involved tables and graphs, which confound the literature on the preparation of slides and are cumbersome to use.

The reason this rule works is simple. If the photography is satisfactory, the problem lies wholly with the original copy that is to be photographed. Texts, maps, or diagrams that are published, or designed for publication, are intended to be read at the standard reading distance of 14 inches and are illegible at substantially greater distances than 14 inches. A book page may have text 4½ inches wide, but few people with normal eyesight can read it from 4½ feet. A topographic or geologic quadrangle map may be 15 inches wide, but no one can read it from 15 feet. Neither of these subjects can be photographed in its entirety into an acceptable slide. Applying the rule in reverse, 14 inches is a little more than 1 foot; consequently, a portion of a quadrangle a little more than 1 inch square can be photographed into a good slide.

On strictly optical grounds, most material must be especially prepared to be photographed into satisfactory slides; in contrast to copy for publication, lines must be heavy, and letters must be large. How heavy and how large can be tested by use of the rule. Look at sample linewidths and Leroy templates from as many feet away as the planned width of the drawing in inches. You will know what the audience can or cannot read.

This test will also reveal that only a few words can be shown on the screen at one time. This has two advantages. First, it minimizes the amount of lettering to be done; and secondly, it helps to solve an important problem that is often overlooked, namely, that there is a limit to what the audience can read and comprehend in the few seconds that a slide is usually left on the screen. A slide showing 20 typewritten rock analyses, flashed on the screen for 20 seconds, is not only illegible, it is incomprehensible. The audience will benefit most from slides that are simply drawn and present a comprehensible amount of information.

Redrawing copy to make slides may sound onerous, but it need not take much longer than drawing the same thing on a blackboard while lecturing. Felt-tipped pens are a help. The audience is more interested in the ideas than in the draftsmanship. A poor drafting job the audience can read is more welcome than a fine drafting job they cannot see.

Look at the original from as many feet away as it is inches wide before photography. It's that simple.

(Originally published in *GSA Bulletin*, v. 76, p. 1081–1082, September 1965.)

David Gallagher (1906–1968) joined the U.S. Geological Survey in 1940 and was among the first to staff the Menlo Park office in 1952. The well-liked Gallagher led an interesting life filled with travel and scientific achievement. For a PDF file of the memorial to this GSA Fellow (Hose, R.K., 1971, Proceedings Volume for 1968: Boulder, Colorado, Geological Society of America, p. 193–196), e-mail Jeanette Hammann at jhammann@geosociety.org.

Technical Session Rooms Get Upgrade for Boston Meeting

If you are presenting at the Annual Meeting in Boston, you now have more choices for your visual aids. In addition to two 35 mm slide projectors, two screens, and one overhead projector, standard technical equipment in each of the oral technical session rooms will now include one LCD projector and one laptop computer loaded with the Windows operating system for anyone interested in giving a PowerPoint presentation. You will have the flexibility of using PowerPoint alone or in addition to slides or overheads.

If you intend to give a PowerPoint presentation, please save your presentation on a 100 MB IBM-formatted Zip disk. The resolution of PowerPoint presentations using the provided equipment is 1024 × 768, VGA output.

The Speaker Ready Room, located in room 204 in the Hynes Convention Center, will be outfitted with the same equipment found in each of the technical session rooms. This room is available to all presenters at the Boston meeting, giving them the opportunity to review their slides, PowerPoint presentations, and overhead transparencies. When you arrive at the convention center, please take advantage of the Speaker Ready Room to test your presentation. More information will be provided in the Speaker's Guide posted on our Web site in mid-August.

Memorial Preprints Now Available

The following memorial preprints are now available, free of charge. To order, contact GSA Member Services by e-mail at member@geosociety.org, by phone at 1-888-443-4472, or (303) 447-2020, by fax at 303-443-1510, or by mail to P.O. Box 9140, Boulder, CO 80301-9140, USA.

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The annual *Memorials* volume for 2000 (v. 31) is available for purchase. To order, see contact information above.

2002 GSA Section Meetings

CALL FOR PAPERS

NORTHEASTERN SECTION

March 25–27, 2002
Sheraton Springfield, Springfield, Mass.

For meeting information: Sheila Seaman, Dept. of Geosciences, University of Massachusetts, 233 Morrill Science Center, Amherst, MA 01003-5820, (413) 545-2822, sjs@geo.umass.edu.

Abstract deadline: December 18, 2001

SOUTHEASTERN AND NORTH-CENTRAL SECTIONS

April 3–5, 2002
Hyatt Regency Hotel and Lexington Civic Center, Lexington, Ky.

For meeting information: John D. Kiefer, kiefer@kgs.mm.uky.edu, or James C. Cobb, cobb@kgs.mm.uky.edu, Kentucky Geological Survey, (859) 257-5500.

Abstract deadline: December 19, 2001

SOUTH-CENTRAL SECTION

April 11–12, 2002
Sul Ross State University Center, Alpine, Texas.

For meeting information: Kevin Urbanczyk, Dept. of Earth & Physical Science, Sul Ross State University, SRSU Box C-143, Alpine, TX 79832-0001, (915) 837-8110, kevinu@sulross.edu.

Abstract deadline: December 27, 2001

ROCKY MOUNTAIN SECTION

May 7–8, 2002
Southern Utah University Campus, Cedar City, Utah.

For meeting information: Robert Eves, Dept. of Geology, Southern Utah University, Cedar City, Utah, (435) 586-1934, eves@suu.edu.

Abstract deadline: February 4, 2002

CORDILLERAN SECTION

May 13–15, 2002
Oregon State University, Corvallis, Oregon.

For meeting information: Robert S. Yeats, Dept. of Geosciences, Oregon State University, 104 Wilkinson Hall, Corvallis, OR 97331-5506, (541) 737-1226, yeatsr@geo.orst.edu.

Abstract deadline: February 7, 2002

Online Meeting Registration: It's Fast, It's Easy, and YES, You CAN Make Changes Later!

Aren't yet sure exactly which days you'll be able to be in Boston? Can't decide whether to attend a luncheon? Not sure if your spouse can attend the meeting with you? You should know that you can make changes to your completed registration, even if you register online.

You can add activities—like field trips, short courses, and special events—or add a guest registration up until the preregistration deadline (September 28). Or, if your plans change and you need to cancel an activity, you can do so up until the cancellation deadline (October 5) and still receive a refund.

So register today for the GSA Annual Meeting, and cross that off of your to-do list. If you decide later to add a short course, field trip, breakfast, luncheon, or special event, or if you need to add a guest registration, contact GSA Member Services, (303) 447-2020, 1-888-443-4472, or member@geosociety.org.

- Tell us you registered for the Boston meeting and want to make a change.
- Have your member number handy, if possible, or include it in your e-mail.
- Give us your changes. You'll need to put any new fees on a credit card (American Express, Visa, MasterCard, or Discover). If you want to write a check, send your changes and the check (in U.S. funds, made payable to 2001 GSA Annual Meeting) by mail to: GSA Annual Meeting, P.O. Box 9140, Boulder, CO 80301-9140.

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Boston 2001—A Geo-Odyssey
November 1–10, 2001

Register online at www.geosociety.org.
Preregistration deadline: Sept. 28 • Cancellation deadline: Oct. 5

ANNOUNCEMENTS

MEETINGS CALENDAR

2001

October 17–19	Gulf Coast Association of Geological Societies and Gulf Coast Section of SEPM 52nd Annual Convention, Shreveport, Louisiana. Information: William R. Downs, General Chairman GCAGS 2001, (318) 429-2136, wwheless@aol.com; Thomas C. Wyche, Program Chairman, (318) 221-0761, tcwych@aol.com, www.gcags.org/convention2001/gcags2001.html.

2002

April 29–May 2	Ninth International Conference on Ground Penetrating Radar, GPR 2002, Santa Barbara, California. Information: Steven Koppenjan, Dept. ECE, GPR 2002 Conference—Hua Lee, University of California, Santa Barbara, CA 93106, USA, fax 805-893-3262, gpr2002@nv.doe.gov, www.ece.ucsb.edu/gpr2002.
October 30–Nov. 1	Gulf Coast Association of Geological Societies and Gulf Coast Section of SEPM 52nd Annual Convention, Austin, Texas. Information: Scott W. Tinker, Technical Program Chairman, GCAGS 2002, (512) 471-1534, fax 512-471-0140, scott.tinker@beg.utexas.edu, www.beg.utexas.edu/gcags2002/index.htm. (*Abstracts deadline: January 11, 2002.*)

2004

August 20–28	32nd International Geological Congress: From the Mediterranean toward a Global Renaissance—Geology, Natural Hazards and Cultural Heritage, Florence, Italy. Information: Ms. Chiara Manetti, Università degli Studi di Firenze, Dipartimento di Scienze della Terra, Via La Pira, 4, 50121 Firenze, Italy, tel./fax: 055/2382146, cmanetti@geo.unifi.it, www.32igc.org. (*Proposal deadline: September 30, 2001.*)

Send notices to jhammann@geosociety.org. Only new or changed information is published in *GSA Today*. A complete listing is posted in the Calendar section at www.geosociety.org.

About People

GSA Member **W. Jerrold Samford** has been elected 32nd president of ASFE, a not-for-profit trade association of geology-related professional, environmental, and civil engineering firms. (The organization, established in 1969 as the Associated Soil and Foundation Engineers, now goes by ASFE.) Samford is vice president and principal-in-charge of geoenvironmental services for Virginia Geotechnical Service, P.C., in Richmond, Virginia. He previously was senior geologist of the Virginia Department of Waste Management's Solid Waste and Superfund programs, and he was an instructor of geology at Virginia State University. Samford earned a B.A. in geology from the College of William & Mary and an M.S. in geology from Virginia Tech.

W. Jerrold Samford

In Memoriam

Glen F. Brown
Reston, Virginia
February 22, 2001

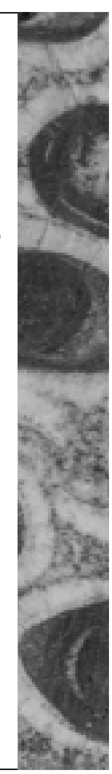
Robert A. Cadigan
Colorado Springs, Colorado
June 6, 2001

Sir Kingsley C. Dunham
Durham, England
April 5, 2001

Stanislaw Dzulynski
Krakow, Poland
June 28, 2001

Karl N. Hendrickson
North Amherst, Massachusetts
April 28, 2001

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



Boston 2001:

November 1–10, 2001

A GEO-ODYSSEY

Field Trips: Where Discovery Begins

Enrich your meeting experience with a field trip. For complete trip and leader descriptions, registration details, and information, see the June issue of *GSA Today* or visit www.geosociety.org.

Preregistration deadline: September 28
Cancellation Deadline: October 5
Register online: www.geosociety.org

Questions?

Contact the field trip's leader or Edna Collis, GSA Field Trip Coordinator, (303) 447-2020, ext. 1134, ecollis@geosociety.org.

1. Quaternary Sea-level Change and Coastal Evolution in Eastern Maine

Thurs.–Sun., Nov. 1–4. Cosponsored by *GSA Quaternary Geology and Geomorphology Division.* Joseph T. Kelley, University of Maine, jtkelley@maine.edu. Cost: $325. *Begins in Bangor, Maine, and ends in Boston.*

2. Rare Element Granitic Pegmatites of Northern New England

Fri. and Sat., Nov. 2–3. Carl Francis, Harvard Mineralogical Museum, francis@eps.harvard.edu. Cost: $230.

3. The Notches: Bedrock and Surficial Geology of New Hampshire's White Mountains

Fri.–Sun., Nov. 2–4. Cosponsored by *GSA Quaternary Geology and Geomorphology Division* and *GSA Structural Geology and Tectonics Division.* Timothy T. Allen, Keene State College, tallen@keene.edu. Cost: $250.

4. and 8. The Science Behind *A Civil Action*

Two trips: Sat., Nov. 3, and Sun., Nov. 4. Cosponsored by *GSA Hydrogeology Division*. Scott Bair, The Ohio State University, bair.1@osu.edu. Cost: $80.

5. The Founders of American Geology: A Visit to Their Tombs and Favorite Exposures

Sat. and Sun., Nov. 3–4. Cosponsored by *GSA History of Geology Division*. Gerald M. Friedman, City University of New York, gmfriedman@juno.com. Cost: $190.

6. Geological, Geochemical, and Environmental Aspects of Metamorphosed Black Shales in Maine

Sat. and Sun., Nov. 3–4. Charles V. Guidotti, University of Maine, guidotti@maine.maine.edu. Cost: $190.

7. Avalonian Through Alleghanian Tectonism in Southeastern New England

Sun., Nov. 4. Cosponsored by *GSA Structural Geology and Tectonics Division*. Daniel Murray, University of Rhode Island, dpmurray@uri.edu. Cost: $70.

9. Geochronology and Geochemistry of the Shelburne Falls Arc and the Taconian Orogeny in Western New England

Sun., Nov. 4. Cosponsored by *GSA Structural Geology and Tectonics Division*. Paul Karabinos, Williams College, paul.m.karabinos@williams.edu. Cost: $70.

10. N-Y-F Pegmatites in the Avalon Terrane of Southeastern New England

Sun., Nov. 4. Michael Wise, Smithsonian Institution, wise.michael@nmnh.si.edu. Cost: $70.

11. Quaternary Environments and History of Boston Harbor, Massachusetts

Sun., Nov. 4. Cosponsored by *GSA Quaternary Geology and Geomorphology Division*. Patrick Colgan, Northeastern University, p.colgan@neu.edu. Cost: $70.

12. Urban Geology of Beacon Hill and Vicinity, Boston, Massachusetts: In Memory of James V. O'Connor—A Walking Tour

Sun., Nov. 4. Cosponsored by *GSA History of Geology Division, GSA Engineering Geology Division, and National Association of Geoscience Teachers*. James W. Skehan, Boston College, skehan@bc.edu. Cost: $20.

13. Cobblestones, Puddingstone, and More: Boston's Use of Stone as an Essential Urban Element—A Walking Tour

Tues., Nov. 6. Dorothy Richter, Hager-Richter Geoscience, Inc., dorothy@hager-richter.com. Cost: $20.

14. Engineering Geology of the Big Dig Project (Boston Central Artery Project)

Tues., Nov. 6. Cosponsored by *GSA Engineering Geology Division*. Dan Bobrow, Parsons Brinckerhoff, djbobrow@bigdig.com. Cost: $80.

15. Igneous Petrology of the Pine Hill Area, Medford, Massachusetts

Tues., Nov. 6. Martin E. Ross, Northeastern University, m.ross@nunet.neu.edu. Cost: $40.

16. Tour of the Salem Harbor Power Plant

Tues., Nov. 6. Cosponsored by *GSA Coal Geology Division*. Cortland F. Eble, Kentucky Geological Survey, eble@kgs.mm.uky.edu. Cost: $25.

17. Geology of East Point, Nahant, Massachusetts

Wed., Nov. 7. Martin E. Ross, Northeastern University, m.ross@nunet.neu.edu. Cost: $40.

18. Geology, Groundwater Contamination, and Groundwater Remediation at the Massachusetts Military Reservation, Cape Cod

Wed., Nov. 7. Rudolph Hon, Boston College, hon@bc.edu. Cost: $55.

19. Deformation, Metamorphism, and Granite Assent in Western Maine

Thurs.–Sun., Nov. 8–11. Cosponsored by *GSA Structural Geology and Tectonics Division*. Gary Solar, State University of New York, solargs@bscmail.buffalostate.edu. Cost: $350.

20. Geology of Mount Monadnock, New Hampshire

Fri., Nov. 9. Cosponsored by *GSA Structural Geology and Tectonics Division*. Peter Thompson, University of New Hampshire, pjt3@hypatia.unh.edu. Cost: $55.

21. Geology and Water Supply Development at the Massachusetts Military Reservation, Cape Cod

Fri., Nov. 9. Peter Dillon, Foster Wheeler Environmental Corporation, pdillon@fwenc.com. Cost: $55.

22. MetroWest Water Supply Tunnel Project

Fri., Nov. 9. Cosponsored by *GSA Engineering Geology Division*. Mario Carnevale, Hager Geoscience Inc., mcarnevale@hagergeoscience.com. Cost: $65.

23. Recent Developments in the Study of the Neoproterozoic Boston Bay Group

Fri., Nov. 9. Richard H. Bailey, Northeastern University, r.bailey@nunet.neu.edu. Cost: $50.

24. Metamorphism of a Fold-Thrust Belt in the Hinterland of the Alleghanian Orogen in Southern New England

Fri. and Sat., Nov. 9–10. Cosponsored by *GSA Structural Geology and Tectonics Division*. Robert P. Wintsch, Indiana University, wintsch@indiana.edu. Cost: $170.

25. The Taconic Questions: Revisiting the Scenes of the Great American Controversies

Fri. and Sat., Nov. 9–10. Cosponsored by *GSA History of Geology Division*. Paul Washington, University of Louisiana, gewashington@ulm.edu. Cost: $170.

26. Prehistoric Bedrock Quarries of the Central Appalachians

Fri.–Sun., Nov. 9–11. Philip La Porta, La Porta & Associates, philiplaporta@cs.com. Cost: $280.

Field Trip Itineraries: Now Just a Click Away

Take note: Field trip itineraries have gone digital! Once you've received the confirmation of your field trip registration from GSA, go to: http://rock.geosociety.org/registration/annual2001/ftrip_logon.asp. Use the ID number from your confirmation or your e-mail address to access your trip itinerary sheet(s). You can download the itineraries for the trips you've registered for, and you can fill out your individual information sheet to submit back to GSA Headquarters.

D. Burton Slemmons: Back in the Central Nevada Seismic Belt

John W. Bell, *Nevada Bureau of Mines and Geology, University of Nevada, Reno*
John Caskey, *San Francisco State University*

D. Burton "Burt" Slemmons at the Fairview Peak, Nevada, fault scarp shortly after the December 16, 1954, M_S7.2 Fairview Peak earthquake. Photo by Karl V. Steinbrugge.

The field trip "Historical Surface Faulting and Paleoseismology of the Central Nevada Seismic Belt," held during the GSA 2000 Annual Meeting in Reno, Nevada, was dedicated to David Burton "Burt" Slemmons, Professor Emeritus of Geology at the University of Nevada, Reno, for his pioneering work in active faulting and paleoseismology. Burt's active-faulting studies began at many of the sites that were visited on this field trip, led by John Caskey, John W. Bell, and Alan R. Ramelli, and, as honorary field trip leader, Burt contributed his historical observations and expertise to the trip. He is truly one of the most admired and respected leaders in his field.

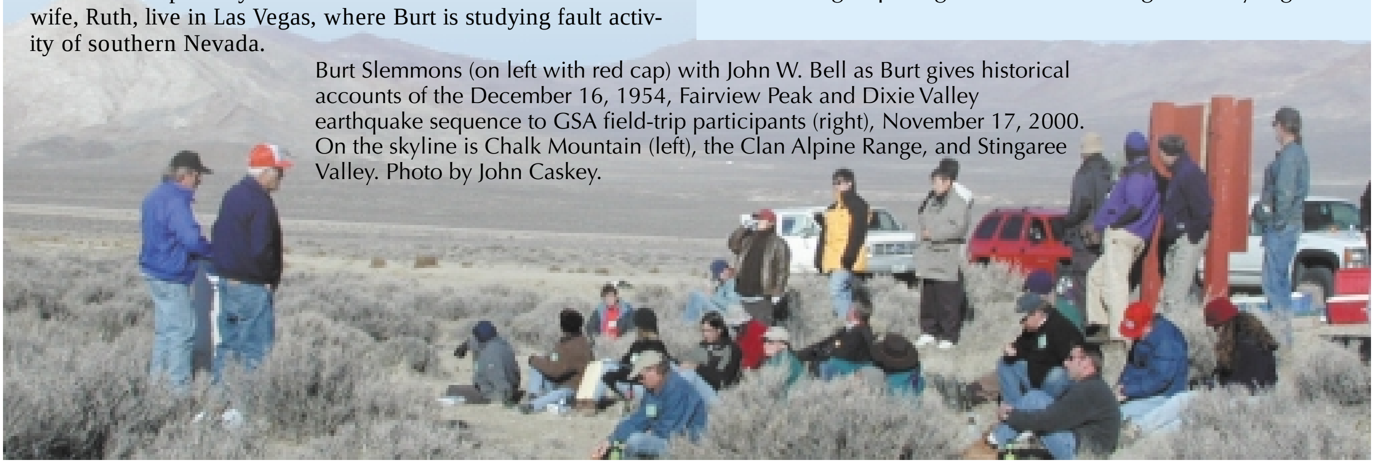
As a fresh Ph.D. graduate from the University of California, Berkeley, Burt began his career at the University of Nevada, Reno, in 1951 when he was hired as an assistant professor to teach courses as a hard rock instructor in petrology and petrography. At that time, Burt was also selected to supervise the University of Nevada Seismographic Station (now the Seismological Laboratory), where he was director from 1952 to 1964. When a series of ground-rupturing earthquakes occurred in the Rainbow Mountain–Dixie Valley–Fairview Peak region in 1954, Burt was one of the first geologists involved with field mapping and documenting the surface fault ruptures.

Burt's paper, "Geological Effects of the Dixie Valley–Fairview Peak, Nevada, Earthquakes of December 16, 1954," published in the *Seismological Society of America Bulletin* is a classic reference for anyone studying the contemporary tectonics of the Basin and Range province. His research on the 1954 rupture zone contributed to his receiving the G.K. Gilbert Award in Seismic Geology from the Carnegie Institute in 1962.

During his subsequent years at Nevada, Burt continued to specialize in active fault research, perfecting his trademark methodology, the use of low-sun-angle aerial photography. He has educated and advised dozens of undergraduate and graduate students (as well as colleagues), many of whom have gone on to become well-known neotectonics experts in teaching, research, and geotechnical consulting. Since retiring from the University of Nevada in 1989, Burt has continued to be active in various earthquake geology research projects, including the assessment of seismic hazards at the proposed high-level nuclear waste repository site at Yucca Mountain. Burt and his wife, Ruth, live in Las Vegas, where Burt is studying fault activity of southern Nevada.

At the Fairview Peak, Nevada, fault scarp on May 1, 2001. After 47 years, still a free-face and with little degradation—on D. Burton "Burt" Slemmons, that is.The fault scarp has not fared so well. The fault scarp shows ~1.0 m of vertical separation. The vertical 1954 free-face scarp (top) has now degraded to a scarp slope angle of ~20° (bottom) although some free face is locally still preserved along this trace (bottom, far right). View is to the north. Photo taken about 300 m south of U.S. Highway 50. Photo by John Caskey.

Whether in the wilds of the Nevada desert or in the urban jungle of the Big Dig Central Artery Project in Boston, you'll find that geology still comes alive during field trips. Don't let the opportunity for discovery and fellowship pass you by. Visit an area you've never seen, or return to a well-studied locale from your student days for fresh inspiration. See page 24 for a list of the Boston 2001 field trips, pick one (or two), and sign up! Register online: www.geosociety.org.



Burt Slemmons (on left with red cap) with John W. Bell as Burt gives historical accounts of the December 16, 1954, Fairview Peak and Dixie Valley earthquake sequence to GSA field-trip participants (right), November 17, 2000. On the skyline is Chalk Mountain (left), the Clan Alpine Range, and Stingaree Valley. Photo by John Caskey.

True Grit

Once or twice a month, members of the Gamma Zeta Chapter of Sigma Gamma Epsilon and other interested graduate and undergraduate students at Kent State University get together for pizza, burritos, and sand grain.

No, it's not a new health-food craze. It's a way to earn funds for the chapter, and it helps you while you're out in the field. These students hand make the pocket-size sand grain sizing folder for sale through the GSA Bookstore.

"We're the only chapter that makes these," said James McCombs of Gamma Zeta. He has participated in the production of folders for six-plus years.

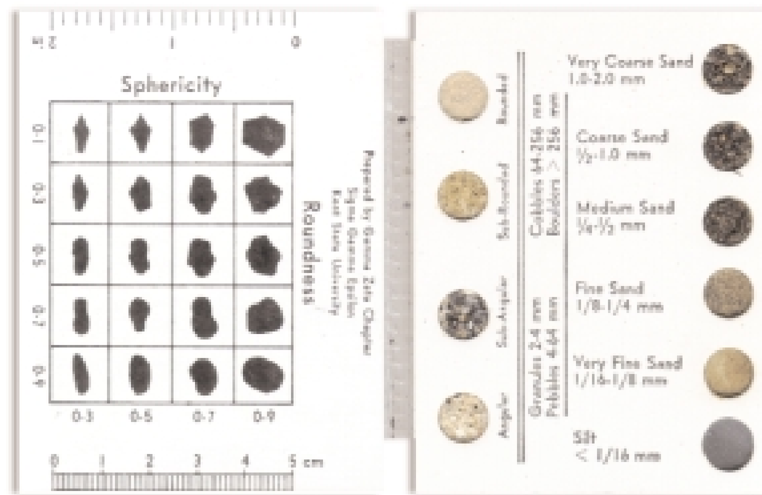
After the group is fortified with rations from The Loft in Kent, they form an assembly line and get to work gluing the grains—from angular to rounded, very coarse to silt—in their cardboard folders. "It's easy to get people to help when you bribe them with burritos," said chapter member Kelly Milner. Orders only seem to get backed up post-holiday, when students get scarce, and post-summer, when schedules get tight.

The chapter has been making the sand grain sizing folders for about 10 years.

"The money raised goes for field camp scholarships," McCombs said. "This year, we had five applicants and all five received scholarships." Profits also go toward paying the chapter's way at the Department of Geology's spring banquet.

The sand grain sizing folder is a useful item: It's pocket size, easy to read, and includes a roundness-sphericity chart and handy reference information that can help make your papers accurate and impress reviewers. And now you know the profits go to a worthy cause!

You can purchase sand grain sizing folders at the GSA Bookstore at the Boston 2001 meeting. Or, go online at www.geosociety.org. List price $7.44. GSA Member price $5.95.



Insider Info

And just where does the sand for the sand grain sizing folders come from?

Angular: Black Hills (brought back to sand-grain central from summer field camp)

Rounded: Lake Bonneville Salt Flats (anyone at Kent going on a field trip is asked to bring back a jug)

Sand: A reservoir beach near Kent (collected and sifted)

Members of the Gamma Zeta Chapter of Sigma Gamma Epsilon (and GSA student members) Kelly Milner and James McCombs know from the reference section of their handmade sand grain sizing folders that this is a boulder. For it to be a cobble, it would need to be between 64 and 256 mm in diameter.

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Positions Open

GEOLOGICAL REMOTE SENSING OR STRUCTURAL GEOLOGY/TECTONICS SOUTHERN ILLINOIS UNIVERSITY CARBONDALE

The Department of Geology at Southern Illinois University Carbondale invites applications for a tenure-track position in geological remote sensing or structural geology/tectonics at the assistant professor level, starting either Jan. 1, 2002, or Aug. 16, 2002. Please visit our Web site http://www.science.siu.edu/geology/position.html for more information. SIUC is an AA/EOE.

CERTIFIED ENGINEERING GEOLOGIST

Growing SW Riverside County, Calif. A geotechnical engineering firm seeks a CEG who is growth oriented and possesses management ability with demonstrated teambuilding, motivation, communication and organization skills. Competitive compensation package commensurate with experience. Submit resume to: H.R., P.O. Box 95, Temecula, CA 92593, fax 909-296-2237, e-mail laura@engencorp.com.

SENIOR GEOLOGIST UTAH GEOLOGICAL SURVEY

The Utah Geological Survey (UGS) is seeking applications for a senior geologist (remote sensing/geologic information coordinator) to provide leadership within the UGS on the applications of new technologies for collecting, interpreting, and distributing geological information and to conduct senior-level geological research. Duties include: assisting the implementation of technologies in remote sensing, GIS, and Web-based applications including Internet map server enhancements for geologic information; representing the UGS in collaborative initiatives with government agencies and the general public; obtaining grants and contracts, and, where appropriate, taking the role of principal investigator in special projects involving senior-level geological research, particularly in remote sensing applications; and overseeing GIS database development and archiving. The successful applicant will report to the manager of the Geologic Information and Outreach Program, and will advise and assist staff in the Energy and Minerals, Geologic Hazards, Geologic Mapping, and Environmental Science geologic programs. Preference will be given to applicants with an M.S. or Ph.D. in earth sciences, with at least 5 years experience in the geologic application of remote sensing, GIS, and Web-based information technologies. A track record in winning funding from government agencies is preferred. Salary range: $37,627–$56,534, with a generous benefits package.

The state of Utah's Department of Human Resources Management (DHRM) has implemented an automated recruitment and selection system. Resumes must be submitted to DHRM to be considered for employment at the UGS. Instructions for submitting resumes are on DHRM's home page, www.dhrm.state.ut.us. Resumes will be accepted until August 31, 2001. To be considered for this position, contact the Department of Natural Resources' human resource office, (801) 538-7210.

Utah Geological Survey, Box 146100, Salt Lake City, Utah 84114-6100. Phone: (801) 537-3305. Home page: www.ugs.state.ut.us. The state of Utah is an equal opportunity employer.

ASSISTANT PROFESSOR UNIVERSITY OF CALIFORNIA, SANTA BARBARA

University of California, Santa Barbara, Department of Geography, invites applications for a tenure-track position at the assistant professor level in Terrestrial Biophysical Processes. A Ph.D. is required by July 1, 2002. The successful applicant shall have research and teaching interests in the interaction between biological and physical-geographical processes at local to regional spatial scales, and in quantitative spatial modeling. Expertise in remote sensing and numerical modeling are highly desirable. Relevant areas include atmosphere-biosphere interactions, regional vegetation dynamics, and biogeochemical cycles. The department has strengths in three systematic areas: (1) modeling, measurement, and computation; (2) human-environment relations; and (3) earth system science. This position is primarily associated with earth system science and systematic area 1, but interests in one or both of the other systematic areas are also expected. The department has a strong commitment to multidisciplinary research and teaching and provides opportunities for interactions with other departments and research units on the campus. The application deadline is October 1, 2001, and the starting date is July 1, 2002. Qualified applicants should mail a complete curriculum vitae, a statement of research and teaching interests, and the names of at least three referees to: Oliver Chadwick, Search Committee Chair, Department of Geography, University of California, Santa Barbara, CA 93106-4060; fax 805-893-3146; e-mail oac@geog.ucsb.edu. To learn more about the department, visit our Web site at www.geog.ucsb.edu. University of California is an Equal Opportunity/Affirmative Action Employer.

HYDROLOGIST NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

New Mexico Tech invites applications for a tenure-track research position in hydrology with the New Mexico Bureau of Geology and Mineral Resources (NMBGMR). This position, located in Carlsbad, New Mexico, will be associated with the National Cave and Karst Research Institute. The position will also involve water resource studies in southern and eastern New Mexico, including the Roswell Basin and the Ogallala aquifer. The bureau, a research and service division of New Mexico Tech, is located in Socorro, New Mexico, and functions as the state geological survey with a staff of 38 earth science professionals. Applicants must have an M.S. with a minimum of 5 years experience or a Ph.D. in hydrology, hydrogeology, geology, or a closely related field, and a demonstrated record of innovative and original research emphasizing field-scale hydrogeology. Academic and practical experience in hydrology or closely related field required. Proficiency in descriptive and quantitative groundwater hydrology, including use of computer models required. Desirable qualifications include a strong geological background, experience in the collection, interpretation, and quantitative analysis of hydrologic data from karst systems, and the application of environmental tracers. The successful candidate will work closely with geologists and hydrogeologists at NMBGMR and state water resource agencies integrating hydrologic, geochemical, and geologic information into

The **U. S. Nuclear Regulatory Commission** is offering the following challenging employment opportunity for a highly motivated senior level professional to become an integral part of our **Rockville, MD** - based team:

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How to Apply

For more information and an application, visit our website at: **www.nrc.gov**, or call the **Office of Human Resources at: (301) 415-7400 or (301) 415-1534** and refer to Vacancy Announcement **# SL01009** when responding. Please send your resume and salary history, SF-171 or OF-612, and statement addressing rating factors, as soon as possible, but no later than **8/31/01**, to: **U.S. Nuclear Regulatory Commission, Office of Human Resources, Attn: Johanna Gallagher, MS: O-3 E 17A, Dept. A-2205, Washington, DC 20555, or e-mail to: jpg2@nrc.gov.** EOE. U.S. Citizenship Required.

U.S. NUCLEAR REGULATORY COMMISSION

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS DHAHRAN, SAUDI ARABIA

College of Sciences
Earth Sciences Department

The Department of Earth Sciences at King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia invites applications for a faculty position at a professor rank in the field of Environmental and Engineering Geology. This position requires someone who is experienced in all aspects of environmental investigations and assessments. Areas of particular interest are interaction of humans with the geologic environment, waste and pollution management, assessing geological hazards and risks, toxic substance control and land use management. Additional requirements are a Ph.D. degree in Environmental Geology / Engineering Geology and at least ten years of industry experience. The successful candidate must be innovative and have the vision and ability to apply advanced scientific and computer techniques to environmental and geological engineering problems. Teaching at the undergraduate and graduate levels and maintaining a strong research program will be expected of the successful candidates.

Salary/Benefits: Two year renewable contract. Competitive salaries based on qualifications and experience. Free furnished air-conditioned on-campus housing unit with free essential utilities and maintenance. The appointment includes the following benefits according to the University's policy: air ticket to Dammam on appointment; annual repatriation air tickets for up to four persons; assistance with local tuition fees for school-age dependent children; local transportation allowance; two months paid summer leave; end-of-service gratuity. KFUPM campus has a range of facilities including a medical and dental clinic, an extensive library, computing, research and teaching laboratory facilities and a recreation center.

To apply: Mail, fax or e-mail cover letter and detailed resume to:

Dean, Faculty & Personnel Affairs
KFUPM, DEPT. ES-2103
Dhahran, 31261, Saudi Arabia
Fax: 966-3-860-2429 E-Mail: faculty@kfupm.edu.sa or
es.chairman@kfupm.edu.sa

Please visit our website address: http://www.kfupm.edu.sa

quantitative models, and will also have the opportunity to interact with New Mexico Tech's nationally recognized hydrology program. Interested applicants should submit a cover letter that specifically addresses academic background and experience with regard to the required and desirable qualifications, a full resume, transcripts, and contact information for three professional references (address, e-mail, and phone), to New Mexico Institute of Mining and Technology, 801 Leroy Pl., Human Resources, Wells Hall Box 60C, Socorro, NM 87801. Incomplete applications will not be considered. For full consideration, application deadline is August 31, 2001, but will remain open until the position is filled. Visit NMBGMR and New Mexico Tech's Web pages at http://geoinfo.nmt.edu and http://www.nmt.edu. E-mail applications NOT accepted. EOEAA.

GEORGE AND ORPHA GIBSON PROFESSORSHIP IN HYDROGEOLOGY AND STUDIES OF GEOFLUIDS

The University of Minnesota Department of Geology and Geophysics invites applications for a faculty position in hydrogeology-geofluids studies. The appointment will be made at the assistant professor or higher level with faculty rank and tenure status dependent on the qualifications of the candidate. Salary will be commensurate with rank and experience. This position will carry the title George and Orpha Gibson Professorship and will be accompanied by considerable resources from the Gibson Endowment for an initial 6-year term, with potential renewal thereafter.

The candidate's interest in the broad aspects of geofluids should serve as background for more specialized research and scholarly activities. Examples of areas of interest include quantitative and computational hydrogeology, scale-dependent heterogeneous flow, continental and oceanic geofluids, basin-scale fluid flow, interactions between crustal fluids and tectonics, hydrothermal systems, surface hydrology, subsurface fluid mechanics, isotope hydrology and hydrogeochemistry, atmosphere-surface water-groundwater interactions, interaction between hydrogeology and geobiology, and the impact of climate change on geofluids systems.

The appointee will develop a vigorous research program, attract external funding, and contribute to the instructional and research efforts of the School of Earth Sciences. The school includes the Department of Geology and Geophysics, the Institute of Rock Magnetism, the Limnological Research Center, and the Minnesota Geological Survey. The potential of this position is enhanced by access to the Minnesota Supercomputer Institute facilities, the inter–disciplinary program in environmental and geophysical fluid dynamics at St. Anthony Falls Hydraulic Laboratory, and the interdisciplinary Water Resources graduate program.

The minimum requirement is a Ph.D. degree earned by the time the appointment is made. The review of completed applications will begin on September 30, 2001, and continue until an appointment is made. Application requirements are: (1) curriculum vitae, (2) complete list of publications, (3) statement of research interests, (4) statement of teaching interests, and (5) names of at least 4 referees. Send application to Gibson Search Committee Chair, Department of Geology and Geophysics, University of Minnesota, 310 Pillsbury Drive S.E., Minneapolis, MN 55455 USA. For further information, phone (612) 624-1333 or fax (612) 625-3819.

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

LIMNOGEOLOGIST UNIVERSITY OF MINNESOTA—TWIN CITIES

The Department of Geology and Geophysics at the Winchell School of Earth Sciences, University of Minnesota—Twin Cities, invites applications for a tenure-track assistant professor, tenure-track/tenured associate professor, or tenured full professor position from outstanding researchers with a proven track record to help focus the department's interdisciplinary efforts in paleolimnology and global environmental change. We seek a candidate who is rigorously trained in current earth science research techniques utilizing lake sediment archives to reconstruct global climatic and environmental changes. The successful applicant is expected to participate fully in the department's undergraduate and graduate course offerings. The choice of courses is flexible and will take into consideration the applicant's as well as existing faculty's specialties. The successful applicant will greatly benefit from the Limnological Research Center which includes "LacCore," an NSF-funded national repository of lake sediment cores, a multi-disciplinary analytical core laboratory modeled after integrated ocean sediment research facilities, and operating core systems for small and large coring expeditions. Existing faculty in geology and geophysics and affiliated units provide excellent opportunities for cooperative research in related disciplines such as sedimentology, paleontology, geochemistry, and sediment magnetism. Interested applicants are invited to visit our Web site (http://www.geo.umn.edu/). At the Twin Cities campus, the Winchell School of Earth Sciences also includes the Institute for Rock Magnetism and the Minnesota Geological Survey. The College of Biological Sciences includes the Department of Ecology and Behavioral Biology, and other departments with strong research programs linked to geologic studies. The Graduate School administers the Large Lakes Observatory on the Duluth campus, which is actively involved in chemical, physical and biological studies of lake systems.

Applicants are expected to have a Ph.D. at the time of appointment. To apply, send a curriculum vitae, statements of teaching and research interests, and names, addresses, telephone numbers, and e-mail addresses of five references to Chair, Limnogeologist Search Committee, University of Minnesota, Department of Geology and Geophysics, 310 Pillsbury Dr. S.E., Minneapolis, MN 55455. Review of files will begin on October 1, 2001. Applications will be accepted until the position is filled. The start date is expected to be fall 2002. Questions may be addressed by e-mail to Professor W.E. Seyfried, Head of Winchell School of Earth Sciences at wes@umn.edu.

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

UNIVERSITY OF UTAH SEDIMENTARY GEOLOGY

The Department of Geology and Geophysics at the University of Utah invites applications for a tenure-track faculty position in sedimentary geology at the assistant professor level, beginning as early as July 2002. Candidates must have a Ph.D. with a strong record of research. We especially encourage applications from individuals who will integrate traditional disciplines of sedimentary geology with innovative and quantitative approaches to understanding the dynamics of sedimentary systems and/or basin evolution. These approaches may include field-based investigations of sedimentary sequences, lab-based analyses of sedimentary rocks, sequence stratigraphy, spatial analysis (GIS), geostatistics, numerical modeling, geochemical modeling, and reservoir characterization. The successful candidate will be expected to develop and teach pertinent courses at the undergraduate and graduate level and to participate in supervision of graduate students.

Review of applications will begin immediately and will continue until the position is filled. Applicants should submit a letter of interest, curriculum vitae, and names of at least three professional references to: Sedimentary Geology Search Committee Chair, Department of Geology and Geophysics, University of Utah, 135 South 1460 East, Rm. 717, Salt Lake City, UT 84112-0111; phone: (801) 581-7162; fax: 801-581-7065.

Information about the department may be found at http://www.mines.utah.edu/geo. The University of Utah is an Equal Opportunity/Affirmative Action employer and encourages applications from women and minorities and provides reasonable accommodation to the known disabilities of applicants and employees.

MACALESTER COLLEGE
SURFICIAL GEOLOGY/GEOMORPHOLOGY

The Geology Department of Macalester College invites applications for a tenure-track position with specialization in "surficial geology." The successful candidate will be a broadly trained earth scientist with research and teaching interests in geomorphology, environmental geology, glacial geology, geoarcheology, or a related field. Teaching responsibilities (2 courses with labs per semester) will include physical or historical geology, environmental geology, geomorphology, and other advanced courses that reflect the candidate's expertise. The successful candidate will maintain an active research program that includes undergraduates. The position requires a Ph.D. and is at the rank of assistant professor. The department currently consists of three tenure-track faculty with backgrounds in structural geology, igneous petrology and geochemistry, sedimentology and stratigraphy, and paleontology. On average, the department graduates 5–10 majors/year (roughly equal numbers of men and women). Students are encouraged to complete honors and summer research projects. The department is housed in a new science complex, and has extensive research facilities (XRD, XRF, SEM-EDS, TEM, INAA, clean lab, a computer lab, and rock and sample preparation). The college and the department are committed to academic excellence, internationalism, and student-faculty collaboration. Additional information can be found on the departmental Web page (http://www.macalester.edu/~geology).

Applicants should send a cover letter describing teaching and research interests, curriculum vitae, and three letters of recommendation to John Craddock, Chair, Geology Department, Macalester College, 1600 Grand Avenue, St. Paul, MN 55105. Application materials must be received by September 15, 2001. Members of the department will be at the national GSA meeting in Boston and will interview selected candidates. Macalester College is a selective, private liberal arts college in the vibrant Minneapolis-St. Paul metropolitan area. Macalester enrolls 1,800 students from 48 states and more than 70 foreign countries and has a long-standing commitment to maintaining a multi-national, multi-ethnic community. Macalester is an Equal Opportunity employer that is committed to having a diverse workforce. The college prides itself on sustaining a strong commitment to excellence in teaching and providing support for faculty scholarship. Successful candidates will be expected to pursue rich research programs as well as to provide support, as appropriate, to the college's emphases on multiculturalism, internationalism, and service, all in a context of excellence in undergraduate education.

PALEONTOLOGY
UNIVERSITY OF CALIFORNIA, SANTA BARBARA

The Department of Geological Sciences invites applications for a tenure-track position in paleontology at the assistant professor level, for an appointment to begin July 1, 2002. We seek a broadly trained scientist who uses data from the fossil record to explore the links between earth processes and the evolution of life. This includes—but is not limited to—employing fossils to address geologic, paleogeographic, paleoevironmental, and/or macro-evolutionary questions. Preference will be given to those working on multicellular organisms and complementing departmental strengths in paleobiology, paleoclimatology, and paleoceanography. The successful applicant is expected to maintain a vigorous research program and to be strongly committed to undergraduate and graduate education. A Ph.D. is required at the time of appointment. Submit resume, statement of research and teaching interests, and names of three references before November 1, 2001.

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André Wyss, Search Committee Chair, Department of Geological Sciences, University of California, Santa Barbara, CA 93106-9630.

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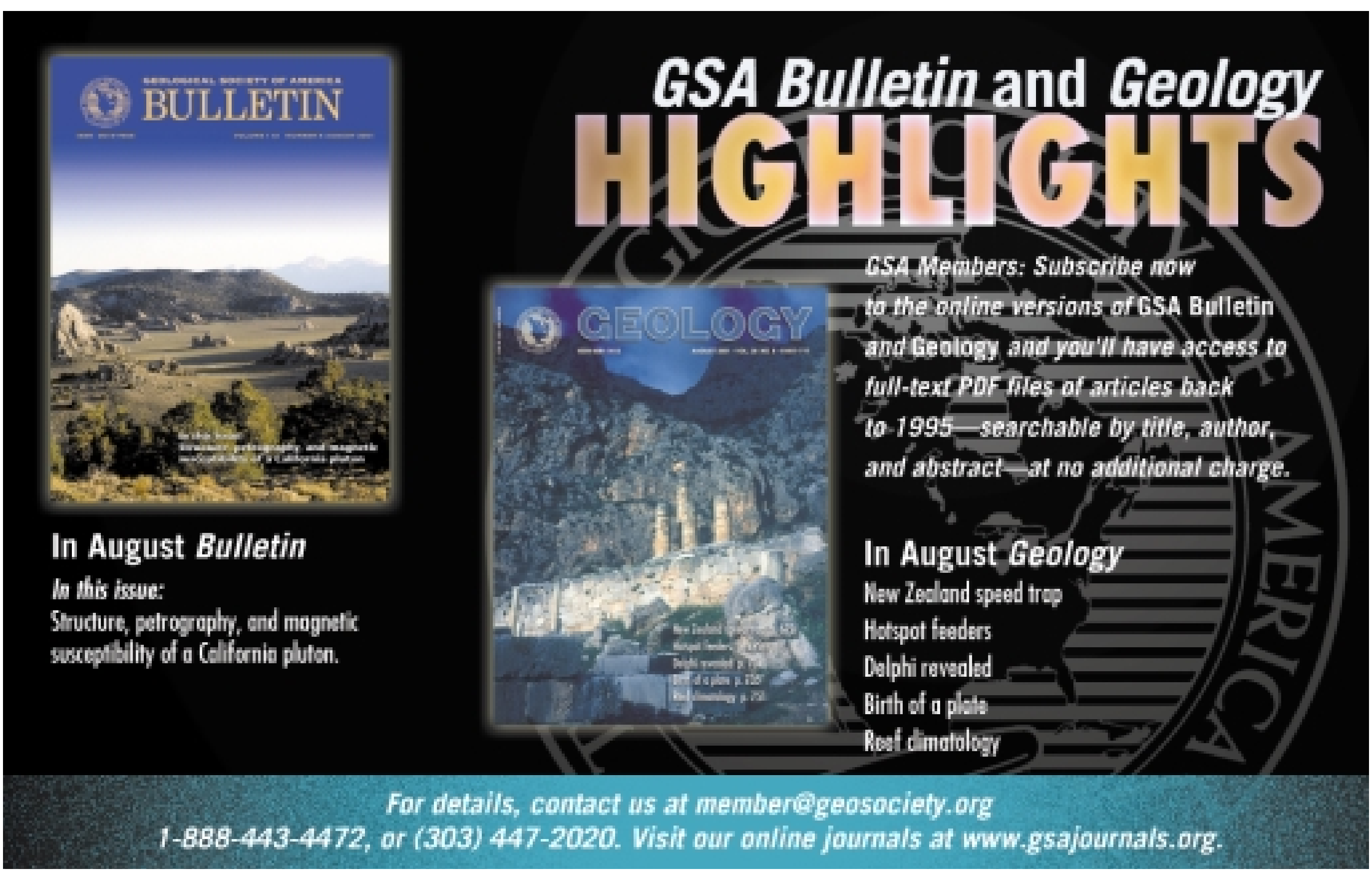

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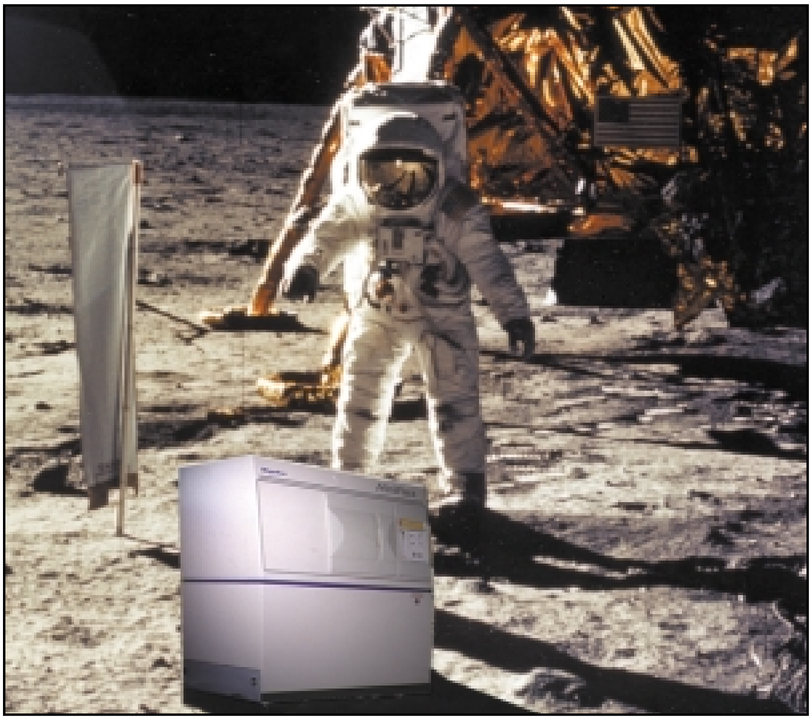

PORTABLE X-RAY DIFFRACTION THAT'S OUT OF THIS WORLD!

Why send samples to a remote laboratory when analysis is needed now. Whether it's on a drilling platform or a laboratory desktop, Rigaku's Miniflex™ lets you identify compounds immediately and locally. No expertise on site? Rigaku's software makes identification easy for novices. Difficult problems? Data can be e-mailed to your off-site analytical laboratory. No analytical laboratory? Let Rigaku's contract services help.

The Miniflex™ is made for rugged environments. Miniflex's™ are found at mine sites, in pick-up trucks for mobility, glove-boxes for isolation and undergraduate laboratories. The low cooling requirements and 110V operation makes it ideal for portable power units. The cost-to-performance ratio is outstanding. Tight coupling of the x-ray source and detector provide amazing intensity at low power. This extremely compact system even gives excellent low angle performance for clay samples.

Rigaku's Miniflex™ was not available for the Apollo program which sampled 6 lunar sites or the un-manned Soviet Luna program which sampled 3 sites, but maybe next time.

For more information contact:

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